NORTHMET PROJECT, MINNESOTA
PRE-FEASIBILITY STUDY

VOLUME 1
PROJECT SUMMARY

Prepared for

PolyMet Mining Corporation

Prepared by

INDEPENDENT
MINING CONSULTANTS, INC.

TUCSON, ARIZONA

April 2001

1.0 EXECUTIVE SUMMARY

1.1 GENERAL

This study evaluates the potential exploitation of the NorthMet polymetallic deposit by open pit methods and the production of the following saleable products using a hydrometallurgical process:

- copper metal,
- nickel metal,
- a precipitate of combined palladium, platinum and gold,
- a cobalt precipitate, and
- a zinc precipitate.

1.2 LOCATION AND INFRASTRUCTURE

The NorthMet Project is located in St. Louis County in northeastern Minnesota (47°36' north latitude and 91°58' west longitude), about 70 miles north of Duluth and 10 miles south of the town of Babbitt (Figure 1-1). The deposit is hosted in the Partridge River Intrusion of the Duluth Gabbro. The project lies along the eastern portion of the Mesabi Iron Range and is directly south of the Northshore open pit iron ore mine.

The NorthMet Project site lies at an elevation of around 1600 feet above mean sea level. The terrain is flat with some low rolling hills. Much of the terrain has relatively poor drainage and is covered with forest and swamp. Wetlands have been identified for about 70% of the area that will be covered by the open pit and overburden dumps. The forest species include white, red and jack pine, spruce, fir, aspen and birch. The majority of the trees are second growth.

The northern Minnesota climate is continental, characterized by wide variations in temperature. The temperature in Babbitt (10 miles north of NorthMet) averages 4° F in January and 66° F in July. The average annual precipitation is about 28 inches with about

30% during the months of November through April and 70% from May through October. Average annual snowfall is 60 inches with 2 to 3 feet of snow on the ground at any one time during the winter. The open pit mines in the area operate year-round with minor additional costs incurred due to snow.

Figure 1-1 NorthMet Project Location

Access to the property is via paved state and local highways and on LTV Steel Mining Company all weather, gravel roads. Rail access is available on the property to ports on Lake Superior.

The infrastructure related to mining is excellent. Available to the project are low-cost power, well-developed railway networks, and supply-equipment centers that support the currently operating iron ore mines. There is a local supply of skilled labor, as well as professional mining expertise.

1.3 LAND STATUS

In 1989, PolyMet (as Fleck Resources) acquired a twenty-year renewable lease for the mineral rights to the NorthMet deposit from U.S. Steel (USX). The lease is subject to yearly lease payments before production and then to 3 to 5 % sliding scale Net Smelter Return royalty based on the value of the ore. The lease payments prior to production are considered advance royalties and will be credited to the production royalty.

The mineral and surface rights have been severed. The United States Forest Service (USFS) acquired the surface rights to the NorthMet property from USX in the 1930's and at present, the USFS remains the surface owner of most of the NorthMet property. USX retained the mineral rights and the right to explore and mine on the site. As a result of this retention, while the USFS is the surface owner for most of the NorthMet property, it cannot prohibit mining on the site and will likely have a limited capacity for decision making relative to site activities. Other surface rights owners of land that will be impacted by the project include LTV Steel Mining Company/Erie Mining Company, the State of Minnesota, and St. Louis County (tax-forfeited land), and other small land owners. There are land issues that require research for the final feasibility study.

PolyMet has approached the USFS with the idea of acquiring the NorthMet surface rights through a land swap. This would simplify the permitting process and give access to land for waste dumps, tailings storage, and plant and office facilities. The USFS has expressed its willingness to do so.

The total amount of property required for the project is estimated at 7430 acres.

1.4 GEOLOGY AND MINING

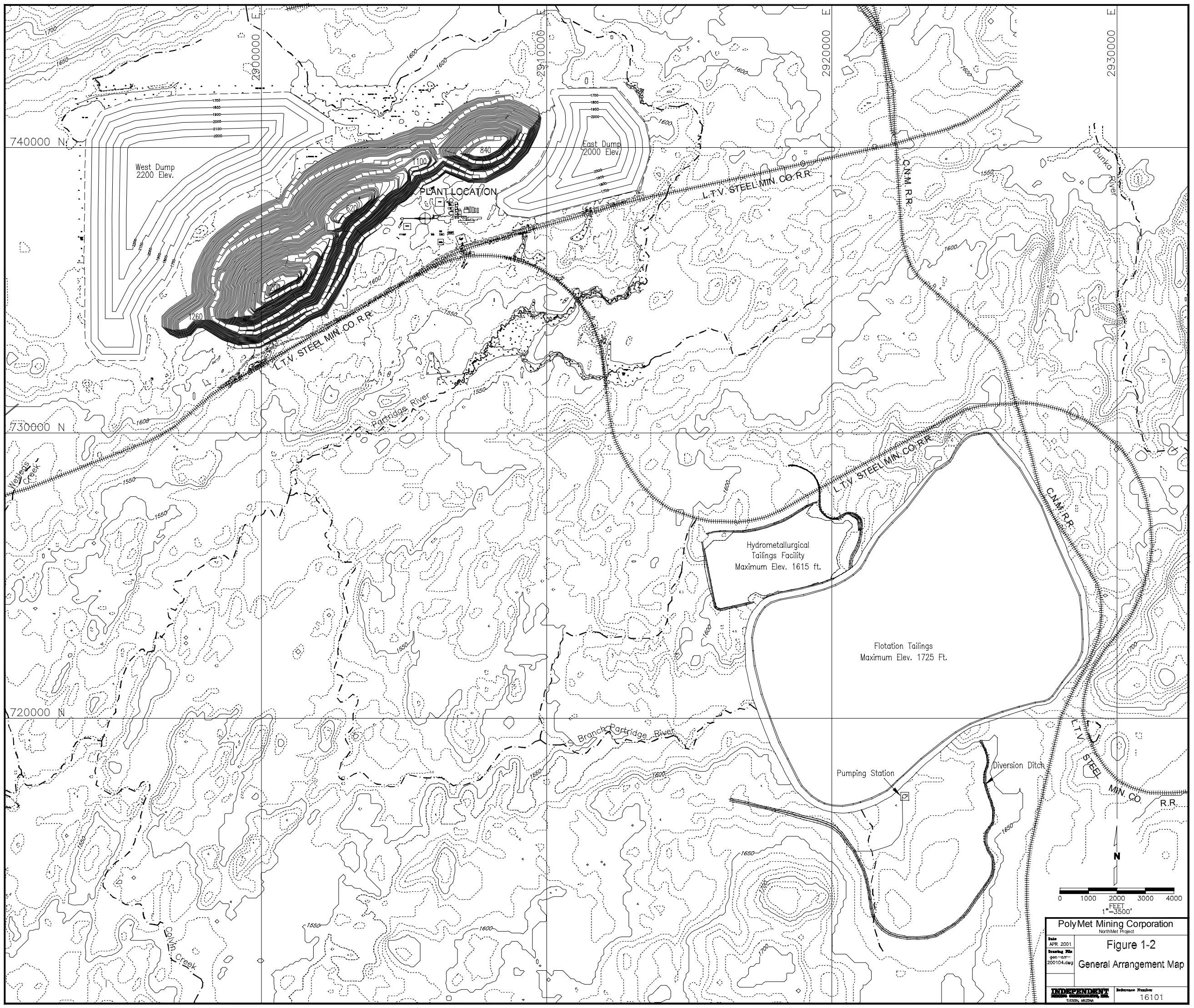
A block model of the NorthMet deposit was developed by Independent Mining Consultants, Inc. (IMC) based on the geologic interpretation and drillhole data provided by PolyMet personnel.

IMC also developed a mine plan for the project to supply ore to the flotation concentrator and pressure oxidation processing facility at the rate of 20,075 ktons (1000 US short tons) per year (about 55,000 tons per day for 365 days per year). Peak total material movements of about 100,000 ktons per year are required to achieve the ore production.

The potential mineable resources for the project are 486,832 ktons of ore. The average metal grades are 0.301% copper, 0.083% nickel, 66.2 ppm cobalt, 0.287 ppm palladium, 0.084 ppm platinum, and 0.042 ppm gold. The project life, based on the above potential mineable resource, is just over 24 years.

Figure 1-2 shows the site layout map as of the end of the project. The pit, waste dumps, and tailings facilities are shown on the maps. The plant is shown just south of the pit.

The tailings facilities will comprise two separate facilities: a large facility for the storage of the flotation tailings (about 380 million yd^3), and a relatively smaller facility for the storage of the hydrometallurgical tailings (about 6.7 million yd^3).



West Dump
2200 Elev.
East Dump
2000 Elev.
PLANT LOCATION
L.T.V. STEEL MIN. CO. R.R.
C.N.M. R.R.
Partridge River
Dunka River
Wyman Creek
Colvin Creek
Branch Partridge River
Hydrometallurgical
Tailings Facility
Maximum Elev. 1615 ft.
Flotation Tailings
Maximum Elev. 1725 Ft.
Pumping Station
Diversion Ditch
L.T.V. STEEL MIN. CO. R.R.
740000 N
730000 N
720000 N
2900000 E
2910000 E
2920000 E
2930000 E
N
0 1000 2000 3000 4000
FEET
1"=3500'
PolyMet Mining Corporation
NorthMet Project
Figure 1-2
General Arrangement Map
APR 2001
16101

1.5 METALLURGY AND PROCESSING

PolyMet has undertaken an extensive metallurgical development program over the past two years. The objective of that program was to develop an economical process for the NorthMet deposit. This meant that the gold and PGM values would have to be recovered in addition to copper, nickel and cobalt.

Two flotation pilot plant campaigns were run at Lakefield Research to provide a bulk concentrate sample for the hydrometallurgical (Hydromet) testing and pilot plant.

PolyMet's objective was achieved. A new process was developed, now called the PlatSol™ Process, that yielded base metal extraction percentages in the high 90's, PGM extraction percentages of 95% and gold extraction near 90%. The feature of the process is the addition of a small amount of chloride to the high temperature pressure oxidation step, with the result that the precious metals dissolve in the autoclave along with the base metals. The PlatSol™ process is shown schematically in Figure 1-3.

The PGM's and gold are then recovered as a saleable PGM concentrate by selective precipitation with sodium hydrosulfide. Copper and nickel are recovered by solvent extraction and electrowinning, while a small quantity of cobalt is recovered as a sulfide precipitate.

The main continuous Hydromet pilot plant campaign run in July 2000 was successful. A 10 day continuous run gave the extractions shown in Table 1-1, which summarises the overall flotation and process recoveries for the project.

Recoveries of the economically significant metals were enhanced by provision of additional flotation residence time during the latter part of the flotation pilot plant. This has allowed the use of the average flotation recoveries for project recoveries over the life of the mine.

Table 1-1: Summary of Process Recoveries						
	Cu	**Ni**	**Co**	**Pd**	**Pt**	**Au**
Head Grade	0.303%	0.083%	0.0066%	0.289g/t	0.084g/t	0.042g/t
Recovery to Concentrate	93.7%	69.0%	42.0%	79.6%	76.9%	75.7%
Pressure Leach Extraction	99.6%	98.9%	96.0%	94.6%	96.0%	89.4%
Recovery from Leach Solution	98.6%	98.0%	95.9%	99.0%	99.0%	99.0%
Overall Recovery	91.9%	66.9%	38.6%	74.6%	73.1%	67.0%

The facilities to process the ore were designed by AMEC Simons Mining and Metals. The facilities designed by AMEC include the following:

The new facilities addressed in the AMEC report and cost estimate are generally as follows:

- Mine fuel storage and distribution, blasting materials storage facilities (requirements provided by IMC)
- Mine truck shop, maintenance facilities and warehousing (requirements provided by IMC)
- Mine engineering and operations facilities (requirements provided by IMC)
- Process facility maintenance and warehousing
- Sample preparation/assay laboratory facility
- Administration building and guard shack
- Primary gyratory crushing station, crushed ore stockpile and conveying
- Semi-autogenous (SAG) and ball mill grinding and classification
- Polymetallic flotation, regrinding, concentrate cleaning, thickening and storage
- Flotation tailings disposal system from mill to a tailings impoundment area. Reclaimed water system for re-use in the mill is also provided.
- Pressure leaching of concentrate followed by solids/liquid separation of pressure leach residue and polish filtration of pregnant leach solution
- Precious and platinum group metal precipitation, followed by precipitate re-leach (base metal removal), filtration and drying to produce a precious/PGM concentrate for sale
- Neutralization of leach solution, followed by filtration of gypsum
- Copper solvent extraction and electrowinning facilities to produce LME Grade A copper cathode for sale
- Recycle of SX raffinate to the autoclave leach circuit to provide cooling water and a recycle of copper and precious metals in remaining in solution

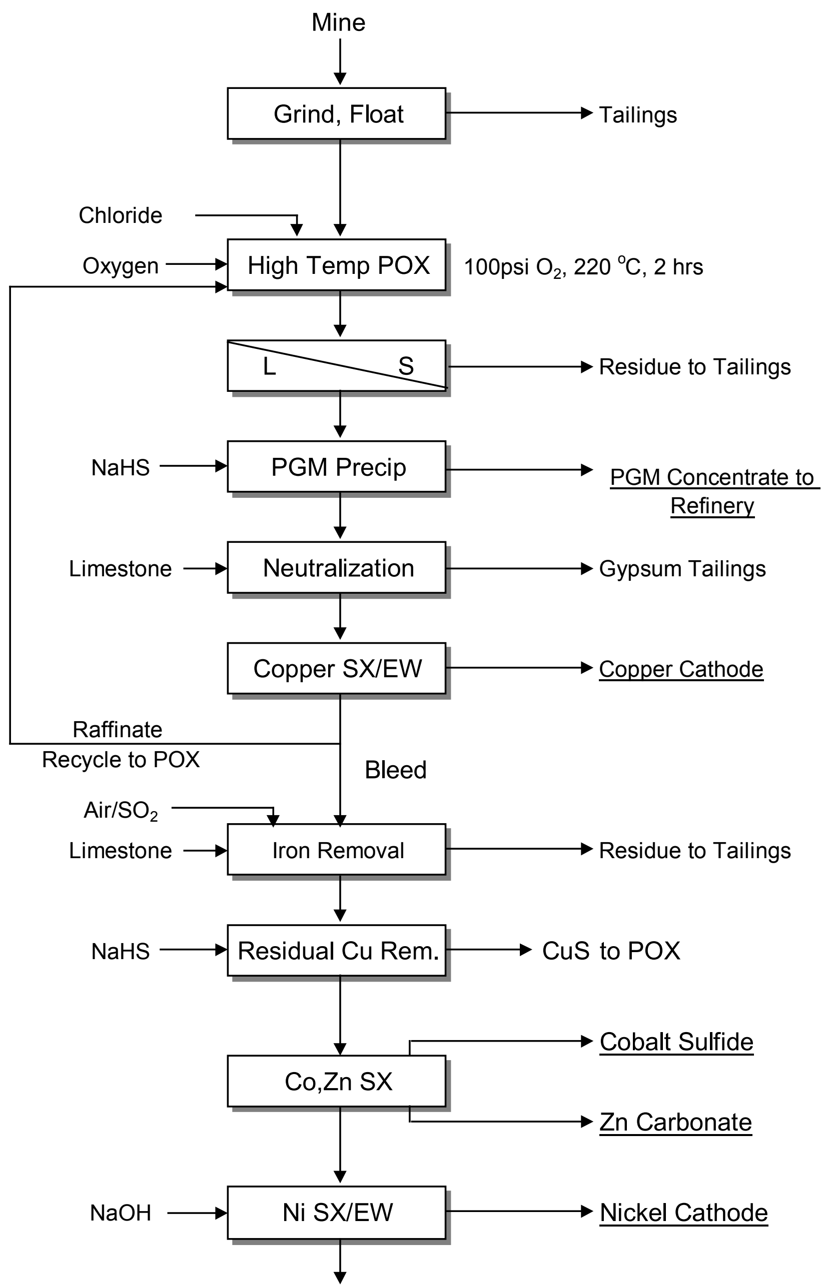
- Neutralization treatment of the raffinate bleed to remove iron and aluminum, followed by filtration of neutralization solids
- Cobalt and zinc recovery using solvent extraction and preferential stripping
- Cobalt precipitation and zinc precipitation from strip solutions to produce cobalt sulfide and zinc hydroxide precipitates for sale
- Nickel solvent extraction and electrowinning to produce Class 1 nickel cathode for sale
- Hydrometallurgical tailing disposal (including all residue and neutralization solids and raffinate streams) from plant to a dedicated tailings impoundment area. Reclaimed water system for re-use in the hydrometallurgical process is also provided
- Fresh water supply and distribution system
- Electric power supply through the main substation, from the Minnesota Power provided high voltage transmission line, pit electrification, and 34 kV/13.8 kV/4.16kV primary distribution
- Process plant site sewage treatment facilities

The construction period is assumed to be 18 months.

Figure 1-3

Simplified Block Flow Diagram for Gold, PGM and Base Metal Recoveries from NorthMet Concentrates

PlatSol™ Process



1.6 CAPITAL COSTS

Table 1-2 summarizes the estimated capital costs for the NorthMet Project by the various cost categories. Initial capital (Years –2 through 1) for project start-up is $630.7 million. Sustaining capital for replacement of mining equipment is $185.6 million and occurs between years 2 and 21. Total capital over the project life is $816.3 million. This amounts to $1.693 per ore ton.

Table 1-2: Summary of Capital Costs ($US x 1000)

	Initial Capital					
Category	Year –2	Year –1	Year 1	Total Initial Capital	Years 2 to 21	Total
Mine Development	0	10,621	0	10,621	0	10,621
Mine Equipment	0	49,702	24,809	74,511	185,618	260,129
Plant/Infrastructure	174,370	261,554	0	435,924	0	435,924
Tailings Dam	0	24,296	0	24,296	0	24,296
Mine/Plant Buildings	3,866	5,800	0	9,666	0	9,666
Land Acquisition	3,715	3,715	0	7,430	0	7,430
Wetlands Mitigation	15,209	1,391	0	16,600	0	16,600
Owners Cost	4,378	5,280	0	9,658	0	9,658
Working Capital	0	0	42,000	42,000	0	42,000
TOTAL	201,538	362,359	66,809	630,706	185,618	816,324

All costs shown on Table 1-2 are in constant 1st quarter 2001 US dollars. They have not been escalated to the expected project start date. The plant/infrastructure and buildings capital cost includes a contingency of $74.5 million (about 20%). The tailings facilities include a contingency of $3.2 million (15%). Of the total plant construction capital, it is assumed for this study that about 40% will be spent in Year –2 and 60% in Year –1.

1.7 OPERATING COSTS

Table 1-3 summarizes the operating costs for the NorthMet Project by several cost categories. It can be seen that total operating costs over the life of the project amount to $4,321.1 million ($4.32 billion) or $8.962 per ore ton. This is based on a total ore production of 482,206 ktons over the life of the project and an annual ore production rate of 20,075 ktons per year. Total operating cost for a typical production year is $179.9 million. The average, onsite, direct operating costs (excluding royalty, refining, marketing and metal freight) is $8.333 per ore ton.

1-3: Summary of Operating Costs ($US x 1000)

Category	Total Cost ($US x 1000)	Cost Per Ore Ton	Typical Year ($US x 1000)
Mining	1,168,363	2.423	48,642
Crushing, Grinding, and Flotation	1,339,098	2.777	55,748
POX, Precipitation, SX, and EW	1,240,857	2.573	51,653
Tailings Embankment	118,460	0.246	4,938
General and Administrative	141,817	0.294	5,904
Wetlands Mitigation	9,514	0.020	396
US Steel Royalty	154,183	0.320	6,419
Refining, Marketing, and Metal Freight	148,769	0.309	6,203
TOTAL	4,321,061	8.962	179,903

The costs shown are all stated in 1st quarter 2001 US dollars. The costs are not escalated to the expected start of the project, nor are they adjusted for anticipated inflation during the life of the project.

Operating costs per unit of metal were calculated. The approach used for the calculation was to prorate all shared costs to the various metals according to the metals percent contribution to revenue (gross revenue less marketing, sales, and off-site refining costs). Table 1-4 summarizes the operating costs by metal.

Table 1-4: Summary of Operating Costs Per Unit Payable Metal				
Metal	Payable Units	Operating Costs ($x1000)	Percent of Total	Unit Cost ($US)
Copper (lbs x 1000)	2,680,718	1,521,688	35.2%	0.568 / lb
Nickel (lbs x 1000)	534,204	1,430,872	33.1%	2.679 / lb
Cobalt (lbs x 1000)	24,356	139,182	3.2%	5.715 / lb
Palladium (oz x 1000)	3,027.9	928,318	21.5%	306.6 / oz
Platinum (oz x 1000)	868.0	240,694	5.6%	277.3 / oz
Gold (oz x 1000)	395.7	60,305	1.4%	152.4 / oz
TOTAL		4,321,059	100.0%	

1.8 FINANCIAL ANALYSIS

1.8.1 Payable Metal and Base Case Commodity Prices

The economic evaluation of the NorthMet Project was performed on an annual cash flow basis using a conventional pro-forma income statement format. These cash flow analyses represent economic quantification of the various project parameters that directly or indirectly impact the economic viability of the project.

Table 1-5 summarizes the base case metal prices used for the economic analyses. The table also shows the quantity of payable metal and the gross revenue from each for the project life.

Table 1-5: Summary of Payable Metal and Base Case Commodity Prices			
Metal	Payable Quantity	Base Case Price	Gross Revenue
Copper	2,680,718 klbs	$0.85	$2,278.6 Million
Nickel	534,204 klbs	$3.25	$1,736.2 Million
Cobalt	24,356 klbs	$8.00	$194.8 Million
Palladium	3,027.9 koz	$550	$1,665.3 Million
Platinum	868.0 koz	$500	$434.0 Million
Gold	395.7 koz	$275	$108.8 Million
Credit for Silver, Zinc, and Other PGM's at $0.30 Per Ore Ton			$144.7 Million
TOTAL GROSS REVENUE			$6,562.4 Million

1.8.2 Basic Assumptions

Discounted net annual cashflow analyses were calculated in accordance with some fundamental assumptions. These basic assumptions pertaining to the economic analyses of the NorthMet Project follow:

- NorthMet is an operating unit contained within a corporate structure that consists of other profitable operations. As such, wherever possible, expenditures are expensed rather than capitalized or amortized. Preproduction development expenditures are an exception.
- NorthMet is evaluated on a 100% equity basis.
- Economic analyses are in 1st quarter 2001 constant U.S. dollars. Inflation is not incorporated into the analyses, nor are costs escalated to the expected project start date.
- State taxes are calculated using current State of Minnesota tax code for domestic mining operations.
- Federal taxes are calculated using U.S. Federal tax code for domestic mining operations.
- Project years designated -2 and -1 in the cashflow analyses represent the project construction period immediately following the record of decision to proceed with project development and subsequent mine production.

- All expenditures prior to the record of decision to proceed with mine development are considered "sunk costs" and are reflected in the cashflow calculations only to the extent of their tax implications.

- A discount rate of 10% is utilized in calculating investment decision parameters.

1.8.3 Before-Tax Financial Results

Both before-tax and after-tax cash flow analyses were calculated for the NorthMet Project. Only the before-tax results are presented in this summary. For after-tax results refer to Section 16.2 of this report. Table 1-6 presents the pertinent before-tax results normally of interest to the financial community.

Table 1-6: Financial Results for Before-Tax Cashflow Analysis	
Net Present Value @ 10% Discount Rate	$171.1 Million
Internal Rate of Return (IRR)	14.09%
Payback Period (Undiscounted) from Beginning of Commercial Production	5.4 Years

1.8.4 Before-Tax Sensitivity Analyses

To ascertain the impact on project economics resulting from changes in key project variables, a simplified project sensitivity analysis was performed. It was decided to measure the sensitivity of overall project economics to changes from the base case estimates for three key variables: 1) commodity prices, 2) capital costs, and 3) operating costs.

For each variable, plus and minus 10% of the base case value was used for the sensitivity analyses. Tables 1-7, 1-8, and 1-9 show the results of before-tax sensitivity analyses on the Net Present Value at 10%, the Internal Rate of Return (IRR), and Payback Period, respectively. The minus 10%, base case, and plus 10% values for the various parameters are also shown on the tables. For the commodity prices, the sensitivity analyses were done on each metal separately and for the three main metal variables simultaneously.

The financial results are most sensitive to the copper price, with the before-tax IRR ranging from 12.34% to 15.77%, though there was not a large amount of difference between the three metals. The response to changes to nickel and palladium prices are very similar (12.76% to 15.38% for nickel and 12.82% to 15.32% for palladium). Based on interpolations of the +/-10% results from the before-tax model, a 1% change in IRR requires a 5 cent change to the copper price, or a 25 cent change to the nickel price, or a $44 change to the palladium price.

The tables also indicate that the project is more sensitive to operating cost than capital cost. The sensitivity of the project to capital cost is similar to the sensitivity of the change in one of the key metal prices. The sensitivity of the project to the operating cost is similar to the sensitivity of all three metal prices simultaneously.

1.8.5 Additional Comments

The Minnesota Mining Tax Guide (October 2000 Version, page 56) states that Economic Development Incentives in the form of grants and loans are available from the State for new mine or processing facilities subject to the net proceeds tax. The maximum amount available for a new project is $65 million. These possible incentives have not been included in the above economic analyses.

The intent of the Pre-Feasibility Study is to bring together all the information developed for the NorthMet Project into one study and supporting document. It is a base case analysis from which various project parameters can be further refined and optimized. One potential process flowsheet change that could provide a substantial economic benefit to the project would be the production of a nickel sulfide instead of nickel metal as the saleable product. This could reduce both the process plant operating and capital costs. Changes in other areas of the project could also provide economic benefits to the NorthMet Project.

Table 1-7: Sensitivity Analysis of Project Net Present Value ($ x 1000). Before-Tax Case.

Sensitivity Parameter	Parameter Values			NPV at 10%		
	-10%	Base Case	+10%	-10%	Base	+10%
Copper Price ($/lb)	0.765	0.85	0.935	95,613	171,081	246,548
Nickel Price ($/lb)	2.925	3.25	3.575	113,457	171,081	228,705
Palladium Price ($/oz)	495	550	605	116,262	171,081	225,899
Cu, Ni, Pd Price	0.77,2.93,495	0.85,3.25,550	0.94,3.58,605	-16,829	171,081	358,991
	+10%	Base Case	-10%	+10%	Base	-10%
Capital Cost ($ x 1000)	897,960	816,327	734,694	110,307	171,081	231,855
Operating Cost ($ x 1000)	4,753,165	4,321,059	3,888,953	27,641	171,081	314,562

Table 1-8: Sensitivity Analysis of Project IRR (%). Before-Tax Case.

Sensitivity Parameter	Parameter Values			DCFROI (%)		
	-10%	Base Case	+10%	-10%	Base	+10%
Copper Price ($/lb)	0.765	0.85	0.935	12.34%	14.09%	15.77%
Nickel Price ($/lb)	2.925	3.25	3.575	12.76%	14.09%	15.38%
Palladium Price ($/oz)	495	550	605	12.82%	14.09%	15.32%
Cu, Ni, Pd Price	0.77,2.93,495	0.85,3.25,550	0.94,3.58,605	9.57%	14.09%	18.19%
	+10%	Base Case	-10%	+10%	Base	-10%
Capital Cost ($ x 1000)	897,960	816,327	734,694	12.44%	14.09%	16.04%
Operating Cost ($ x 1000)	4,753,165	4,321,059	3,888,953	10.70%	14.09%	17.17%

Table 1-9: Sensitivity Analysis of Project Payback Period (Years). Before-Tax Case.

Sensitivity Parameter	Parameter Values			Payback Period		
	-10%	Base Case	+10%	-10%	Base	+10%
Copper Price ($/lb)	0.765	0.85	0.935	6.1	5.4	4.9
Nickel Price ($/lb)	2.925	3.25	3.575	6.0	5.4	5.0
Palladium Price ($/oz)	495	550	605	5.9	5.4	5.0
Cu, Ni, Pd Price	0.77,2.93,495	0.85,3.25,550	0.94,3.58,605	7.8	5.4	4.4
	+10%	Base Case	-10%	+10%	Base	-10%
Capital Cost ($ x 1000)	897,960	816,327	734,694	6.1	5.4	4.8
Operating Cost ($ x 1000)	4,753,165	4,321,059	3,888,953	6.6	5.4	4.7

1.9 PERMITTING AND ENVIRONMENT

The regulatory climate in northern Minnesota is quite favorable to mining due primarily to the long-term presence of large iron mines in the vicinity of the NorthMet Project. Although the NorthMet Project will be different from the iron mining operations, the regulatory agencies are familiar with mining and have indicated a willingness to work with operators to ensure timely permitting of new facilities. However, permitting of a new operation will require a substantial investment of both time and money. The estimated permitting time frame is 3 to 3.5 years at an estimated cost of $6 to $6.5 million.

The timetable for the NorthMet Project to move from pre-feasibility through permitting and construction to full operation is estimated to be six years. This estimate incorporates the 3 to 3.5 years for permitting and 1.5 years for plant construction.

1.10 DISCLAIMER

This report was prepared exclusively for PolyMet Mining Corporation by Independent Mining Consultants, Inc., AMEC E&C Services Inc., O'Kane Consultants, Inc., Steffen Robertson and Kirsten (Canada) Inc., Anne C. Baldrige, Call & Nicholas, Inc. (collectively, the project contractors). The quality of information, conclusions and estimates contained herein is consistent with the level of effort involved in the project contractors services based on: 1) information available at the time of preparation, 2) data supplied by outside sources and 3) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by PolyMet Mining Corporation only, subject to the terms of its contract with the project contractors. Any other use of, or reliance on, this report by any third part is at that party's sole risk.

2.0 INTRODUCTION

This pre-feasibility study is prepared for PolyMet Mining Corporation (PolyMet). The objectives of this pre-feasibility study are:

1) to clarify and quantify to the extent possible the basic factors that govern the chances for project success,

2) to assess the various relationships that exist between the variables that directly or indirectly affect project economics, and

3) to provide PolyMet the information necessary to decide whether or not the NorthMet Project justifies the expenditure of additional monies for completion of a final feasibility study (bankable document).

Specifically, this study evaluates the potential exploitation of the NorthMet polymetallic deposit by open pit methods and the production of the following saleable products using a hydrometallurgical process:

- copper metal,
- nickel metal,
- a precipitate of combined palladium, platinum and gold,
- a cobalt precipitate, and
- a zinc precipitate.

The pre-feasibility study commenced in November 2000 with the development of the orebody model and definition of potential mineable resource. The remaining mine-related work, process flowsheet and plant design work, tailings storage evaluation, and ongoing environmental work was completed during December 2000 through March 2001.

2.1 LOCATION

The NorthMet Project is located in St. Louis County in northeastern Minnesota (47^{o}36’ north latitude and 91^{o}58’ west longitude), about 70 miles north of Duluth and 10 miles south of the town of Babbitt (Figure 2-1). The deposit is hosted in the Partridge River Intrusion of the Duluth Gabbro. The project lies along the eastern portion of the Mesabi Iron Range and is directly south of the Northshore open pit iron ore mine.

Figure 2-1 NorthMet Project Location

The NorthMet Project site lies at an elevation of around 1600 feet above mean sea level. The terrain is flat with some low rolling hills. Much of the terrain has relatively poor drainage and is covered with forest and swamp. Wetlands have been identified for about 70% of the area that will be covered by the open pit and overburden dumps. The forest species include white, red and jack pine, spruce, fir, aspen and birch. The majority of the trees are second growth.

The northern Minnesota climate is continental, characterized by wide variations in temperature. The temperature in Babbitt (10 miles north of NorthMet) averages 4^{o} F in January and 66^{o} F in July. The average annual precipitation is about 28 inches with about 30% during the months of November through April and 70% from May through October.

Average annual snowfall is 60 inches with 2 to 3 feet of snow on the ground at any one time during the winter. The open pit mines in the area operate year-round with minor additional costs incurred due to snow.

2.2 ACCESS AND INFRASTRUCTURE

Access to the property is via paved state and local highways and on LTV Steel Mining Company all-weather, gravel roads. Rail access is available on the property to ports on Lake Superior.

The infrastructure related to mining is excellent. Available to the project are low-cost power, well-developed railway networks, and supply-equipment centers that support the currently operating iron ore mines. There is a local supply of skilled labor, as well as professional mining expertise.

2.3 HISTORY

Mining has a long history in Minnesota, although NorthMet would be the first non-ferrous mine in the state. Prospectors first discovered copper and nickel near Ely, Minnesota about 20 miles north of NorthMet in the 1940s. Subsequently, Bear Creek Mining Company conducted a regional exploration program resulting in the discovery of the Babbitt or Minnamax deposit (northeast of NorthMet and within the Duluth Gabbro). US Steel (USX) started an exploration program in the Duluth Complex in the late 1960s and over the next few years drilled 112 core holes into the NorthMet property (then called Dunka Road). USX investigated the deposit as a high-grade, underground copper-nickel resource, but it was considered to be uneconomic due to lower than expected copper and nickel grades, and the inability to produce separate, clean nickel and copper concentrates. At this time there was no recognition of any contained platinum, palladium (PGMs) or gold in the deposit.

In 1987 the Minnesota Natural Resources Research Institute (NRRI) published data suggesting that a large resource of platinum group minerals or PGMs could be contained within the base of the Duluth Complex. PolyMet (then known as Fleck Resources) leased the NorthMet property from USX in 1989. PolyMet re-assayed pulps and rejects from the previous USX drilling to obtain data on the PGMs.

NERCO Minerals and later Argosy Mining leased the property from PolyMet in the early 1990s. Work continued on the delineation of the contained PGMs and a few additional core holes were drilled. At that time there was no metallurgical process that could economically produce either: 1) separate, clean copper and nickel concentrates for sale to a smelter, or 2) economically extract the various contained metals from a bulk concentrate.

In the mid-1990s PolyMet began investigating the use of hydrometallurgical processes (including bio-leaching and pressure oxidation) for the recovery of the various metals found in the NorthMet polymetallic deposit. As a result of work performed by PolyMet's metallurgical consultants and testing conducted by Lakefield Research Limited (Lakefield), the PlatSol Process was developed, a pressure oxidation process. This process has shown superior recoveries of PGMs, as well as copper and nickel, in extensive pilot plant tests.

From 1998 to present, PolyMet has conducted three drilling programs totaling 87 holes for approximately 49,500 feet of core and reverse circulation drilling. PolyMet has continued the metallurgical testing program to further develop and improve the process plant flow sheet. This pre-feasibility study was contracted in late 2000 to summarize the project's attributes and potentials based on information available to date. The third drilling program (13 holes for about 9,000 feet) was completed in December 2000, after completion of the orebody model for the pre-feasibility study. The December 2000 information is included in an addendum resource calculation referenced in the appendix to the IMC mining study. Additional work, as recommended throughout this document, will be required prior to making the NorthMet project the first non-ferrous mine in the State of Minnesota.

2.4 PRE-FEASIBILITY TEAM

PolyMet contracted with Independent Mining Consultants, Inc. (IMC) to assemble the pre-feasibility study based on work completed by IMC and other qualified contractors. Each contractor has prepared its own report for the scope of work assigned to it. These reports form the basis of the pre-feasibility study and are provided as appendices to this document. The areas of responsibility assigned to each of the consultants for the pre-feasibility study are shown in Table 2-1.

Table 2-1

Contractors' Areas of Responsibility

Contractor	Report Reference	Areas of Responsibility
Independent Mining Consultants, Inc. Tucson, Arizona	IMC	Resource Model and Tabulation, Mining Resource, Mine Planning, Mine Operating and Capital Cost Estimates, Overall Pre-Feasibility Report Compilation and Project Management
O'Kane Consultants, Inc. Vancouver, British Columbia	O'Kane	Process Flow Sheet, Mass Balances, Oversee Metallurgical Test Work, Oversee Development of Process Plant Design and Cost Estimates
AMEC Simons Mining and Metals Phoenix, Arizona	AMEC	Process Plant Design, Process Plant Equipment Specifications, Process Plant Capital and Operating Cost Estimates, Project Infrastructure and G&A Cost Estimates
SRK Consulting Vancouver, British Columbia	SRK	Tailings Site Location Evaluation, Tailings Storage Facility Design, Tailings Storage Cost Estimates
Anne C. Baldrige Denver, Colorado	Baldrige	Applicable Environmental Regulations, Environmental Baseline Programs, Environmental Program Input to Pre-Feasibility, Project Life Environmental Programs
Call & Nicholas, Inc. Tucson, Arizona	CNI	Pit Wall Slope Angle Recommendations

The members of the pre-feasibility team are responsible for various volumes of the report and sections within the Summary, Volume 1. AMEC Simons Mining and Metals is responsible for the content in Section 8 of Volume 1 and Volume 5 (Plant and Infrastructure) of the report. SRK Consulting wrote the Tailings Management portion of Volume 6 and is responsible for the content in Section 9 of Volume 1. O'Kane Consultants provided the contents for Sections 7 and 15 of Volume 1 and directed the metallurgical test work presented in Volume 4. Anne Baldrige wrote Sections 10 and 12 of Volume 1 and the Permitting/Environment portion of Volume 6. IMC is responsible for Sections 5, 6 and 16 in Volume 1 and Volumes 2, 3 and 7. IMC complied and wrote the remaining Sections (1, 2, 3, 4, 11, 13, 14, 17, 18 and 19) of Volume 1 using information provided by PolyMet and the other members of the pre-feasibility team.

2.5 INTENT OF THE PRE-FEASIBILITY STUDY

The intent of the Pre-Feasibility Study is to bring together all the information developed for the NorthMet Project into one study and supporting document. Various aspects of the project have been studied independently in the past, and this is the first time all of the data has been compiled and analyzed within a single study. The various components of the project contain different levels of detail, and this has been noted in each section. An example of the differences in detail is illustrated by the extensive metallurgical test work performed to demonstrate the application of the process flowsheet to the NorthMet mineralized material, while to date there has been no geotechnical testing of potential tailings storage areas. Another example is that portions of the deposit have been drilled sufficiently to identify a measured resource, but other areas with much wider spaced drillings are in the indicated and inferred resource categories.

The Pre-Feasibility Study provides a base case analysis from which various project engineering and economic parameters can be further refined and optimized. For example, the process plant throughput rate is not optimized, nor are the mining or overburden waste disposal plans. Also, additional metallurgical test work could refine the capabilities of predicting variability in metallurgical recoveries within different areas of the deposit. Further work in all aspects of the project should result in a more optimized project and improved economics. This pre-feasibility study is the base case from which more efficient alternatives can be developed.

2.6 PROJECT UNITS

The units of measure for the pre-feasibility study are predominately US units. Tonnage is in short tons (2000 pounds); distances are in inches, feet or miles. Metal grades are reported in percent (%) or parts per million (ppm). Volume measures are in US gallons, cubic yards, and cubic feet. Metric units have been used in Section 7 for concentrations (grams per liter, g/l) and temperature (centigrade, ^{o}C).

2.7 AVAILABLE DATA

There is a large amount of data available for the NorthMet Project. PolyMet has categorized the data and made it available to all of the contractors who have worked on this pre-feasibility study. The data is from various sources and includes the drilling information, geologic maps and sections, geologic reports, various technical reviews, metallurgical reports, environmental reports, legal documents and publications. A list of the available information is in Appendix 2-1 of this report.

2.8 USE OF INFERRED RESOURCES

Inferred resources have been included within the mine production schedule for this pre-feasibility study. The open pit design limits are based on the economics that included measured and indicated resources only (inferred resources were treated as waste). However, this pit geometry also contains some internal resources currently classified as inferred. The inferred material included within the mining schedule amounts to 16.9 percent of the total mill feed over the 25 year project life.

The inferred material is between widely spaced drill holes and additional drilling in these areas will be done prior to the development of a bankable, feasibility study. PolyMet drilled 13 holes during December 2000 that were not included in the pre-feasibility study. This drilling was located in a small area along the northern part of the deposit in an area with minimal drill holes, and the drilling confirmed the continuity of the mineralized zones developed for the pre-feasibility model. The December 2000 drilling was used to update the pre-feasibility resource estimate computer model. This model was completed in March 2001 and has not been incorporated into the pre-feasibility study documented in this report. The pre-feasibility study final pit geometry was evaluated against the March 2001 model. The tabulation of the resources inside the total pit boundary showed a reduction of the inferred material within the pit limits from 16.9% to 14.6% based on drilling in a very localized area of the deposit.

IMC recommends a 69 hole drill program to fill in between the widely spaced USX drill holes and to cover the total range of the deposit. The completion of this drilling should provide adequate sample spacing for the total pit resource to be classified as measured and indicated in the next level of study.

2.9 QUALIFIED PERSONS

Included here are the certificates of the qualified persons for the various disciplines of the NorthMet pre-feasibility study. Table 2-2 is a list of the qualified persons.

Table 2-2

Qualified Persons

Company	Area of Responsibility	Responsible Person
PolyMet Mining, Inc.	Exploration	Leah Mach
Independent Mining Consultants, Inc. Tucson, Arizona	Resource Model, Mine Planning, Mine Operating and Capital Costs	Michael Hester Herb Welhener
O'Kane Consultants, Inc. Vancouver, British Columbia	Process Flow Sheet, Mass Balance, Metallurgical Test Work	P. T. O'Kane
AMEC Simons Mining and Metals Phoenix, Arizona	Process Plant Design, Process Equipment Specifications, Plant Operating and Capital Costs G&A Cost Estimates	Brian Kennedy
SRK Consulting Vancouver, British Columbia	Tailing Site Location and Design Tailing Storage Cost Estimate	Cameron Scott
Anne C. Baldrige Denver, Colorado	Environmental Regulations and Application	Anne Baldrige
Call & Nicholas, Inc. Tucson, Arizona	Pit Wall Slope Angle Recommendations	David Nicholas

CERTIFICATE OF ANNE BALDRIGE

I, Anne Baldrige, do hereby certify that:

1) I am an independent environmental consultant running a small consulting firm, ACB Consulting, located at 2240 South Grant Street, Denver, Colorado 80210, U.S.A.

2) I am graduate of the University of Pittsburgh with a B.S. degree in geology, 1979, and Regis University with a M.B.A. in Finance and Accounting, 1992.

3) I am member in good standing of the Rocky Mountain Mineral Law Foundation.

4) I have practiced as an environmental and permitting specialist for over 20 years. I have worked for several consulting firms (including Orbital Engineering, SRK and Golder Associates), the Colorado Department of Natural Resources, Division of Minerals and Geology, Battle Mountain Gold Company, and had my own businesses (EIC Corporation and ACB Consulting).

5) I last visited the NorthMet property on December 12, 2000.

6) I have been involved with the environmental and water management portions of the pre-feasibility study.

7) I am not aware of any material fact or material change with respect to the subject matter of the technical report which is not reflected in the technical report, or the omission to disclose said material which makes the technical report misleading.

8) I am an independent qualified person based on the tests set out in Section 1.5 of Form 43-101. On July 19, 2000, in recognition of my assistance in selecting an environmental consultant and developing environmental scopes and budgets in late 1999 and early 2000, PolyMet Mining Corporation’s Board of Directors awarded me 20,000 shares of stock options (exercisable @ Cdn$1.00) in the company. These options were granted for outstanding performance on previous work. These options have not been exercised at this time.

9) I have been involved with the NorthMet property since September 1999 as an independent environmental consultant on permitting for the site. I have written several memos to PolyMet and North Mining on the permitting process and time frames as well as helped to establish environmental budgets and assisted in the selection of an environmental consultant to perform baseline studies.

10) I have read Instrument 43-101 and Form 43-101F and the technical report has been prepared in compliance with both documents.

____

Anne Baldrige
Environmental and Permitting Specialist

CERTIFICATE OF LEAH E. MACH

I, Leah E. Mach, do hereby certify that:

1) I am employed by PolyMet Mining Company as Project Manager. The home office of PolyMet is 13949 W. Colfax Ave., Golden, Colorado 80401; the address of the local office is 510 W. 3rd Ave. N., Aurora, MN 55705.

2) I am a graduate of University of Idaho, M.S. in Geology, 1986, and Castleton State College, B.A., 1981.

3) I am a member in good standing of the Society of Mining, Metallurgy and Exploration (SME).

4) I have practiced my profession as geologist for 15 years. I have worked for Echo Bay Mines (1987 – 1997) and PolyMet Mining Company (1999 to present), and as an independent consultant (1998-1999).

5) I am currently assigned to the Aurora, Minnesota office of PolyMet, located near the NorthMet property.

6) I am responsible for the on-site operations of the NorthMet project, including exploration. I have been involved with the geology and land status portions of the pre-feasibility study.

7) I am not aware of any material fact or material change with respect to the subject matter of the technical report which is not reflected in the technical report, or the omission to disclose said material which makes the technical report misleading.

8) I have read Instrument 43-101 and Form 43-101F1 and the technical report has been prepared in compliance with both documents.

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Leah E. Mach
Project Manager

CERTIFICATE OF CAMERON C. SCOTT

I, Cameron C. Scott, do hereby certify that:

1) I am employed by the consulting firm of Steffen Robertson and Kirsten (Canada) Inc. in the capacity of principal geotechnical engineer. The office of Steffen Robertson and Kirsten (Canada) Inc. is located at 800, 580Hornby Street, Vancouver, BC V6C 3B6

2) I am a graduate of University of British Columbia with a B.App.Sc. degree in Geological Engineering, 1974 and a University of Alberta with an M.Eng. degree in Geotechnical Engineering, 1984.

3) I am a member in good standing of the Association of Professional Engineers and Geoscientists of British Columbia, the Association of Professional Engineers Geologists and Geophysicists of the Northwest Territories, and the Vancouver Branch of the Canadian Institute of Mining Metallurgy and Petroleum.

4) I have practiced my profession as a consulting geotechnical engineer for over 25 years. I have worked for Steffen Robertson and Kirsten (Canada) Inc. since 1986 and presently a director.

5) I visited the NorthMet property on December 12 and 13, 2000.

6) I have been involved with the tailings management portion of the pre-feasibility study.

7) I am not aware of any material fact or material change with respect to the subject matter of the technical report which is not reflected in the technical report, or the omission to disclose said material which makes the technical report misleading.

8) I am an independent qualified person based on the tests set out in Section 1.5 of Form 43-101.

9) I have read Instrument 43-101 and Form 43-101F1 and the technical report has been prepared in compliance with both documents.

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Cameron C. Scott
Principal Geotechnical Engineer

CERTIFICATE OF PATRICK TERRANCE O'KANE

I, Patrick Terrance O'Kane, do hereby certify and swear that:

1) I am employed by O'Kane Consultants, Inc., an independent management and engineering consulting firm, in the capacity of Principal Consulting Metallurgical Engineer. I reside at 3001 Brio Entrance, Whistler, BC V0N 1B3. The O'Kane Consultants, Inc. office is located at Suite 502, 455 Granville Street, Vancouver, BC V6C 1T1.

2) I am a 1955 graduate of The University of Saskatchewan with a Bachelor of Science degree in Chemical Engineering.

3) I am a registered Professional Engineer in The Association of Professional Engineers and Geoscientists of B.C., Member No. 11171. I am a member in good standing of the Canadian Institute of Mining and Metallurgy (CIM) and of the Society of Mining, Metallurgical and Exploration (SME).

4) I have practiced my profession for more than 45 years. I have worked for Sherritt Gordon Mines Ltd., (1955 to 1970), Marinduque Mining & Industrial Corporation in The Philippines (1970-77), Fluor Daniel Wright Engineers, Vancouver, (1978-1993) and in 1993 founded O'Kane Consultants, Inc. I was the original President of that company.

5) I have specialized in development of new metallurgical processes and am the co-inventor of 10 patents in the field of hydrometallurgy of nickel, copper, cobalt and platinum. I have extensive operating and project management experience.

6) I was retained by PolyMet to coordinate the metallurgical process development of the NorthMet property. I last visited Lakefield Research, Ltd., the site of the metallurgical testing and pilot plant, on December 11& 12, 2000.

7) I have been involved with metallurgy portion of the pre-feasibility study.

8) I am not aware of any material act or material change with respect to the subject matter of the technical report which is not reflected in the technical report, or the omission to disclose said material which makes the technical report misleading.

9) I am an independent qualified person based on the test set out in Section 1.5 of Form 43-101. I am a shareholder in the company holding the rights to the process technology proposed for NorthMet and I own 5,000 common shares of PolyMet. Other than consulting fees, I have not received, nor do I have any arrangement to receive securities or other compensation with respect to the Project.

CERTIFICATE OF PATRICK TERRANCE O'KANE (continued)

10) O'Kane Consultants, Inc. issued a scoping study on the NorthMet Project in July 1999. I was the principal author of that report.

11) I have read Instrument 43-101and Form 43-101.F1 and the technical report has been prepared in compliance with both documents.

P.T. O'Kane

Patrick Terrance O'Kane, P.Eng.

Principal

CERTIFICATE OF BRIAN D. KENNEDY

I, Brian D. Kennedy, do hereby certify that:

1) I am employed by the engineering and construction company AMEC E&C Services Inc., in the capacity of senior metallurgical engineer. I reside in the Phoenix office of AMEC, located at 2001 West Camelback Road, Suite 430, Phoenix, Arizona, USA, 85015.

2) I am a graduate of the University of British Columbia with a Bachelor of Applied Science degree in Metallurgical Engineering, 1985.

3) I am a member of the Association of Professional Engineers and Geoscientists of the Province of British Columbia.

4) I have practiced my profession as a consulting engineer for over 13 years. I have worked for Fluor Daniel Wright, Ltd. (1987-1996), Rescan Engineering, Ltd. (1996-1997), and AMEC E&C Services Inc. (1997-present).

5) I have not visited the NorthMet property.

6) I have been responsible for the process plant and infrastructure facilities portion of the prefeasibility study.

7) I am not aware of any material fact or material change with respect to the subject matter of the technical report which is not reflected in the technical report, or the omission to disclose said material which makes the report misleading.

8) I am an independent qualified person based on the tests set out in Section 1.5 of Form 43-101.

9) I have read Instrument 43-101 and Form 43-101F1 and the technical report has been prepared in compliance with both documents.

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Brian D. Kennedy, P.Eng.
Senior Metallurgical Engineer

CERTIFICATE OF DAVID E. NICHOLAS

I, David E. Nicholas, do hereby certify that:

1. I am employed by the consulting firm of Call & Nicholas, Inc. in the capacity of geological engineer. The office of Call & Nicholas, Inc. is located at 2475 N. Coyote Dr., Tucson, Arizona, 85745, USA.

2. I am a graduate of the University of Arizona with a M.S. degree in Geological Engineering, 1976.

3. I am a member in good standing with the Society of Mining, Metallurgy, and Exploration.

4. I have practiced my profession as a consulting engineer for 25 years. I have worked for Hanna Mining Company. (1970-1973) in Montana, Missouri, and Arizona.

5. I have not visited the property but an engineer in our company, Mr. Dan Lowe has.

6. I have been involved in the geotechnical assessment of the open-pit portion of the pre-feasibility study.

7. I am not aware of any material fact or material change with respect to the subject matter of the technical report which is not reflected in the technical report, or the omission to disclose said material which makes the technical report misleading.

8. I am an independent qualified person based on the tests set out in Section 1.5 of Form 43-101.

9. A memorandum entitled "Pre-Feasibility Level Geotechnical Recommendations for the PolyMet Mining Corporation's NorthMet Pit" was published in March 2001 and a memorandum entitled "Initial Northmet Slope Angles for Cone Miner" was published in September 1999 by Call & Nicholas, Inc.

10. I have read Instrument 43-101 and Form 43-101F1 and the technical report has been prepared in compliance with both documents.

____

David E. Nicholas
President

CERTIFICATE OF DANIEL J. LOWE

I, Daniel J. Lowe, do hereby certify that:

1) I am employed by the consulting firm of Call & Nicholas, Inc. in the capacity of geological engineer. The office of Call & Nicholas, Inc. is located at 2475 N. Coyote Dr., Tucson, Arizona, 85745, USA.

2) I am a graduate of Michigan Technological University with a B.S. degree in Geological Engineering, 1992.

3) I am a member in good standing with the Society of Mining, Metallurgy, and Exploration.

4) I have practiced my profession as a consulting engineer for seven years. I have worked for Cleveland-Cliffs Iron Co. (1992-1993) at the Tilden Mine.

5) I last visited the NorthMet property during October 12-22, 1999.

6) I have been involved in the geotechnical assessment of the open-pit portion of the pre-feasibility study.

7) I am not aware of any material fact or material change with respect to the subject matter of the technical report which is not reflected in the technical report, or the omission to disclose said material which makes the technical report misleading.

8) I am an independent qualified person based on the tests set out in Section 1.5 of Form 43-101.

9) A memorandum entitled "Pre-Feasibility Level Geotechnical Recommendations for the PolyMet Mining Corporation's NorthMet Pit" was published in March 2001 and a memorandum entitled "Initial Northmet Slope Angles for Cone Miner" was published in September 1999 by Call & Nicholas, Inc.

10) I have read Instrument 43-101 and Form 43-101F1 and the technical report has been prepared in compliance with both documents.

Daniel J. Lowe
Geological Engineer

CERTIFICATE OF MICHAEL G. HESTER

I, Michael G. Hester, do hereby certify that:

1) I am employed by the consulting firm of Independent Mining Consultants, Inc. in the capacity of Vice President and principal mining engineer. The office of Independent Mining Consultants, Inc. is located at 2700 E. Executive Drive, Suite 140, Tucson, Arizona, 85711, USA.

2) I am a graduate of the University of Arizona with a M.S. degree in Mining Engineering, 1982, and a B.S. degree in Mining Engineering, 1979.

3) I am a member in good standing of the Society of Mining, Metallurgy and Exploration (SME), and the Canadian Institute of Mining, Metallurgy and Petroleum (CIM).

4) I have practiced my profession as a consulting mining engineer for over 22 years. I have worked for Pincock, Allen & Holt, Inc. (1979 – 1983) and Independent Mining Consultants, Inc. (1983 to present) of which I am one of the founding partners. I also worked in the Department of Mining and Geological Engineering of the University of Arizona as an Adjunct Lecturer during 1997 and 1998, where I taught classes in mine planning and mine evaluation.

5) I have not visited the NorthMet property.

6) I have been involved with the following items of the pre-feasibility report: 1) development of the resource model and review of the available quality control data, 2) development of the mine capital and operating costs, 3) financial analysis and development of the cashflow model, and 4) overall assembly of the pre-feasibility report.

7) I am not aware of any material fact or material change with respect to the subject matter of the technical report which is not reflected in the technical report, or the omission to disclose said material which makes the technical report misleading.

8) I am an independent qualified person based on the tests set out in Section 1.5 of Form 43-101.

9) I have read Instrument 43-101 and Form 43-101F1 and the technical report has been prepared in compliance with both documents.

____

Michael G. Hester
Vice President and Principal Mining Engineer

CERTIFICATE OF HERBERT E. WELHENER

I, Herbert E. Welhener, do hereby certify that:

1) I am employed by the consulting firm of Independent Mining Consultants, Inc. in the capacity of Vice President and principal mining engineer. The office of Independent Mining Consultants, Inc. is located at 2700 E. Executive Drive, Suite 140, Tucson, Arizona, 85711, USA.

2) I am a graduate of University of Arizona with a B.S. degree in Geology, 1973.

3) I am a member in good standing of the Society of Mining, Metallurgy and Exploration (SME) for which I have served on a number of committees both at the national and local levels.

4) I have practiced my profession as a consulting mining engineer for over 25 years. I have worked for Pincock, Allen & Holt, Inc. (1972 – 1983) and Independent Mining Consultants, Inc. (1983 to present) of which I am one of the founding partners.

5) I last visited the NorthMet property during the period of December 12 and 13, 2000.

6) I have been involved with the mining portion of the pre-feasibility study along with the overall assembly of the pre-feasibility report.

7) I am not aware of any material fact or material change with respect to the subject matter of the technical report which is not reflected in the technical report, or the omission to disclose said material which makes the technical report misleading.

8) I am an independent qualified person based on the tests set out in Section 1.5 of Form 43-101.

9) A report entitled "Interim Report on Resource Estimation, NorthMet Project" was published by Independent Mining Consultants, Inc. in October 1999. I was the principal author of this report.

10) I have read Instrument 43-101 and Form 43-101F1 and the technical report has been prepared in compliance with both documents.

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Herbert E. Welhener
Vice President and Principal Mining Engineer

3.0 PROJECT ASSUMPTIONS

Several assumptions have been made during the development of the NorthMet pre-feasibility study, some of which will be revised as the project moves forward. The assumptions made provided a basis for the pre-feasibility study and include such items as:

- Mill Throughput Rate. The mill average throughput rate of 55,000 tons per day was selected based on early evaluations prepared by O'Kane in July 1999. Further study is needed to optimize the process rate relative to mine production, cutoff grade, and capital and operating costs.

- Uniform Recoveries Throughout The Deposit. The plant recoveries are based on the bulk sample collected from the drilling during late 1999 and early 2000 from the near surface, north central area of the deposit. The samples for the August 2000 variability testwork were collected from the same area. The results of this testwork showed similar recovery results over the grade ranges tested from the above-mentioned area of the deposit. Based on this work, the process recoveries have been assumed to be uniform throughout the deposit in both location and grade range for the pre-feasibility study. More test work will be needed to confirm this assumption as the project moves forward.

- Open Pit Slope Angles. CNI has provided preliminary slope angles and a worst-case recommendation that all of the Virginia Formation be mined from the footwall side of the pit. The CNI slope angle recommendations have been incorporated into the pit design, but the recommendation to remove all of the Virginia Formation from the footwall has not been incorporated. Additional slope angle investigation work will be completed as part of the next stage of the project.

- Waste Dump Sequence. The waste dumps have been designed and sequenced as two large dumps north of the pit and one small backfill dump in the northeast pit area. The dumps have been built from the bottom up to the maximum size of the dump footprint. The land disturbance can be reduced by sequencing the dumps into smaller units that expand outward over the life of the project. Different approaches to waste placement will be investigated in the next stage of the project.

- Land Surface Rights. It is assumed for the pre-feasibility study that surface rights to all required land can be obtained. To date there are no indications that this is not achievable.

- LTV assets. The LTV Mining Company has declared bankruptcy. Access to the NorthMet project is across LTV land; it is assumed that this access will be available in the future. The LTV rail line goes through the NorthMet project area and it is assumed that it will be available for the project.

- Water Management. The management of the water resources is important to the project and it is planned for the re-cycle of the supernatant water from both the flotation and hydrometallurgical tailings facilities back to the process plant. This will minimize the amount of required make-up water or possible water discharge from the tailings facilities.

- Make-Up Water. The plant will require a quantity of make up water as part of the process. It is assumed that this water will be available from one of the near-by closed iron ore pits.

- Water Discharge. Water may be discharged from the property during periods of high precipitation. The amount and quality of this water is not known at this time; it is assumed that if treatment is necessary it can be achieved to meet water quality regulations for discharge.

- Project Permitting. It is assumed that all operating and environmental permits will be received in a timely manner. Based on the preliminary environmental work already completed, there is no indication that this will not happen.

4.0 LAND STATUS

4.1 MINERAL RIGHTS

In 1989, PolyMet (as Fleck Resources) acquired a twenty-year renewable lease for the mineral rights to the NorthMet deposit from USX. The lease is subject to yearly lease payments before production and then to 3 to 5 % sliding scale Net Smelter Return royalty based on the value of the ore. The lease payments prior to production are considered advance royalties and will be credited to the production royalty.

The lease covers Sections 1, 2, 3, 9, 10, 11, and 12 of Township 59N, Range 13W, with the following exceptions:

- Section 1, SE ¼ of SE1/4
- Section 9, SW ¼ of SE ¼
- Section 10, SW ¼ of SW ¼, NW ¼ of SW ¼, SE ¼ of SE ¼ and SW ¼ of SE ¼
- Section 12, NW ¼ of NE ¼

Preliminary work done by North Mining as part of the NorthMet Joint Venture indicates that the Longyear Mesaba Trust holds the parcels in section 9 and the SW ¼ of Section 10. The only parcel that contains ore within the pit is the NW ¼ of the SW ¼ of Section 10.

Figure 4-1 shows the mineral rights in the area of the pit, potential waste dumps and tailings storage areas. USX owns the mineral rights in Section 4 that would be covered by one of the potential waste dumps. Substantial portions of the area covered by potential tailings are held by the State of Minnesota, with the remainder held by other individuals or organizations. The information on the map, with the exception of sections 1, 2, 3, 9, 10, 11, and 12 in Township 59N, Range 13W comes from preliminary work done by North Mining.

4.2 SURFACE OWNERSHIP

The United States Forest Service (USFS) acquired the surface rights to the NorthMet property from USX in the 1930's and, at present, the USFS remains the surface owner of most of the NorthMet property. USX retained the mineral rights and the right to explore and mine on the site. As a result of this retention, while the USFS is the surface owner for most of the NorthMet Property, they cannot prohibit mining on the site and will likely have a somewhat limited capacity for decision making relative to site activities. LTV Steel Mining Company/Erie Mining Company owns portions of sections 10, 11, and 12 near their private railroad. Figure 4-2 shows the surface owners in the area of the potential NorthMet pit, waste dumps, and tailings storage. In the tailings area surface owners are the USFS, the State of Minnesota, and St. Louis County (tax-forfeited land). Information on the land map was compiled from preliminary work done by North Mining and from the St. Louis County Land Atlas and Plat Book (1996).

PolyMet has approached the USFS with the idea of acquiring the NorthMet surface rights through a land swap. This would simplify the permitting process and give access to land for waste dumps, tailings storage, and plant and office facilities. The USFS has expressed its willingness to do so. The swap would include all of sections 1, 2, 3, 4, and 9, and those portions of sections 10, 11, and north half of 12 that are owned by the USFS, as well as the portions of sections 17, 19, 20, 21, 29, and 30 in Township 59 N, Range 12 W that may be covered by tailings. The total amount of property involved in the land swap would be approximately 5850 acres out of a total project requirement of nearly 7430 acres.

4.3 FUTURE WORK

Land issues that have to be researched for the final bankable feasibility document include:

- Mineral rights ownership of the seven parcels that are excluded from the USX lease
- Surface ownership of the property that is not held by the USFS, i.e. near the LTV railroad
- Mineral rights and surface owners of the land that will be covered by the tailings facility

For the bankable document, PolyMet believes it necessary to secure, as a minimum, options on the surface and mineral rights for all the land that would be impacted by the planned waste dumps, tailings storage facilities, mine plant and other buildings, and the pit.

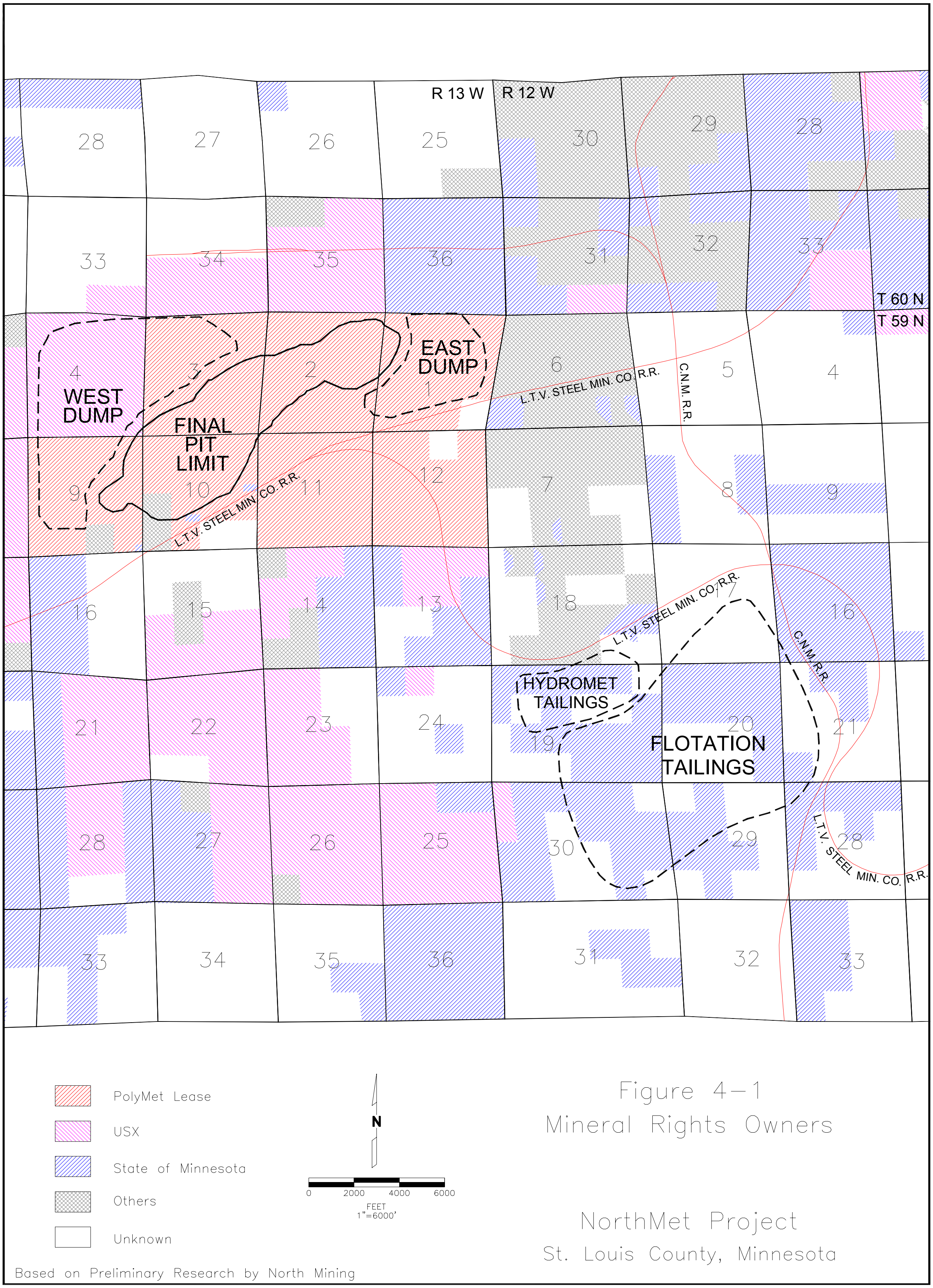


Figure 4–1
Mineral Rights Owners

NorthMet Project
St. Louis County, Minnesota

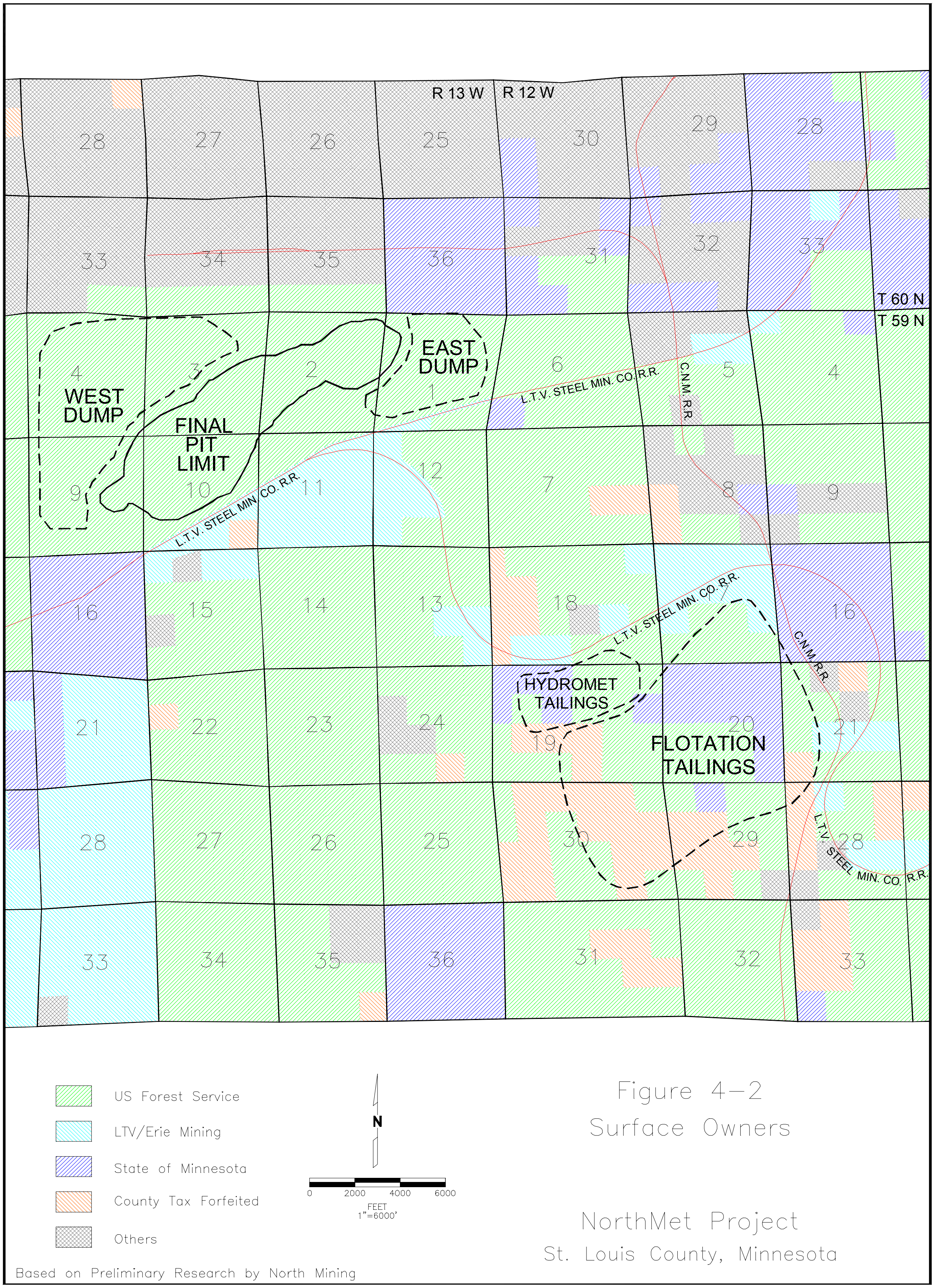


Figure 4-2
Surface Owners

5.0 GEOLOGY AND RESOURCES

5.1 REGIONAL GEOLOGY

The geology of northeastern Minnesota is predominately Precambrian in age. Approximately 1.1 billion years ago, intra-continental rifting resulted in huge volumes of mafic volcanics and associated intrusions along a portion of the Midcontinent Rift System, which extends through the Lake Superior Region to Kansas (Figure 5-1). The rift system is characterized by a gravity high and the thinning or absence of continental crust.

The Midcontinent Rift consists of three parts: thick lava flows, intrusive rock, and overlying sedimentary rock. The volcanic sequences are generally tholeiitic to subalkaline flood basalts derived from a mantle source. Minor felsic to intermediate flows exhibit crustal contamination. There are three major intrusive complexes: the Coldwell Complex of Ontario, the Mellen Complex along the south shore of Lake Superior and the Duluth complex along the north shore. The sedimentary rocks are mainly fluvial red beds filling the rift structure. The Duluth Complex (Figure 5-2) is the host of NorthMet mineralization. The complex lies along the projection of the Great Lakes Tectonic Zone, an Archean suture zone, the Archean Vermilion Fault, and the Early Proterozoic shelf margin. It extends in an arcuate belt from Duluth to the northeastern tip of Minnesota. Emplacement of the intrusion appears to have been along a system of northeast-trending normal faults that form half-grabens stepping down to the southeast (Figure 5-3). The magma was intruded as sheet-like bodies along the contact between the Early Proterozoic sedimentary rocks of the Animikie Group and the basaltic lava flows of the North Shore Volcanic Group.

There are two types of mineralization related to the rift event: hydrothermal and magmatic. The hydrothermal deposits include native copper in basalts and sedimentary interbeds, such as on the Keewenaw Peninsula, sediment-hosted copper sulfide and native copper, represented by the White Pine Mine of Michigan, copper sulfide veins in volcanics, and polymetallic veins (Ag-Ni-Co-As-Bi) in volcanics. The magmatic deposits include Cu-Ni-PGM mineralization and Ti-Fe mineralization in the Duluth complex, uranium and rare earth elements in carbonatites, and Cu-Mo in breccia pipes. More locally (Figure 5-4), the magmatic deposits lie along the northwestern contact of the Duluth Complex with the underlying sediments and Giants Range Batholith. NorthMet and the Babbitt (or Minnamax) deposits are the largest of the Cu-Ni-PGM mineralization.

5.2 LOCAL GEOLOGY AND DEPOSIT DESCRIPTION

5.2.1 Rock Types

The Duluth Complex is represented by the Partridge River Intrusion in the NorthMet area. The intrusion consists of light to dark gray troctolitic rock varying from troctolitic anorthosite to augite troctolite, with thin layers of melatroctolite or picrite. The rock types are classified by percentage of plagioclase, olivine, and clinopyroxene. The melatroctolite layers tend to be fine-grained with distinct layering. The Partridge River Intrusives have been sub-divided into seven lithologic units (Figure 5-5):

- Unit 7 and Unit 6 – texturally homogeneous plagioclase-rich troctolite, each with a persistent ultramafic base. Unit 6 contains a mineralized horizon in the southwestern portion of NorthMet, which is relatively enriched in PGM's relative to copper. Units 6 and 7 are each about 400 ft thick.
- Unit 5 – coarse-grained anorthositic troctolite (300 ft) grading down to Unit 4.
- Unit 4 - homogeneous augite troctolite and troctolite, with a less persistent ultramafic horizon. The contact between 4 and 5 is difficult to establish and the two units may actually be a single unit.
- Unit 3 – the most easily recognized unit because of its mottled appearance due to olivine oikocrysts. It is a fine-grained troctolitic anorthosite to anorthositic troctolite. Average thickness is 250 feet, but locally can be up to 600 feet.
- Unit 2 – homogeneous troctolite with abundant ultramafic units and a generally persistent basal ultramafic. This unit shows the most variation in thickness and may be absent entirely.
- Unit 1 – the most heterogeneous unit, both texturally and compositionally. Grain size is generally coarser at the top of the unit and fines downward. The unit contains abundant inclusions of the footwall rock and is noritic toward the base. This is the main sulfide-bearing unit. Two ultramafic layers are generally present. Unit 1 is probably the result of multiple pulses of magma injection. Average thickness is about 450 feet.

The footwall consists of Proterozoic sedimentary rocks of the Animikie Group, which resulted from a single depositional sequence in a transgressive sea. The oldest formation, the Pokegama Quartzite represents well-sorted clastic material deposited on a stable shelf. The Biwabik Iron Formation contains alternating sequences of ferruginous chert and slate. The Iron Formation has been extensively studied because of its importance to the iron mining industry and contains several members and submembers. The youngest formation is the Virginia Formation, consisting of argillite and graphitic argillite with interbeds of greywacke, siltstone, and minor calc-silicate. The Virginia Formation appears to decrease in thickness from the surface contact with the Duluth Complex toward the interior of the Complex to the southeast. Inclusions of the Virginia Formation, as biotite hornfels, can be found in all units, but are especially abundant in Unit 1.

5.2.2 Structure

The general trend of the sedimentary rocks at the NorthMet deposit is to strike to the east-northeast and to dip to the southeast about 15-25 degrees, and the Partridge River Intrusion appears to follow this general trend. Two east-northeast-trending faults have been identified through the construction of cross-sections. The faults are steeply dipping and normal in character; offset ranges from negligible to 600 feet down to the southeast. A third major fault has been identified in the western portion of the area and can be traced to the Northshore Mine to the north. Movement on this fault is down to the east. Numerous other faults can be identified in the cross-sections, but offset is small and they lack continuity. The cross-sectional view shows considerable offset in the more southerly fault, and less offset on the more northerly fault. This relationship can vary over the strike of the deposit.

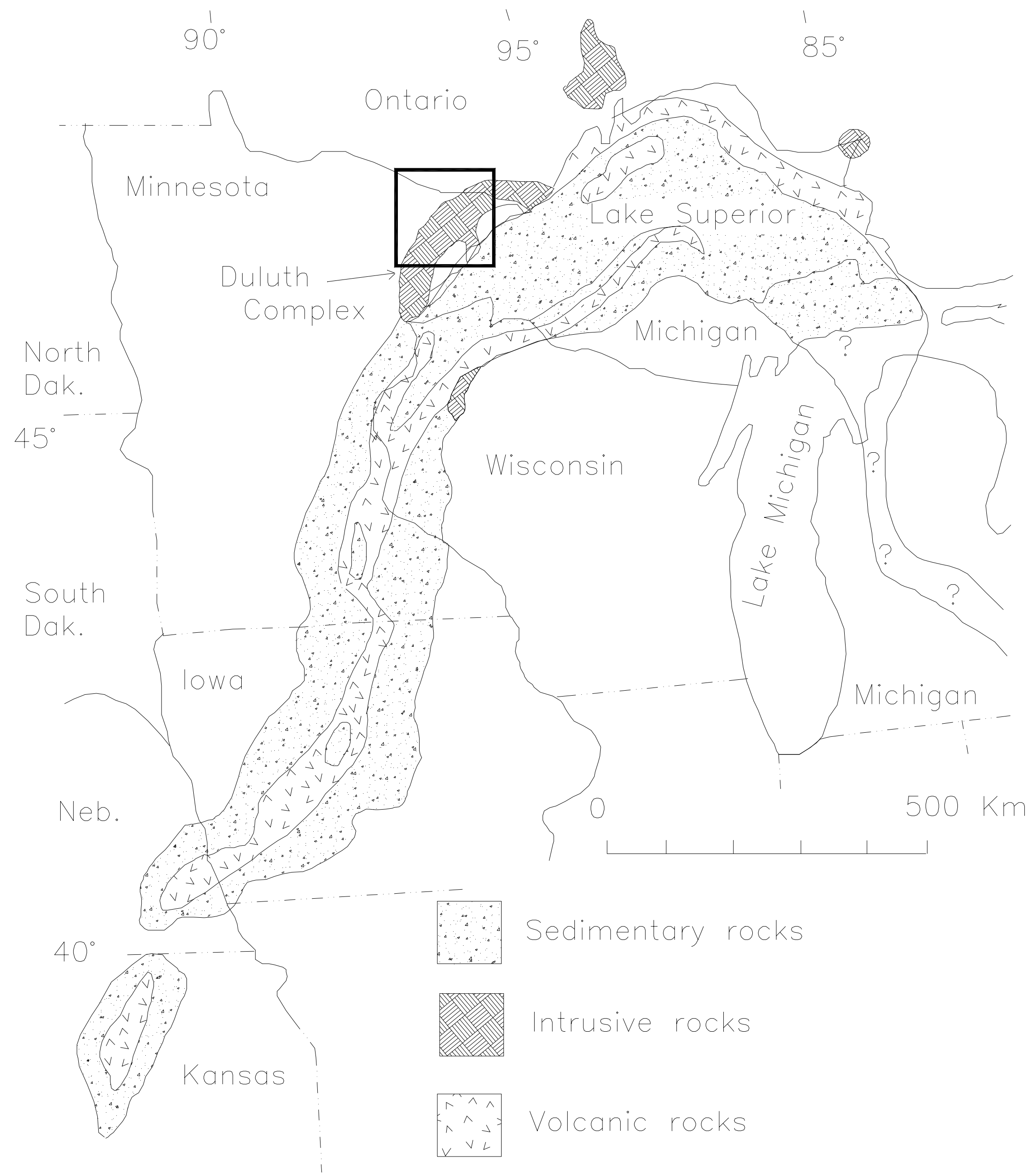


Figure 5-1: Sketch map showing the location of the midcontinent rift system. Map from Chandler, 1990.

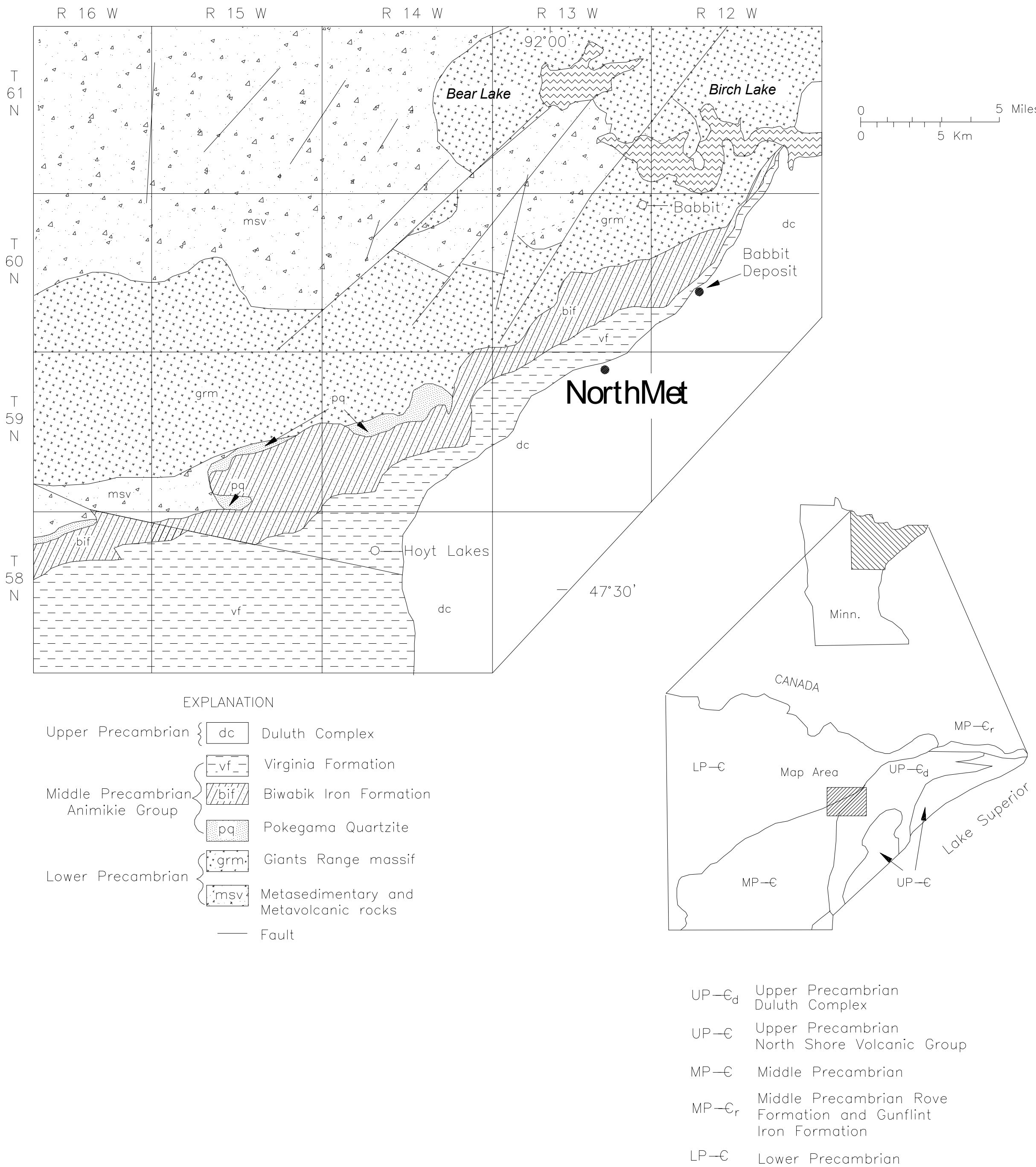


Figure 5-2: Regional Geology of the NorthMet area. Scale c. 1:500,000.
After a map in Andrews and Ripley, 1989.

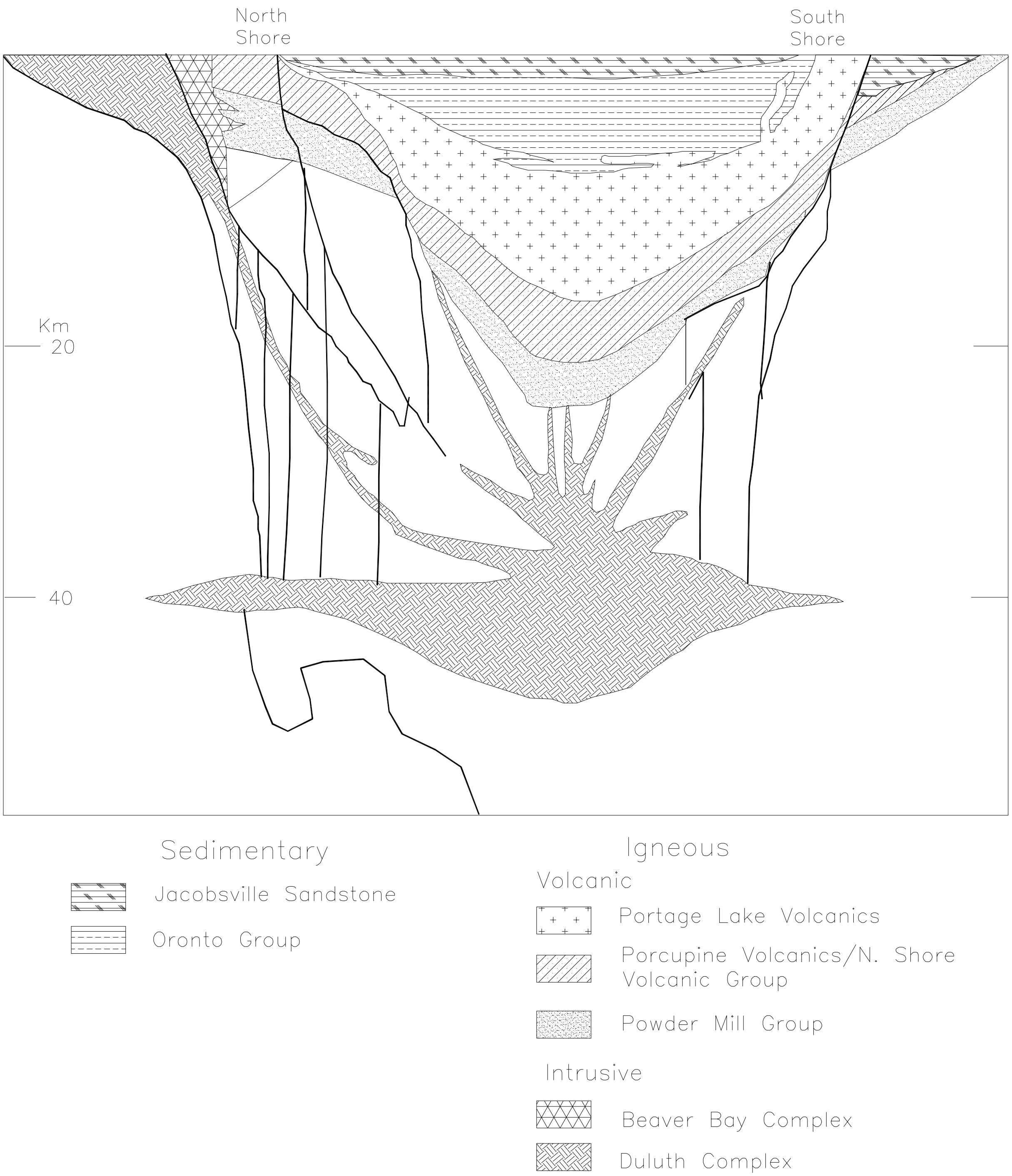


Figure 5–3: Generalized Cross–Section
Mid Continent Rift System

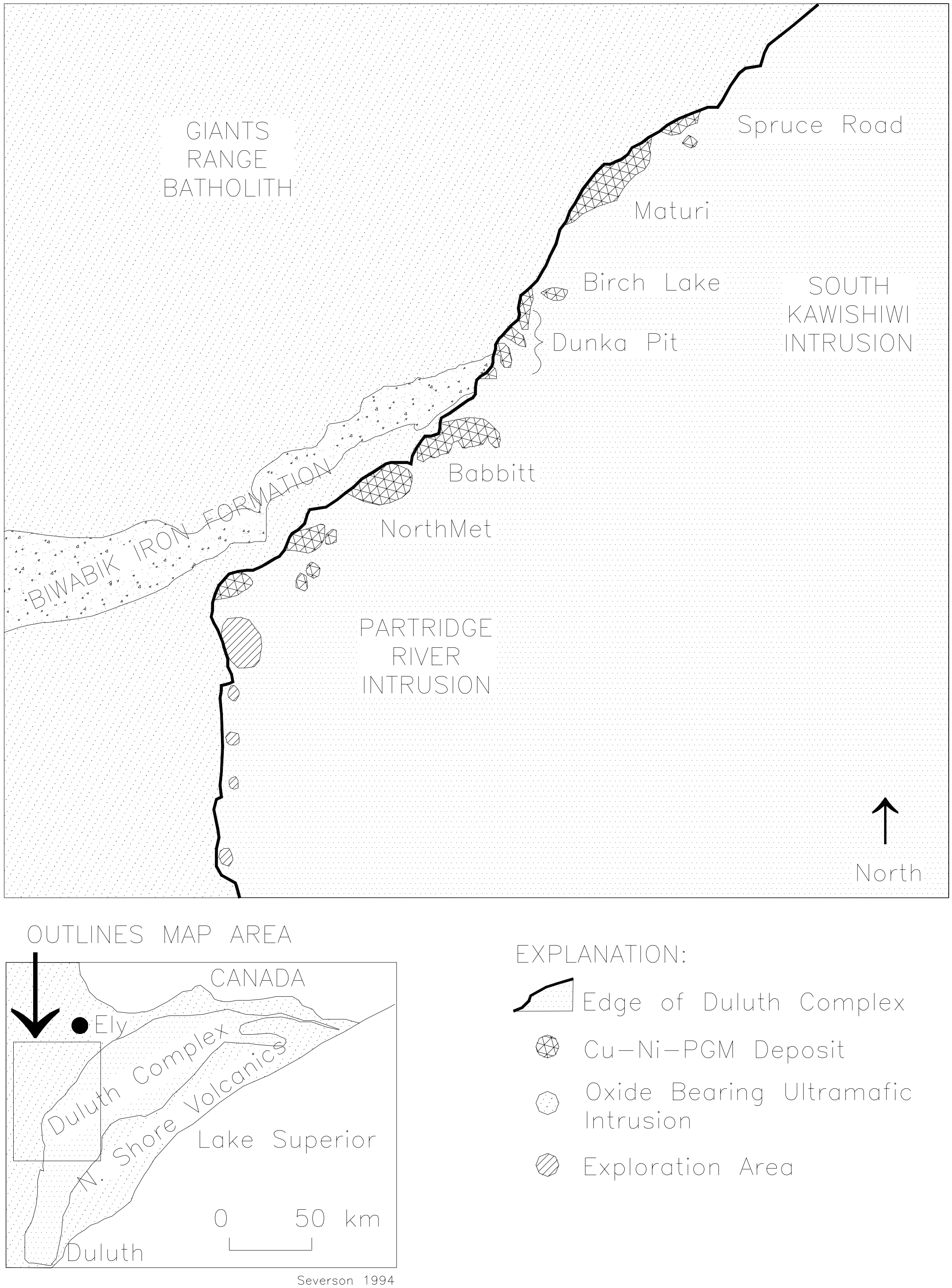


Figure 5-4: West Edge, Duluth Complex

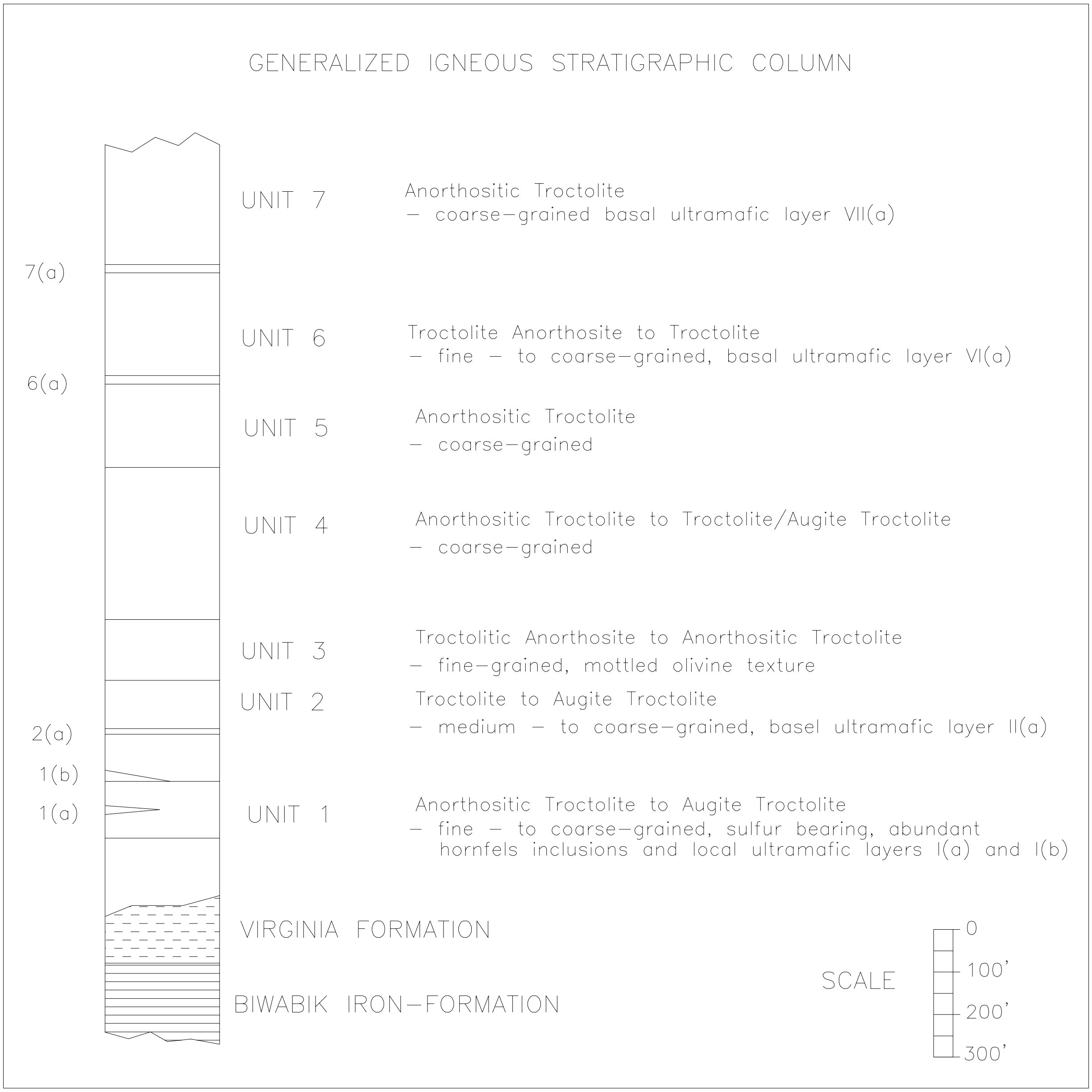


FIGURE 5-5: Generalized igneous stratigraphic column for the NorthMet deposit, taken from Geerts, 1991.

5.3 MINERALOGY

The metals of interest at NorthMet are copper, nickel, cobalt, platinum, palladium, gold, and lesser amounts of rhodium and ruthenium. In general, the metals are positively correlated with copper mineralization; cobalt is the main exception. Mineralization occurs in four horizons throughout the NorthMet property. Three of these horizons are within basal Unit 1, and in some drillholes the horizons are indistinguishable from each other. The thickness of each of the three horizons varies from 5 to more than 200 feet. Unit 1 mineralization is found throughout the deposit. A less extensive mineralized zone is found in Unit 6, and it is relatively enriched in PGM's compared to Unit 1.

Sulfide mineralization consists of chalcopyrite, cubanite, pyrrhotite, and pentlandite, with minor bornite, violarite, pyrite, sphalerite, galena, talnakhite, mackinawite, and valleriite. Sulfide minerals occur mainly as blebs interstitial with plagioclase, olivine, and augite grains, but also may occur within plagioclase and augite grains, as intergrowths with silicates, or as fine veinlets. The percentage of sulfide varies from trace to about 5%. Palladium, platinum, and gold are associated with the sulfides.

5.4 ALTERATION

The majority of the rock at NorthMet is unaltered, with minor alteration found along fractures and micro-fractures. Alteration consists of serpentine, chlorite, and magnetite replacing olivine, uralite and biotite replacing pyroxene, and sausserite and sericite replacing plagioclase. As would be expected in a magmatic deposit of this type, sulfide mineralization does not appear to be directly related to alteration.

5.5 SUMMARY OF DRILLING PROGRAMS

Table 5-1 summarizes the drilling campaigns for the NorthMet property. The US Steel drilling was done during the late 1960's. The original US Steel work was based on a copper-nickel underground mining scenario. US Steel's assaying did not include the platinum group metals.

In 1989, PolyMet (then Fleck Resources) entered into a 20-year renewable lease with US Steel for the NorthMet (then Dunka Road) deposit. At that time, PolyMet did some re-logging and considerable re-assaying, including gold and PGM assays, but did not drill additional holes.

NERCO Minerals Co. leased the property from PolyMet during 1990 and drilled 4 holes (2 were un-sampled metallurgical holes) and did a resource calculation as part of an evaluation of the property. NERCO allowed their option to expire during 1991.

Table 5-1: Summary of Drilling Programs

Company	Drilling Type	No. of Holes	No. of Feet	Assay Intervals
US Steel	BX Core	112	133,909	5,037
NERCO	BQ Core	2	842	167
1998 PolyMet	RC	14	6,370	1,274
1999 PolyMet	BTW Core	3	2,476	455
	RC	18	9,300	1,868
	Mixed Core/RC	3	2,660	534
2000 PolyMet	BTW Core	16	10,714	1,984
	RC	20	8,980	1,798
PolyMet Total		74	40,500	7,913
TOTAL		**188**	**175,251**	**13,117**
	Core Total	133	147,941	7,643
	RC Total	52	24,650	4,940
	Mixed Total	3	2,660	534

During 1998, 1999, and 2000 PolyMet did considerable additional RC and core drilling, as shown on Table 5-1. One purpose for much of the drilling was to supply material for metallurgical testing.

Table 5-1 shows that the drilling through October 2000 consists of 133 core holes for 147,941ft, 52 RC holes for 24,650ft and 3 mixed holes (initial RC followed by core) for 2,660ft. PolyMet drilled 13 core holes in November-December 2000 that are not included in this prefeasibility study.

Figure 5-6 is a hole location map showing the locations of the US Steel and PolyMet drilling. The NERCO holes are also posted, but they are not obvious since they twinned US Steel holes. The map shows that the PolyMet drilling is mostly in the area where the deposit is near the surface (since the deposit strikes about N57^{o}E and dips 25^{o} to 36^{o} southeast. The only deep drilling is provided by the US Steel holes.

Figure 5-7 shows a cross section of the deposit with the rock type geology included. It can be seen that the geologic interpretation consists of 20^{o} dipping rock units offset by near vertical faulting. Copper grades are also shown on the section.

FIGURE 5–6
Hole Location Map

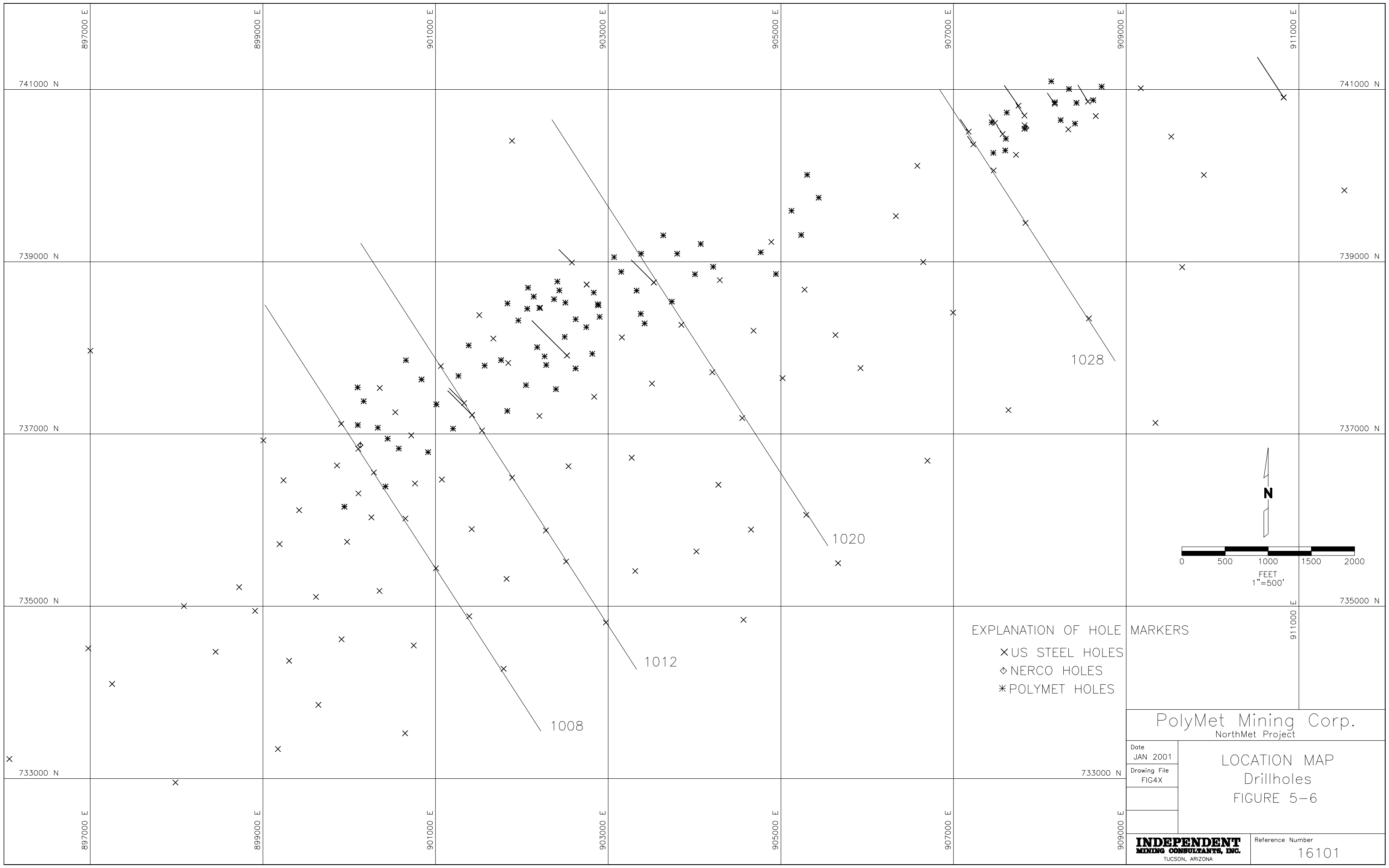
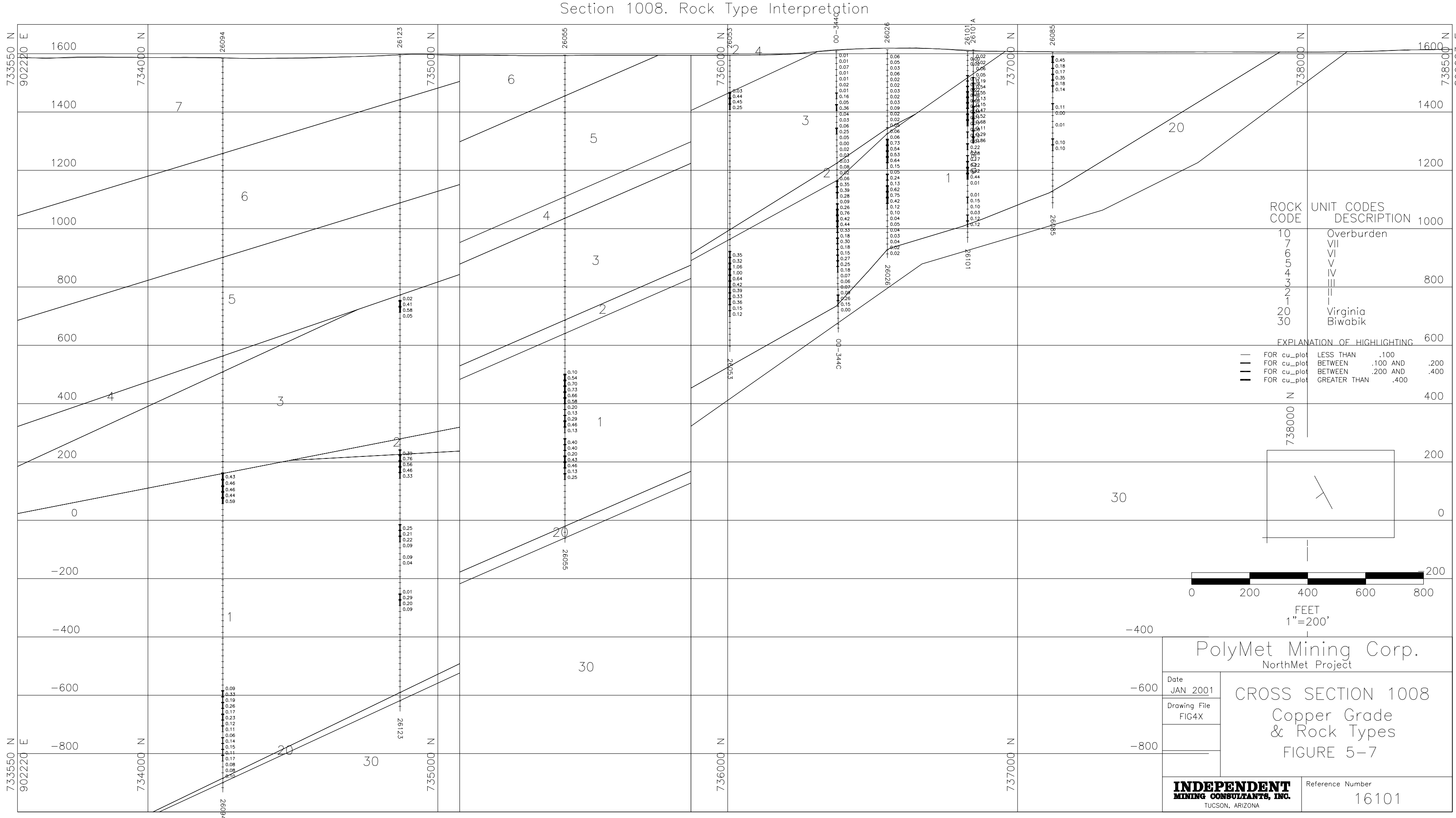


FIGURE 5-7
Section 1008. Rock Type Interpretation



5.6 METALLURGICAL SAMPLING PROGRAMS

Metallurgical samples have been collected for three different sampling programs:

1. The 1998 bench scale testing program. This included samples from 514 drillhole sample intervals.
2. The year 2000 pilot plant program. This included 747 drillhole sample intervals.
3. The variability testing program (20 samples, one each from 20 holes).

All of the metallurgical samples are from the PolyMet drilling programs.

Figure 5-8 shows the location of the drillholes from which the various metallurgical samples were drawn compared to the entire drillhole database. It can be seen that the portion of the orebody less than 1000 ft in depth is reasonably well represented in the sampling programs. To date, no samples have been taken from deeper ore zones.

Table 5-2 shows summary statistics for the sample intervals used for the various programs. It can be seen that the pilot plant samples included 747 samples at a mean copper grade of 0.397%. The bench scale samples included 514 samples at a mean copper grade of 0.424% and the variability samples included 20 samples at a mean copper grade of 0.451%.

The bottom of Table 5-2 shows the summary statistics of 20ft drillhole composites inside the IMC ore zones (based on NSR cutoff of $US 4.00). There are 2,252 composites with a mean copper grade of 0.288%. To date, lower grade material that will likely be processed has been significantly under-represented in the metallurgical sampling.

Future studies need to sample material from the deeper ore zones and test more lower-grade material.

Figure 5-8
Location of Metallurgical Samples
With Respect to All Drillholes

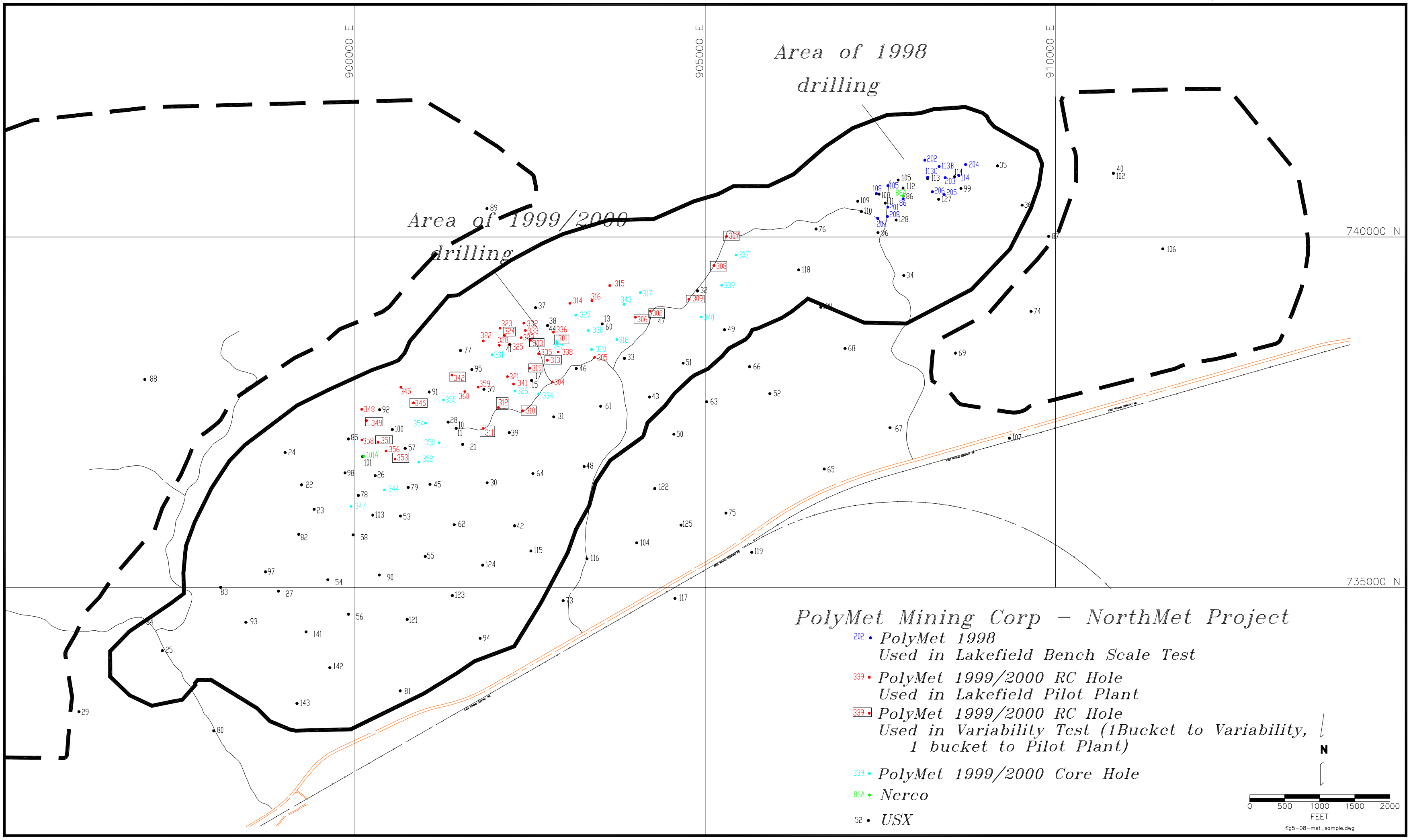


Table 5-2: Summary of Metallurgical Samples Versus 20ft Composites in Ore Zone								
Description	No. of Samples	NSR ($US)	Copper (%)	Nickel (%)	Cobalt (ppm)	Palladium (ppm)	Platinum (ppm)	Gold (ppm)
Pilot Plant Samples	747	14.80	0.397	0.116	82.4	0.363	0.086	0.054
Bench Scale Samples	514	16.02	0.424	0.131	86.3	0.385	0.094	0.057
Variability Samples	20	15.85	0.451	0.133	88.4	0.334	0.100	0.042
20ft Composites (Ore Zone)	2252	10.89	0.288	0.082	66.1	0.273	0.074	0.039

5.7 BLOCK GRADE ESTIMATION

The resource estimate used for this study is based on a block model developed by IMC. Block grade estimates were done for copper, nickel, cobalt, platinum, palladium, gold, iron, and sulfur. The grade estimates were done by ordinary kriging. An ore zone was also developed for the grade estimations. This was done by an indicator kriging method using a discriminator NSR value of $4.00 per ton to identify the blocks likely to be above this economic threshold. Only blocks identified as being in the zone were estimated and only drillhole composites inside the zone were used to estimate the blocks. The structural boundaries, and some of the rock type boundaries, were also respected during the estimation.

5.8 GEOLOGIC RESOURCE

5.8.1 Pre-Feasibility Study Resource Estimate

Table 5-3 presents the geologic resources of the NorthMet deposit by various NSR cutoff grades. These are the resources based on the model used for the pre-feasibility study. The resources are also shown by the measured, indicated, and inferred resource categories. At the $US 4.00 NSR cutoff the total resource is 1.0 billion tons at 0.323% copper, 0.085% nickel, 62.07 ppm cobalt, 0.319 ppm palladium, 0.088 ppm platinum, and 0.045 ppm gold. The NSR and copper equivalent grades of this material are $12.24 and 0.877% respectively. It can also be seen that roughly 1/3 of the resource falls in each resource category.

Table 5-4 shows the geologic resource by various total copper cutoff grades. At the 0.1% copper cutoff the resource is about 1.0 billion tons. It can be seen that the median copper grade of the resource is about 0.3%; about ½ of the resource is above and ½ below this grade. It can also be seen that only about 1/10th of the resource is above 0.5% copper and almost none of the resource is above 0.6% copper.

Table 5-3: Geologic Resource by Various NSR Cutoff Grades and Resource Classification

NSR Cutoff	Resource Category	Ore Ktons	NSR ($US)	Copper (%)	Nickel (%)	Cobalt (ppm)	Palladium (ppm)	Platinum (ppm)	Gold (ppm)	Cu Eq (%)
$4.00	Measured	334,822	11.46	0.303	0.084	65.99	0.287	0.079	0.041	0.821
$4.00	Indicated	308,378	12.45	0.329	0.085	61.56	0.326	0.091	0.047	0.892
$4.00	Inferred	360,234	12.78	0.337	0.086	58.88	0.343	0.093	0.048	0.916
$4.00	Total	1,003,434	12.24	0.323	0.085	62.08	0.319	0.088	0.045	0.877
$5.00	Measured	323,719	11.69	0.309	0.086	66.08	0.295	0.081	0.042	0.838
$5.00	Indicated	295,123	12.80	0.337	0.087	61.41	0.339	0.094	0.049	0.918
$5.00	Inferred	335,061	13.40	0.351	0.089	58.89	0.365	0.099	0.051	0.961
$5.00	Total	953,903	12.63	0.332	0.087	62.11	0.333	0.091	0.047	0.906
$6.00	Measured	301,167	12.15	0.320	0.088	66.41	0.310	0.084	0.043	0.871
$6.00	Indicated	278,108	13.24	0.347	0.089	61.58	0.354	0.098	0.051	0.949
$6.00	Inferred	309,555	14.05	0.365	0.092	59.30	0.390	0.105	0.054	1.007
$6.00	Total	888,830	13.15	0.344	0.090	62.42	0.352	0.096	0.049	0.943
$7.00	Measured	278,579	12.61	0.332	0.090	66.73	0.325	0.088	0.045	0.904
$7.00	Indicated	263,776	13.61	0.356	0.091	61.67	0.368	0.102	0.053	0.976
$7.00	Inferred	289,048	14.59	0.377	0.094	59.43	0.410	0.110	0.056	1.046
$7.00	Total	831,403	13.62	0.355	0.092	62.59	0.368	0.100	0.051	0.976
$8.00	Measured	254,073	13.10	0.345	0.093	66.91	0.342	0.092	0.047	0.939
$8.00	Indicated	247,175	14.02	0.365	0.092	61.89	0.384	0.106	0.055	1.005
$8.00	Inferred	271,815	15.04	0.387	0.096	59.96	0.427	0.115	0.058	1.078
$8.00	Total	773,063	14.08	0.366	0.094	62.86	0.385	0.105	0.053	1.009
$9.00	Measured	225,035	13.70	0.361	0.095	67.07	0.362	0.097	0.050	0.982
$9.00	Indicated	222,012	14.65	0.380	0.095	62.47	0.407	0.112	0.057	1.050
$9.00	Inferred	244,546	15.78	0.403	0.099	60.64	0.455	0.121	0.062	1.131
$9.00	Total	691,593	14.74	0.382	0.096	63.32	0.409	0.110	0.056	1.057
$10.00	Measured	193,265	14.38	0.379	0.098	67.27	0.385	0.102	0.052	1.031
$10.00	Indicated	197,282	15.29	0.395	0.097	62.81	0.430	0.118	0.060	1.096
$10.00	Inferred	225,163	16.32	0.416	0.101	61.00	0.474	0.126	0.064	1.170
$10.00	Total	615,710	15.38	0.398	0.099	63.55	0.432	0.116	0.059	1.103

Table 5-4: Geologic Resource by Various Copper Cutoff Grades and Resource Classification

Copper Cutoff (%)	Resource Category	Ore Ktons	NSR ($US)	Copper (%)	Nickel (%)	Cobalt (ppm)	Palladium (ppm)	Platinum (ppm)	Gold (ppm)	Cu Eq (%)
0.10	Measured	335,588	11.44	0.303	0.084	65.92	0.286	0.078	0.041	0.820
0.10	Indicated	311,128	12.37	0.327	0.085	61.49	0.323	0.090	0.047	0.887
0.10	Inferred	365,596	12.65	0.334	0.085	58.83	0.338	0.092	0.048	0.906
0.10	Total	1,012,312	12.16	0.322	0.085	62.00	0.316	0.087	0.045	0.872
0.15	Measured	315,618	11.82	0.314	0.086	66.00	0.298	0.081	0.042	0.847
0.15	Indicated	295,601	12.76	0.338	0.087	61.39	0.336	0.094	0.049	0.914
0.15	Inferred	343,509	13.16	0.347	0.088	58.88	0.355	0.096	0.050	0.943
0.15	Total	954,728	12.59	0.333	0.087	62.01	0.330	0.090	0.047	0.902
0.20	Measured	265,142	12.79	0.341	0.091	66.67	0.326	0.088	0.046	0.917
0.20	Indicated	262,250	13.55	0.359	0.091	61.87	0.361	0.100	0.052	0.971
0.20	Inferred	297,593	14.25	0.374	0.093	59.78	0.391	0.105	0.054	1.021
0.20	Total	824,985	13.56	0.359	0.092	62.66	0.361	0.098	0.051	0.972
0.25	Measured	210,692	13.85	0.373	0.097	67.25	0.357	0.096	0.050	0.993
0.25	Indicated	217,550	14.59	0.387	0.096	62.34	0.394	0.109	0.056	1.046
0.25	Inferred	249,319	15.44	0.404	0.099	60.57	0.431	0.115	0.059	1.107
0.25	Total	677,561	14.67	0.389	0.097	63.22	0.396	0.107	0.055	1.052
0.30	Measured	157,165	15.07	0.408	0.103	68.02	0.395	0.105	0.053	1.081
0.30	Indicated	170,524	15.79	0.419	0.101	63.23	0.433	0.119	0.060	1.132
0.30	Inferred	202,347	16.67	0.435	0.105	61.57	0.474	0.125	0.063	1.195
0.30	Total	530,036	15.91	0.422	0.103	64.02	0.437	0.117	0.059	1.141
0.40	Measured	73,814	17.76	0.482	0.114	69.12	0.484	0.127	0.064	1.273
0.40	Indicated	89,310	18.49	0.487	0.113	65.32	0.530	0.141	0.070	1.326
0.40	Inferred	116,844	19.23	0.502	0.117	64.66	0.561	0.143	0.073	1.378
0.40	Total	279,968	18.61	0.492	0.115	66.05	0.531	0.138	0.070	1.334
0.50	Measured	25,590	20.40	0.560	0.126	70.92	0.566	0.144	0.074	1.463
0.50	Indicated	33,291	21.12	0.565	0.124	66.81	0.616	0.153	0.081	1.514
0.50	Inferred	45,046	21.97	0.592	0.130	67.95	0.636	0.157	0.084	1.575
0.50	Total	103,927	21.31	0.575	0.127	68.32	0.612	0.153	0.081	1.528
0.60	Measured	5,806	23.31	0.643	0.136	69.14	0.663	0.168	0.085	1.671
0.60	Indicated	8,070	24.94	0.662	0.135	65.94	0.760	0.189	0.099	1.787
0.60	Inferred	16,145	25.18	0.693	0.143	69.64	0.732	0.180	0.096	1.805
0.60	Total	30,021	24.75	0.675	0.139	68.55	0.726	0.180	0.095	1.774

5.8.2 March 2001 Model Update

During March 2001, near the end of the pre-feasibility study, IMC was provided with additional drilling information and requested to update the resource model. The new holes were drilled by PolyMet. The new drilling amounted to 13 holes, 8,967 ft of drilling, and 1,620 assay intervals. Figure 5-9 shows the location of the new holes in relation to the other data. It can also be seen that the holes are part of the program proposed by PolyMet and discussed in Section 4.7 of the mining report.

Rock type geology was updated in the area influenced by the new holes. The ore zones were revised and grades were estimated using the same methods used for the pre-feasibility study model.

Tables 5-5 and 5-6 show the geologic resource for the updated model by NSR and copper cutoff grades respectively. These tables compare with Tables 5-3 and 5-4. At the $4.00 NSR cutoff grade the total resource decreased about 0.77% in tonnage from 1,003,437 ktons to 995,755 ktons. The decrease was predominantly in the inferred resource category as measured resource increased 7.89% from 334,822 ktons to 361,225 ktons. Measured plus indicated resource increased 2.86% from 643,200 ktons to 661,584 ktons.

FIGURE 5-9
Additional Year 2000 Holes

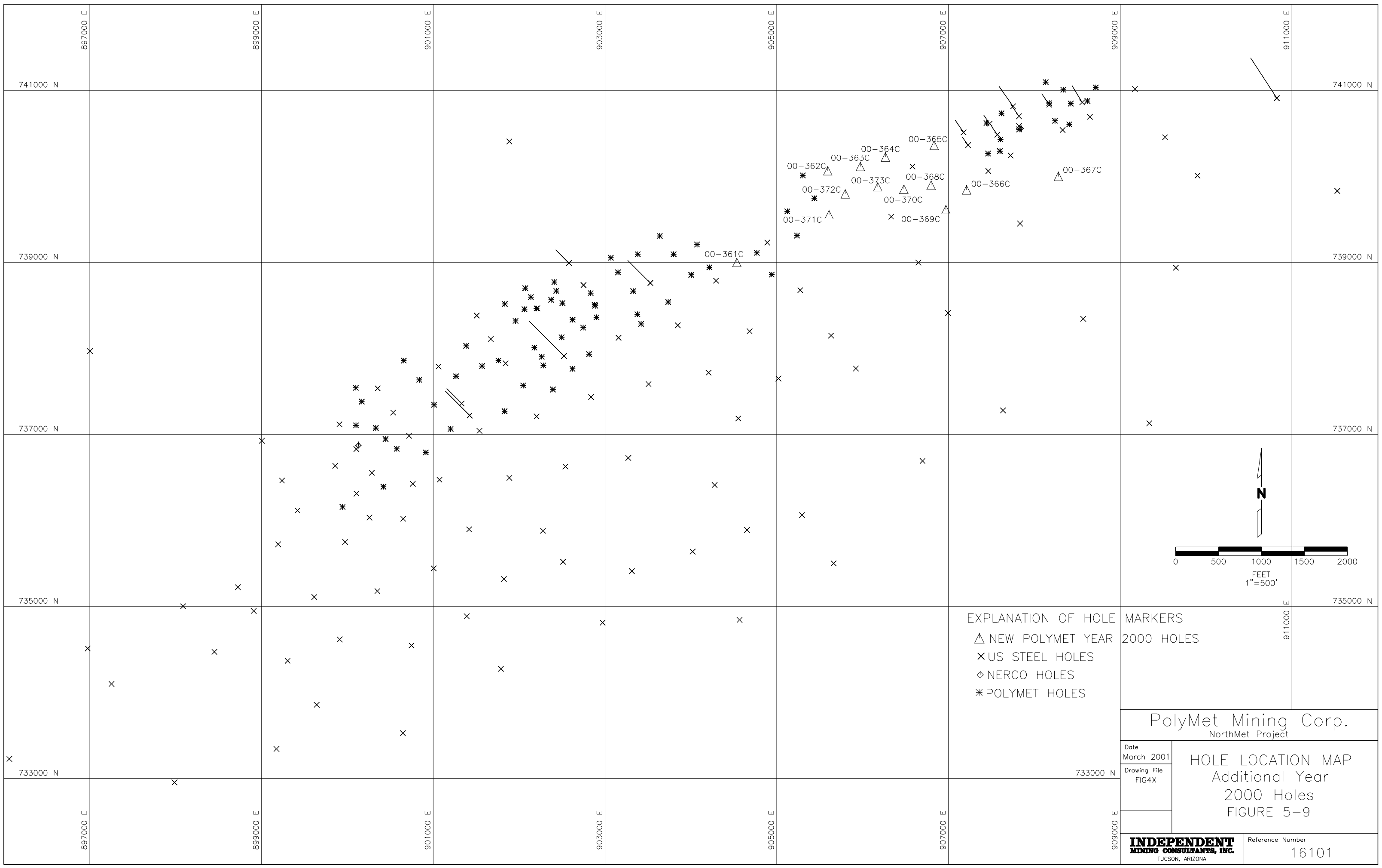


Table 5-5: Geologic Resource by Various NSR Cutoff Grades and Resource Classification

Revised March 8, 2001 with 13 New Drill Holes

NSR Cutoff	Resource Category	Ore Ktons	NSR ($US)	Copper (%)	Nickel (%)	Cobalt (ppm)	Palladium (ppm)	Platinum (ppm)	Gold (ppm)	Cu Eq (%)
$4.00	Measured	361,225	11.41	0.301	0.084	66.31	0.287	0.078	0.040	0.818
$4.00	Indicated	300,359	12.46	0.330	0.085	61.67	0.327	0.091	0.047	0.893
$4.00	Inferred	334,164	12.87	0.340	0.086	58.84	0.346	0.095	0.049	0.923
$4.00	Total	995,748	12.22	0.323	0.085	62.40	0.319	0.088	0.045	0.876
$5.00	Measured	349,993	11.63	0.307	0.085	66.41	0.294	0.080	0.041	0.834
$5.00	Indicated	287,063	12.82	0.338	0.087	61.53	0.340	0.095	0.049	0.919
$5.00	Inferred	308,916	13.55	0.355	0.089	58.84	0.370	0.101	0.052	0.971
$5.00	Total	945,972	12.62	0.332	0.087	62.46	0.333	0.091	0.047	0.905
$6.00	Measured	327,475	12.05	0.317	0.087	66.76	0.308	0.083	0.043	0.864
$6.00	Indicated	269,863	13.28	0.349	0.089	61.74	0.356	0.099	0.051	0.952
$6.00	Inferred	283,860	14.26	0.371	0.092	59.28	0.397	0.107	0.055	1.022
$6.00	Total	881,198	13.14	0.344	0.089	62.81	0.351	0.096	0.049	0.942
$7.00	Measured	304,457	12.47	0.328	0.090	67.05	0.322	0.086	0.044	0.894
$7.00	Indicated	256,610	13.63	0.357	0.091	61.77	0.369	0.102	0.052	0.977
$7.00	Inferred	265,853	14.79	0.383	0.095	59.33	0.417	0.113	0.057	1.060
$7.00	Total	826,920	13.58	0.355	0.092	62.93	0.367	0.100	0.051	0.973
$8.00	Measured	277,481	12.95	0.340	0.092	67.26	0.338	0.090	0.046	0.928
$8.00	Indicated	240,073	14.06	0.366	0.092	61.98	0.385	0.106	0.054	1.008
$8.00	Inferred	250,922	15.23	0.392	0.096	59.87	0.434	0.117	0.059	1.092
$8.00	Total	768,476	14.04	0.365	0.093	63.20	0.384	0.104	0.053	1.007
$9.00	Measured	245,836	13.52	0.355	0.094	67.42	0.358	0.095	0.048	0.969
$9.00	Indicated	215,846	14.68	0.381	0.094	62.47	0.408	0.112	0.057	1.052
$9.00	Inferred	226,199	15.97	0.408	0.099	60.55	0.463	0.124	0.063	1.145
$9.00	Total	687,881	14.69	0.381	0.096	63.61	0.408	0.110	0.056	1.053
$10.00	Measured	209,814	14.21	0.373	0.098	67.51	0.382	0.100	0.051	1.018
$10.00	Indicated	192,824	15.30	0.396	0.097	62.61	0.431	0.118	0.060	1.097
$10.00	Inferred	210,301	16.45	0.420	0.101	60.83	0.480	0.128	0.065	1.180
$10.00	Total	612,939	15.32	0.396	0.099	63.68	0.431	0.115	0.059	1.098

Table 5-6: Geologic Resource by Various Copper Cutoff Grades and Resource Classification

Revised March 8, 2001 with 13 New Drill Holes

Copper Cutoff (%)	Resource Category	Ore Ktons	NSR ($US)	Copper (%)	Nickel (%)	Cobalt (ppm)	Palladium (ppm)	Platinum (ppm)	Gold (ppm)	Cu Eq (%)
0.10	Measured	361,918	11.39	0.301	0.084	66.24	0.286	0.078	0.040	0.817
0.10	Indicated	303,089	12.38	0.328	0.085	61.60	0.324	0.090	0.047	0.887
0.10	Inferred	339,507	12.72	0.336	0.085	58.79	0.341	0.093	0.048	0.912
0.10	Total	1,004,514	12.14	0.321	0.085	62.32	0.316	0.087	0.045	0.870
0.15	Measured	342,178	11.74	0.311	0.086	66.34	0.296	0.080	0.041	0.841
0.15	Indicated	287,689	12.77	0.338	0.087	61.51	0.336	0.094	0.049	0.916
0.15	Inferred	317,690	13.28	0.351	0.088	58.84	0.359	0.098	0.050	0.952
0.15	Total	947,557	12.57	0.333	0.087	62.36	0.329	0.090	0.046	0.901
0.20	Measured	289,899	12.64	0.336	0.091	67.01	0.323	0.087	0.045	0.906
0.20	Indicated	255,375	13.57	0.359	0.091	61.96	0.361	0.100	0.052	0.973
0.20	Inferred	275,202	14.39	0.379	0.094	59.74	0.396	0.107	0.055	1.032
0.20	Total	820,476	13.52	0.358	0.092	63.00	0.359	0.098	0.051	0.969
0.25	Measured	229,523	13.68	0.367	0.096	67.50	0.354	0.094	0.048	0.980
0.25	Indicated	212,867	14.59	0.387	0.096	62.28	0.395	0.109	0.056	1.046
0.25	Inferred	231,257	15.60	0.409	0.099	60.47	0.437	0.117	0.060	1.118
0.25	Total	673,647	14.63	0.388	0.097	63.44	0.395	0.107	0.055	1.048
0.30	Measured	164,864	14.99	0.405	0.102	68.11	0.394	0.104	0.053	1.074
0.30	Indicated	167,020	15.77	0.419	0.101	62.90	0.434	0.119	0.060	1.131
0.30	Inferred	190,707	16.75	0.438	0.105	61.24	0.477	0.126	0.064	1.201
0.30	Total	522,591	15.88	0.422	0.103	63.94	0.437	0.117	0.059	1.139
0.40	Measured	75,745	17.69	0.480	0.113	69.07	0.483	0.125	0.063	1.268
0.40	Indicated	87,699	18.49	0.488	0.112	65.00	0.530	0.141	0.070	1.325
0.40	Inferred	112,962	19.20	0.502	0.116	64.14	0.562	0.143	0.073	1.376
0.40	Total	276,406	18.56	0.492	0.114	65.76	0.530	0.137	0.069	1.330
0.50	Measured	25,763	20.31	0.559	0.125	70.82	0.564	0.142	0.074	1.456
0.50	Indicated	32,821	21.08	0.566	0.123	66.58	0.616	0.153	0.080	1.511
0.50	Inferred	43,290	21.90	0.593	0.128	67.36	0.637	0.156	0.084	1.570
0.50	Total	101,874	21.23	0.576	0.126	67.98	0.612	0.151	0.080	1.522
0.60	Measured	5,731	23.24	0.644	0.135	68.86	0.661	0.167	0.085	1.666
0.60	Indicated	7,996	24.91	0.662	0.134	65.72	0.760	0.188	0.099	1.785
0.60	Inferred	15,694	25.06	0.694	0.140	69.01	0.730	0.178	0.096	1.796
0.60	Total	29,421	24.66	0.676	0.137	68.09	0.725	0.179	0.095	1.768

6.0 MINING

6.1 GENERAL

A mine plan was developed for the NorthMet Project to supply ore to a flotation concentrator and autoclave at the rate of 20,075 ktons per year (about 55,000 tons per day for 365 days per year). The mine is scheduled to operate 360 days per year. Each operating day will consist of three 8-hour shifts, matching the current practice at other mines in the area. Four mining crews will cover the operation.

6.2 PIT DESIGN AND POTENTIAL MINEABLE RESOURCE

The final pit design was based on a floating cone pit geometry at the base case prices of $0.85 per pound copper, $3.25 per pound nickel, $550 per ounce palladium, $8.00 per pound cobalt, $500 per ounce platinum, and $275 per ounce gold. Only measured and indicated resource was allowed to contribute to revenue. Time value of money discounting was not considered in the floating cone calculation. This floating cone contained 498,373 ktons of ore at an average NSR head grade of $11.61 (at an NSR cutoff grade of $4.31 NSR) and 1.8 billion tons of total material. As will be discussed in more detail below the above tonnage contains a small amount of inferred resource.

Table 6-1 shows the open pit design parameters.

Table 6-1: Open Pit Design Parameters	
Haul Road Width	100 ft
Haul Road Grade	8%
Operating Bench Height	20 or 40 ft
Footwall Interramp Slope Angle	30^{o}
Hangingwall Interramp Slope Angle	50^{o}
Nominal Minimum Mining Width	300 ft

Figure 6-1 shows the final pit design. There are five pit exits maintained to allow access to the crusher and stockpiles on the southeast side of the pit and the waste storage areas on the east and west sides. The pit bottom is at the 200 ft elevation. The highest wall is about 1400 ft in the south. The total area disturbed by the pit is about 1,026 acres.

The final pit design was used to tabulate the potential mineable resources. Table 6-2 presents the mineable resources at various NSR cutoff grades. At the base internal cutoff grade of $4.31, the potential mineable resource amounts to 486,832 ktons of ore at an NSR value of $11.43. The average metal grades at this cutoff grade are 0.301% copper, 0.083% nickel, 66.20 ppm cobalt, 0.287 ppm palladium, 0.084 ppm platinum, 0.042 ppm gold, 6.09% iron, and 0.74% sulfur. The total material contained in the pit geometry is 1,921,266 ktons.

Table 6-3 presents the potential mineable resource at various copper cutoff grades.

Although the pit design is based on only measured and indicated resource, inferred material in the design geometry is also included in the above potential mineable resources. This amounts to 82,339 ktons (16.9% of the total) at an NSR value of $12.50. The inferred material amounts to only about 4 years of production of the total mine life of 25 years. The continuity of the mineralized zones is good, and it is the opinion of IMC that most of the inferred resource will be upgraded to measured/indicated resource when additional drilling is done. Thirteen holes drilled by PolyMet during December 2000, that are not included in this study, reduced the amount of inferred material in the pit from 16.9% to 14.6%. The holes were drilled in a localized area in the northeast part of the deposit.

The measured, indicated, and small amount of inferred resource contained within the pit geometry designed using only measured and indicated resource is the basis for the mine production schedule and base case economics.

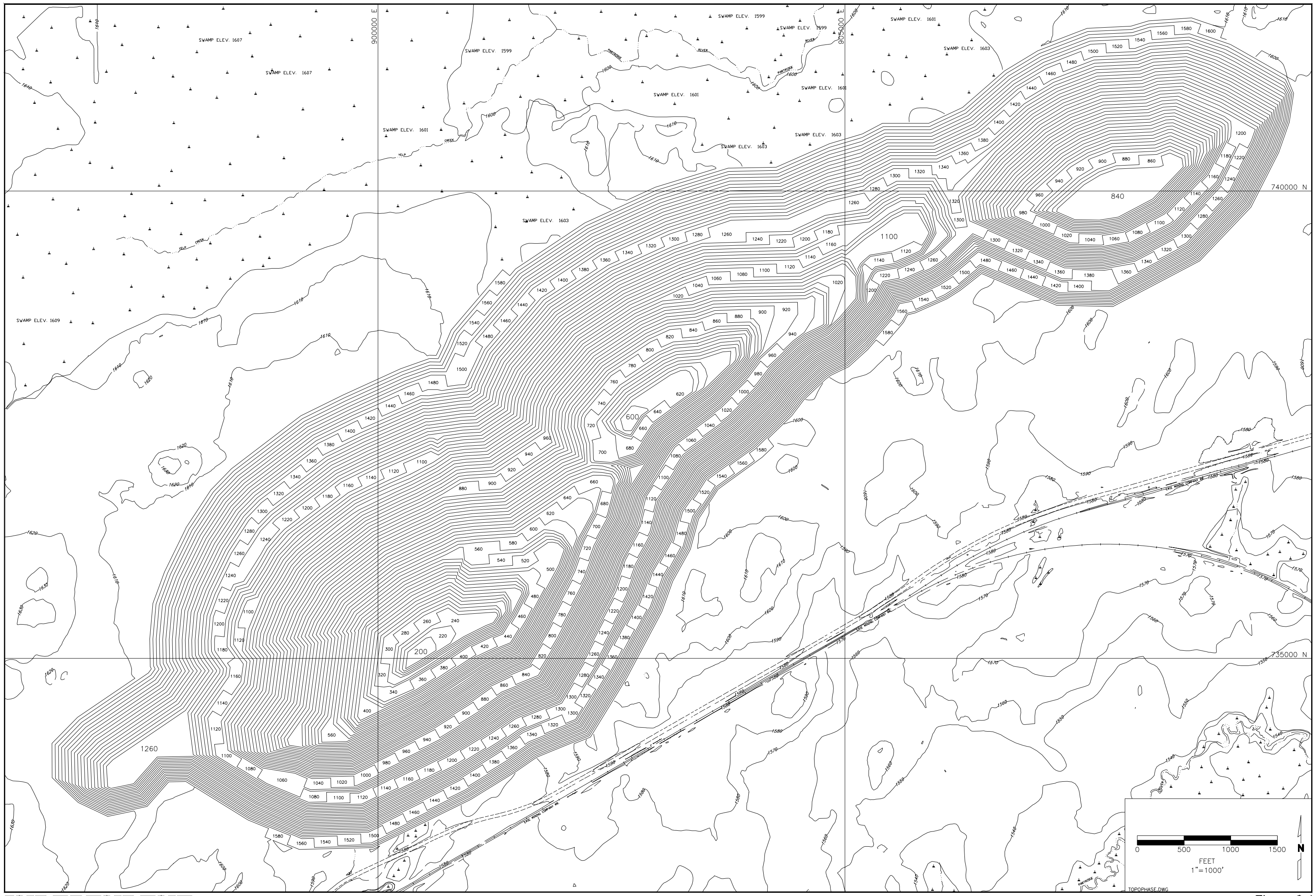


Figure 6-1
Final Pit Design

Table 6-2: Mineable Resources by Various NSR Cutoffs

NSR Cutoff $US	Ore Ktons	Meas/Ind Ktons	NSR $US	Cu Eq %	Copper %	Nickel %	Cobalt ppm	Palladium ppm	Platinum ppm	Gold ppm	Iron %	Sulfur %	Strip Ratio
$4.31	486,832	404,477	11.43	0.819	0.301	0.083	66.20	0.287	0.084	0.042	6.09	0.74	2.95
$4.50	484,696	402,696	11.46	0.822	0.302	0.083	66.20	0.288	0.084	0.042	6.09	0.74	2.96
$4.86	478,490	397,560	11.55	0.828	0.304	0.083	66.23	0.290	0.085	0.042	6.09	0.74	3.02
$5.00	476,139	395,581	11.58	0.830	0.305	0.083	66.25	0.291	0.085	0.042	6.09	0.74	3.04
$5.50	463,087	385,352	11.76	0.843	0.309	0.085	66.42	0.297	0.087	0.043	6.09	0.74	3.15
$7.50	396,025	327,849	12.66	0.908	0.332	0.089	67.18	0.327	0.094	0.047	6.08	0.78	3.85
Total Material in Final Pit Geometry is 1,921,266 ktons.													

Note: Ore Ktons and Grade Columns include measured, indicated, and inferred material in the pit geometry.

Table 6-3: Mineable Resources by Various Copper Cutoffs

Copper Cutoff	Ore Ktons	Meas/Ind Ktons	NSR $US	Cu Eq %	Copper %	Nickel %	Cobalt ppm	Palladium ppm	Platinum ppm	Gold ppm	Iron %	Sulfur %	Strip Ratio
0.10	489,039	406,327	11.40	0.817	0.300	0.082	66.18	0.285	0.083	0.042	6.08	0.74	2.93
0.15	461,497	383,195	11.74	0.842	0.311	0.084	66.30	0.295	0.086	0.043	6.09	0.76	3.16
0.18	421,601	348,382	12.24	0.877	0.325	0.087	66.77	0.309	0.090	0.045	6.10	0.78	3.56
0.20	390,545	321,848	12.61	0.904	0.336	0.089	67.18	0.319	0.093	0.046	6.12	0.79	3.92
0.22	356,932	293,775	13.03	0.934	0.349	0.091	67.50	0.331	0.096	0.048	6.12	0.81	4.38
0.25	305,064	248,960	13.69	0.982	0.369	0.095	68.21	0.349	0.101	0.050	6.18	0.84	5.30
0.30	225,989	181,013	14.87	1.065	0.403	0.100	69.00	0.384	0.111	0.055	6.25	0.88	7.50
0.40	100,920	78,488	17.51	1.255	0.481	0.112	70.77	0.461	0.133	0.065	6.73	0.96	18.04
Total Material in Final Pit Geometry is 1,921,266 ktons.													

Note: Ore Ktons and Grade Columns include measured, indicated, and inferred material in the pit geometry.

6.3 MINING PHASES AND MINE PRODUCTION SCHEDULE

IMC designed a set of seven mining phases for the NorthMet Project. Figure 6-2 shows the outline of the phases on the 1500 bench. The goal of the phasing was to develop the mine in a logical order by commencing mining with higher grade, low strip ratio ore and then progressing to higher strip ratio, lower grade ore. Phase 1 is in the northeastern part of the deposit and is based on a floating cone run at 55% of the base case prices cone, i.e. 55% recovery of NSR value. Phase 2, also based on the 55% of base case cone, is in the southwestern part of the deposit. The remaining five phases push the hangingwall south and join the two ends of the deposit. Exits are maintained on the south side in all phases for access to the crusher, possible low-grade stockpile area, and to the tailings facility. Exits on the north wall are maintained in all phases for access to the waste storage areas. In all phases, the north wall is at approximate final position.

Phase 3 is an extension of phase 2 to the northeast.

Phase 4 pushes phase 1 in the northeastern part of the deposit to the south and reaches final position on the south side.

Phase 5 pushes phase 3 to the south and reaches final position on the south side on the southwestern portion of the phase.

Phase 6 pushes phase 5 to the northeast.

Phase 7 pushes phase 6 northeast connecting it with phase 4. This phase mines the pit to the final limits.

Table 6-4 summarizes the tonnages in each phase.

A mine production schedule was developed to show the relationship of ore and waste mining rates throughout the life of the mine. The ore and waste contained in each of the mining phases was used to develop the schedule, assuring that criteria such as continuous ore exposure, mining accessibility, and consistent material movements were met.

The approach used in the development of the production schedule was as follows:

1. The schedule is based on delivering ore to a flotation concentrator and autoclave at a rate of 20,075 ktons per year of ore. The first full year of ore processing is scheduled at 17,000 ktons, about 85% of full capacity.

2. The waste movement schedule is based on establishing the average annual waste movement required to get over the highest stripping peaks and to mine at that average rate. This results in a "smooth" total material schedule.

IMC examined about 50 different schedules using different cutoff grade strategies. The main criteria used to rank the schedules were the accumulated discounted cash flow achieved by the schedule at the end of year 7. This was to attempt to generate a large amount of cash during the first 7 years of mining to pay back as much capital as possible. The cutoff grade strategy chosen by IMC is as follows:

Mining Years	$NSR Cutoff Grade
PP, 1, 3, 7, 9, 11-14	$5.00
2	$5.25
4-6	$5.50
8, 10	$4.50
15-25	$4.31

Table 6-5 shows the mine production of mill ore for each mining year. This table also shows the total material movement from the mine by year. It should be noted that material described as "waste" on this table includes about 4,624 ktons of low grade stockpile material that is accumulated during mining years preproduction through 14 while the cutoff grade is elevated.

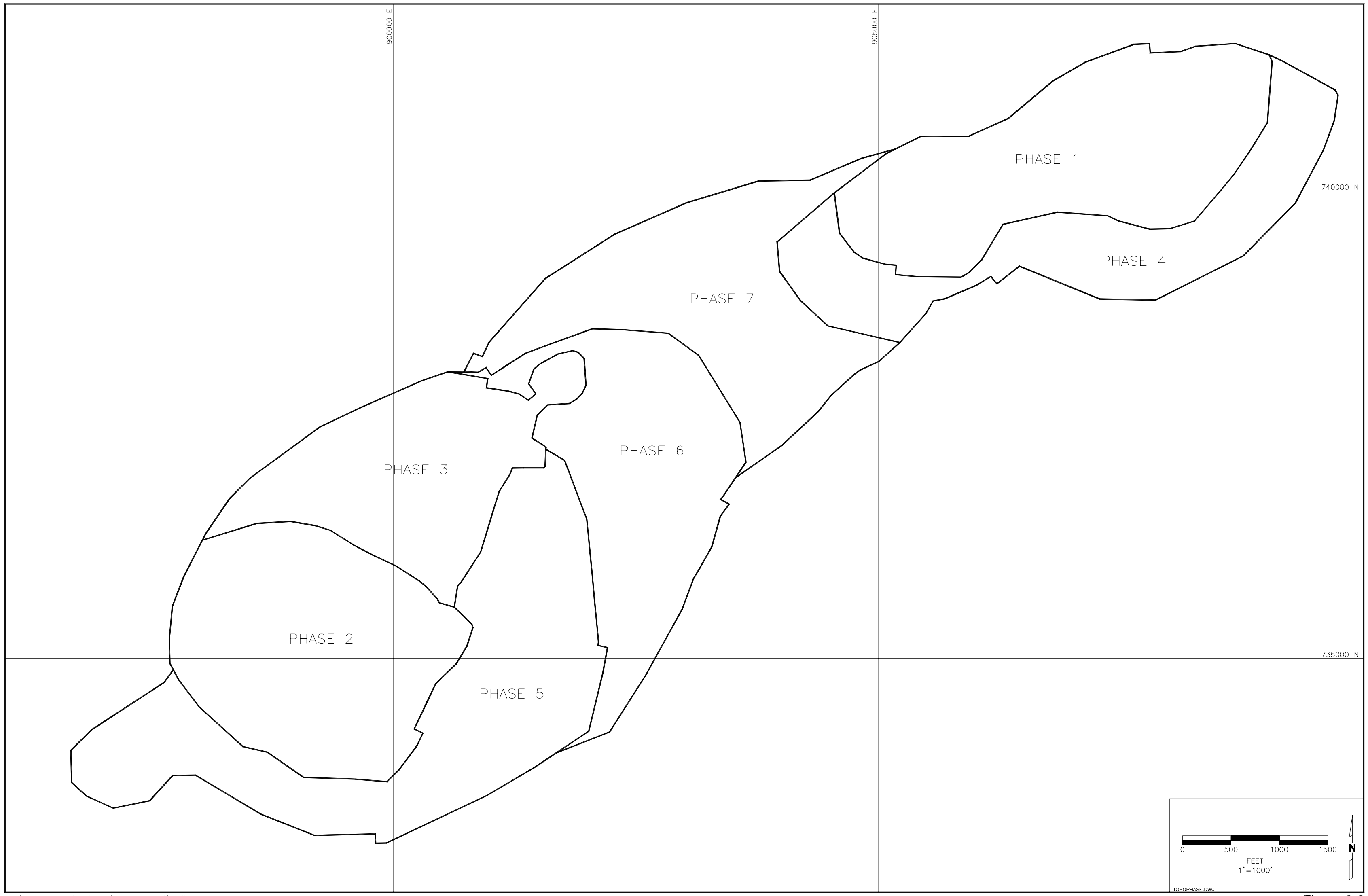


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Figure 6-2
Mining Phase Design
Phases on the 1500 Bench

Table 6-4
POLYMET MINING CORPORATION - NORTHMET PROJECT
Pre-Feasibility Study
Summary of Mining Phases

Internal Cutoff Grade - $4.31 NSR

Phase	Ore Ktons	NSR $US	Cu Eq %	Copper %	Nickel %	Cobalt ppm	Palladium ppm	Platinum ppm	Gold ppm	Total Ktons	Strip Ratio
Phase 1	52,129	12.61	0.904	0.320	0.099	69.78	0.325	0.081	0.043	175,624	2.37
Phase 2	56,261	12.52	0.898	0.348	0.080	59.47	0.308	0.106	0.054	201,143	2.58
Phase 3	54,142	10.92	0.783	0.296	0.082	66.38	0.264	0.072	0.037	147,117	1.72
Phase 4	45,247	11.39	0.816	0.291	0.084	63.70	0.303	0.073	0.039	199,522	3.41
Phase 5	115,148	12.77	0.915	0.338	0.084	63.32	0.329	0.109	0.050	550,292	3.78
Phase 6	76,184	10.28	0.737	0.278	0.078	72.38	0.239	0.071	0.036	343,624	3.51
Phase 7	87,721	9.61	0.689	0.241	0.077	67.98	0.241	0.062	0.033	303,945	2.46
TOTAL	486,832	11.43	0.819	0.301	0.083	66.20	0.287	0.084	0.042	1,921,267	2.95

Breakeven Cutoff Grade - $4.86 NSR

Phase	Ore Ktons	NSR $US	Cu Eq %	Copper %	Nickel %	Cobalt ppm	Palladium ppm	Platinum ppm	Gold ppm	Total Ktons	Strip Ratio
Phase 1	52,129	12.61	0.904	0.320	0.099	69.78	0.325	0.081	0.043	175,624	2.37
Phase 2	55,176	12.68	0.909	0.351	0.081	59.71	0.313	0.108	0.055	201,143	2.65
Phase 3	53,627	10.98	0.787	0.297	0.082	66.56	0.266	0.072	0.037	147,117	1.74
Phase 4	45,186	11.40	0.817	0.291	0.084	63.70	0.304	0.073	0.039	199,522	3.42
Phase 5	112,180	12.99	0.931	0.344	0.085	63.07	0.336	0.111	0.051	550,292	3.91
Phase 6	74,673	10.39	0.745	0.281	0.079	72.40	0.242	0.072	0.036	343,624	3.60
Phase 7	85,519	9.74	0.698	0.244	0.077	68.15	0.245	0.063	0.033	303,945	2.55
TOTAL	478,490	11.55	0.828	0.304	0.083	66.23	0.290	0.085	0.042	1,921,267	3.02

$5.00 NSR Cutoff

Phase	Ore Ktons	NSR $US	Cu Eq %	Copper %	Nickel %	Cobalt ppm	Palladium ppm	Platinum ppm	Gold ppm	Total Ktons	Strip Ratio
Phase 1	52,045	12.62	0.905	0.320	0.099	69.79	0.325	0.081	0.043	175,624	2.37
Phase 2	54,883	12.72	0.912	0.352	0.081	59.76	0.315	0.109	0.055	201,143	2.66
Phase 3	53,507	11.00	0.788	0.298	0.082	66.60	0.266	0.072	0.037	147,117	1.75
Phase 4	45,181	11.40	0.817	0.291	0.084	63.70	0.304	0.073	0.039	199,522	3.42
Phase 5	111,827	13.01	0.933	0.344	0.085	63.09	0.337	0.111	0.051	550,292	3.92
Phase 6	74,271	10.42	0.747	0.282	0.079	72.44	0.243	0.072	0.036	343,624	3.63
Phase 7	84,425	9.81	0.703	0.246	0.078	68.18	0.247	0.064	0.033	303,945	2.60
TOTAL	476,139	11.58	0.830	0.305	0.083	66.25	0.291	0.085	0.042	1,921,267	3.04

$5.50 NSR Cutoff

Phase	Ore Ktons	NSR $US	Cu Eq %	Copper %	Nickel %	Cobalt ppm	Palladium ppm	Platinum ppm	Gold ppm	Total Ktons	Strip Ratio
Phase 1	51,885	12.65	0.907	0.321	0.099	69.82	0.326	0.081	0.043	175,624	2.38
Phase 2	52,756	13.02	0.933	0.359	0.082	59.78	0.326	0.113	0.057	201,143	2.81
Phase 3	53,198	11.03	0.791	0.298	0.083	66.70	0.267	0.073	0.037	147,117	1.77
Phase 4	44,533	11.48	0.823	0.294	0.085	63.72	0.306	0.074	0.039	199,522	3.48
Phase 5	109,898	13.15	0.943	0.348	0.086	63.23	0.342	0.112	0.052	550,292	4.01
Phase 6	71,861	10.59	0.759	0.286	0.080	72.78	0.248	0.074	0.037	343,624	3.78
Phase 7	78,956	10.12	0.725	0.253	0.080	68.59	0.257	0.066	0.035	303,945	2.85
TOTAL	463,087	11.76	0.843	0.309	0.085	66.42	0.297	0.087	0.043	1,921,267	3.15

$7.50 NSR Cutoff

Phase	Ore Ktons	NSR $US	Cu Eq %	Copper %	Nickel %	Cobalt ppm	Palladium ppm	Platinum ppm	Gold ppm	Total Ktons	Strip Ratio
Phase 1	49,573	12.92	0.926	0.327	0.101	70.15	0.334	0.083	0.044	175,624	2.54
Phase 2	44,403	14.27	1.023	0.387	0.087	59.47	0.371	0.128	0.063	201,143	3.53
Phase 3	47,288	11.57	0.829	0.312	0.086	67.95	0.284	0.076	0.039	147,117	2.11
Phase 4	41,054	11.90	0.853	0.305	0.087	63.91	0.319	0.076	0.041	199,522	3.86
Phase 5	99,468	13.85	0.993	0.366	0.089	63.43	0.365	0.119	0.055	550,292	4.53
Phase 6	55,573	11.82	0.847	0.319	0.087	75.90	0.284	0.083	0.041	343,624	5.18
Phase 7	58,666	11.42	0.819	0.283	0.087	70.24	0.302	0.076	0.039	303,945	4.18
TOTAL	396,025	12.66	0.908	0.332	0.089	67.18	0.327	0.094	0.047	1,921,267	3.85

Note: All of the above tabulations include measured, indicated, and inferred material in the phases.

Table 6-5: Mine Production Schedule

			ORE GRADES											
Mining Year	NSR Cutoff	Ore Ktons	NSR $US	Cu Eq %	Copper %	Nickel %	Cobalt ppm	Palladium ppm	Platinum ppm	Gold ppm	Iron %	Sulfur %	Waste Ktons	Total Ktons
-1	5.00	1,308	11.96	0.858	0.304	0.088	61.72	0.322	0.079	0.039	4.03	0.68	17,542	18,850
1	5.00	15,693	12.23	0.877	0.310	0.095	68.12	0.319	0.077	0.040	4.86	0.76	54,307	70,000
2	5.25	20,075	12.33	0.884	0.310	0.095	67.94	0.321	0.083	0.043	4.57	0.74	49,925	70,000
3	5.00	20,075	12.75	0.914	0.324	0.092	65.02	0.330	0.101	0.050	4.96	0.69	49,925	70,000
4	5.50	20,075	12.76	0.915	0.341	0.086	62.09	0.322	0.107	0.053	5.35	0.72	49,925	70,000
5	5.50	20,075	12.52	0.898	0.355	0.081	60.96	0.299	0.104	0.053	6.61	0.72	49,925	70,000
6	5.50	20,075	10.54	0.756	0.293	0.081	69.13	0.235	0.072	0.037	6.79	0.78	49,936	70,010
7	5.00	20,075	11.50	0.824	0.311	0.085	65.90	0.281	0.077	0.041	6.58	0.71	49,925	70,000
8	4.50	20,075	11.40	0.817	0.306	0.082	62.98	0.290	0.075	0.040	6.40	0.60	79,925	100,000
9	5.00	20,075	10.93	0.784	0.282	0.078	62.20	0.287	0.077	0.039	5.62	0.63	79,925	100,000
10	4.50	20,075	11.15	0.800	0.278	0.080	62.52	0.301	0.083	0.041	4.44	0.65	79,925	100,000
11	5.00	20,075	11.42	0.819	0.284	0.078	62.64	0.310	0.093	0.042	4.84	0.67	79,925	100,000
12	5.00	20,075	12.08	0.866	0.302	0.079	62.50	0.328	0.108	0.046	5.61	0.65	63,214	83,289
13	5.00	20,075	11.84	0.849	0.306	0.076	60.48	0.304	0.114	0.048	6.44	0.63	69,666	89,741
14	5.00	20,075	9.80	0.702	0.251	0.073	67.09	0.240	0.073	0.037	6.70	0.69	79,942	100,017
15	4.31	20,075	11.01	0.789	0.306	0.081	69.25	0.257	0.072	0.040	7.02	0.77	79,925	100,000
16	4.31	20,075	11.19	0.802	0.304	0.083	72.21	0.265	0.075	0.041	7.16	0.81	79,925	100,000
17	4.31	20,075	12.23	0.877	0.328	0.085	66.99	0.311	0.088	0.047	6.86	0.81	69,926	90,000
18	4.31	20,075	9.83	0.705	0.248	0.073	62.62	0.251	0.072	0.037	6.38	0.59	69,925	90,000
19	4.31	20,075	11.76	0.843	0.315	0.085	68.90	0.286	0.088	0.042	6.75	0.84	62,824	82,899
20	4.31	20,075	11.94	0.856	0.334	0.085	70.40	0.278	0.088	0.042	6.41	0.95	45,120	65,195
21	4.31	20,075	10.92	0.783	0.295	0.080	71.90	0.262	0.076	0.037	6.44	1.01	38,384	58,459
22	4.31	20,075	9.41	0.675	0.236	0.075	68.84	0.230	0.066	0.032	6.38	0.75	39,147	59,222
23	4.31	20,075	11.75	0.843	0.295	0.086	67.47	0.312	0.084	0.041	6.13	0.69	19,596	39,671
24	4.31	20,075	12.19	0.874	0.324	0.093	72.77	0.306	0.074	0.039	6.59	0.87	27,185	47,260
25	4.31	3,480	14.31	1.026	0.422	0.106	73.58	0.329	0.080	0.046	6.62	1.25	3,173	6,653
TOTAL		482,206	11.49	0.824	0.303	0.083	66.31	0.289	0.084	0.042	6.09	0.74	1,439,062	1,921,266

NOTE: The 482,206 ktons of ore shown on this table does not include the 4,624 ktons of low grade stockpile material that is mined during years -1 through 14. The low grade stockpile material is included as "waste" on this table.

NOTE: Tabulation includes measured, indicated, and inferred material in the pit geometry.

6.4 WASTE STORAGE AREAS AND STOCKPILES

Two waste storage areas, two stockpile areas, and three pit backfill waste storage phases were designed for the NorthMet Project. The stockpile areas are for the overburden and for the low grade material. Table 6-6 shows the amount of material placed in each area by year. The final configuration of these is shown in Figure 6-3. The waste facilities were constructed in two 20 foot lifts at an overall slope angle of about 22 degrees (2.5H:1V). A swell factor of 30% was used for all dump volume calculations.

1. The waste storage facility to the east of the pit contains 210,772 ktons of material that represents waste from phase 1 and approximately 64% of the waste from phase 4.

2. The waste storage facility to the west of the pit contains 938,884 ktons of material. All of the waste from phases 2 and 3 went to this facility. The other 36% of phase 4 and portions of phases 5, 6, and 7 also went to this facility.

3. Table 6-6 and Figure 6-3 show three phases of pit backfill. The first begins in year 13, after mining phase 4 is complete and is in the northeast area of the pit. The second phase of backfill occurs in a small pod located at the southwestern part of the pit. The third phase of backfill is a continuation of the first phase that can occur after year 22, when a road is no longer needed.

4. The tailings embankment facility requires hard rock waste and overburden material in years preproduction through 23. The material is hauled to a stockpile area near the tailings facility where it will be placed in the embankment by an independent contractor.

Table 6-6: Waste Rock and Stockpile Storage Allocation by Year

			Overburden Destinations		Hard Rock Waste Destinations						
Mining Year	Mill Ore Ktons	Low Grade Stockpile Ktons	Overburden Stockpile Ktons	Tailings Embankment Ktons	East Dump Ktons	West Dump Ktons	Pit Backfill Phase 1 Ktons	Pit Backfill Phase 2 Ktons	Pit Backfill Phase 3 Ktons	Tailings Embankment Ktons	TOTAL MATERIAL Ktons
0	1,308		5,706	1,958	6,815					3,063	18,850
1	15,693	76		329	52,185					1,717	70,000
2	20,075	288	4,772	1,565	34,746	6,837				1,717	70,000
3	20,075	460			12,940	34,808				1,717	70,000
4	20,075	972	2,984	1,536	11,946	30,770				1,717	70,000
5	20,075	1,161		28	14,771	32,248				1,717	70,000
6	20,075	259	4,779	916		41,564				2,417	70,010
7	20,075	274	1,702	1,834		43,698				2,417	70,000
8	20,075	35			54,696	22,777				2,417	100,000
9	20,075	39	3,059	916	12,870	60,610				2,431	100,000
10	20,075		1,750	4,330		71,414				2,431	100,000
11	20,075	204				77,477				2,244	100,000
12	20,075	305				60,665				2,244	83,289
13	20,075	179					67,243			2,244	89,741
14	20,075	372					77,326			2,244	100,017
15	20,075					35,038	27,830	14,813		2,244	100,000
16	20,075					77,681				2,244	100,000
17	20,075		2,503	1,477		64,642				1,303	90,000
18	20,075					68,622				1,303	90,000
19	20,075					61,522				1,303	82,900
20	20,075					43,814				1,303	65,192
21	20,075					37,080				1,303	58,458
22	20,075					32,409			5,470	1,268	59,222
23	20,075								18,331	1,268	39,674
24	20,075								27,185		47,260
25	3,480								3,173		6,653
TOTAL	482,206	4,624	27,255	14,889	200,969	903,676	172,399	14,813	54,159	46,276	1,921,266

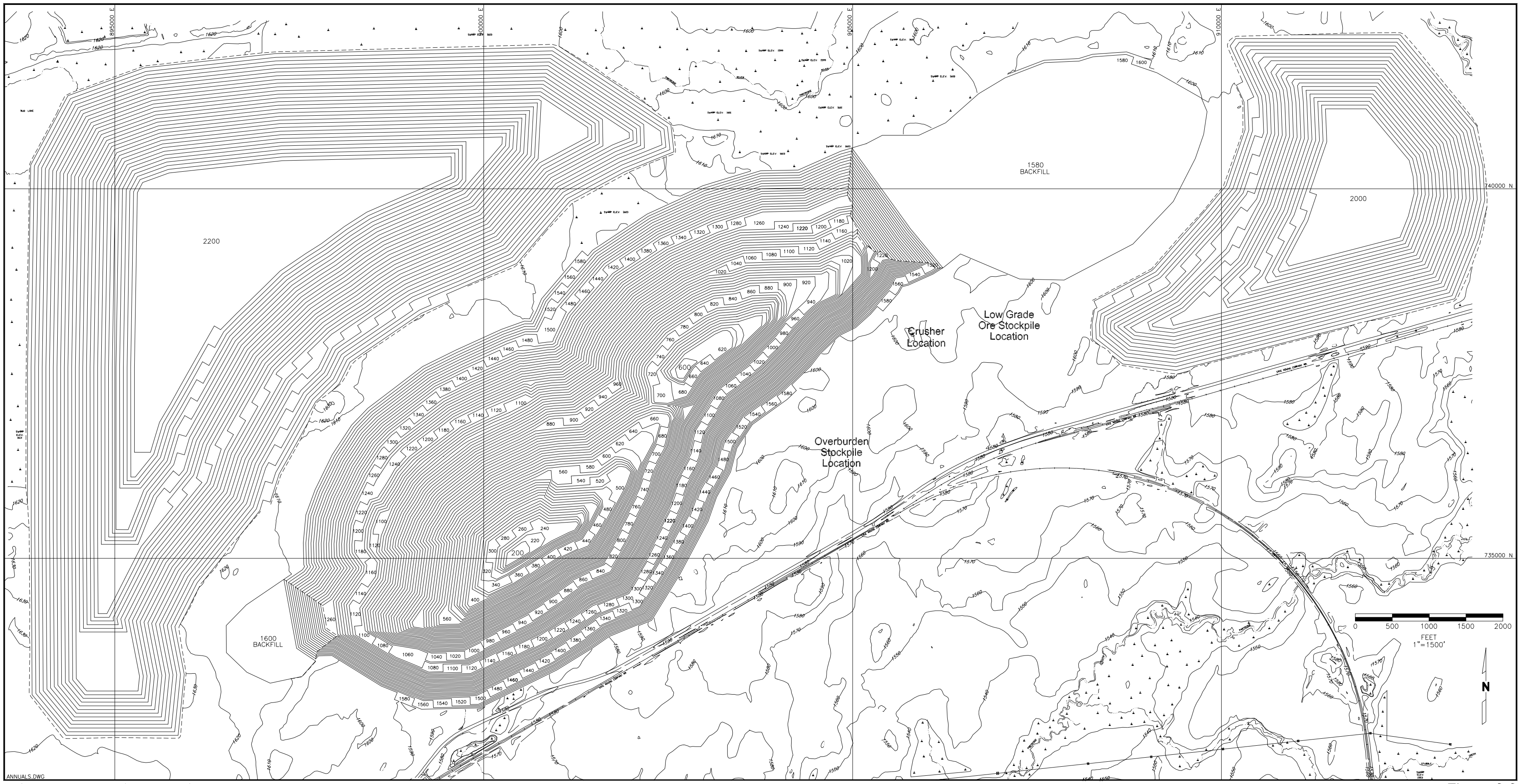

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Figure 6-3
Final Pit and Dump Configuration

6.5 MINE EQUIPMENT REQUIREMENTS

Mine equipment requirements were calculated based on the annual mine production schedule, the mine work schedule, and equipment shift production estimates. The size and type of mining equipment is consistent with the size of the project, i.e. peak material movements of about 100 million tons per year.

Specific manufacturers' model numbers for equipment are specified in this report for the purpose of illustrating size and class of equipment required. This should not be considered as a final recommendation of equipment manufacturers by IMC.

A summary of the total fleet requirement by year for the mine major equipment is shown in Table 6-7. This represents the equipment necessary to perform the following duties:

1. Construct the initial out-of-pit mine access roads from the pit area to the ore crusher and waste storage areas.

2. Remove topsoil from the mine and waste storage areas. Replace topsoil on the waste storage areas as a reclamation activity.

3. Preproduction development required to expose ore for initial production.

4. Mine and transport ore to the crusher (or crusher stockpile). Mine and transport waste material from the pit areas to the waste storage areas.

5. Maintain all the mine work areas, in-pit haul roads, and external haul roads. Also maintain the waste storage areas.

6. Haul hard rock waste and overburden to the tailings facility for construction of tailings embankments.

Table 6-7: Mine Major Equipment Fleet Requirement

	Time Period													
Equipment Type	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12
Driltech D90KS Drill		1	4	3	4	4	4	3	4	5	5	5	5	4
P&H 4100 Shovel		1	2	2	2	2	2	2	2	3	3	3	3	3
Cat 994D Loader		2	1	2	1	2	1	2	2	2	2	2	2	2
Cat 793C (240t) Haul Truck		9	13	16	16	17	19	18	19	31	29	29	29	26
Cat D10R Track Dozer		3	4	4	4	4	4	4	4	5	5	5	5	5
Cat 834B Wheel Dozer		2	2	2	2	3	2	2	3	3	3	3	3	3
Cat 16H Grader		2	2	2	2	2	2	2	2	3	3	3	3	3
Cat 773D Water Truck		2	2	2	2	2	2	2	2	3	3	3	3	3
Cat 992G Loader		1	1	1	1	1	1	1	1	1	1	1	1	1
Cat 777D Haul Truck		3	3	3	3	3	3	3	3	3	3	3	3	3
Crawlair 370 Drill		1	1	1	1	1	1	1	1	1	1	1	1	1
TOTAL		27	35	38	38	41	41	40	43	60	58	58	58	54

	Time Period													
Equipment Type	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Driltech D90KS Drill	5	5	5	5	5	5	4	4	3	3	2	3	2	0
Cat 994D Loader	3	3	3	3	3	3	3	2	2	2	2	2	1	0
P&H 2800 Shovel	2	2	2	2	2	2	2	1	1	1	1	1	1	0
Cat 793C (240t) Haul Truck	27	28	36	40	35	32	39	34	28	26	15	18	12	0
Cat D10R Track Dozer	5	5	5	5	5	5	5	4	4	4	3	2	2	0
Cat 834B Wheel Dozer	3	3	3	3	3	3	3	2	2	2	2	2	1	0
Cat 16H Grader	2	2	2	2	3	2	3	2	2	2	2	1	1	0
Cat 773D Water Truck	2	2	2	2	3	2	3	2	2	2	2	1	1	0
Cat 992G Loader	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Cat 777D Haul Truck	3	3	3	3	3	3	3	3	3	3	3	3	3	0
Crawlair 370 Drill	1	1	1	1	1	1	1	1	1	1	1	1	1	0
TOTAL	54	55	63	67	64	59	67	56	49	47	34	35	26	0

Mine equipment requirements were not estimated for the following activities:

1. Construction of any major surface water diversion channels and settlement ponds, other than the ditching and sedimentation ponds for the waste storage areas.

2. Construction of the shop area, plant area, and tailings dam area.

Table 6-8 summarizes the maximum fleet requirements for preproduction and for commercial production.

Table 6-8
Maximum Fleet Requirements for Preproduction and Commercial Production.

Equipment Type:	Preproduction	Commercial Production
Driltech D90KS Drill	1	5
P&H 4100 Shovel	1	3
Caterpillar 994D Wheel Loader	2	2
Caterpillar 793C (240t) Haul Truck	9	40
Caterpillar D10R Track Dozer	3	5
Caterpillar 834B Wheel Dozer	2	3
Caterpillar 16H Grader	2	3
Caterpillar 773D Water Truck	2	3
Caterpillar 992G Wheel Loader	1	1
Caterpillar 777D (100t) Haul Truck	3	3
Ingersoll Rand Crawlair 370 Drill	1	1

6.6 MINE MANPOWER REQUIREMENTS

6.6.1 Salaried Staff

Mine salaried staff requirements over the project life are shown in Table 6-9. The staff consists of 32 persons during preproduction and most of the commercial production years. It is reduced to 23 persons in Year 23 and after corresponding with reduced mine tonnages and activity.

Of the 32 persons assigned to most of the years, nine are in mine operations, eight in mine maintenance, nine in mine engineering, and six in mine geology.

Annual costs for the personnel, including fringe benefits, are also shown on Table 6-9. These numbers are based on information collected by IMC for a previous project in the Western US, escalated to 1st quarter 2001 US dollars. Fringe benefits are 30%.

6.6.2 Hourly Labor

Mine total hourly requirements are shown in Table 6-10. The required number of personnel is 122 persons during preproduction and 180 persons during Year 1. The number of personnel is at its maximum of 363 during Year 16. After Year 16, the personnel start to reduce due to lower mining activity, especially waste stripping.

Table 6-10 also shows the annual cost for hourly personnel, including fringe benefits.

As shown on Table 6-10, the majority of persons in mine operations are equipment operators. The number of operators for major equipment was calculated as part of the "Equipment Operating Requirements" information provided in Section 6.3 of this report.

The number of mine maintenance personnel was calculated based on the estimated maintenance labor portions of the equipment owning and operating costs. The ratio of mechanics, mechanics helpers, electricians, and welders shown on Table 6-10 is in approximately a 2:1:1:1 ratio.

An additional allowance in the manpower is required to cover vacations, sick leave, and absenteeism. The 7.4% VS&A allowance is based on 15 vacation days plus 5 sick days out of 270 scheduled shifts per crew per year.

Table 6-9: Salaried Staff Labor Requirements

JOB TITLE	Annual Cost ($US)	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
MINE OPERATIONS:																											
Mine Superintendent	110,500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mine Secretary	32,500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mine General Foreman	91,000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mine Shift Foreman	67,600	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Drilling/Blasting Foreman	67,600	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Mine Operations Total		9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	8	8
MINE MAINTENANCE:																											
Maint. Superintendent	97,500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maint. General Foreman	78,000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maint. Shift Foreman	67,600	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3
Maint. Planner	39,000	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Mine Maintenance Total		8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	6	6	6
MINE ENGINEERING:																											
Chief Engineer	84,500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Senior Mining Engineer	68,250	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
Mining Engineer	58,500	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
Geotechnical Engineer	58,500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Chief Surveyor	47,040	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Engineering Technician	39,000	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Mine Engineering Total		9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	6	6	6
MINE GEOLOGY:																											
Chief Geologist	73,500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Senior Mine Geologist	66,150	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
Mine Geologist	58,500	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Ore Control Technician	39,000	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Mine Geology Total		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	3	3	3
TOTAL PERSONNEL		32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	23	23	23

Annual Cost includes Fringes at 30%

.

Table 6-10: Mine Hourly Labor Requirements

JOB TITLE	Annual Cost	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
MINE OPERATIONS:																											
Drill Operator	50,618	4	11	10	11	10	11	10	10	15	14	14	15	13	13	15	15	15	13	14	12	10	9	9	6	7	4
Shovel/Loader Operator	54,740	9	10	11	9	11	9	11	10	14	15	15	14	12	12	14	14	14	13	12	12	9	8	8	6	6	4
Haul Truck Driver	54,740	27	40	50	49	56	59	58	61	98	94	93	93	82	86	91	115	130	113	101	126	108	90	83	47	57	37
Track Dozer Operator	54,740	6	9	8	8	10	8	8	9	12	12	12	12	12	10	10	10	11	12	10	12	9	9	8	5	4	5
Wheel Dozer Operator	54,740	5	5	5	5	6	5	5	6	7	7	7	7	7	6	6	6	6	7	6	7	5	5	5	5	4	3
Grader Operator	54,740	4	5	5	5	5	5	5	5	6	6	6	6	6	5	5	5	5	6	5	6	5	5	5	4	3	3
Water Truck Operator	54,740	4	5	5	5	5	5	5	5	6	6	6	6	6	5	5	5	5	6	5	6	5	5	5	4	3	3
Service Crew (1)	54,740	7	5	5	7	8	4	4	4	5	5	7	5	4	4	4	4	6	5	5	4	5	4	5	3	4	5
Laborer	43,721	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	2
Powderman	54,740	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Blasting Crew	46,469	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Operations Total		71	97	106	106	118	113	113	117	170	166	167	165	149	148	157	181	199	182	165	192	163	142	135	86	94	69
MINE MAINTENANCE:																											
Mechanic	53,633	15	24	26	26	28	28	28	29	43	42	42	42	38	38	40	47	51	46	42	48	41	35	33	20	24	16
Mechanic's Helper	53,633	7	11	12	12	14	13	13	13	21	21	20	20	17	18	20	23	25	22	21	23	20	17	16	9	11	7
Welder	53,633	8	12	13	13	14	14	14	15	22	21	21	21	19	19	20	23	26	23	21	24	20	17	16	10	12	8
Electrician	53,633	7	12	12	13	14	14	13	14	21	21	21	21	17	19	20	23	25	22	21	24	20	17	16	10	11	8
Fuel & Lube Man	51,305	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3
Tire Man	51,305	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3
General Labor	43,721	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3
Maintenance Total		43	71	75	76	82	81	80	83	119	117	116	116	103	106	112	128	139	125	117	131	113	98	93	61	67	48
VS&A at 7.4%	54,740	8	12	13	13	15	14	14	15	21	21	21	21	19	19	20	23	25	23	21	24	20	18	17	11	12	9
TOTAL LABOR REQUIREMENT		122	180	194	195	215	208	207	215	310	304	304	302	271	273	289	332	363	330	303	347	296	258	245	158	173	126
Maint/Operations Ratio		0.61	0.73	0.71	0.72	0.69	0.72	0.71	0.71	0.70	0.70	0.69	0.70	0.69	0.72	0.71	0.71	0.70	0.69	0.71	0.68	0.69	0.69	0.69	0.71	0.71	0.70

Notes:
1. Service Crew operates 992G Loader, 777D Trucks, Crawlair Drill, Backhoes, Excavators, etc..
2. VSA Basis: 15 Vacation Days + 5 Sick Leave/270 Days Per Year

6.7 MINE CAPITAL COST

The estimated mine capital cost includes the following items:

1. Mine major equipment
2. Mine support equipment
3. Shop tools
4. Initial inventory of spare parts
5. Mine physical structures
6. Engineering and safety equipment
7. Mine preproduction development expense

The initial and sustaining capital costs are shown in Table 6-11.

Table 6-11: Summary of Mine Capital ($US x 1000)

Category	Initial Cap. (Years –1,1)	Sustaining (Years 2-25)	Total Capital
Mine Major Equipment	65,758	170,895	236,653
Mine Support Equipment	4,422	8,757	13,179
Shop Tools	1,973	3,875	5,848
Initial Spare Parts	1,973	1,386	3,359
Physical Structures	Included in Plant/Infrastructure Capital		
Mine Engineering and Safety Equipment	385	705	1,090
Mine Preproduction Development	10,621	0	10,621
TOTAL	85,132	185,618	270,750

Table 6-12 shows the details of the capital cost estimate over the project life. Mine preproduction development costs are not shown on Table 6-12. Mine preproduction development is based on the estimated mine operating costs during the preproduction period.

The following parameters were used to develop the capital costs:

1. Costs are shown in constant 1st quarter 2001 US dollars in the year in which the equipment is required. It is assumed that payment for the equipment is made at the time of delivery.

2. Equipment costs reflect 1st quarter 2001 dealer budget quotes for new equipment. Costs are based on prices obtained by IMC during the last few years and escalated 2% per year.

3. The costs shown include delivery to the site and assembly.

4. Sales taxes are not included. The sales taxes are collected by the state of Minnesota, but the taxes of almost all mining equipment and consumables are refunded.

5. A zero salvage value was assigned for the equipment, facilities, and the spare parts inventory.

6. A contingency is not included in the mine capital cost. It is likely that final negotiated sales prices, with fleet discounts, will be somewhat lower than the budget quotes used for this study. If a contingency is desired, IMC would recommend a fairly small value such as 5%.

The number of units of major equipment purchased during each year is based on the required number of units by year (Section 6.5) and an appropriate equipment replacement schedule for each piece of equipment. The replacement schedule for the major equipment is based on the estimated life of the equipment in metered hours as shown on Table 6-12 and the number of shifts that the equipment is scheduled for each production year during the mine life. IMC has assumed metered time as 7.17 hours per shift. The replacement for the support equipment is based on the estimated life in years.

Table 6-12: Mine Equipment Capital Costs

	Unit Cost ($1000)	Life Hours	Year -2 No.	Year -2 ($1000)	Year -1 No.	Year -1 ($1000)	Year 1 No.	Year 1 ($1000)	Year 2 No.	Year 2 ($1000)	Year 3 No.	Year 3 ($1000)	Year 4 No.	Year 4 ($1000)
MINE MAJOR EQUIPMENT:														
Drilltech D90KS Drill	1,385	45,000	0	0	1	1,385	3	4,156	0	0	0	0	0	0
P&H 4100 Shovel	9,964	80,000	0	0	1	9,964	1	9,964	0	0	0	0	0	0
Cat 994D Loader	2,653	48,000	0	0	2	5,306	0	0	0	0	0	0	0	0
Cat 793C (240t) Truck	1,812	60,000	0	0	9	16,307	4	7,247	3	5,436	0	0	3	5,436
Cat D10R Track Dozer	763	36,000	0	0	3	2,290	1	763	0	0	0	0	0	0
Cat 834B Wheel Dozer	505	48,000	0	0	2	1,010	0	0	0	0	0	0	1	505
Cat 16H Grader	423	48,000	0	0	2	846	0	0	0	0	0	0	0	0
Cat 773D Water Truck (50 klit)	558	48,000	0	0	2	1,117	0	0	0	0	0	0	0	0
Cat 992G Loader	1,185	30,000	0	0	1	1,185	0	0	0	0	0	0	0	0
Cat 777D (91mt) Haul Truck	825	48,000	0	0	3	2,476	0	0	0	0	0	0	0	0
Crawlair 370 Drill	244	48,000	0	0	1	244	0	0	0	0	0	0	0	0
Cat 773D Fuel/Lube Truck	594	48,000	0	0	1	594	1	594	0	0	0	0	0	0
Cat 325B Excavator	310	48,000	0	0	1	310	0	0	0	0	0	0	0	0
Subtotal Major Equipment				0		43,033		22,725		5,436		0		5,940
MINE SUPPORT EQUIPMENT:		Years												
Cat 938G Blast Hole Stemmer	185	6	0	0	1	185	0	0	0	0	0	0	0	0
Cat 980G Cable Reeler	381	9	0	0	1	381	0	0	0	0	0	0	0	0
Cat 436C Backhoe Loader	92	9	0	0	1	92	0	0	0	0	0	0	0	0
Snow Plow/Sander Truck	128	9	0	0	1	128	0	0	0	0	0	0	0	0
Tire Truck with Handler	164	6	0	0	1	164	1	164	0	0	0	0	0	0
Mechanics Truck with Crane	79	6	0	0	1	79	2	157	0	0	0	0	0	0
Welding Truck	64	6	0	0	1	64	2	128	0	0	0	0	0	0
Mobile Crane (125t)	804	15	0	0	1	804	0	0	0	0	0	0	0	0
Rough Terrain Crane (100t)	869	15	0	0	1	869	0	0	0	0	0	0	0	0
Forklift (4mt)	49	9	0	0	1	49	1	49	0	0	0	0	0	0
Boom Truck (25t)	186	6	0	0	1	186	0	0	0	0	0	0	0	0
Flatbed Truck (7.3mt)	68	6	0	0	1	68	1	68	0	0	0	0	0	0
Man Van (4x4)	21	4	0	0	1	21	1	21	0	0	0	0	1	21
Crew Bus	54	6	0	0	1	54	0	0	0	0	0	0	0	0
Crew Cab Pickup	24	4	0	0	1	24	1	24	0	0	0	0	1	24
Pickup (4x4)	22	4	0	0	10	215	5	108	0	0	0	0	10	215
Pumper Fire Truck	104	15	0	0	1	104	0	0	0	0	0	0	0	0
Cat Portable Light Tower	17	6	0	0	8	138	0	0	0	0	0	0	0	0
Mine Radios	45	15	0	0	1	45	0	0	0	0	0	0	0	0
Mine Pumps	32	15			1	32	0	0	1	32	1	32	1	32
Pit Power Distribution					Included in Plant/Infrastructure Capital									
Subtotal Mine Support Equipment				0		3,702		720		32		32		293
ENGINEERING/SAFETY EQUIPMENT:														
Safety Equipment	25	6	0	0	1	25	0	0	0	0	0	0	0	0
Engineering Equipment	250	6	0	0	1	250	0	0	0	0	0	0	0	0
Maintenance Equipment	35	6	0	0	1	35	0	0	0	0	0	0	0	0
GPS Station	75	15	0	0	1	75	0	0	0	0	0	0	0	0
Subtotal Engineering/Safety Equipment				0		385		0		0		0		0
PHYSICAL STRUCTURES:					Included in Plant/Infrastructure Capital									
Mine Shop														
Mine Warehouse														
Fuel Storage														
Subtotal Physical Structures				0		0		0		0		0		0
Shop Tools (3% of Major Equipment)		3.0%		0		1,291		682		163		0		178
Initial Spare Parts (3% of Major Equipment)		3.0%		0		1,291		682		163		0		178
Contingency (0%)														
TOTAL EQUIPMENT/FACILITIES CAPITAL				0		49,702		24,808		5,794		32		6,589

	Year 5 No.	Year 5 ($1000)	Year 6 No.	Year 6 ($1000)	Year 7 No.	Year 7 ($1000)	Year 8 No.	Year 8 ($1000)	Year 9 No.	Year 9 ($1000)	Year 10 No.	Year 10 ($1000)
MINE MAJOR EQUIPMENT:												
Drilltech D90KS Drill	0	0	0	0	0	0	1	1,385	0	0	1	1,385
P&H 4100 Shovel	0	0	0	0	0	0	1	9,964	0	0	0	0
Cat 994D Loader	0	0	0	0	0	0	0	0	0	0	0	0
Cat 793C (240t) Truck	0	0	0	0	0	0	12	21,742	0	0	7	12,683
Cat D10R Track Dozer	0	0	0	0	0	0	1	763	0	0	3	2,290
Cat 834B Wheel Dozer	0	0	0	0	0	0	0	0	0	0	0	0
Cat 16H Grader	0	0	0	0	0	0	1	423	0	0	0	0
Cat 773D Water Truck (50 klit)	0	0	0	0	0	0	1	558	0	0	0	0
Cat 992G Loader	0	0	0	0	0	0	0	0	0	0	0	0
Cat 777D (91mt) Haul Truck	0	0	0	0	0	0	0	0	0	0	0	0
Crawlair 370 Drill	0	0	0	0	0	0	0	0	0	0	0	0
Cat 773D Fuel/Lube Truck	0	0	0	0	0	0	0	0	0	0	0	0
Cat 325B Excavator	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal Major Equipment		0		0		0		34,836		0		16,358
MINE SUPPORT EQUIPMENT:												
Cat 938G Blast Hole Stemmer	0	0	1	185	0	0	0	0	0	0	0	0
Cat 980G Cable Reeler	0	0	0	0	0	0	0	0	0	0	0	0
Cat 436C Backhoe Loader	0	0	0	0	0	0	0	0	1	92	0	0
Snow Plow/Sander Truck	0	0	0	0	0	0	0	0	1	128	0	0
Tire Truck with Handler	0	0	1	164	1	164	0	0	0	0	0	0
Mechanics Truck with Crane	0	0	1	79	2	157	0	0	0	0	0	0
Welding Truck	0	0	1	64	2	128	0	0	0	0	0	0
Mobile Crane (125t)	0	0	0	0	0	0	0	0	0	0	0	0
Rough Terrain Crane (100t)	0	0	0	0	0	0	0	0	0	0	0	0
Forklift (4mt)	0	0	0	0	0	0	0	0	1	49	1	49
Boom Truck (25t)	0	0	1	186	0	0	0	0	0	0	0	0
Flatbed Truck (7.3mt)	0	0	1	68	1	68	0	0	0	0	0	0
Man Van (4x4)	1	21	0	0	0	0	1	21	1	21	0	0
Crew Bus	0	0	1	54	0	0	0	0	0	0	0	0
Crew Cab Pickup	1	24	0	0	0	0	1	24	1	24	0	0
Pickup (4x4)	5	108	0	0	0	0	10	215	5	108	0	0
Pumper Fire Truck	0	0	0	0	0	0	0	0	0	0	0	0
Cat Portable Light Tower	0	0	8	138	0	0	0	0	0	0	0	0
Mine Radios	0	0	0	0	0	0	0	0	0	0	0	0
Mine Pumps	0	0	1	32	0	0	0	0	0	0	1	32
Pit Power Distribution												
Subtotal Mine Support Equipment		153		970		517		261		422		81
ENGINEERING/SAFETY EQUIPMENT:												
Safety Equipment	0	0	1	25	0	0	0	0	0	0	0	0
Engineering Equipment	0	0	1	150	0	0	0	0	0	0	0	0
Maintenance Equipment	0	0	1	35	0	0	0	0	0	0	0	0
GPS Station	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal Engineering/Safety Equipment		0		210		0		0		0		0
PHYSICAL STRUCTURES:												
Mine Shop												
Mine Warehouse												
Fuel Storage												
Subtotal Physical Structures		0		0		0		0		0		0
Shop Tools (3% of Major Equipment)		0		0		0		1,045		0		491
Initial Spare Parts (3% of Major Equipment)		0		0		0		1,045				
Contingency (0%)												
TOTAL EQUIPMENT/FACILITIES CAPITAL		153		1,180		517		37,187		422		16,930

	Year 11 No.	Year 11 ($1000)	Year 12 No.	Year 12 ($1000)	Year 13 No.	Year 13 ($1000)	Year 14 No.	Year 14 ($1000)	Year 15 No.	Year 15 ($1000)
MINE MAJOR EQUIPMENT:										
Drilltech D90KS Drill	3	4,156	0	0	0	0	0	0	0	0
P&H 4100 Shovel	0	0	0	0	0	0	0	0	0	0
Cat 994D Loader	0	0	2	5,306	0	0	0	0	0	0
Cat 793C (240t) Truck	5	9,059	0	0	0	0	4	7,247	8	14,495
Cat D10R Track Dozer	1	763	0	0	0	0	0	0	0	0
Cat 834B Wheel Dozer	0	0	0	0	2	1,010	0	0	0	0
Cat 16H Grader	0	0	2	846	0	0	0	0	0	0
Cat 773D Water Truck (50 klit)	0	0	2	1,117	0	0	0	0	0	0
Cat 992G Loader	0	0	0	0	0	0	0	0	0	0
Cat 777D (91mt) Haul Truck	0	0	0	0	0	0	0	0	0	0
Crawlair 370 Drill	0	0	0	0	0	0	0	0	0	0
Cat 773D Fuel/Lube Truck	1	594	1	594	0	0	0	0	0	0
Cat 325B Excavator	0	0	1	310	0	0	0	0	0	0
Subtotal Major Equipment		14,573		8,173		1,010		7,247		14,495
MINE SUPPORT EQUIPMENT:										
Cat 938G Blast Hole Stemmer	0	0	1	185	0	0	0	0	0	0
Cat 980G Cable Reeler	0	0	0	0	0	0	0	0	0	0
Cat 436C Backhoe Loader	0	0	0	0	0	0	0	0	0	0
Snow Plow/Sander Truck	0	0	0	0	0	0	0	0	0	0
Tire Truck with Handler	0	0	1	164	1	164	0	0	0	0
Mechanics Truck with Crane	0	0	1	79	2	157	0	0	0	0
Welding Truck	0	0	1	64	2	128	0	0	0	0
Mobile Crane (125t)	0	0	0	0	0	0	0	0	1	804
Rough Terrain Crane (100t)	0	0	0	0	0	0	0	0	1	869
Forklift (4mt)	0	0	0	0	0	0	0	0	0	0
Boom Truck (25t)	0	0	1	186	0	0	0	0	0	0
Flatbed Truck (7.3mt)	0	0	1	68	1	68	0	0	0	0
Man Van (4x4)	0	0	1	21	1	21	0	0	0	0
Crew Bus	0	0	1	54	0	0	0	0	0	0
Crew Cab Pickup	0	0	1	24	1	24	0	0	0	0
Pickup (4x4)	0	0	10	215	5	108	0	0	0	0
Pumper Fire Truck	0	0	0	0	0	0	0	0	1	104
Cat Portable Light Tower	0	0	8	138	0	0	0	0	0	0
Mine Radios	0	0	0	0	0	0	0	0	1	45
Mine Pumps	0	0	0	0	0	0	0	0	0	0
Pit Power Distribution										
Subtotal Mine Support Equipment		0		1,198		670		0		1,822
ENGINEERING/SAFETY EQUIPMENT:										
Safety Equipment	0	0	1	25	0	0	0	0	0	0
Engineering Equipment	0	0	1	150	0	0	0	0	0	0
Maintenance Equipment	0	0	1	35	0	0	0	0	0	0
GPS Station	0	0	0	0	0	0	0	0	1	75
Subtotal Engineering/Safety Equipment		0		210		0		0		75
PHYSICAL STRUCTURES:										
Mine Shop										
Mine Warehouse										
Fuel Storage										
Subtotal Physical Structures		0		0		0		0		0
Shop Tools (3% of Major Equipment)		437		245		30		217		435
Initial Spare Parts (3% of Major Equipment)										
Contingency (0%)										
TOTAL EQUIPMENT/FACILITIES CAPITAL		15,011		9,827		1,710		7,465		16,826

	Year 16 No.	Year 16 ($1000)	Year 17 No.	Year 17 ($1000)	Year 18 No.	Year 18 ($1000)	Year 19 No.	Year 19 ($1000)	Year 20 No.	Year 20 ($1000)	Year 21 No.	Year 21 ($1000)	Project Total
MINE MAJOR EQUIPMENT:													
Drilltech D90KS Drill	0	0	1	1,385	0	0	0	0	3	4,156	0	0	18,011
P&H 4100 Shovel	2	19,928	0	0	0	0	0	0	0	0	0	0	49,819
Cat 994D Loader	0	0	0	0	0	0	0	0	0	0	0	0	10,612
Cat 793C (240t) Truck	0	0	10	18,118	0	0	8	14,495	0	0	0	0	132,265
Cat D10R Track Dozer	0	0	1	763	0	0	3	2,290	0	0	0	0	9,921
Cat 834B Wheel Dozer	0	0	1	505	0	0	0	0	0	0	0	0	3,029
Cat 16H Grader	0	0	0	0	0	0	0	0	0	0	0	0	2,114
Cat 773D Water Truck (50 klit)	0	0	0	0	0	0	0	0	0	0	0	0	2,792
Cat 992G Loader	1	1,185	0	0	0	0	0	0	0	0	0	0	2,370
Cat 777D (91mt) Haul Truck	0	0	0	0	0	0	0	0	0	0	0	0	2,476
Crawlair 370 Drill	0	0	0	0	0	0	0	0	0	0	0	0	244
Cat 773D Fuel/Lube Truck	0	0	0	0	0	0	0	0	0	0	0	0	2,378
Cat 325B Excavator	0	0	0	0	0	0	0	0	0	0	0	0	621
Subtotal Major Equipment		21,113		20,772		0		16,784		4,156		0	236,653
MINE SUPPORT EQUIPMENT:													
Cat 938G Blast Hole Stemmer	0	0	0	0	1	185	0	0	0	0	0	0	741
Cat 980G Cable Reeler	0	0	0	0	0	0	0	0	0	0	0	0	381
Cat 436C Backhoe Loader	0	0	0	0	1	92	0	0	0	0	0	0	275
Snow Plow/Sander Truck	0	0	0	0	1	128	0	0	0	0	0	0	384
Tire Truck with Handler	0	0	0	0	1	164	1	164	0	0	0	0	1,313
Mechanics Truck with Crane	0	0	0	0	1	79	2	157	0	0	0	0	943
Welding Truck	0	0	0	0	1	64	2	128	0	0	0	0	770
Mobile Crane (125t)	0	0	0	0	0	0	0	0	0	0	0	0	1,607
Rough Terrain Crane (100t)	0	0	0	0	0	0	0	0	0	0	0	0	1,739
Forklift (4mt)	0	0	0	0	0	0	0	0	0	0	0	0	197
Boom Truck (25t)	0	0	0	0	1	186	0	0	0	0	0	0	744
Flatbed Truck (7.3mt)	0	0	0	0	1	68	1	68	0	0	0	0	542
Man Van (4x4)	1	21	1	21	0	0	0	0	1	21	1	21	254
Crew Bus	0	0	0	0	1	54	0	0	0	0	0	0	217
Crew Cab Pickup	1	24	1	24	0	0	0	0	1	24	1	24	289
Pickup (4x4)	0	0	0	0	0	0	0	0	10	215	5	108	1,614
Pumper Fire Truck	0	0	0	0	0	0	0	0	0	0	0	0	207
Cat Portable Light Tower	0	0	0	0	8	138	0	0	0	0	0	0	550
Mine Radios	0	0	0	0	0	0	0	0	0	0	0	0	90
Mine Pumps	0	0	0	0	1	32	2	64	0	0	1	32	320
Pit Power Distribution													
Subtotal Mine Support Equipment		45		45		1,190		581		261		185	13,179
ENGINEERING/SAFETY EQUIPMENT:													
Safety Equipment	0	0	0	0	1	25	0	0	0	0	0	0	100
Engineering Equipment	0	0	0	0	1	150	0	0	0	0	0	0	700
Maintenance Equipment	0	0	0	0	1	35	0	0	0	0	0	0	140
GPS Station	0	0	0	0	0	0	0	0	0	0	0	0	150
Subtotal Engineering/Safety Equipment		0		0		210		0		0		0	1,090
PHYSICAL STRUCTURES:													
Mine Shop													0
Mine Warehouse													0
Fuel Storage													0
Subtotal Physical Structures		0											0
Shop Tools (3% of Major Equipment)		633											5,848
Initial Spare Parts (3% of Major Equipment)													3,359
Contingency (0%)													0
TOTAL EQUIPMENT/FACILITIES CAPITAL		21,792		20,817		1,400		17,366		4,417		185	260,129

6.8 MINE OPERATING COST

Mine operating costs were developed from the recommended mine equipment requirements and the mine personnel requirements. The mine operating costs include all the parts, supplies, and labor costs associated with mine supervision, operation, and maintenance.

Table 6-13 summarizes the total mine operating costs including parts, consumables, supervisory labor, and operations and maintenance labor for each operating year. The costs are shown by several cost centers. The total mine operating cost over the life of the project is estimated to be about $US 1,179.0 million. During the preproduction development period in Year –1, the direct mining costs is estimated to be $US 10.62 million. During commercial production and reclamation in Years 1 through 24 (full mining years), the operating costs range from a low of $US 27.8 million in Year 23 to $US 68.1 million in Year 16.

Table 6-14 summarizes the mine operating costs in terms of cost per ton of total material for each cost center. The average mining cost over the life of the project is $US 0.614 per total ton. It is important to note that this is per total ton, not just the ore tons. The average mine operating cost per ore ton is $US 2.445 as shown in the last column of table 6-13.

The following factors are considered for the operating cost calculations:

1. Local unit costs for consumable items such as diesel fuel, blasting agents, electricity, and spare parts were used.
2. Local hourly labor rates and fringe benefits were used.

The costs shown are in 1st quarter 2001 US dollars. It should be noted that the Year –1 operating costs have been included in the preproduction development capital cost.

The general activities that are included in the operating cost estimates are as follows:

1. Construct the initial out-of-pit mine access roads from the pit area to the ore crusher and waste storage areas.

2. Remove topsoil from the mine and waste storage areas. Replace topsoil on the waste storage areas as a reclamation activity.

3. Preproduction development required to expose ore for initial production.

4. Mine and transport ore to the crusher (or crusher stockpile). Mine and transport waste material from the pit areas to the waste storage areas.

5. Maintain all the mine work areas, in-pit haul roads, and external haul roads. Also maintain the waste storage areas.

6. Mine dewatering.

7. Development drilling.

8. Haulage of hard rock waste and overburden to the embankment facility.

Table 6-15 summarizes the mine operating cost by cost category. The following information is included in the table:

1. Scheduled shifts for each category of major equipment.
2. Electrical power costs for the drills and shovels.
3. Diesel fuel consumption for each category of equipment.
4. Total diesel fuel cost.
5. Tire costs for each category of equipment and total cost.
6. Lubricants, filters, repair parts, and wear items cost for each category of major equipment.
7. Drill bits and down hole accessories costs.
8. Explosives costs.
9. General mine, general maintenance, development drilling, and pumping costs.
10. Mine labor costs.

It is noted that the total cost shown on Table 6-15 varies from the cost shown on Table 6-13 by a small amount, $1,178,984 versus $1,178,950, and the units are $ x 1000. The difference is due to rounding.

Table 6-16 is a concise summary of Table 6-15, showing total dollar amounts for each cost category. This table is included to facilitate sensitivity analysis to various cost items that might be required for the cash flow analysis.

Table 6-13: Summary of Mine Operating Costs - Total Dollars ($US x 1000)

Mining Year	Total Material (kt)	Drilled/ Blasted (kt)	Drilling	Blasting	Loading	Hauling	Auxiliary	General Mine	General Maint.	G&A	TOTAL	Cost/ Total Ton	Cost/ Ore Ton
-2													
-1	18,850	11,186	441	490	1,558	4,232	1,818	330	528	1,224	10,621	0.563	8.120
1	70,000	69,671	2,682	2,738	4,490	12,669	4,132	1,707	1,952	2,667	33,037	0.472	2.105
2	70,000	63,663	2,447	2,515	4,743	15,628	3,794	1,716	1,973	2,722	35,539	0.508	1.770
3	70,000	70,000	2,687	2,750	4,416	15,519	4,120	1,726	1,979	2,722	35,919	0.513	1.789
4	70,000	65,480	2,501	2,582	4,680	17,556	4,824	1,758	2,011	2,831	38,743	0.553	1.930
5	70,000	69,972	2,691	2,749	4,425	18,673	3,523	1,764	2,005	2,776	38,606	0.552	1.923
6	70,010	64,315	2,465	2,539	4,718	18,402	3,646	1,792	2,000	2,776	38,340	0.548	1.910
7	70,000	66,464	2,532	2,619	4,595	19,184	4,005	1,802	2,016	2,831	39,585	0.565	1.972
8	100,000	100,000	3,804	3,866	6,373	30,982	5,015	2,263	2,659	3,159	58,122	0.581	2.895
9	100,000	96,025	3,636	3,718	6,567	29,755	5,052	2,300	2,648	3,159	56,836	0.568	2.831
10	100,000	93,920	3,568	3,640	6,631	29,465	5,241	2,329	2,643	3,159	56,676	0.567	2.823
11	100,000	100,000	3,805	3,866	6,376	29,368	5,019	2,327	2,643	3,159	56,564	0.566	2.818
12	83,289	83,289	3,196	3,244	5,330	25,847	4,824	2,084	2,323	3,050	49,898	0.599	2.486
13	89,741	89,741	3,392	3,484	5,692	27,084	4,182	2,178	2,436	3,050	51,498	0.574	2.565
14	100,017	100,017	3,804	3,866	6,374	28,657	4,180	2,340	2,622	3,105	54,948	0.549	2.737
15	100,000	100,000	3,807	3,866	6,379	36,209	4,183	2,321	2,707	3,269	62,741	0.627	3.125
16	100,000	100,000	3,807	3,866	6,378	40,942	4,639	2,305	2,766	3,378	68,081	0.681	3.391
17	90,000	86,020	3,278	3,346	5,893	35,600	4,993	2,212	2,541	3,269	61,133	0.679	3.045
18	90,000	90,000	3,453	3,494	5,710	31,942	4,367	2,206	2,498	3,159	56,829	0.631	2.831
19	82,899	82,899	3,133	3,230	5,308	39,705	4,823	2,145	2,467	3,324	64,134	0.774	3.195
20	65,195	65,195	2,494	2,572	4,152	34,085	4,145	1,893	2,105	3,105	54,550	0.837	2.717
21	58,459	58,459	2,236	2,321	3,717	28,404	3,902	1,373	1,923	2,995	46,872	0.802	2.335
22	59,222	59,222	2,260	2,350	3,761	26,072	3,725	1,353	1,908	2,941	44,369	0.749	2.210
23	39,671	39,671	1,512	1,623	2,554	14,786	2,707	1,034	1,443	2,108	27,767	0.700	1.383
24	47,260	47,260	1,797	1,905	2,984	18,028	2,365	1,151	1,459	2,163	31,852	0.674	1.587
25	6,653	6,653	254	284	429	2,930	624	408	262	500	5,690	0.855	1.635
26													
TOTAL	1,921,266	1,879,122	71,683	73,521	124,234	631,723	103,850	46,816	54,520	72,603	1,178,950	0.614	2.445
PERCENT			6.1%	6.2%	10.5%	53.6%	8.8%	4.0%	4.6%	6.2%	100.0%		

Table 6-14: Summary of Mine Operating Costs - Per Total Ton

Mining Year	Total Material (kt)	Drilled/ Blasted (kt)	Drilling	Blasting	Loading	Hauling	Auxiliary	General Mine	General Maint.	G&A	TOTAL	Total Cost
-2												
-1	18,850	11,186	0.023	0.026	0.083	0.224	0.096	0.018	0.028	0.065	0.563	10,621
1	70,000	69,671	0.038	0.039	0.064	0.181	0.059	0.024	0.028	0.038	0.472	33,037
2	70,000	63,663	0.035	0.036	0.068	0.223	0.054	0.025	0.028	0.039	0.508	35,539
3	70,000	70,000	0.038	0.039	0.063	0.222	0.059	0.025	0.028	0.039	0.513	35,919
4	70,000	65,480	0.036	0.037	0.067	0.251	0.069	0.025	0.029	0.040	0.553	38,743
5	70,000	69,972	0.038	0.039	0.063	0.267	0.050	0.025	0.029	0.040	0.552	38,606
6	70,010	64,315	0.035	0.036	0.067	0.263	0.052	0.026	0.029	0.040	0.548	38,340
7	70,000	66,464	0.036	0.037	0.066	0.274	0.057	0.026	0.029	0.040	0.565	39,585
8	100,000	100,000	0.038	0.039	0.064	0.310	0.050	0.023	0.027	0.032	0.581	58,122
9	100,000	96,025	0.036	0.037	0.066	0.298	0.051	0.023	0.026	0.032	0.568	56,836
10	100,000	93,920	0.036	0.036	0.066	0.295	0.052	0.023	0.026	0.032	0.567	56,676
11	100,000	100,000	0.038	0.039	0.064	0.294	0.050	0.023	0.026	0.032	0.566	56,564
12	83,289	83,289	0.038	0.039	0.064	0.310	0.058	0.025	0.028	0.037	0.599	49,898
13	89,741	89,741	0.038	0.039	0.063	0.302	0.047	0.024	0.027	0.034	0.574	51,498
14	100,017	100,017	0.038	0.039	0.064	0.287	0.042	0.023	0.026	0.031	0.549	54,948
15	100,000	100,000	0.038	0.039	0.064	0.362	0.042	0.023	0.027	0.033	0.627	62,741
16	100,000	100,000	0.038	0.039	0.064	0.409	0.046	0.023	0.028	0.034	0.681	68,081
17	90,000	86,020	0.036	0.037	0.065	0.396	0.055	0.025	0.028	0.036	0.679	61,133
18	90,000	90,000	0.038	0.039	0.063	0.355	0.049	0.025	0.028	0.035	0.631	56,829
19	82,899	82,899	0.038	0.039	0.064	0.479	0.058	0.026	0.030	0.040	0.774	64,134
20	65,195	65,195	0.038	0.039	0.064	0.523	0.064	0.029	0.032	0.048	0.837	54,550
21	58,459	58,459	0.038	0.040	0.064	0.486	0.067	0.023	0.033	0.051	0.802	46,872
22	59,222	59,222	0.038	0.040	0.064	0.440	0.063	0.023	0.032	0.050	0.749	44,369
23	39,671	39,671	0.038	0.041	0.064	0.373	0.068	0.026	0.036	0.053	0.700	27,767
24	47,260	47,260	0.038	0.040	0.063	0.381	0.050	0.024	0.031	0.046	0.674	31,852
25	6,653	6,653	0.038	0.043	0.064	0.440	0.094	0.061	0.039	0.075	0.855	5,690
26												
TOTAL	1,921,266	1,879,122	0.037	0.038	0.065	0.329	0.054	0.024	0.028	0.038	0.614	1,178,950
PERCENT			6.1%	6.2%	10.5%	53.6%	8.8%	4.0%	4.6%	6.2%	100.0%	
Per Ton Drilled/Blasted			0.038	0.039								

Table 6-15: Mine Operating Costs by Category

		Units	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
SCHEDULED SHIFTS FOR MAJOR EQUIPMENT:																														
Driltech D90KS Drill		Shifts		440	2,741	2,505	2,754	2,576	2,753	2,531	2,615	3,935	3,778	3,695	3,935	3,277	3,531	3,935	3,935	3,935	3,385	3,541	3,262	2,565	2,300	2,330	1,561	1,860	262	73,937
P&H 4100 Shovel		Shifts		261	1,623	1,483	1,630	1,525	1,630	1,498	1,548	2,329	2,237	2,188	2,329	1,940	2,090	2,330	2,329	2,329	2,004	2,096	1,931	1,519	1,362	1,379	924	1,101	166	43,769
Cat 994D Loader		Shifts		837	859	1,339	833	1,194	835	1,288	1,115	1,189	1,507	1,676	1,189	991	1,067	1,190	1,189	1,189	1,389	1,071	986	775	695	704	472	562	79	26,224
Cat 793C (240t) Truck		Shifts		3,573	10,701	13,169	13,128	14,811	15,772	15,567	16,188	26,193	25,142	24,920	24,814	21,827	22,868	24,209	30,565	34,565	30,066	26,982	33,532	28,783	23,999	22,001	12,484	15,219	2,473	533,551
Cat D10R Track Dozer		Shifts		798	2,413	2,081	2,142	2,478	2,045	2,061	2,357	3,040	3,041	3,066	3,041	3,003	2,680	2,680	2,680	2,758	3,028	2,714	3,003	2,407	2,357	2,085	1,388	1,116	287	60,746
Cat 834B Wheel Dozer		Shifts		582	1,273	1,382	1,201	1,564	1,201	1,382	1,564	1,819	1,819	1,819	1,819	1,819	1,637	1,637	1,637	1,637	1,819	1,637	1,819	1,382	1,382	1,201	1,128	946	191	37,298
Cat 16H Grader		Shifts		513	1,324	1,142	1,142	1,382	1,142	1,142	1,382	1,623	1,623	1,623	1,623	1,623	1,382	1,382	1,382	1,382	1,623	1,382	1,623	1,382	1,382	1,142	902	662	166	33,078
Cat 773D Water Truck (50 klit)		Shifts		513	1,324	1,142	1,142	1,382	1,142	1,142	1,382	1,623	1,623	1,623	1,623	1,623	1,382	1,382	1,382	1,382	1,623	1,382	1,623	1,382	1,382	1,142	902	662	166	33,078
Cat 992G Loader		Shifts		197	310	259	383	447	179	217	194	289	306	343	290	226	194	194	194	326	280	252	226	278	194	247	129	182	59	6,395
Cat 777D (91mt) Haul Truck		Shifts		538	800	668	1,042	1,214	427	542	447	714	763	876	716	522	447	447	447	848	684	623	522	702	447	632	298	480	162	16,010
Crawlair 370 Drill		Shifts		97	194	194	194	258	194	194	258	258	258	258	258	258	194	194	194	194	258	194	258	258	258	194	194	129	32	5,424
Total Shifts		Shifts		8,348	23,562	25,365	25,591	28,833	27,320	27,565	29,052	43,012	42,096	42,086	41,637	37,108	37,473	39,580	45,935	50,546	46,158	41,875	48,784	41,434	35,760	33,058	20,383	22,919	4,030	869,510
ELECTRICAL POWER:	Cost/Shift																													
Driltech D90KS Drill	100.62	$x1000		44	276	252	277	259	277	255	263	396	380	372	396	330	355	396	396	396	341	356	328	258	231	234	157	187	26	7,440
P&H 4100 Shovel	251.55	$x1000		66	408	373	410	384	410	377	389	586	563	550	586	488	526	586	586	586	504	527	486	382	343	347	232	277	39	11,010
Total Electrical Power		$x1000		110	684	625	687	643	687	631	653	982	943	922	982	818	881	982	982	982	845	884	814	640	574	581	389	464	65	18,450
FUEL CONSUMPTION:	Gal/Shift																													
Driltech D90KS Drill	0.00	Galx1000		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P&H 4100 Shovel	0.00	Galx1000		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cat 994D Loader	308.17	Galx1000		258	265	413	257	368	257	397	344	367	465	516	367	305	329	367	367	367	428	330	304	239	214	217	145	173	24	8,081
Cat 793C (240t) Truck	387.00	Galx1000		1,383	4,141	5,096	5,081	5,732	6,104	6,024	6,265	10,137	9,730	9,644	9,603	8,447	8,850	9,369	11,829	13,377	11,636	10,442	12,977	11,139	9,288	8,514	4,831	5,890	957	206,484
Cat D10R Track Dozer	143.33	Galx1000		114	346	298	307	355	293	295	338	436	436	439	436	430	384	384	384	395	434	389	430	345	338	299	199	160	41	8,707
Cat 834B Wheel Dozer	86.00	Galx1000		50	110	119	103	135	103	119	135	156	156	156	156	156	141	141	141	141	156	141	156	119	119	103	97	81	16	3,208
Cat 16H Grader	57.33	Galx1000		29	76	65	65	79	65	65	79	93	93	93	93	93	79	79	79	79	93	79	93	79	79	65	52	38	9	1,896
Cat 773D Water Truck (50 klit)	100.33	Galx1000		51	133	115	115	139	115	115	139	163	163	163	163	163	139	139	139	139	163	139	163	139	139	115	91	66	17	3,319
Cat 992G Loader	179.17	Galx1000		35	56	46	69	80	32	39	35	52	55	61	52	40	35	35	35	58	50	45	40	50	35	44	23	33	11	1,146
Cat 777D (91mt) Haul Truck	143.33	Galx1000		77	115	96	149	174	61	78	64	102	109	126	103	75	64	64	64	122	98	89	75	101	64	91	43	69	23	2,295
Crawlair 370 Drill	43.00	Galx1000		4	8	8	8	11	8	8	11	11	11	11	11	11	8	8	8	8	11	8	11	11	11	8	8	6	1	233
Total Fuel Consumption		Galx1000		2,003	5,249	6,257	6,154	7,073	7,039	7,141	7,409	11,516	11,218	11,210	10,983	9,721	10,029	10,586	13,045	14,686	13,069	11,662	14,250	12,221	10,287	9,457	5,489	6,516	1,100	235,369
Fuel Cost at	0.85 per gallon ($x1000)	$x1000		1,702	4,461	5,318	5,231	6,012	5,983	6,070	6,297	9,789	9,535	9,529	9,336	8,263	8,525	8,998	11,088	12,483	11,109	9,913	12,112	10,388	8,744	8,038	4,666	5,538	935	200,063
TIRE COSTS:	Cost/Shift																													
Driltech D90KS Drill	0.00	$x1000		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P&H 4100 Shovel	0.00	$x1000		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cat 994D Loader	168.85	$x1000		141	145	226	141	202	141	218	188	201	255	283	201	167	180	201	201	201	235	181	166	131	117	119	80	95	13	4,428
Cat 793C (240t) Truck	206.04	$x1000		736	2,205	2,713	2,705	3,052	3,250	3,207	3,335	5,397	5,180	5,135	5,113	4,497	4,712	4,988	6,298	7,122	6,195	5,569	6,909	5,930	4,945	4,533	2,572	3,136	510	109,933
Cat D10R Track Dozer	0.00	$x1000		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cat 834B Wheel Dozer	34.40	$x1000		20	44	48	41	54	41	48	54	63	63	63	63	63	56	56	56	56	63	56	63	48	48	41	39	33	7	1,283
Cat 16H Grader	17.92	$x1000		9	24	20	20	25	20	20	25	29	29	29	29	29	25	25	25	25	29	25	29	25	25	20	16	12	3	693
Cat 773D Water Truck (50 klit)	30.10	$x1000		15	40	34	34	42	34	34	42	49	49	49	49	49	42	42	42	42	49	42	49	42	42	34	27	20	5	996
Cat 992G Loader	53.03	$x1000		10	16	14	20	24	10	12	10	15	16	18	15	12	10	10	10	17	15	13	12	15	10	13	7	10	3	339
Cat 777D (91mt) Haul Truck	53.75	$x1000		29	43	36	56	65	23	29	24	38	41	47	38	28	24	24	24	46	37	33	28	38	24	34	16	26	9	861
Crawlair 370 Drill	0.00	$x1000		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Tire Cost ($US x 1000)		$x1000		962	2,517	3,092	3,018	3,462	3,519	3,568	3,678	5,792	5,632	5,623	5,508	4,845	5,049	5,346	6,655	7,508	6,621	5,910	7,256	6,228	5,210	4,795	2,757	3,330	549	118,432
LUBRICANTS, REPAIRS, WEAR ITEMS:	Cost/Shift																													
Driltech D90KS Drill	317.41	$x1000		140	870	795	874	818	874	803	830	1,249	1,199	1,173	1,249	1,040	1,121	1,249	1,249	1,249	1,074	1,124	1,035	814	730	740	495	590	83	23,468
P&H 4100 Shovel	1321.68	$x1000		344	2,145	1,960	2,155	2,016	2,154	1,980	2,046	3,079	2,956	2,891	3,079	2,564	2,763	3,079	3,079	3,079	2,648	2,771	2,552	2,007	1,800	1,823	1,221	1,455	205	57,849
Cat 994D Loader	425.92	$x1000		357	366	570	355	509	356	549	475	507	642	714	507	422	455	507	507	507	592	456	420	330	296	300	201	239	34	11,169
Cat 793C (240t) Truck	327.09	$x1000		1,169	3,500	4,307	4,294	4,845	5,159	5,092	5,295	8,567	8,224	8,151	8,116	7,139	7,480	7,919	9,998	11,306	9,834	8,826	10,968	9,415	7,850	7,196	4,083	4,978	809	174,519
Cat D10R Track Dozer	211.49	$x1000		169	510	440	453	524	432	436	498	643	643	648	643	635	567	567	567	583	640	574	635	509	498	441	294	236	61	12,847
Cat 834B Wheel Dozer	93.81	$x1000		55	119	130	113	147	113	130	147	171	171	171	171	171	154	154	154	154	171	154	171	130	130	113	106	89	18	3,499
Cat 16H Grader	80.12	$x1000		41	106	92	92	111	92	92	111	130	130	130	130	130	111	111	111	111	130	111	130	111	111	92	72	53	13	2,650
Cat 773D Water Truck (50 klit)	94.89	$x1000		49	126	108	108	131	108	108	131	154	154	154	154	154	131	131	131	131	154	131	154	131	131	108	86	63	16	3,139
Cat 992G Loader	282.8	$x1000		56	88	73	108	126	51	61	55	82	86	97	82	64	55	55	55	92	79	71	64	79	55	70	37	51	17	1,808
Cat 777D (91mt) Haul Truck	154.94	$x1000		83	124	104	161	188	66	84	69	111	118	136	111	81	69	69	69	131	106	97	81	109	69	98	46	74	25	2,481
Crawlair 370 Drill	111.08	$x1000		11	22	22	22	29	22	22	29	29	29	29	29	29	22	22	22	22	29	22	29	29	29	22	22	14	4	603
Total Lube, Repair Parts, Wear Items		$x1000		2,472	7,976	8,601	8,735	9,443	9,426	9,356	9,686	14,720	14,352	14,293	14,270	12,429	12,926	13,861	15,939	17,364	15,457	14,335	16,238	13,663	11,699	11,002	6,663	7,843	1,283	294,032
DRILL DOWNHOLE ITEMS:	Cost/Shift																													
Driltech D90KS Drill	205.44	$x1000		90	563	515	566	529	566	520	537	808	776	759	808	673	725	808	808	808	695	728	670	527	473	479	321	382	54	15,190
Crawlair 370 Drill	227.80	$x1000		22	44	44	44	59	44	44	59	59	59	59	59	59	44	44	44	44	59	44	59	59	59	44	44	29	7	1,236
Total Drill Downhole Items ($US x 1000)		$x1000		112	607	559	610	588	610	564	596	867	835	818	867	732	770	853	852	852	754	772	729	586	531	523	365	411	61	16,425
EXPLOSIVES:																														
Explosive Cost		$x1000		378	2,355	2,152	2,366	2,213	2,365	2,174	2,246	3,380	3,246	3,174	3,380	2,815	3,033	3,381	3,380	3,380	2,907	3,042	2,802	2,204	1,976	2,002	1,341	1,597	225	63,514
Initiation Cost		$x1000		38	235	215	237	221	237	217	225	338	325	317	338	282	303	338	338	338	291	304	280	220	198	200	134	160	22	6,351
Total Cost		$x1000		416	2,590	2,367	2,603	2,435	2,602	2,391	2,471	3,718	3,570	3,492	3,718	3,097	3,337	3,719	3,718	3,718	3,198	3,346	3,082	2,424	2,174	2,202	1,475	1,757	247	69,866
Explosive Weight Cost/lb=	0.13	Lbx1000		2,908	18,114	16,552	18,200	17,025	18,193	16,722	17,281	26,000	24,967	24,419	26,000	21,655	23,333	26,004	26,000	26,000	22,365	23,400	21,554	16,951	15,199	15,398	10,314	12,288	1,730	488,572
OTHER CONSUMABLES:																														
General Mine		$x1000		283	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,500	1,500	1,500	1,500	1,249	1,346	1,500	1,500	1,500	1,350	1,350	1,243	978	877	888	595	709	100	28,819
General Maint.		$x1000		283	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,500	1,500	1,500	1,500	1,249	1,346	1,500	1,500	1,500	1,350	1,350	1,243	978	877	888	595	709	100	28,819
Development Drilling		$x1000		0	472	472	472	472	472	472	472	472	472	472	472	472	472	472	472	472	472	472	472	472	0	0	0	0	0	9,440
Pumping		$x1000		4	10	19	29	61	67	95	105	117	153	182	180	188	185	193	174	158	215	209	254	268	321	289	308	311	286	4,382
Total Other Consumables		$x1000		569	2,582	2,591	2,601	2,633	2,639	2,668	2,677	3,589	3,625	3,654	3,652	3,158	3,349	3,666	3,646	3,630	3,387	3,381	3,213	2,696	2,075	2,066	1,498	1,728	486	71,460
TOTAL CONSUMABLES		$x1000		6,343	21,417	23,153	23,484	25,216	25,465	25,248	26,059	39,457	38,493	38,331	38,333	33,342	34,836	37,424	42,881	46,537	41,372	38,540	43,445	36,624	31,006	29,208	17,812	21,073	3,627	788,728
LABOR COSTS:																														
Partial Year Factor		none		0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.25	
Salaried Staff		$x1000		1,005	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	1,506	1,506	377	48,613
Hourly Labor (Includes VS&A)		$x1000		3,273	9,610	10,376	10,426	11,518	11,132	11,083	11,517	16,657	16,335	16,336	16,222	14,548	14,654	15,515	17,851	19,536	17,753	16,280	18,681	15,918	13,858	13,152	8,449	9,274	1,686	341,643
TOTAL LABOR		$x1000		4,278	11,620	12,386	12,436	13,528	13,142	13,092	13,527	18,667	18,345	18,346	18,232	16,558	16,664	17,525	19,861	21,546	19,763	18,290	20,691	17,928	15,868	15,162	9,955	10,780	2,063	390,256
TOTAL COSTS		$x1000		10,622	33,037	35,539	35,920	38,744	38,607	38,341	39,586	58,123	56,838	56,677	56,565	49,900	51,500	54,949	62,743	68,083	61,135	56,831	64,137	54,552	46,874	44,370	27,768	31,853	5,690	1,178,984

Table 6-16: Summary of Mine Operating Costs by Category

	Units	-2	-1	1	2	3	4	5	6	7	8	9	10	11
PARTS AND CONSUMABLES:														
Electrical Power	$x1000		110	684	625	687	643	687	631	653	982	943	922	982
Diesel Fuel	$x1000		1,702	4,461	5,318	5,231	6,012	5,983	6,070	6,297	9,789	9,535	9,529	9,336
Tires	$x1000		962	2,517	3,092	3,018	3,462	3,519	3,568	3,678	5,792	5,632	5,623	5,508
Lubricants, Repairs, Wear Items	$x1000		2,472	7,976	8,601	8,735	9,443	9,426	9,356	9,686	14,720	14,352	14,293	14,270
Drill Down Hole Items	$x1000		112	607	559	610	588	610	564	596	867	835	818	867
Explosives	$x1000		416	2,590	2,367	2,603	2,435	2,602	2,391	2,471	3,718	3,570	3,492	3,718
Gen.Mine/Gen. Maint/Pumping	$x1000		569	2,582	2,591	2,601	2,633	2,639	2,668	2,677	3,589	3,625	3,654	3,652
TOTAL PARTS AND CONSUMABLES	$x1000		6,343	21,417	23,153	23,484	25,216	25,465	25,248	26,059	39,457	38,493	38,331	38,333
LABOR:														
Salaried Staff	$x1000		1,005	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010
Hourly Labor	$x1000		3,273	9,610	10,376	10,426	11,518	11,132	11,083	11,517	16,657	16,335	16,336	16,222
TOTAL LABOR	$x1000		4,278	11,620	12,386	12,436	13,528	13,142	13,092	13,527	18,667	18,345	18,346	18,232
TOTAL MINING COST	$x1000		10,622	33,037	35,539	35,920	38,744	38,607	38,341	39,586	58,123	56,838	56,677	56,565
Total Tons Mined	tonx1000		18,850	70,000	70,000	70,000	70,000	70,000	70,010	70,000	100,000	100,000	100,000	100,000
Per Total Ton	$/ton		0.563	0.472	0.508	0.513	0.553	0.552	0.548	0.566	0.581	0.568	0.567	0.566

	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total	% of Total
PARTS AND CONSUMABLES:																
Electrical Power	818	881	982	982	982	845	884	814	640	574	581	389	464	65	18,450	1.6%
Diesel Fuel	8,263	8,525	8,998	11,088	12,483	11,109	9,913	12,112	10,388	8,744	8,038	4,666	5,538	935	200,063	17.0%
Tires	4,845	5,049	5,346	6,655	7,508	6,621	5,910	7,256	6,228	5,210	4,795	2,757	3,330	549	118,432	10.0%
Lubricants, Repairs, Wear Items	12,429	12,926	13,861	15,939	17,364	15,457	14,335	16,238	13,663	11,699	11,002	6,663	7,843	1,283	294,032	24.9%
Drill Down Hole Items	732	770	853	852	852	754	772	729	586	531	523	365	411	61	16,425	1.4%
Explosives	3,097	3,337	3,719	3,718	3,718	3,198	3,346	3,082	2,424	2,174	2,202	1,475	1,757	247	69,866	5.9%
Gen.Mine/Gen. Maint/Pumping	3,158	3,349	3,666	3,646	3,630	3,387	3,381	3,213	2,696	2,075	2,066	1,498	1,728	486	71,460	6.1%
TOTAL PARTS AND CONSUMABLES	33,342	34,836	37,424	42,881	46,537	41,372	38,540	43,445	36,624	31,006	29,208	17,812	21,073	3,627	788,728	66.9%
LABOR:																
Salaried Staff	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	2,010	1,506	1,506	377	48,613	4.1%
Hourly Labor	14,548	14,654	15,515	17,851	19,536	17,753	16,280	18,681	15,918	13,858	13,152	8,449	9,274	1,686	341,643	29.0%
TOTAL LABOR	16,558	16,664	17,525	19,861	21,546	19,763	18,290	20,691	17,928	15,868	15,162	9,955	10,780	2,063	390,256	33.1%
TOTAL MINING COST	49,900	51,500	54,949	62,743	68,083	61,135	56,831	64,137	54,552	46,874	44,370	27,768	31,853	5,690	1,178,984	100.0%
Total Tons Mined	83,289	89,741	100,017	100,000	100,000	90,000	90,000	82,899	65,195	58,459	59,222	39,671	47,260	6,653	1,921,266	
Per Total Ton	0.599	0.574	0.549	0.627	0.681	0.679	0.631	0.774	0.837	0.802	0.749	0.700	0.674	0.855	0.614	

6.9 SUMMARY OF MINE CAPITAL AND OPERATING COSTS

Table 6-17 summarizes the total mine capital and operating costs for the life of the project.

Table 6-17
SUMMARY OF MINE CAPITAL AND OPERATING COSTS
($US x 1000)

Year	Initial Capital Cost	Sustaining Capital Cost	Mine Preprod. Develop.	Total Mine Capital	Operating Cost	TOTAL COST
-2						
-1	49,702		10,621	60,324		60,324
1	24,808			24,808	33,037	57,845
2		5,794		5,794	35,539	41,332
3		32		32	35,919	35,951
4		6,589		6,589	38,743	45,332
5		153		153	38,606	38,759
6		1,180		1,180	38,340	39,519
7		517		517	39,585	40,102
8		37,187		37,187	58,122	95,308
9		422		422	56,836	57,258
10		16,930		16,930	56,676	73,606
11		15,011		15,011	56,564	71,574
12		9,827		9,827	49,898	59,725
13		1,710		1,710	51,498	53,209
14		7,465		7,465	54,948	62,413
15		16,826		16,826	62,741	79,567
16		21,792		21,792	68,081	89,872
17		20,817		20,817	61,133	81,950
18		1,400		1,400	56,829	58,228
19		17,366		17,366	64,134	81,500
20		4,417		4,417	54,550	58,967
21		185		185	46,872	47,057
22		0		0	44,369	44,369
23		0		0	27,767	27,767
24		0		0	31,852	31,852
25		0		0	5,690	5,690
26						
TOTAL	74,511	185,618	10,621	270,750	1,168,328	1,439,078

6.10 MARCH 2001 MODEL UPDATE

As discussed in Section 5.8.2, the model was updated with 13 additional drillholes during March 2001.

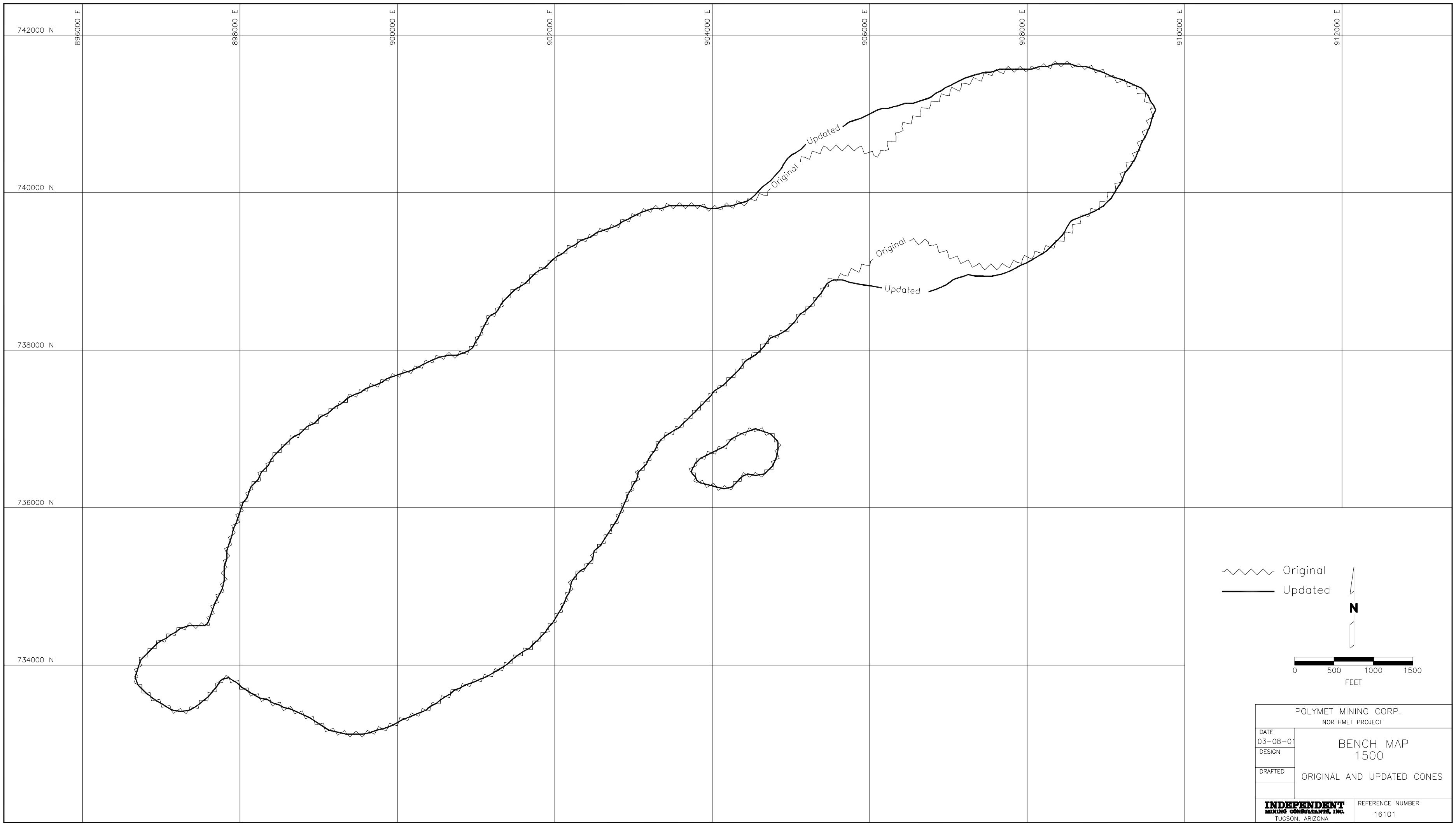
A floating cone was done on the updated model using the same parameters used for the base case cone used for final pit design. This cone was based on 100% recovery of NSR value and did not include time value of money discounting. Figure 6-4 shows the original and updated cone on the 1500 bench. The updated cone expands the pit slightly in the northeast.

Table 6-18 compares the original and updated cone tonnages and grades. Ore tonnage and total tonnage increased 3.2% and 5.7% respectively. Ore grades generally decreased, but by small amounts. The tonnages presented include measured, indicated, and inferred material located inside the cone geometries.

Table 6-18: Comparison of Cone Results From Original and Updated Resource Models

	Ore Ktons	NSR ($US)	Copper (%)	Nickel (%)	Cobalt (ppm)	Palladium (ppm)	Platinum (ppm)	Gold (ppm)	Cueq (%)	Total Ktons
Original Cone	498,373	11.61	0.306	0.083	66.06	0.293	0.085	0.043	0.832	1,799,171
Updated Cone	514,277	11.52	0.303	0.083	66.22	0.291	0.084	0.042	0.826	1,901,714
% Variance	3.2%	-0.8%	-1.0%	0.0%	0.2%	-0.7%	-1.2%	-2.3%	-0.7%	5.7%

Figure 6-4
Comparison of Cone Results From Original
and Updated Resource Models on the 1500 Bench



7.0 METALLURGY

7.1 SUMMARY

PolyMet has undertaken an extensive metallurgical development program over the past two years. The objective of that program was to develop an economical process route for the NorthMet deposit. This meant that the gold and PGM values would have to be recovered in addition to copper, nickel and cobalt.

Two flotation pilot plant campaigns were run at Lakefield Research to provide a bulk concentrate sample for the hydrometallurgical (Hydromet) testing and pilot plant.

PolyMet's objective was achieved. A new process development, now called the PlatSol™ Process was applied to give base metal extraction percentages in the high 90's, PGM extraction percentages of 95% and gold extraction near 90%. The feature of the process is the addition of a small amount of chloride to the high temperature pressure oxidation step with the result that the precious metals dissolve in the autoclave along with the base metals. The PlatSol™ process is shown schematically in Figure 7-1.

The PGM's are then recovered as a saleable PGM concentrate by selective precipitation with sodium hydrosulfide. Copper and nickel are recovered by solvent extraction and electrowinning, while a small quantity of cobalt is recovered as a sulfide.

The main continuous Hydromet pilot plant campaign run in July 2000 was successful.
A 10-day continuous run gave the extractions shown in Table 7-1 that summarizes the overall flotation and process recoveries for the project.

Recoveries of the economically significant metals were enhanced by provision of additional flotation residence time during the latter part of the flotation pilot plant. This has allowed the use of the average flotation recovery to project recoveries over the life of the mine.

Table 7-1: Summary of Process Recoveries						
	Percent			ppm or %		
	Cu	Ni	Co	Au	Pt	Pd
Ore Grade	0.43	0.12	0.009	0.05	0.08	0.36
Conc. Recovery	93.7	69	42	75.7	76.9	79.6
Conc. Grade	14.6	3.1	0.15	1.4	2.3	10.4
Process Extraction	99.6	98.9	96	89.4	96	94.6
Process Recovery	98.1	96.9	92	88.4	95	93.6
Overall Recovery	91.9	66.9	38.6	66.9	73.1	74.5

In Table 7-1, the Overall Recovery is the product of Concentrate Recovery and Process Recovery.

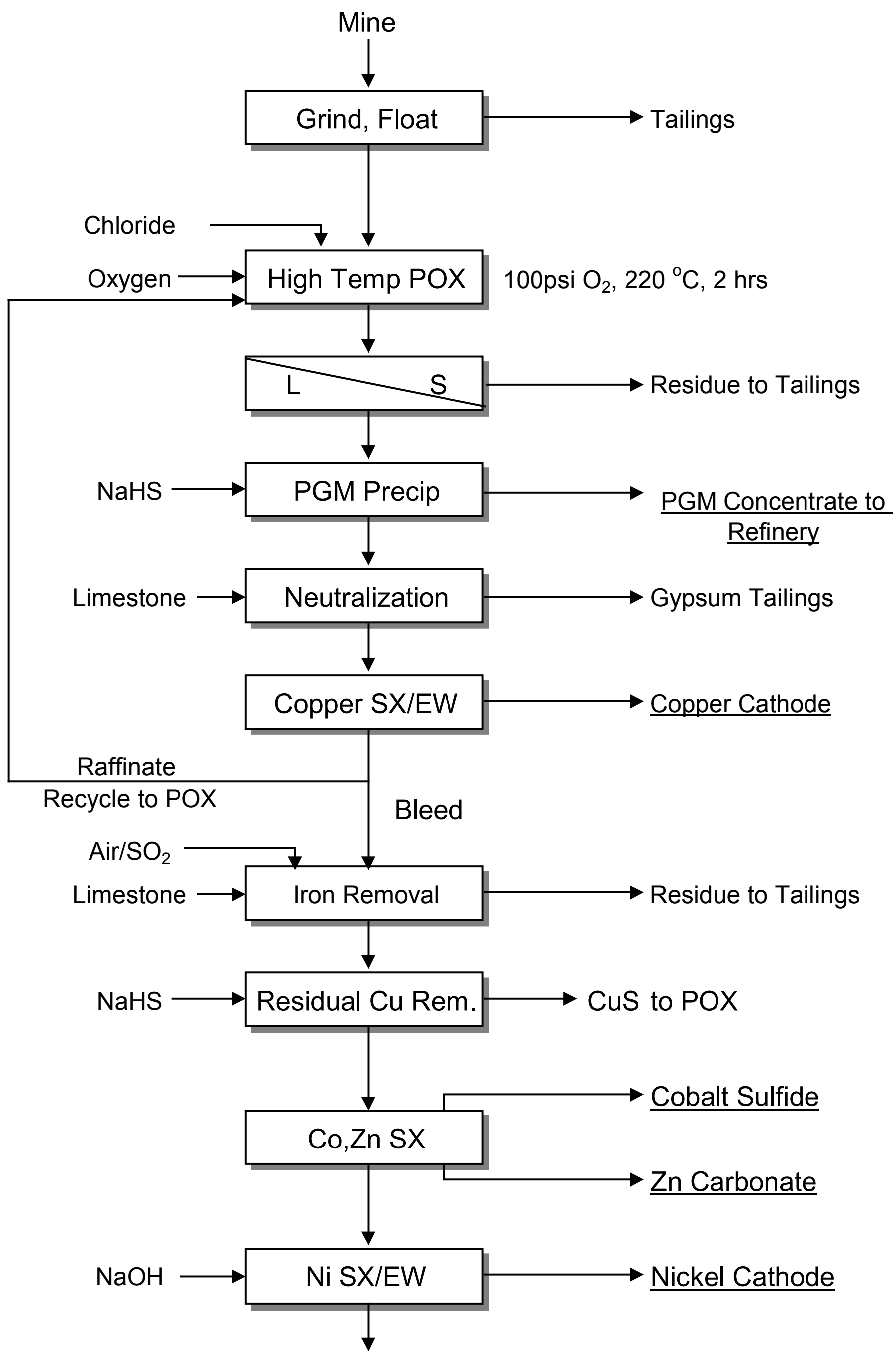
In addition, it is noted that the ore grades shown on Table 7-1 are the average grades of the test samples and are not the same as the projected average head grades from the mine.

It is also noted that the ore grade values for copper in Table 7-1 are different than on Table 5-2 (0.43% versus 0.40%). Table 5-2 is based on Chemex assays while Table 7-1 is based on assays done at Lakefield.

Figure 7-1

Simplified Block Flow Diagram for Gold, PGM and Base Metal Recoveries from NorthMet Concentrates

PlatSol™ Process



7.2 BACKGROUND

Previous work on the NorthMet property (formerly called "Dunka Road") consisted of efforts to produce saleable concentrates with emphasis on copper and nickel recovery. A development program undertaken by Nerco in the early 1990's considered gold and PGM's as well, but was not successful in obtaining acceptable extractions of the precious metals.

PolyMet decided to focus on producing a bulk concentrate, thereby maximizing metal recoveries. There was unlikely to be a market for a bulk concentrate, thus treatment at site was deemed the only alternative. Further, smelting was not considered to be an option because of the relatively low grade of the bulk concentrate and because of environmental considerations.

Thus, it was decided to attempt to develop a viable hydrometallurgical treatment process taking advantage of recent technological developments. The leaching processes considered were partial or total pressure oxidation in autoclaves and bio-leaching. Generally, the base metals dissolve in the leaching step while precious metals would remain in the leach residue. The residue would then be subjected to cyanidation or chloridation to dissolve and recover gold and PGM's. The copper and nickel would then be recovered by sequential solvent extraction and electrowinning. Significant cobalt values would also be recovered in the process.

The following sections describe the process in more detail. Figure 7-1 in the previous section shows the general approach.

Samples for metallurgical testing came from two drilling campaigns, which produced some 60 tons of reverse circulation drill chips. These samples were processed in two flotation pilot plant campaigns at Lakefield Research in December 1998, and May-June of 2000.

The bulk concentrate from the first flotation campaign was used for bench scale testing of the hydrometallurgical process options. The second campaign provided a concentrate sample for the continuous hydrometallurgical pilot campaign carried out at Lakefield during the year 2000.

7.3 GRINDING AND FLOTATION

7.3.1 Mineralogy

The mineralogy of the ore is as follows:

Copper – approximately 2/3 as chalcopyrite – $CuFeS_2$
and 1/3 as cubanite – $CuFe_2S_3$. This is variable.

Nickel – approximately 75% as pentlandite – (Ni,Fe)S and
the balance as nickel silicates. Again this is variable.

Iron - pyrrhotite and ferric silicates

Cobalt - no discreet cobalt minerals

Gold and PGM's – the grades are too low for detailed assessment of the presence of specific minerals.

7.3.2 First Pilot Plant Run – December 1998

The first pilot plant run was carried out in December 1998 wherein 26 tons of material was processed to concentrate over a period of 42 hours. The primary objective was to produce concentrate for the hydrometallurgical test program.

The pilot plant operation was successful with the following results:

Table 7-2: Results From First Flotation Pilot Plant Run			
	Feed (Head) Grade	**Bulk Concentrate Grade**	**Metal Recoveries (%)**
Copper	0.43%	15.5%	94.6
Nickel	0.12%	3.69%	77.2
Cobalt	0.009%	0.149%	46.4
Platinum	0.08 g/t	2.49 g/t	76.4
Palladium	0.37 g/t	11.1 g/t	75.8
Gold	0.06 g/t	2.80 g/t	76.6

Approximately 1300 lbs. of concentrate were produced. The primary grind was set to 80% passing 200 microns. Regrinding in the cleaner circuit gave a final concentrate size of about 80% passing 35 microns.

For details, refer to Lakefield Report No. LR5349, April 1999.

7.3.3 Second Pilot Plant Run – May/June, 2000

The second run processed about 30 tons of ore over a 48 hour period with average results similar to the first run as indicated in Table 7-3 below:

Table 7-3: Results From Second Flotation Pilot Plant Run			
	Feed (Head) Grade	**Bulk Concentrate Grade**	**Metal Recoveries (%)**
Copper	0.43%	14.6%	93.7
Nickel	0.12%	3.1%	69
Cobalt	0.009%	0.15%	42
Platinum	0.08 g/t	2.3 g/t	76.9
Palladium	0.36 g/t	10.4 g/t	79.6
Gold	0.05 g/t	1.4g/t	75.7

The exceptions were the nickel and palladium recoveries. The nickel recovery was 69% compared to 77% in the first run. This can be ascribed to higher nickel silicate in the second sample.

Palladium recovery was nearly 80% compared to 76% in the first run. It was decided part way through the run to determine if additional retention time in the scavenger cells would improve recoveries. This proved to be the case as shown below in Table 7-4. While improvement was not dramatic, it was decided to incorporate the additional residence time into the plant design.

Table 7-4: Recoveries From Second Pilot Plant Run – Effect of Additional Retention Time in Scavenger Cells

	Copper	Nickel	Cobalt	Gold	Platinum	Palladium
Overall Pilot Run	93.7	69.0	42.0	75.7	76.9	79.6
PP-5	95.1	70.6		80.9	79.3	81.4
PP-6	95.0	69.9		65.3	78.0	79.2

The final 2 runs, PP-5 and PP-6 showed better recoveries for the most significant economic elements: copper, nickel and palladium. These results were consistent with variability bench flotation tests. Hence, it was concluded that projection of expected recoveries at different ore grades should be based on the results of PP-5 and PP-6 rather than the overall pilot plant run. Further, the variability tests indicated that recoveries are relatively constant over a wide grade range. One can thus use constant recovery at different grades without introducing significant error.

For details, refer to Lakefield Report No. LR10054, August 2000.

7.4 HYDROMETALLURGICAL PROCESS SELECTION

Test programs were carried out during the first six months of 1999 by Lakefield Research, Dynatec and BacTech to evaluate leaching process options followed by recovery of gold and PGM's from the leach residue. The processes considered were high temperature pressure oxidation (POX) (sulfides converted to sulfates) at 220^{0}C, partial oxidation (sulfides converted to elemental sulfur) and bacterial leaching.

All leach processes gave excellent base metal extractions in the order of 97 to 99%. None were completely satisfactory in the subsequent residue leaching to recover gold and PGM's. The total pressure oxidation approach gave the best results, with tolerable cyanide consumption. Gold extraction was over 90%, palladium was in the 60-70% range, and platinum was less than 30%. Excessive cyanide consumption was experienced with the other leaching options.

It was decided to try adding a small amount of chloride to the high temperature leach to take advantage of the high temperature and high acid conditions. This gave dramatic results as demonstrated in the following two tables, 7-5 and 7-6.

Table 7-5: Pressure Leaching Test Conditions

Test No.	Concentrate Reground	Feed K_{80} (μm)	Autoclave Temp (^oC)	O_2 Pressure (psi)	Time (h)	Chloride (g/L)
1	No	32	220	100	2	0
2	No	32	220	100	2	6
3	Yes	15-20	220	100	2	3
4	Yes	15-20	200	100	2	6
5	Yes	15-20	220	100	2	6
6	Yes	15-20	220	100	2	6

Table 7-6: Pressure Leaching Metallurgical Results										
	Copper		Nickel		Gold		Platinum		Palladium	
Test No.	Assay %	Ext %	Assay %	Ext %	Assay (g/t)	Ext %	Assay (g/t)	Ext %	Assay (g/t)	Ext %
Feed	13.8		3.52		2.24		1.75		8.91	
1	0.16	99.3	0.23	97.7	3.32	~0	2.15	~0	5.36	61
2	0.05	99.7	0.31	93.4	0.27	91	0.49	79	1.37	88
3	0.12	99.4	0.27	94.3	0.64	79	0.16	93	1.01	92
4	0.28	98.3	0.38	90.8	2.71	~0	1.97	4	10.9	~0
5	**0.11**	**99.4**	**0.31**	**93.3**	**0.13**	**96**	**0.06**	**98**	**0.72**	**94**
6	**0.10**	**99.4**	**0.26**	**94.3**	**0.13**	**96**	**0.06**	**98**	**0.64**	**95**

It is seen that regrinding of the concentrate to about 15 microns and addition of 3 to 6 g/l of chloride as sodium chloride results in over 95% of the gold, platinum and palladium being dissolved in the autoclave. The gold and PGM's can then be precipitated selectively from the leach solution as shown in Table 7-7.

Table 7-7: NaHS Precipitation of Gold and the PGM's from Pregnant Solution							
		Cu	**Ni**	**Fe**	**Au**	**Pt**	**Pd**
Preg solution	mg/L	17000	19900	1550	0.32	0.34	1.23
Barren solution	mg/L	14300	18200	1340	0.01	0.00	0.01
Precipitate		61.8%	0.19%	0.37%	92 g/t	102 g/t	484 g/t
Precipitation Efficiency	%	16	<0.1	1	97	~100	99

The PGM precipitate would be filtered, releached to remove copper, then sent to a platinum refinery for final recovery of the gold, platinum, palladium and any silver and other PGM's contained therein.

This process, dubbed the "PlatSol™" Process, was clearly superior to the other options tested, specifically because the high temperature POX leach conditions permitted the dissolution of gold and PGM's in the leach autoclave.

Extractions and assumed overall metal recoveries, based on test results, are as shown in Table 7-8:

Table 7-8:
Hydrometallurgical Process Extractions and Recoveries

	Cu	Ni	Co	Au	Pt	Pd
Leach Extractions - %	98.5	96.5	96.5	96	98	95
Recoveries	97.5	94.5	92.5	94	94	94

The test work briefly described above and a subsequent optimization program are described in detail in Lakefield Research Report No. LR5428, June1999.

7.5 PROCESS DESCRIPTION

The hydrometallurgical (Hydromet) process chosen for piloting and preliminary design is described in this section. Refer to Figure 7-1 for the schematic flow diagram of the process.

7.5.1 Chemistry

The autoclave oxidation process converts metal sulfide minerals into metal sulfates and iron hydrolysis products (primarily hematite). The oxidation of gold, palladium, platinum and other PGM's is favored by the presence of small amounts of chloride in solution. The chloride stabilizes the various platinum group elements as dissolved chloro complexes.

The chemical reactions believed to occur in the autoclave are shown below. (Note that the mineralogy of the PGM's may be very complex, but for simplicity only the metallic species are considered.)

Chalcopyrite Oxidation/Iron Hydrolysis:

$$CuFeS_2 + 17/4O_2 + H_2O \rightarrow CuSO_4 + 1/2Fe_2O_3 + H_2SO_4 \quad (1)$$

Pyrite Oxidation:

$$FeS_2 + 15/4O_2 + 2H_2O \rightarrow 1/2Fe_2O_3 + 2H_2SO_4 \quad (2)$$

Nickel Sulfide Oxidation:

$$NiS + 2O_2 \rightarrow NiSO_4 \quad (3)$$

Gold Oxidation/Chlorocomplex Formation:

$$Au + 1/4O_2 + 1/2\ H_2SO_4 + 4NaCl \rightarrow Na_3AuCl_4 + 1/2\ Na_2SO_4 + 1/2\ H_2O \quad (4)$$

Platinum Oxidation/Chlorocomplex Formation:

$$Pt + O_2 + 2H_2SO_4 + 6NaCl \rightarrow Na_2PtCl_6 + 2Na_2SO_4 + 2H_2O \quad (5)$$

Palladium Oxidation/Chlorocomplex Formation:

$$Pd + 1/2O_2 + H_2SO_4 + 4NaCl \rightarrow Na_2PdCl_4 + Na_2SO_4 + H_2O \quad (6)$$

7.5.2 Description

7.5.2.1 Leaching

Thickened concentrate from the concentrator is reground in a tower mill to about 15 microns, then is pumped directly into the autoclave as a 50% solids slurry. The oxidation reactions are highly exothermic, thus raffinate from the copper electrowinning step will also be injected into the autoclave to cool the slurry (and coincidentally increase the nickel tenor in solution to 15 to 20 g/l because of the recycle).

Autoclave conditions are 220 ^{0}C, 100 psi oxygen overpressure (~450 psig total pressure) and 2 hours residence time. Copper, nickel, and cobalt all dissolve in the autoclave, as do the gold and PGM's. Iron is leached, but subsequently hydrolyzes to form hematite and sulfuric acid while still in the autoclave. Some of the iron precipitates as basic ferric sulfate and/or jarosite. Dissolved iron in the autoclave slurry discharge is 3 to 5 g/l. Sulfuric acid in the leach solution will be 50 to 70 g/l.

The slurry leaving the autoclave is flashed to atmospheric pressure, then is cooled, thickened and filtered. About 20% of the contained solution flashes off.

The leach residue will contain up to 15% sulfate, probably as sodium jarosites and/or basic ferric sulfates. This serves well as a purge for sodium, but it is also prudent to add sufficient limestone to the residue going to tailings to ensure the residue will never become acid generating.

It was also found, during the pilot plant campaign (discussed later), that it was possible to recover up to 50% of the remaining PGM's by a simple froth flotation step. This flotation circuit has been incorporated into the plant design and cost estimates with the intention that the concentrate produced is recycled to the leach feed. No allowance for increased PGM recovery has been assumed.

7.5.2.2 PGM Recovery

The gold and PGM's can be selectively precipitated with sodium hydrosulfide (NaHS). The pregnant leach solution is pre-reduced with sulfur dioxide to minimize NaHS consumption. Copper also can be precipitated under these high acid conditions, but the precious metals are more noble than copper, thus copper precipitation can be minimized by careful control of NaHS injection and intense agitation at the point of injection. Nevertheless, some copper will be co-precipitated, thus a releach of the PGM precipitate will be necessary to concentrate the PGM concentrate to an expected 30 to 50% PGM grade. The releach will be carried out batch-wise in a small autoclave in the absence of chlorides. The leached copper will be recycled to the primary leach autoclave.

The PGM concentrate will be air shipped in 5-gallon plastic pails to a custom PGM refinery.

7.5.2.3 Neutralization

The PGM-free solution must be neutralized to pH 2 prior to copper solvent extraction. This is accomplished with limestone. Ground limestone is added as a slurry to the three neutralization tanks in series. The resultant gypsum slurry is filtered and washed and the gypsum is pumped to tailings, unless a commercial use can be determined.

7.5.2.4 Copper Solvent Extraction/Electrowinning

The solution at about 17 g/l Cu and 17 g/l Ni then passes to a conventional copper solvent extraction (SX) step. A scrub stage is included in addition to the two extraction stages to ensure that no chlorides get through to copper electrowinning. The raffinate from copper SX contains <0.5 g/l Cu, 17 g/l Ni and 25-30 g/l H_2SO_4.

The organic phase is stripped in two stages with spent electrolyte from the copper tankhouse. The tankhouse also will be conventional and will be based on use of stainless steel cathode blanks.

7.5.2.5 Bleed Stream Purification

About 75 % of the Cu SX raffinate will be recycled to the leach step to serve as coolant in the autoclaves. The amount of recycle is thus dependent on the sulfur content of the flotation concentrate.

The remaining raffinate must then be purified prior to recovering the nickel and minor base metals therefrom. This solution also contains magnesium and manganese, which will be bled from the circuit in the cobalt and zinc barren liquors and the nickel SX raffinate.

Residual iron is first removed in two stages using limestone to raise the pH and a mixture of SO_2 and oxygen to oxidize the iron to goethite. The reaction is carried out in stirred tank reactors at 80 ^{0}C. The pH is raised to 3.5 in the first stage to minimize co-precipitation of nickel with the iron-gypsum solids. This slurry is thickened, filtered, washed and disposed to tailings. The pH is raised to 4.3 in the second stage with the objective of lowering the iron content to < 1 mg/l. The precipitate will contain nickel, and thus is recycled back to the leach autoclave step to preclude valuable metal loss.

The bleed solution also contains 1200 – 2500 mg/l of aluminum. Under the conditions used for iron, aluminum will also precipitate such that the purified solution will be < 20 mg/l Al, a satisfactory level.

The residual copper must also be removed from solution prior to the cobalt and nickel SX. This is done by addition of NaHS to the iron free solution. Copper is precipitated as the sulfide, which can be filtered off and recycled to the leach autoclaves. The copper free liquor will contain < 1 mg/l Cu.

7.5.2.6 Nickel and Cobalt Recovery

The process steps from this point onwards generally follows that of the Bulong nickel laterite metals recovery circuit. Bulong has overcome their initial problems, particularly with calcium deposition in the settlers. The first step is to remove cobalt (and residual zinc) by SX using the proven Cyanex 272 reagent. The cobalt free liquor then undergoes another SX step, using Versatic 10 to extract nickel. The Versatic 10 SX step is operated in conjunction with a nickel electrowinning tankhouse.

Feed solution to cobalt SX will have the following tenor:

Ni	11 – 12 g/l	S	~ 38 g/l
Co	1.9 – 2.1 g/l	Mn	~ 40 mg/l
Zn	~ 0.2 g/l	Cu	< 2 mg/l
Mg	3.3 – 3.8 g/l	Fe	< 10 mg/l
Ca	0.5 – 0.6 g/l		

The cobalt SX step will consist of four stages of extraction and a scrub stage to extract cobalt and zinc followed by three and two stripping stages to strip cobalt and zinc respectively. NaOH is used to control pH in the extraction stages. Sulfuric acid is used in the stripping stages. The key operation is the selective stripping of cobalt and then zinc from the loaded organic. Zinc is a nuisance with cobalt, but cobalt with the zinc stream would be a problem. Cobalt is stripped at pH 4.0 and zinc at pH 2.0.

NaHS is used to precipitate cobalt from the cobalt strip solution. The 30% cobalt sulfide produced is filtered, dried and shipped to a cobalt refiner. Zinc is precipitated as a carbonate with soda ash. The zinc carbonate at ~25% Zn will be sold to a zinc refinery. The barren liquors from the two strip operations will go to tailings and will contain most of the manganese.

Cobalt and zinc free liquor (Co, Zn SX raffinate) will pass to the Versatic 10 Nickel SX circuit consisting of four extract and one scrub stages followed by organic strip stages. Anolyte from the EW cells is used to strip the organic. The nickel tankhouse will employ the bagged anode system developed by Inco and successfully implemented at Cawse in Australia.

Nickel SX raffinate will be sent to tailings. It will be the primary purge for magnesium and sodium.

7.5.2.7 Tailings

The flotation tailings will be segregated from the Hydromet tailings. Water reclaimed from the flotation tailings pond will be used for scrubbing the autoclave and flash tank vapor streams. Water from the Hydromet tailings pond will be recycled to the Hydromet plant.

7.5 HYDROMETALLURGICAL PILOT PLANTS

The Hydromet pilot plant operation at Lakefield Research was divided into two parts. The first "loop" comprised the autoclave leaching, PGM recovery, neutralization, copper SX/EW, associated liquid/solid separation steps and recycle of copper raffinate to the autoclave. The second operation treated the bleed solution accumulated in the first run. The iron removal, residual copper precipitation, Co/Zn SX and Ni SX/EW were piloted. The first part was run during July 2000, while the bleed stream processing took place in September and December 2000.

Approximately 750 kg of concentrate was processed at a feed rate of 2 kg/hour.

7.6.1 First Campaign

7.6.1.1 Set-up

The pilot plant equipment consisted of the continuous autoclave, stirred reactors for PGM precipitation with NaHS, stirred reactors for neutralization and continuous copper SX/EW equipment. A carbon-in-pulp (CIP) system was also set up to test carbon adsorption of PGM's as an alternative to NaHS precipitation. The various liquid-solid separation operations were done batch wise using pan filters.

7.6.1.2 Results

The campaign began with several shakeout runs. These were followed by a continuous 10-day run where conditions were very steady with but a few short interruptions. The operation lasted a total of 14 days. The average leaching results are shown below, using the following leach conditions:

Temperature	225 ^{0}C
Oxygen overpressure	100 psi
Retention time	2 hrs.
Cl concentration	9 g/l

Table 7-9: Pilot Plant Leach Results

	%			g/t or %		
	Cu	Ni	Co	Au	Pt	Pd
Concentrate Grade	13.8-14.6	3-3.5	0.14-.15	1.4-2.2	1.8-2.2	8.8-8.9
Extractions	99.6	98.9	96	89.4	96	94.6

With the exception of gold, all extractions equalled or exceeded the bench scale results. Standard froth flotation on the leach residue recovered an additional 30-50% of gold and PGM's from the leach residue in a concentrate containing 8-9% Au+PGM's and 25-30% graphitic carbon. This potentially could increase PGM extractions to the 95 to 97% range.

The response of this concentrate to the PlatSol™ leaching conditions has not been verified, nor incorporated into this study.

It was necessary to convert the CIP PGM adsorption to carbon-in-column (CIC) when it was found that iron in solids started to dissolve. This was unexpected. Both carbon adsorption and precipitation with NaHS achieved essentially total removal of gold and PGM's from the leach liquor. Stripping and regeneration of the carbon was problematical. While it is anticipated this can be resolved, it was decided to proceed on the basis of NaHS precipitation.

The neutralization step ran very smoothly using the sample of Michigan Limestone that is proposed for the commercial operation. The gypsum produced was clean and contained <0.05% of copper or nickel. These are excellent numbers.

The copper SX/EW operation was also successful. After a start-up period, copper in the raffinate was generally less than 500 mg/l and good current efficiencies were attained. The copper cathode met ASTM B115-93 specifications as shown by Table 7-10.

Table 7-10: Copper Cathode Assays

Element (ppm)	Cu Cathode 1	Cu Cathode 2	ASTM B115-93	Element (ppm)	Cu Cathode 1	Cu Cathode 2	ASTM B115-93
Se	.33	.16	1	Pb	0.05	0.15	5
Te	<0.05	<0.05	0.2	Si	0.12	0.09	1
Bi	<0.001	<0.001	1	Sn	<0.01	0.02	0.4
Cr	0.01	0.003	0.2	Ni	0.03	0.006	0.8
Mn	<0.001	0.005	0.2	Fe	0.02	0.01	5
Cd	<0.01	<0.01	0.2	Zn	<0.05	<0.05	1
P	<0.001	<0.001	1	Co	0.02	0.007	0.2
As	0.07	0,05	1	S	2.5	0.8	10
Sb	<0.005	<0.005	1	Ag	0.16	0.15	12

The details of this pilot plant run are included in Lakefield Research Progress Report No. 10054-005, September 2000.

7.5.2 Second Campaign

The second pilot campaign comprised the bleed stream treatment steps, which consisted of the purification steps plus Co/Zn SX and Ni SX/EW. The details of the purification steps are contained in Lakefield Research Report 10054-007, Progress Report No.1 while Progress Report No. 2 reports on the Co/Zn SX and the NI/SX EW Steps.

7.5.2.1 Purification

The purification circuit consisted of a five tank cascade for iron removal, two tanks for aluminum removal and another five tanks for CuS precipitation.

It was demonstrated that iron in the bleed stream could be effectively removed to <10 mg/l by SO_2 coupled with oxygen process using limestone for neutralization. Sodium meta bisulphite ($Na_2S_2O_5$) was used in place of SO_2 in the pilot plant. The oxidation operation worked smoothly and could be controlled by emf measurement of the oxidized pulp. The gypsum produced at pH 3.5, typically contained < 0.15%. Most of the aluminum in the bleed stream precipitated with iron. Aluminum was reduced to <20 mg/l in a second neutralization stage with a final pH of 4.3.

Copper was effectively removed to the 1 mg/l level with NaHS at 120% of stoichiometric and with 300% recycle of product for seeding. This process is kinetically fast and trouble-free.

This stage of the pilot operated for four days at a feed rate of 12 – 15 litres/hr.

7.5.2.2 Cobalt/Zinc SX and Ni SX/EW

This circuit was set up to run continuously. The run lasted five days. The full four extract, one scrub and five strip stages were installed for the Co/Zn SX with Cyanex 272. The nickel SX step with Versatic 10 had four extraction, one scrub and three strip stages, and was tied in with nickel electrowinning cell consisting of two bagged anodes and one cathode.

The feed solution to cobalt SX had the following analysis:

Ni	11 – 12 g/l	S	~ 38 g/l
Co	1.9 – 2.1 g/l	Mn	~ 40 mg/l
Zn	~ 0.2 g/l	Cu	< 2 mg/l
Mg	3.3 – 3.8 g/l	Fe	< 10 mg/l
Ca	0.5 – 0.6 g/l		

In general the results were good as summarized below:

- A good quality nickel cathode was produced at 95% current efficiency. It assayed 99.9% nickel with major impurities being lead and iron. The quality of the cathode can be further improved by introducing an ion exchange (IX) step in the electrowinning circuit to remove iron plus copper, cobalt and zinc. The lead was high because of the new anodes used. Lead will not be a problem commercially.

- The cobalt strip liquor tenor was 7.5 g/l Co, 7.5 g/l Mg, ~0.5 g/l Mn and <0.1 g/l Zn. This solution was treated with NaHS to yield a sulfide containing 30% Co, 2.6% Ni and 0.4% Zn.

- The zinc strip liquor assayed ~50 g/l Zn, but with an average of 300 mg/l of cobalt. Carbonate precipitation yielded a zinc concentrate analyzing 54% Zn and 0.33% Co. Based on these results, a slight modification of the Cyanex 272 strip circuit has been recommended to mitigate the high cobalt content.

A few operational issues were encountered during the operation, which were similar to those encountered at Bulong during their start-up. This included crud formation in the Cyanex circuit, and gypsum formation in the Versatic 10 circuit. These issues can be managed with proper engineering, but frequent removal of gypsum crystals will be required at the commercial scale.

8.0 PROCESSING AND FACILITIES

8.1 GENERAL

This report section describes the current status of the process plant and ancillary facilities designs and includes information and testwork results developed as of March 2001. The mill feed ore to be mined over the life of the NorthMet Project, as provided by IMC, is estimated to be 482.2 million tons averaging 0.303% copper, 0.083% nickel, 66.3 ppm cobalt, 0.289 ppm palladium, 0.084 ppm platinum, and 0.042 ppm gold. Annual plant feed rate is 20,075,000 tons per year.

Average daily milling rate is 55,000 tons per day, with a plant design tonnage of 60,440 tons per day based on a 91% plant availability (332 operating days per year). The project is expected to produce for sale, over a 25-year project mine life, an annual average of the following products:

- 55,910 tons of copper
- 11,140 tons of nickel
- 512 tons of cobalt
- 126,233 oz palladium
- 35,932 oz platinum
- 16,456 oz gold

Products will be platinum, palladium and gold in the form of a precious metal concentrate (precipitate) for sale to smelters, LME grade A copper cathode, cobalt sulfide precipitate, zinc hydroxide precipitate, and Class 1 nickel cathode.

All currency amounts are expressed in 1st quarter 2001 US dollars. They have not been escalated to the expected project start date.

8.2 METALLURGY AND PROCESS PLANT DESIGN

The evaluation of metallurgical testwork and the development of flowsheet unit operations for NorthMet samples has been completed by O'Kane and is discussed in Section 7.0 of this report. The metallurgical testwork results, recommendations, and flowsheet design, as provided by O'Kane, has been incorporated into the process facility design and equipment list without confirmation or audit by AMEC. The process mass and material balances provided by O'Kane have been reviewed for calculation accuracy and completeness, but have not been audited.

A summary of design metallurgical recoveries is presented in the table below.

Table 8-1: Summary of Metallurgical Recoveries

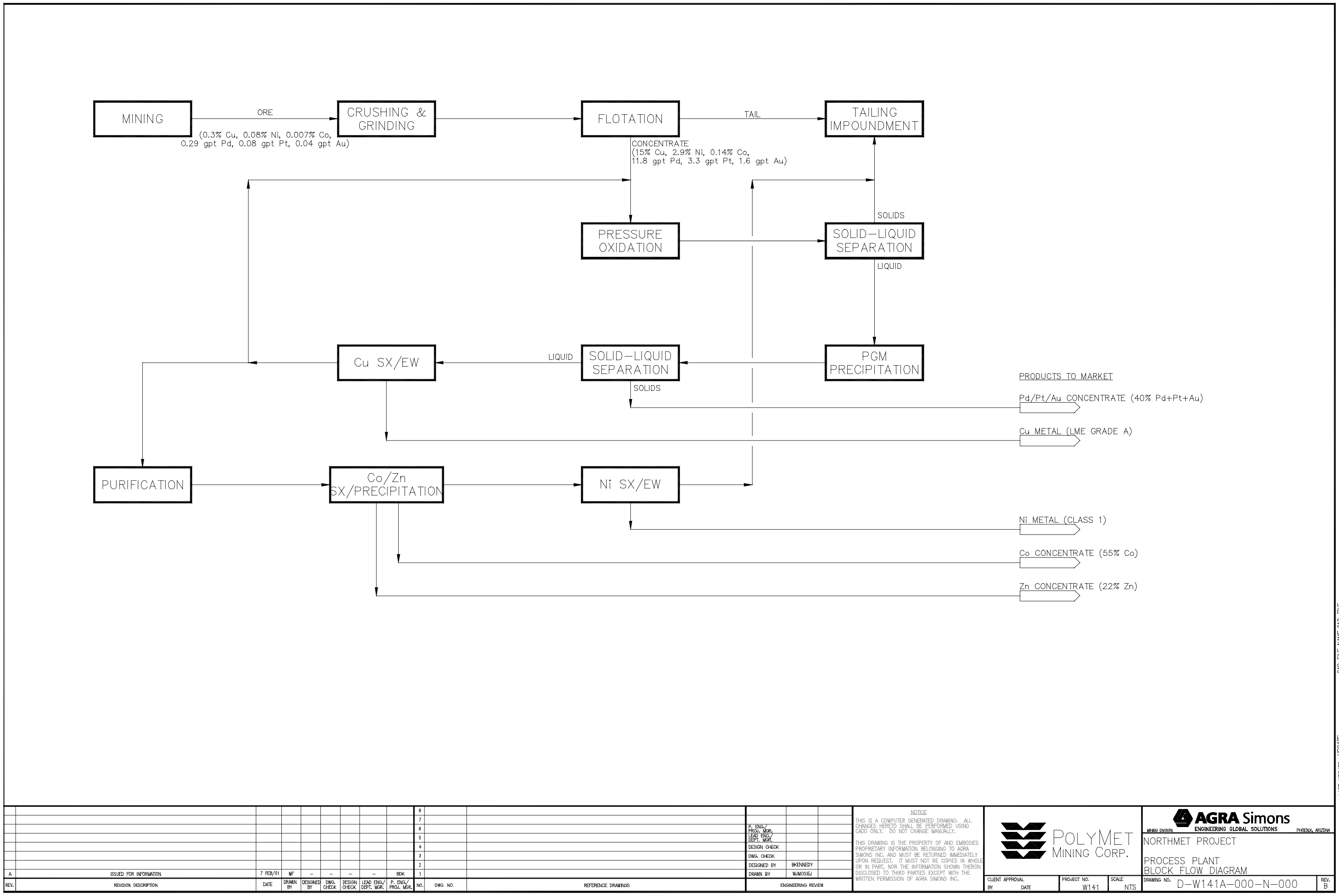
	Cu	Ni	Co	Pd	Pt	Au
Head Grade	0.303%	0.083%	0.0066%	0.289g/t	0.084g/t	0.042g/t
Recovery to Concentrate	93.7%	69.0%	42.0%	79.6%	76.9%	75.7%
Pressure Leach Extraction	99.6%	98.9%	96.0%	94.6%	96.0%	89.4%
Recovery from Leach Solution	98.6%	98.0%	95.9%	99.0%	99.0%	99.0%
Overall Recovery	91.9%	66.9%	38.6%	74.6%	73.1%	67.0%

The proposed NorthMet Project flowsheet will utilize proven and common unit processes to recover the contained metals from the mined feed materials. Polymetallic sulfide ores will be delivered by the mine to the proposed new milling and hydrometallurgical processing facilities to recover the contained metals. The project process flowsheet incorporates crushing and grinding of the mill feed to produce a flotation concentrate for additional downstream hydrometallurgical processing. Mill and flotation tailing will be pumped to a dedicated impoundment. Hydrometallurgical processing includes autoclave pressure leaching of flotation concentrate to solubilize all valuable metals, followed by staged metal recovery unit processes - precious metal precipitation, copper solvent extraction and electrowinning (SX/EW), cobalt and zinc SX/precipitation, and nickel SX/EW.

A simplified overall process plant block flow diagram for the proposed process facility is presented in Figure 8-1 (AMEC Drawing D-W141A-000-N-000).

The new facilities addressed in the AMEC report and cost estimate are generally as follows:

- Mine fuel storage and distribution, blasting materials storage facilities (requirements provided by IMC)
- Mine truck shop, maintenance facilities and warehousing (requirements provided by IMC)
- Mine engineering and operations facilities (requirements provided by IMC)
- Process facility maintenance and warehousing
- Sample preparation/assay laboratory facility
- Administration building and guard shack
- Primary gyratory crushing station, crushed ore stockpile and conveying
- Semi-autogenous (SAG) and ball mill grinding and classification
- Polymetallic flotation, regrinding, concentrate cleaning, thickening and storage
- Flotation tailings disposal system from mill to a tailings impoundment area. Reclaimed water system for re-use in the mill is also provided.
- Pressure leaching of concentrate followed by solids/liquid separation of pressure leach residue and polish filtration of pregnant leach solution
- Precious and platinum group metal precipitation, followed by precipitate re-leach (base metal removal), filtration and drying to produce a precious/PGM concentrate for sale
- Neutralization of leach solution, followed by filtration of gypsum
- Copper solvent extraction and electrowinning facilities to produce LME Grade A copper cathode for sale
- Recycle of SX raffinate to the autoclave leach circuit to provide cooling water and a recycle of copper and precious metals in remaining in solution
- Neutralization treatment of the raffinate bleed to remove iron and aluminum, followed by filtration of neutralization solids
- Cobalt and zinc recovery using solvent extraction and preferential stripping
- Cobalt precipitation and zinc precipitation from strip solutions to produce cobalt sulfide and zinc hydroxide precipitates for sale
- Nickel solvent extraction and electrowinning to produce Class 1 nickel cathode for sale
- Hydrometallurgical tailing disposal (including all residue and neutralization solids and raffinate streams) from plant to a dedicated tailings impoundment area. Reclaimed water system for re-use in the hydrometallurgical process is also provided
- Fresh water supply and distribution system
- Electric power supply through the main substation, from the Minnesota Power provided high voltage transmission line, pit electrification, and 34 kV/13.8 kV/4.16kV primary distribution
- Process plant site sewage treatment facilities


MINING
ORE
(0.3% Cu, 0.08% Ni, 0.007% Co, 0.29 gpt Pd, 0.08 gpt Pt, 0.04 gpt Au)
CRUSHING & GRINDING
FLOTATION
TAIL
TAILING IMPOUNDMENT
CONCENTRATE (15% Cu, 2.9% Ni, 0.14% Co, 11.8 gpt Pd, 3.3 gpt Pt, 1.6 gpt Au)
PRESSURE OXIDATION
SOLID-LIQUID SEPARATION
SOLIDS
LIQUID
PGM PRECIPITATION
SOLID-LIQUID SEPARATION
LIQUID
SOLIDS
Cu SX/EW
PURIFICATION
Co/Zn SX/PRECIPITATION
Ni SX/EW
PRODUCTS TO MARKET
Pd/Pt/Au CONCENTRATE (40% Pd+Pt+Au)
Cu METAL (LME GRADE A)
Ni METAL (CLASS 1)
Co CONCENTRATE (55% Co)
Zn CONCENTRATE (22% Zn)
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ENGINEERING GLOBAL SOLUTIONS
PHOENIX, ARIZONA
NORTHMET PROJECT
PROCESS PLANT
BLOCK FLOW DIAGRAM
DRAWING NO. D-W141A-000-N-000
REV. B

8.3 CAPITAL COSTS

The total estimated cost to construct and install the process plant and site facilities described in this report is US $445.6 million.

The facilities and associated costs included in this report are all those that are required to meet the operational intent and production estimates cited for the process plant facilities. A contingency allowance of 20% of all costs is included to reflect the preliminary nature of the report and to cover unknowns at this stage of project development. Contingency does not account for scope changes to the design and facilities presented in this report.

This estimate is categorized as prefeasibility with an expected accuracy range of ±25% at the bottom line. The estimate covers the direct field costs of executing the project, plus the indirect costs associated with the design, construction and commissioning of the facilities. Major mechanical process equipment, and high/medium voltage electrical equipment costs are based on budgetary vendor quotations. Other equipment and installation costs were estimated from in-house data. Civil, structural, and building costs have been estimated based on preliminary material take-offs from project drawings and sketches. Piping, electrical and instrumentation costs are based on factors of mechanical equipment costs. All inclusive labor rates were calculated using typical wages and benefits for union contractors in Northern Minnesota. The average rate was approximately $64/hr. Indirect costs have been estimated based on factored direct costs. A preliminary analysis of construction manpower for the process facility requirements (excluding mine pre-production, tailings dam, and oxygen plant construction) indicates that the peak construction workforce would be approximately 600-800 personnel.

The estimated project capital cost by major area is given in Table 8-2. Excluded from these costs are all costs associated with mining and mine development, mining pre-production costs, site access roads, high voltage power line to the site (high voltage power to be supplied by Minnesota Power to the project site), the tailings impoundment facility, oxygen plant purchase (oxygen will be purchased “over the fence”), owners costs during development, sunk costs, permitting costs, escalation, taxes, working capital, cost of financing and interest during construction.

Table 8-2:
Process Plant and Ancillary Facilities
Capital Cost Summary

Plant Area	(US$ 000's)
100 Mine Ancillaries	$ 684
200 Concentrator (incl. POX)	146,617
300 Precious Metal Recovery	18,195
400 Copper SX/EW	31,180
500 Ni/Co/Zn Recovery	49,669
600 Tailings and Reclaim Water	6,601
700 Utilities and Services	22,089
800 Facilities	11,442
Total Direct Costs	**$ 286,477**
Indirect Costs	84,652
Contingency (20%)	74,461
Total Indirect Costs	**$ 159,113**
Total Plant Facility Capital Costs	**$ 445,590**

8.4 OPERATING COSTS

Average operating expenditures are $107.3 million dollars per year, or $5.34 per ton ore milled, based on annual plant feed rate of 20,075,000 tons per year.

It is estimated that the process plant and ancillary facilities (excluding mining operations, mine maintenance and warehousing, general and administration, and environmental) will employ approximately 198 personnel, as detailed in the staffing plan in Table 8-3.

Table 8-3: Plant Staffing Plan	
Labor Component	**# of Personnel**
Plant operations staff supervision	1
Plant technical personnel	5
Laboratory supervision and operations personnel	19
Plant warehouse supervisory and operations personnel	6
Maintenance planning and supervisory personnel	6
Maintenance personnel	43
Plant operations shift supervisory personnel	11
Operations control room and plant operators	107
Total Process Plant Workforce	**198**

The life-of-mine average operating costs by cost center are presented in Table 8-4. No contingency has been applied to the operating costs. It is expected that the financial sensitivity analysis for the operating costs will accommodate any reasonable eventuality expected during actual operation. Excluded from these operating costs are all costs associated with mining operations, all general and administration costs, and any sustaining capital.

Table 8-4: Summary of Plant Facility Operating Costs		
Plant Cost Area	**US$ 000's**	**US$ / ton Milled**
Reagents and Consumables [1]	$ 63,820	3.179
Labor	12,701	0.633
Electrical Power	26,165	1.303
Plant Operating Supplies [2]	600	0.030
Maintenance Supplies [3]	4,000	0.199
Total	**$107,286**	**5.344**

Notes:
1. Reagent costs include 6.5% tax on mill liners and balls
2. Operating supplies allow for general plant supplies and plant mobile equipment operations and maintenance
3. Maintenance supplies are factored based on equipment capital costs

8.5 FUTURE PROJECT DEVELOPMENT

This prefeasibility report represents the current status of the NorthMet Project process plant facilities development. In order to further develop the project to the final feasibility study level of project development, a number of technical and project related criteria, assumptions and exclusions will require confirmation or they will need to be developed into project criteria.

1. The basis of the prefeasibility process design has been that the testwork program and process flowsheet development has been based on samples representative of the overall NorthMet deposit. As the scope of this report does not address this issue, this basis requires confirmation. Geological characterization of the NorthMet deposit, and geo-metallurgical analysis of the ore grade material to determine if there are separate and significant geological regions in the deposit that will respond differently to the process flowsheet, is a significant project development work package required to validate the mine plan and process design. Should this work identify areas that respond differently to the process flowsheet, additional laboratory testwork will be required to confirm the process criteria.

2. Additional crushing and grinding testwork is required on bulk representative sample materials to verify crushing and grinding work indices and abrasion indexes assumed in this report for mill power calculations, mill sizing, and for liner and grinding media consumptions. Current testwork has been completed on reverse circulation chip samples only. Also, depending on the results of geo-metallurgical analysis, additional crushing and grinding testwork may be required to determine grind characteristic variability with different ore types.

3. No economic process trade-off studies have been performed during the development of this prefeasibility report. As the average head grades and estimated metal production vary with in-fill drilling and modifications to the mine plan and ore delivery schedule, there could be economic justification to produce an alternate nickel product than taking nickel to electrowon metal. Producing a bulk sulfide precipitate with cobalt will significantly reduce capital costs in the bleed treatment flowsheet and may positively affect economic return. Additionally, the pressure leaching process could be designed as a two stage process with inter-stage solid/liquid separation to allow primary leaching of base metals in a low retention time leach, and secondary leaching of a reduced amount of solids in a longer retention time leach to extract precious metals. This could lead to reduced autoclave equipment and pressure leach ancillary equipment costs.

9.0 TAILINGS MANAGEMENT

9.1 INTRODUCTION

The tailings facilities will comprise two separate facilities: a large facility for the storage of the flotation tailings and a relatively small facility for the storage of the hydrometallurgical tailings. This section of the prefeasibility study discusses these facilities, in particular the design criteria, site selection, conceptual design of the selected sites, operational considerations, the water balance and closure.

9.2 DESIGN CRITERIA

The design criteria for sizing the tailings facilities are based on a life of mine total tailings production of 490 million tonnes and an annual tonnage split of 98.1% flotation tailings and 1.9%, hydrometallurgical tailings. The void ratio of the settled tailings is assumed to be 1.0, which leads to the assumptions and requirements listed in Table 9-1.

In summary, the volumetric storage requirements of the flotation and hydrometallurgical tailings facilities are approximately 380 million yd^3 and 6.7 million yd^3, respectively. Based on current information, the flotation tailings facility need not be lined, but the hydrometallurgical tailings facility will require a liner.

Table 9-1: Design Criteria for the Tailings Facilities

Parameter	Flotation Tailings	Hydrometallurgical Tailings
Annual tonnage split[1]	19, 684,450 tons	390,550 tons
Relative tonnage split	98.1%	1.9%
Total tonnage over LOM[2]	480,467,273 tons	9,532,727 tons
Void ratio of settled tailings	1.0	1.0
Specific gravity of solids[3]	3.00	3.39
Dry density	94 pcf	106 pcf
Total LOM storage requirement	379,628,462 yd^3	6,665,515 yd^3
Lining required	No[4]	Yes
Diversion ditches	1 in 100 year peak instantaneous flood	
Closure spillways	probable maximum flood (PMF)	

Notes:

(1) based on information provided by AMEC.

(2) LOM = life of mine (24.4 years).

(3) based on testing data provided by PolyMet.

(4) based on existing information related to geochemistry and permitting requirements.

9.3 SITE SELECTION

Siting criteria used to guide the identification and layout of potential tailings disposal sites were provided by PolyMet and required that potential sites:

- be within the Partridge River catchment to minimize environmental impacts;
- lay outside the main channel of the Partridge River for logistical and permitting reasons;
- be south of the Northshore mine because of access concerns;
- avoid mining leases occupied by other companies for legal and financial reasons;
- avoid the intersection of existing rail and power lines for cost reasons;
- be within reasonable proximity of the NorthMet ore body and plant site; and
- provide the necessary storage with dam heights that are less than or equal to the heights of the existing tailings facilities at the LTV mine (approximately 200 feet).

Aside from mining lease issues, PolyMet indicated that potential land ownership issues be excluded as a factor influencing site selection.

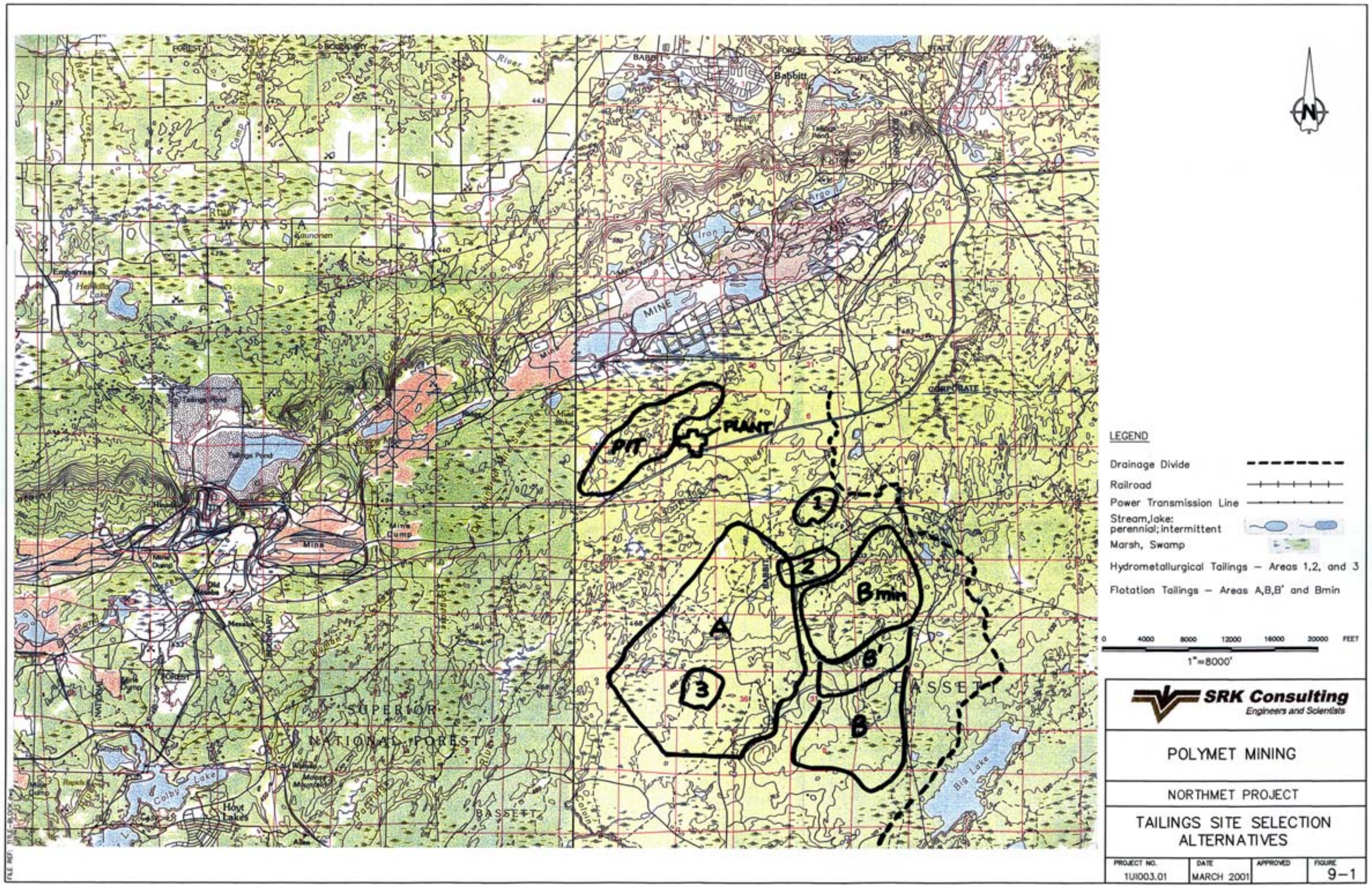
The areas north, east, southwest and south of the ore body were eliminated on the basis of the siting criteria. This left the area southeast of the ore body, although potential layouts in this area were affected by the Partridge River catchment boundary, several rail lines and a power line. Four flotation sites (A, B, B' and Bmin) and three hydrometallurgical sites (1, 2 and 3) were identified. Figure 9-1 shows the location of the various sites. Sites 1 and 3 were eliminated because they had several distinct disadvantages relative to site 2. A preliminary evaluation of the storage characteristics of the four floatation sites and hydrometallurgical Site B lead to the summary provided in Table 9-2.

Table 9-2: Comparison of Short-Listed Tailings Disposal Sites					
Site	A	B	B'	Bmin	2
Final Dam Elev. (ft)	1,625	1,690	1,710	1,730	1,630
Final Dam Height (ft)	95	120	140	160	35
Dam Volume (yd^3)	13.4 M	13.8 M	23.6 M	34.6 M	0.24 M
Final Area (acres)	5,912	4,500	2,755	2,010	365
Storage Ratio	28.3	27.4	16.1	11.0	29.4
Starter Dam Elev. (ft)	1,565	1,610	1,610	1,610	1,600
Dam Height (ft)	35	40	40	40	15
Dam Volume (yd^3)	2.3 M	1.7 M	1.7 M	1.7 M	0.05 M

In view of the large areas associated with the four flotation sites and the potential cost implications associated with wetlands compensation, the smallest flotation site, Site Bmin, was selected. The details of the land ownership at Site Bmin are not known.

The layouts of the two sites offer the following advantages:

- The ratios between impoundment storage and dam volume at the two sites are relatively efficient.
- The close proximity of the two sites offers efficiency in terms of operation and monitoring.


PIT
PLANT
1
2
3
A
B
B'
Bmin
MINE
Babbitt
SUPERIOR
NATIONAL FOREST
BASSETT
Big Lake
Colby Lake
Hoyt Lakes
Tailings Pond
Mine Dump
LEGEND
Drainage Divide
Railroad
Power Transmission Line
Stream,lake: perennial; intermittent
Marsh, Swamp
Hydrometallurgical Tailings – Areas 1,2, and 3
Flotation Tailings – Areas A,B,B' and Bmin
0 4000 8000 12000 16000 20000 FEET
1"=8000'
SRK Consulting
Engineers and Scientists
POLYMET MINING
NORTHMET PROJECT
TAILINGS SITE SELECTION ALTERNATIVES
PROJECT NO. 1UI003.01
DATE MARCH 2001
APPROVED
FIGURE 9–1

9.4 FLOTATION TAILINGS FACILITY DESIGN

The storage capacity curve for the flotation tailings facility is provided in Figure 9-2. Initial construction will comprise a cross-valley dam approximately 40 feet high. However, in order to avoid impacting a rail line along the east side of the facility during the later operational stages, the tailings facility will ultimately become a ring impoundment (Figure 9-3). The final maximum height of the flotation tailings dam will be 160 feet. A typical cross-section through the flotation tailings dam is provided in Figure 9-4. Based on current data, the flotation tailings facility will be unlined.

Foundation conditions at the dam are not known but, based on regional conditions, are expected to comprise scattered thin deposits of organic soils underlain by deposits of till up to 30 feet thick and/or bedrock. Local bedrock tends to be strong and relatively free of fractures.

A diversion ditch will be constructed on the south side of the facility to minimise the inflow of runoff to the facility. The ditch will be sized to handle the 1 in 100-year (1:100) peak instantaneous flow, which corresponds to 860 cubic feet per second (cfs). Within a few years, as the dam extends along the south side of the facility, a pump and pipeline system will be required to pump water which collects against the south side of the dam to the diversion ditch.

Tailings geochemical testing to provide an indication of the potential quality of seepage from the floatation tailings is ongoing. Definitive test results are, as yet, unavailable. No allowance has been made in the cost estimate for a seepage collection pond, but local topography is conducive to the construction of a seepage collection dam, if required.

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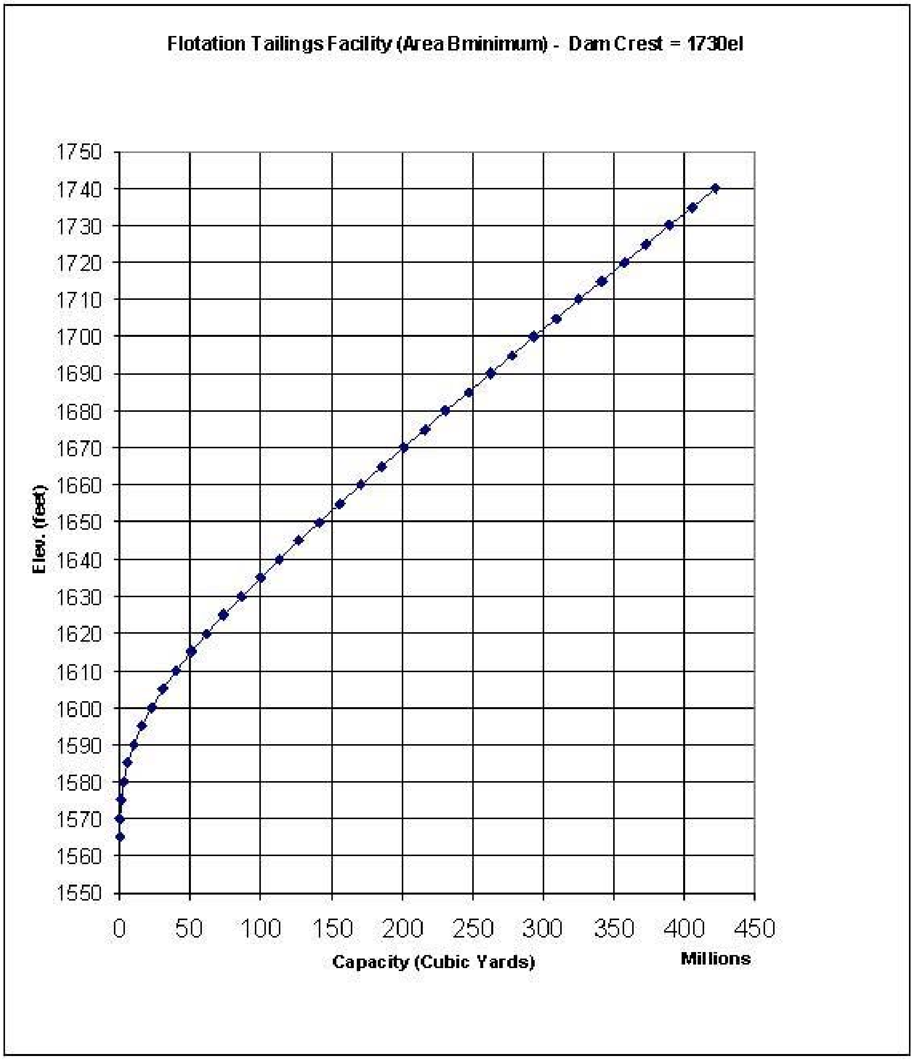


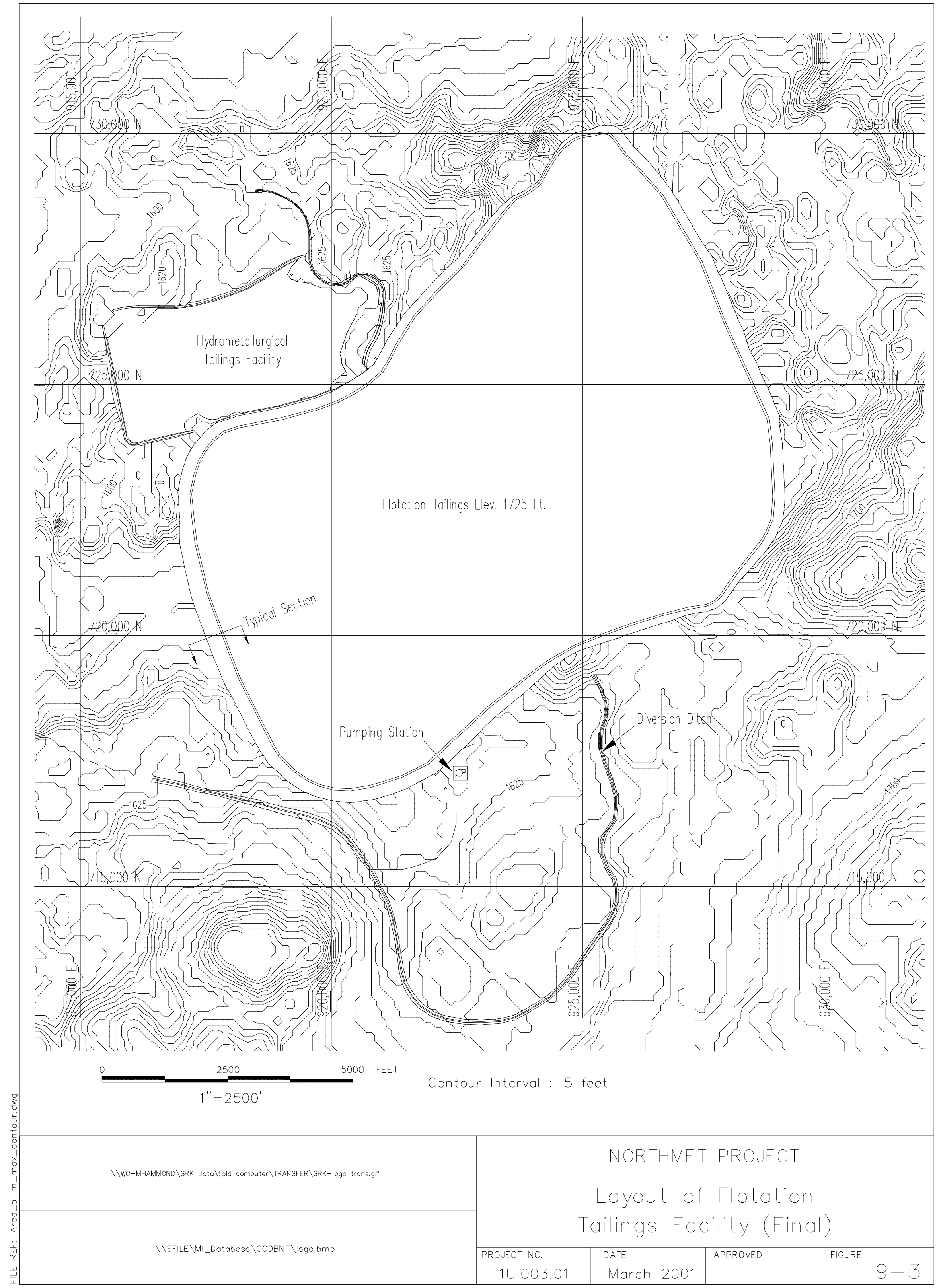
NORTHMET PROJECT

STORAGE CAPACITY CURVE FOR FLOTATION TAILINGS FACILITY

POLYMET MINING

PROJECT:	DATE:	APPROVED:	FIGURE:
1UI003.01	March 2001		9-2

Figure 9-2


730,000 N
725,000 N
720,000 N
715,000 N
915,000 E
920,000 E
925,000 E
930,000 E
1600
1620
1625
1700
Hydrometallurgical
Tailings Facility
Flotation Tailings Elev. 1725 Ft.
Typical Section
Pumping Station
Diversion Ditch
0
2500
5000 FEET
1"=2500'
Contour Interval : 5 feet
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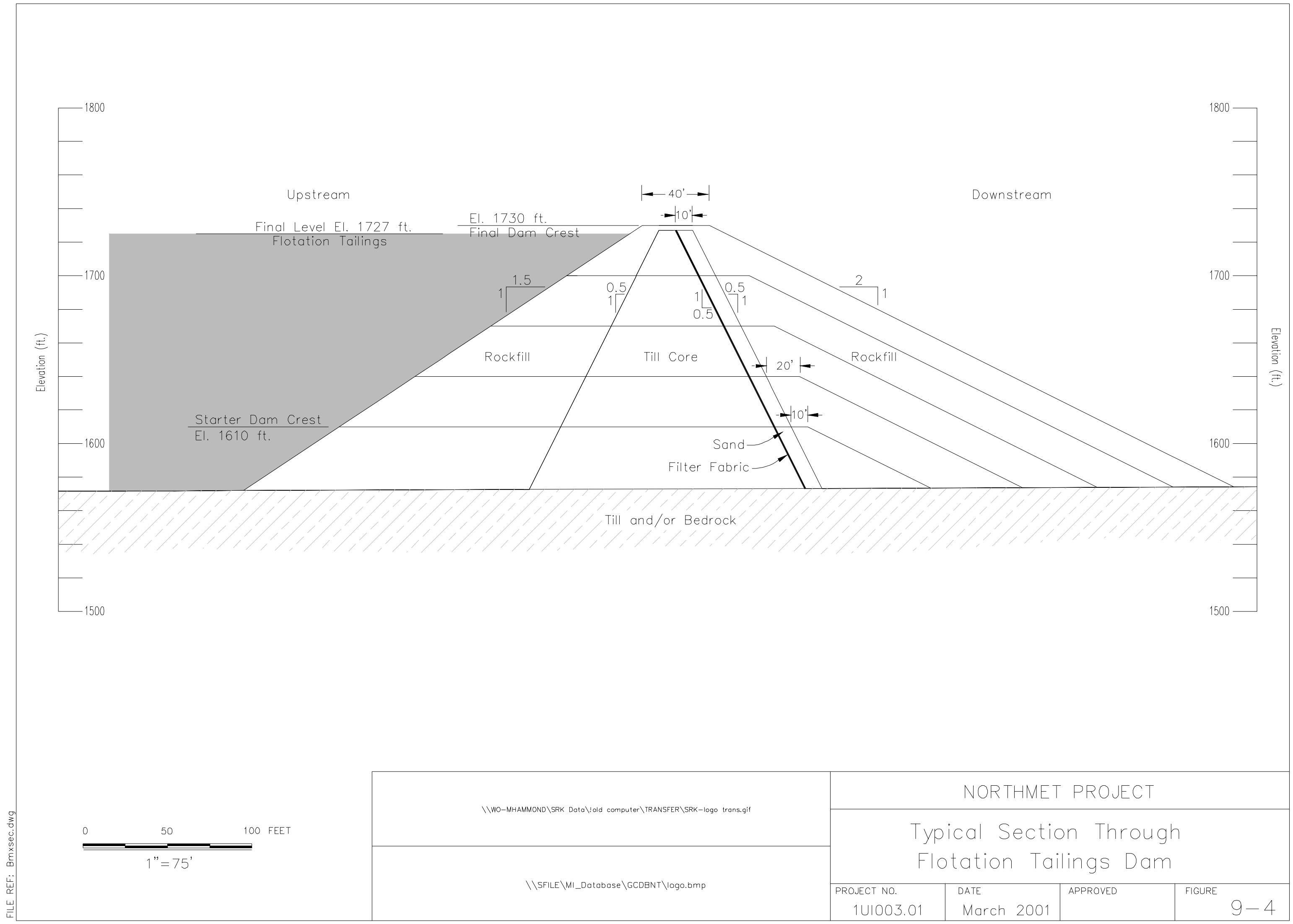
NORTHMET PROJECT
Layout of Flotation
Tailings Facility (Final)
PROJECT NO.
1UI003.01
DATE
March 2001
APPROVED
FIGURE
9-3


Elevation (ft.)
1800
1700
1600
1500
Upstream
Downstream
Final Level El. 1727 ft.
Flotation Tailings
El. 1730 ft.
Final Dam Crest
40'
10'
1.5
1
0.5
1
2
1
Rockfill
Till Core
Rockfill
20'
10'
Starter Dam Crest
El. 1610 ft.
Sand
Filter Fabric
Till and/or Bedrock
0
50
100 FEET
1"=75'
FILE REF: Bmxsec.dwg
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NORTHMET PROJECT
Typical Section Through
Flotation Tailings Dam
PROJECT NO.
1UI003.01
DATE
March 2001
APPROVED
FIGURE
9-4

9.5 HYDROMETALLURGICAL TAILINGS FACILITY DESIGN

The storage capacity curve for the hydrometallurgical tailings facility is provided in Figure 9-5. Initial construction will comprise a cross-valley dam approximately 15 feet high. Over time, the dam will extend most of the way along the north and south sides of the tailings facility (Figure 9-6). The final maximum height of the flotation tailings dam will be 45 feet. A typical cross-section through the flotation tailings dam is provided in Figure 9-7. The hydrometallurgical tailings facility will be lined with a 60-mil HDPE geomembrane.

Foundation conditions at the dam are expected to be similar to the conditions at the flotation tailings dam.

A diversion ditch will be constructed on the east side of the facility to minimise the inflow of runoff to the facility. The ditch will be sized to handle the 1:100 peak instantaneous flow, which corresponds to 330 cfs.

Seepage flows are expected to be negligible due to the HDPE liner. Therefore, no allowance has been made in the cost estimate for a seepage collection structure downstream of the tailings facility.

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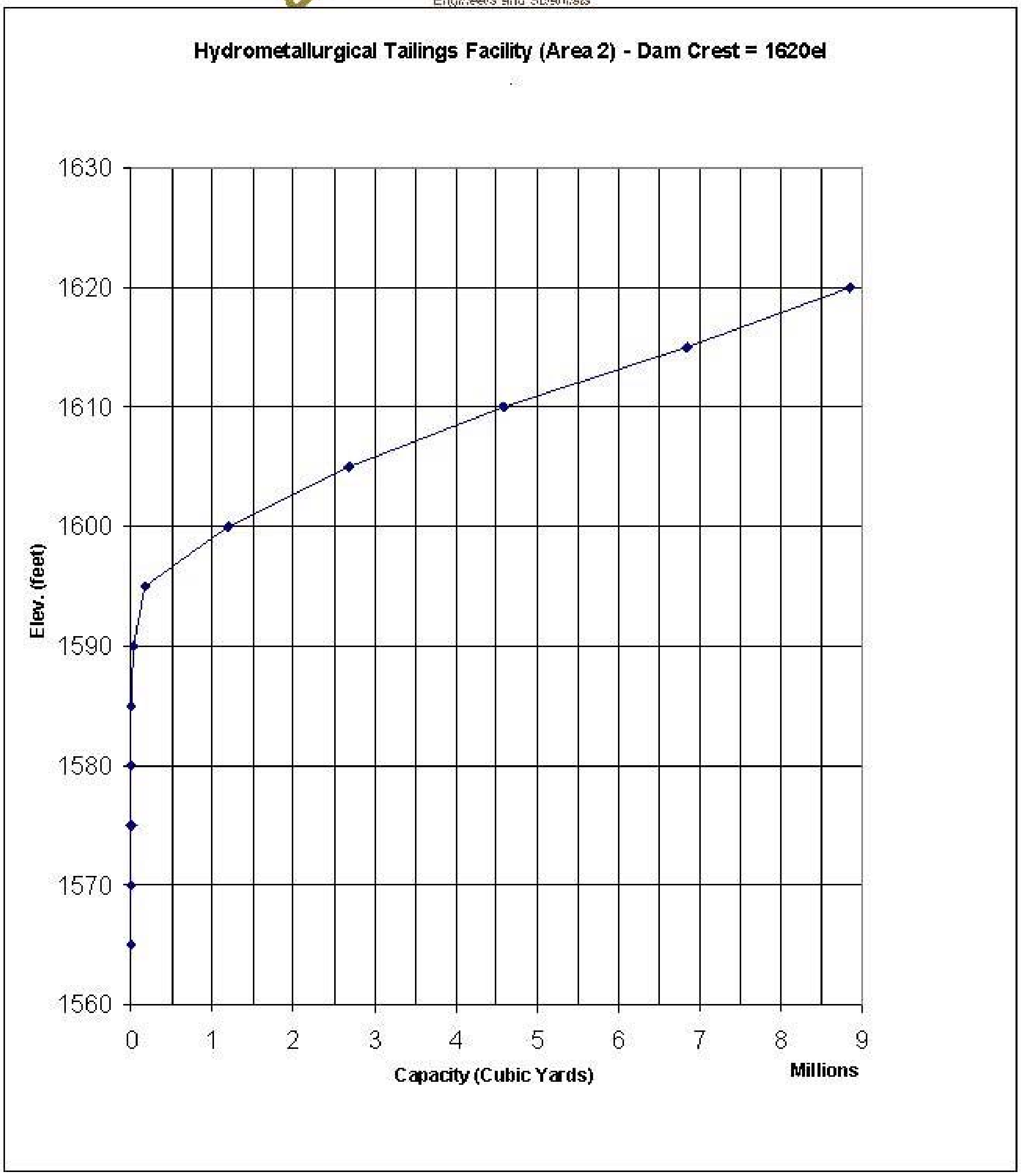
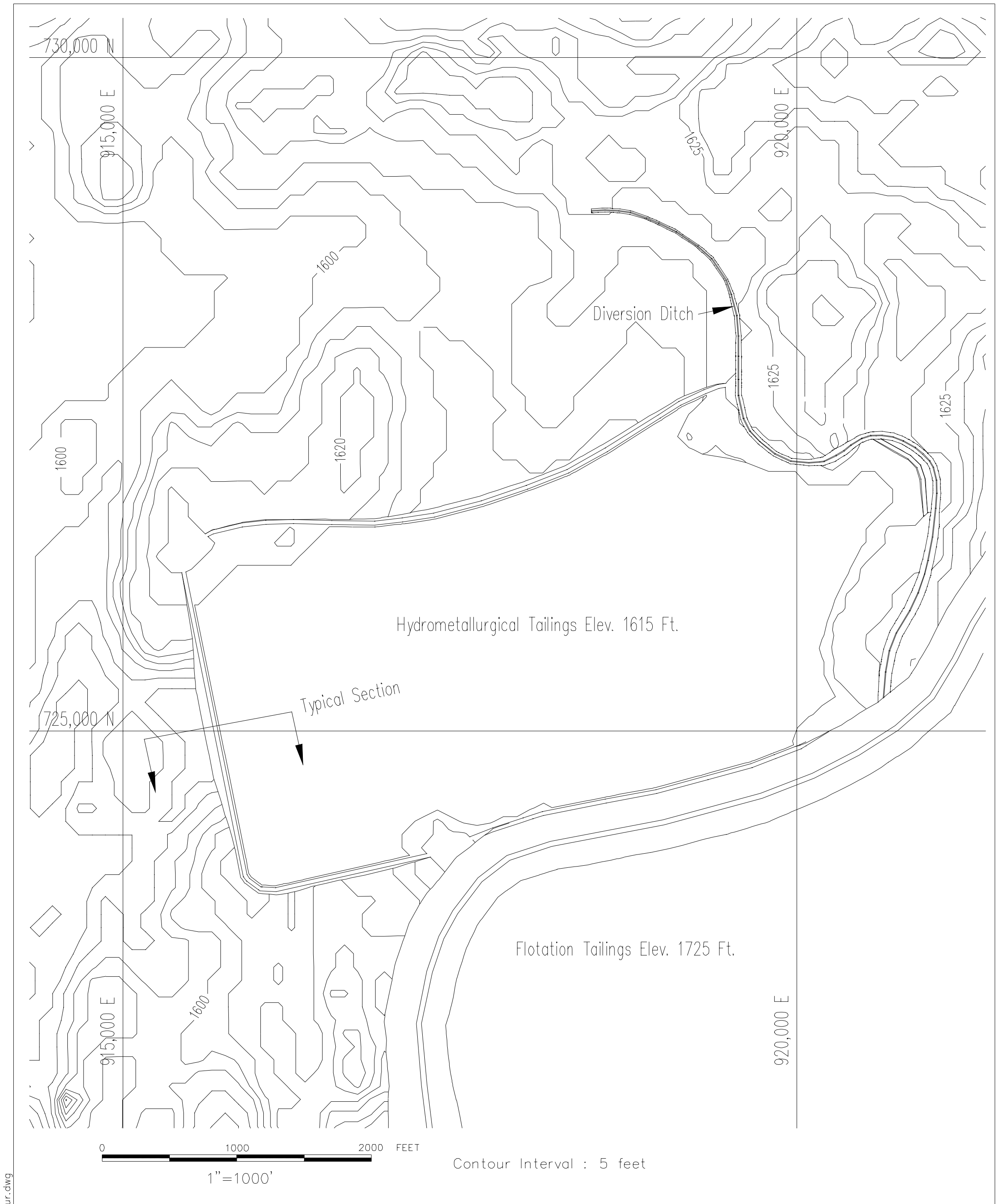


	NORTHMET PROJECT
POLYMET MINING	STORAGE CAPACITY CURVE FOR HYDROMETALLURGICAL TAILINGS FACILITY

PROJECT:	DATE:	APPROVED:	FIGURE:
1UI003.01	March 2001		9.5



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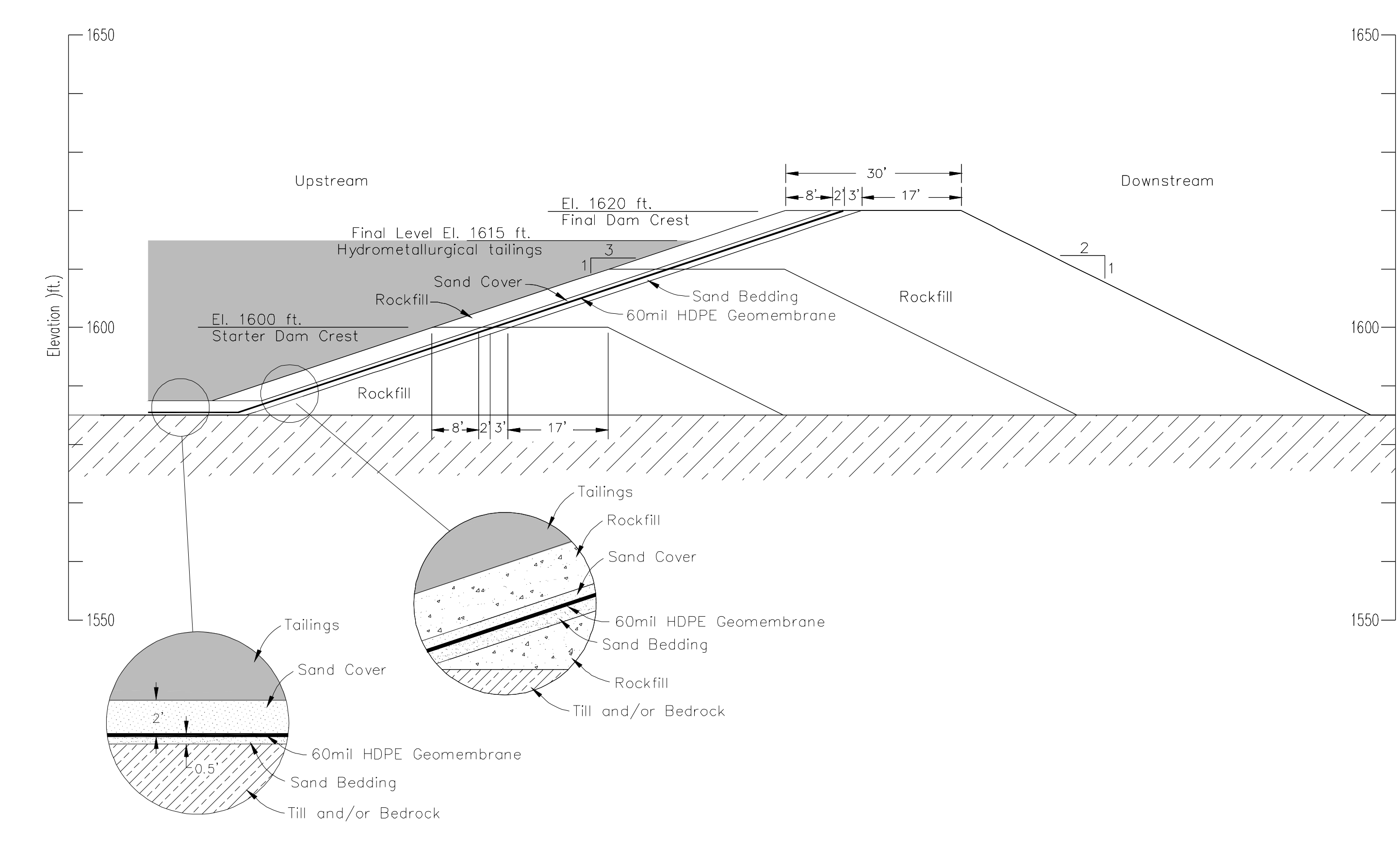
NORTHMET PROJECT

Layout of Hydrometallurgical Tailings Facility (Final)

PROJECT NO.	DATE	APPROVED	FIGURE
1UI003.01	March 2001		9-6



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NORTHMET PROJECT

Typical Section Through
Hydrometallurgical Tailings Dam

PROJECT NO.	DATE	APPROVED	FIGURE
1UI003.01	March 2001		9-7

9.6 CONSTRUCTION OF THE TAILINGS FACILITIES

In general, the construction concepts at the two dams will be very similar. Starter dams will be constructed by a contractor using mine waste removed from the ore body during pre-stripping. The two waste materials required for construction will consist of till and waste rock that has, at worst, a low potential to generate acid. Sand, if available from stripping operations, will be used in filter construction, but it is anticipated that the vast majority of the sand required as filters at the dams will be imported from one of the sand deposits known to exist in the region.

The diversion ditches will be constructed in conjunction with the starter dams.

Annual raises of the dams will be undertaken. Each spring or early summer, the mine will start to deposit mine waste suitable for construction in an area near the tailings dams. With the onset of the summer construction season, the contractor will undertake the earthworks and liner installation that are required that year. Work will be scheduled so that the required construction is completed by the subsequent fall.

9.7 OPERATIONS

Consideration was given to the benefits and potential use of thickened tailings. However, based on the potential cost implications relative to the anticipated benefits associated with the conditions specific to this project, conventional slurry deposition was selected.

During summer, tailings will be spigotted into each of the impoundments from a pipeline along the west side of the respective impoundment. In winter, tailings will be discharged from one of a series of discharge points. The discharge points will be moved periodically. Over time, the deposition points will extend along the south and north sides of the impoundments. In both cases, the ponds will be maintained well to the east of the starter dams. A floating barge will be maintained at each facility to pump supernatant water to the plant for re-cycling.

Evaluations of flood storage during extreme wet years indicates the pond volume would fluctuate over ranges of 184 and 46 million ft^3 in the flotation and hydrometallurgical tailings facilities, respectively. The freeboard required to accommodate these fluctuations is typically 5 feet or less in both ponds.

Regular inspections of the tailings facilities will be carried out in accordance with suitable guidelines, such as those published by the Mining Association of Canada.

9.8 CLOSURE AND RECLAMATION OF THE FLOTATION TAILINGS

Closure of the flotation tailings facility is currently assumed to comprise a vegetative cover over the tailings and an emergency spillway.

Currently, it is assumed that the surface of the tailings will be revegetated with grass using an organic mulch soil amendment, fertilizer and broadcast and harrow planting methods. It is further assumed that this work can be done during the spring and early summer before the frost leaves the ground. However, as more information regarding geochemistry is gathered, the possibility exists that a more expensive cover option may be required.

The emergency spillway will be located in the northeast corner of the impoundment. The height of the dam will be a minimum in this area but a spillway chute may be required. Alternatively, there is a possibility that the flood waters could be stored largely within the impoundment and then released at a much lower rate than has been assumed for design purposes.

The tailings geochemical test work is on going with no definitive test results available at this time. It is not possible to evaluate the quality of seepage from the flotation tailings facility after closure. No allowance has been made in the closure cost estimate for a seepage control structure, but local topography is conducive to the construction of a seepage collection dam, if required.

9.9 CLOSURE AND RECLAMATION OF THE HYDROMETALLURGICAL TAILINGS FACILITY

Closure of the hydrometallurgical tailings facility is currently assumed to comprise a till cap and vegetative cover over the tailings and an emergency spillway.

A till cap approximately three feet thick will be installed over the tailings. It is anticipated that geotextile will be required over approximately 25% of the facility in order to facilitate access for till placement. Currently, it is assumed that the surface of the till will be revegetated with grass using an organic mulch soil amendment, fertilizer, and broadcast and harrow planting methods. However, as more information regarding geochemistry is gathered, the possibility exists that a more expensive cover option may be required.

The emergency spillway will be established in bedrock at the east end of the north side of the impoundment.

Seepage flows are expected to be negligible due to the HDPE liner. Therefore, no allowance has been made in the closure cost estimate for a seepage collection structure downstream of the tailings facility.

9.10 CAPITAL, OPERATING, AND CLOSURE COSTS

The top of Table 9-3 shows the annual material requirements, applicable unit costs, and the construction cost for the flotation tailings facility. The bottom of Table 9-3 shows the same information for the hydrometallurgical tailings facility. The unit costs are based on estimates provided by contractors local to the area.

In addition to the construction costs, an additional amount of $150,000 per year is budgeted to maintain the facilities.

IMC estimated a cost of $461,000 to construct a road from the mine to the tailings facility. The road width is 100 ft to accommodate the 240-ton trucks.

All the above costs are summarised on the bottom of Table 9-3. The preproduction cost for the facilities is estimated at $21.1 million. During commercial production the costs range from $4.1 million to $6.3 million per year.

The barges discussed in Section 9.7 are included in the plant/infrastructure capital cost estimate.

Table 9-4 shows the details of the closure costs estimate. The total tailings facility closure cost is estimated at $8.6 million, with $3.0 million allocated to the flotation tailings facility and $5.6 million allocated to the hydrometallurgical tailings facility.

Table 9-3: Tailings Embankments Material Requirements and Construction Costs

Northmet Flotation Tailings - Area B$_{minimum}$ - Dam Construction and Ditch Excavation Quantities

Material	Units	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Tailings Dam (fill)																										
Till Core	(yd³)	893,648	464,475	464,475	464,475	464,475	464,475	544,135	544,135	544,135	544,135	544,135	337,602	337,602	337,602	337,602	337,602	337,602	125,316	125,316	125,316	125,316	125,316	125,316	125,316	8,839,518
Geotextile Filter (area)	(ft²)	166,334	114,544	114,544	114,544	114,544	114,544	180,700	180,700	180,700	180,700	180,700	176,014	176,014	176,014	176,014	176,014	176,014	326,607	326,607	326,607	326,607	326,607	326,607	326,607	4,984,886
Rockfill Shells (u/s & d/s)	(yd³)	1,191,517	724,826	724,826	724,826	724,826	724,826	1,100,109	1,100,109	1,100,109	1,100,109	1,100,109	1,101,210	1,101,210	1,101,210	1,101,210	1,101,210	1,101,210	896,692	896,692	896,692	896,692	896,692	896,692	896,692	23,200,296
Sand Filter (u/s & d/s)	(yd³)	61,948	41,864	41,864	41,864	41,864	41,864	67,932	67,932	67,932	67,932	67,932	65,210	65,210	65,210	65,210	65,210	65,210	53,377	53,377	53,377	53,377	53,377	53,377	53,377	1,375,827
Clearing (area)	(yd²)	488,243	125,820	125,820	125,820	125,820	125,820	62,474	62,474	62,474	62,474	62,474	40,643	40,643	40,643	40,643	40,643	40,643	18,109	18,109	18,109	18,109	18,109	18,109	18,109	1,800,333
Stripping	(yd³)	97,649	25,164	25,164	25,164	25,164	25,164	12,496	12,496	12,496	12,496	12,496	8,129	8,129	8,129	8,129	8,129	8,129	3,622	3,622	3,622	3,622	3,622	3,622	3,622	360,067
Diversion Ditch (total cut)	(yd³)	737,292	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	737,292
Diversion Ditch (cut in rock)	(yd³)	365,938	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	365,938
Diversion Ditch (cut in soil)	(yd³)	371,354	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	371,354
Flotation Dam Cost																										
Till Core	($ x 1000)	2,279	1,184	1,184	1,184	1,184	1,184	1,388	1,388	1,388	1,388	1,388	861	861	861	861	861	861	320	320	320	320	320	320	320	22,541
Geotextile Filter (area)	($ x 1000)	250	172	172	172	172	172	271	271	271	271	271	264	264	264	264	264	264	490	490	490	490	490	490	490	7,477
Rockfill Shells (u/s & d/s)	($ x 1000)	3,575	2,174	2,174	2,174	2,174	2,174	3,300	3,300	3,300	3,300	3,300	3,304	3,304	3,304	3,304	3,304	3,304	2,690	2,690	2,690	2,690	2,690	2,690	2,690	69,601
Sand Filter (u/s & d/s)	($ x 1000)	465	354	354	354	354	354	575	575	575	575	575	552	552	552	552	552	552	452	452	452	452	452	452	452	11,580
Clearing (area)	($ x 1000)	171	44	44	44	44	44	22	22	22	22	22	14	14	14	14	14	14	6	6	6	6	6	6	6	630
Stripping	($ x 1000)	190	49	49	49	49	49	24	24	24	24	24	16	16	16	16	16	16	7	7	7	7	7	7	7	702
Diversion Ditch (cut in rock)	($ x 1000)	3,604	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,604
Diversion Ditch (cut in soil)	($ x 1000)	928	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	928
Subtotal Flotation Dam	($ x 1000)	11,462	3,978	3,978	3,978	3,978	3,978	5,580	5,580	5,580	5,580	5,580	5,010	5,010	5,010	5,010	5,010	5,010	3,965	3,965	3,965	3,965	3,965	3,965	3,965	117,064

Flotation Dam Unit Costs

Material	Units	Starter Facility	Year 1 to Closure
Till Core	(yd³)	$2.55	$2.55
Geotextile Filter (area)	(ft²)	$1.50	$1.50
Rockfill Shells (u/s & d/s)	(yd³)	$3.00	$3.00
Sand Filter (u/s & d/s)	(yd³)	$7.50	$8.46
Clearing (area)	(yd²)	$0.35	$0.35
Stripping	(yd³)	$1.95	$1.95
Diversion Ditch (cut in rock)	(yd³)	$9.85	$9.85
Diversion Ditch (cut in soil)	(yd³)	$2.50	$2.50

Northmet Hydrometallurgical Tailings - Area 2 - Dam Construction and Ditch Excavation Quantities

Material	Units	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Tailings Dam (fill)																										
HDPE Liner on dam face	(yd²)	43,485	14,732	14,732	14,732	14,732	14,732	14,732	14,732	14,732	19,505	19,505	19,505	19,505	19,505	19,505	19,505	19,505	19,505	19,505	19,505	19,505	19,505			414,899
HDPE Liner over pond area	(yd²)	773,718	37,867	37,867	37,867	37,867	37,867	37,867	37,867	37,867	20,840	20,840	20,840	20,840	20,840	20,840	20,840	20,840	20,840	20,840	20,840	20,840	20,840			1,347,571
Sand Zone (d/s)	(yd³)	1,496	550	550	550	550	550	550	550	550	721	721	721	721	721	721	721	721	721	721	721	721	721			15,269
Sand Zone (u/s)	(yd³)	1,105	373	373	373	373	373	373	373	373	484	484	484	484	484	484	484	484	484	484	484	484	484			10,385
Rockfill Facing (waste rock)	(yd³)	4,419	1,494	1,494	1,494	1,494	1,494	1,494	1,494	1,494	1,936	1,936	1,936	1,936	1,936	1,936	1,936	1,936	1,936	1,936	1,936	1,936	1,936			41,539
Rockfill Zone (waste rock)	(yd³)	25,721	9,988	9,988	9,988	9,988	9,988	9,988	9,988	9,988	16,694	16,694	16,694	16,694	16,694	16,694	16,694	16,694	16,694	16,694	16,694	16,694	16,694			322,640
Clearing (area)	(yd²)	787,955	42,601	42,601	42,601	42,601	42,601	42,601	42,601	42,601	26,553	26,553	26,553	26,553	26,553	26,553	26,553	26,553	26,553	26,553	26,553	26,553	26,553			1,473,946
Stripping	(yd³)	2,847	947	947	947	947	947	947	947	947	1,143	1,143	1,143	1,143	1,143	1,143	1,143	1,143	1,143	1,143	1,143	1,143	1,143			25,275
Sand Bedding	(yd³)	128,901	6,309	6,309	6,309	6,309	6,309	6,309	6,309	6,309	3,472	3471.94	3,472	3,472	3,472	3,472	3,472	3,472	3,472	3,472	3,472	3,472	3471.94			224,506
Sand Cover	(yd³)	515,296	25,219	25,219	25,219	25,219	25,219	25,219	25,219	25,219	13,879	13879.4	13,879	13,879	13,879	13,879	13,879	13,879	13,879	13,879	13,879	13,879	13879.4			897,482
Diversion Ditch (total cut)	(yd³)	110,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			110,000
Diversion Ditch (cut in rock)	(yd³)	33,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			33,000
Diversion Ditch (cut in soil)	(yd³)	77,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			77,000
Hydromet Dam Cost																										
HDPE Liner on dam face	($ x 1000)	176	60	60	60	60	60	60	60	60	79	79	79	79	79	79	79	79	79	79	79	79	79			1,680
HDPE Liner over pond area	($ x 1000)	3,134	153	153	153	153	153	153	153	153	84	84	84	84	84	84	84	84	84	84	84	84	84			5,458
Sand Zone (d/s)	($ x 1000)	11	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6			128
Sand Zone (u/s)	($ x 1000)	8	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4			87
Rockfill Facing (waste rock)	($ x 1000)	18	7	7	7	7	7	7	7	7	9	9	9	9	9	9	9	9	9	9	9	9	9			185
Rockfill Zone (waste rock)	($ x 1000)	77	30	30	30	30	30	30	30	30	50	50	50	50	50	50	50	50	50	50	50	50	50			968
Clearing (area)	($ x 1000)	276	15	15	15	15	15	15	15	15	9	9	9	9	9	9	9	9	9	9	9	9	9			516
Stripping	($ x 1000)	6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			49
Sand Bedding	($ x 1000)	967	53	53	53	53	53	53	53	53	29	29	29	29	29	29	29	29	29	29	29	29	29			1,776
Sand Cover	($ x 1000)	3,865	213	213	213	213	213	213	213	213	117	117	117	117	117	117	117	117	117	117	117	117	117			7,098
Diversion Ditch (cut in rock)	($ x 1000)	325	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			325
Diversion Ditch (cut in soil)	($ x 1000)	193	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			193
Subtotal Hydromet Dam	($ x 1000)	9,054	541	541	541	541	541	541	541	541	391	391	391	391	391	391	391	391	391	391	391	391	391			18,461

Hydromet Dam Unit Costs

Material	Units	Starter Facility	Year 1 to Closure
HDPE Liner on dam face	(yd²)	$4.05	$4.05
HDPE Liner over pond area	(yd²)	$4.05	$4.05
Sand Zone (d/s)	(yd³)	$7.50	$8.46
Sand Zone (u/s)	(yd³)	$7.50	$8.46
Rockfill Facing (waste rock)	(yd³)	$4.00	$4.50
Rockfill Zone (waste rock)	(yd³)	$3.00	$3.00
Clearing (area)	(yd²)	$0.35	$0.35
Stripping	(yd³)	$1.95	$1.95
Sand Bedding	(yd³)	$7.50	$8.46
Sand Cover	(yd³)	$7.50	$8.46
Diversion Ditch (cut in rock)	(yd³)	$9.85	$9.85
Diversion Ditch (cut in soil)	(yd³)	$2.50	$2.50

COST SUMMARY		-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Flotation Dam Construction	($ x 1000)	11,462	3,978	3,978	3,978	3,978	3,978	5,580	5,580	5,580	5,580	5,580	5,010	5,010	5,010	5,010	5,010	5,010	3,965	3,965	3,965	3,965	3,965	3,965	3,965	117,064
Hydromet Dam Construction	($ x 1000)	9,054	541	541	541	541	541	541	541	541	391	391	391	391	391	391	391	391	391	391	391	391	391	0	0	18,461
Road Construction	($ x 1000)	461																								
Other Costs	($ x 1000)	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	3,600
TOTAL TAILINGS DAM	($ x 1000)	21,127	4,669	4,669	4,669	4,669	4,669	6,271	6,271	6,271	6,121	6,121	5,551	5,551	5,551	5,551	5,551	5,551	4,505	4,505	4,505	4,505	4,505	4,115	4,115	139,587

Table 9-4: Closure of Tailings Facilities				
	Units	Amount	Unit Cost	Cost
Closure of Flotation Facility:				
Total Area	(sq ft)	87,575,688		
Revegetation	(acre)	2,010	$1,000	$2,010,000
Spillway (Cut in Rock)	(cu yd)	100,750	$9.85	$992,388
Total for Flotation Facility	($US)			$3,002,388
Closure of Hydromet Facility:				
Total Area	(sq ft)	15,897,350		
Geotextile 25.0% of Area	(sq yd)	441,593	$1.50	$662,390
Till Cover (3 ft)	(cu yd)	1,766,372	$2.55	$4,504,249
Revegetation	(acre)	365	$1,000	$365,000
Spillway (Cut in Rock)	(cu yd)	2,500	$9.85	$24,625
Total for Hydromet Facility	($US)			$5,556,264
TOTAL CLOSURE COST	($US)			$8,558,651

9.11 FUTURE CONSIDERATIONS

Key issues related to tailings disposal that need to be addressed during a feasibility study include the following:

1. Land Ownership Issues - The land ownership issues need to be resolved.

2. Physical Properties of the Tailings Products - The density parameters used to size the tailings facilities are based on available specific gravity data and assumed void ratios. Consolidation and permeability testing on representative samples of tailings are needed in order to verify these assumptions.

3. Optimization of the Flotation Tailings Facility - The location of the flotation tailings facility is optimal in terms of minimizing embankment costs and inflow of runoff. However, water management is complicated by the tendency of natural runoff to pond against the south side of the facility. Consideration should be given to modifying the footprint of the site so it maintains a minimal total area but facilitates more efficient surface water diversion.

4. Optimization of the Hydrometallurgical Tailings Facility - This facility is presently quite low. Consideration should be given to increasing its height so that its footprint can be reduced.

5. Geotechnical Characterization of the Dam Sites - Detailed reconnaissance and drill hole and/or test pit data are required to confirm the geotechnical conditions at the dam sites for each tailings facility.

6. Geochemical Characterization - More detailed assessment of the geochemistry of the tailings and the waste rock that will be used for dam construction is needed. It has been assumed that it will be feasible to identify waste rock with acceptable geochemical characteristics during mining. The results will also be used to re-evaluate the details of the closure scenarios.

7. Characteristics of Seepage from the Flotation Tailings Facility - There is no allowance for seepage collection in the capital costs. Additional effort is needed to characterize the expected quality of the seepage from the flotation tailings in order to determine whether seepage collection and/or water treatment are required. The results will also be used to re-evaluate the details of the closure scenarios.

10.0 WATER MANAGEMENT

Like any mining project, the NorthMet Project will require close water management to ensure a continuous supply for the water necessary to keep the facility in operation. In addition, any water collected on the site, either through precipitation or through seepage, will need to be properly managed to minimize the potential for pollutants such as sediment to migrate from the site. Water used in the processing will need to be recycled or treated prior to discharge. At this time the quantity or quality of water that might potentially be discharged is not known. It is assumed that if treatment is required it can be accomplished to meet all discharge water quality standards. Sanitary wastewater will also need to be properly handled.

Figure 10-1 shows an estimated water balance for the NorthMet operations. Once start-up operations have been completed, the estimated fresh water make-up required for the facilities is 3,557 to 5,220 gallons per minute, depending on the year of operation. The primary water requirement is for operation of the process plant. The process plant (flotation plus hydromet) will require an estimated 3,506 to 5,070 gallons per minute of make-up water depending on the year of operation and the availability of water collected from other sources, such as the waste rock disposal area runoff or seepage. The following discussion evaluates the major water requirements inputs and discharges for each of the project facilities that will use water.

10.1 MINE AREA

The mine area will not use much water, but will receive water from direct precipitation on the mine pit area and from seepage into the mine pit. The average amount of precipitation (200 to 951 gpm depending on the year of operation) and seepage (189 to 902 gpm depending on the year of operation) has been estimated in Section 6.0 to determine pumping requirements and costs. The water that collects in the mine pit will need to be pumped from the pit. This water will be pumped directly to the process plant for use as make-up water in the plant. If the process plant does not need this make-up water, it is likely that the water in the pit area will require treatment prior to discharge.

Potable water requirements for the mine area will include approximately 20 gallons per day for each person per shift. There are approximately 32 salary mine workers who will work dayshift and approximately 93 to 273 workers each day divided into three shifts. The total potable water requirements are 2,500 to 6,100 gallons per day.

Personnel numbers for administration of the site are estimated to be 43 individuals, all dayshift with no access to shower facilities. The estimated water usage for this group is 860 gallons per day.

10.2 WASTE ROCK DISPOSAL AREAS

The waste rock disposal areas will receive water from precipitation which will either runoff the surface of the areas or infiltrate into the waste rock. Some of the infiltrated water may resurface as seepage at the toe of the waste rock disposal areas. Once the surfaces have been revegetated, most of the infiltrated water will be taken up by the vegetation. The reclamation of the waste rock disposal areas will be an on-going activity throughout the mine life to minimize the amount of potential runoff. However, from areas not vegetated, the runoff and seepage will be collected for at least sediment control and this water may require further treatment prior to discharge. Another option would be to collect and convey this water to the process plant for use as make-up water. The exact amount of water that could runoff has not been calculated and limited geochemical testing of the waste rock has not allowed evaluation of the potential water quality.

10.3 PROCESS PLANT

The process plant will receive fresh make-up water, plant and tailings recycled water, water pumped from the pit areas and, potentially, water collected from runoff and/or seepage from the waste rock disposal areas. The required water for the grinding and flotation circuits is 20,539 gpm. Of this amount, approximately 913 gpm can be recycled internally from other parts of the processing. Approximately 389 to 1,852 gpm, depending on the year, is expected to be seepage or run-on in the mine area pumped to the process plant. Approximately 13,927 gpm can be recycled from the flotation tailings and approximately 440 gpm can be recycled from the hydromet tailings.

In order to make-up the difference, fresh water will need to be added to the grinding and flotation circuit and to the hydromet circuit. The estimated requirement for the grinding and flotation circuit is 3,406 to 4,870 gpm and for the hydromet circuit is 100 to 200 gpm.

10.4 TAILINGS FACILITIES

There are two tailings facilities planned, one to hold the flotation tailings and one to hold the hydromet tailings. The tailings facilities will receive water from the tailings slurry and from precipitation on the tailings and surrounding areas which drain to the tailings. Some of the water will be retained in the tailings, but a large portion of the water will be available for recycling back to the processing plant. The other water loss from the tailings facilities will be through evaporation.

Figure 10-1 shows the estimated gains and losses to the tailings facilities. For the flotation tailings facility precipitation is estimated at 778 gpm and run-on for areas not included in the diversion ditch system is estimated at 950 gpm. Output from the facility includes recycled water at 13,927 gpm and evaporation of 760 gpm. For the hydromet tailings facility precipitation is estimated at 383 gpm and run-on for areas not included in the diversion ditch system is estimated at 104 gpm. Output from the facility includes recycled water at 440 gpm and evaporation of 374 gpm.

10.5 ROAD WATERING

Dust control will be required for project roads. The primary roads requiring dust control will be the haul routes for ore and waste rock. The estimate of annualized water requirements for dust control is between 45 to 142 gpm depending on the year. Actual dust control will vary throughout the year depending on the precipitation conditions that exist at any given time. Water used in dust control will evaporate or be absorbed onto the road surface. No runoff is expected from this activity and no water will be available for recycling.

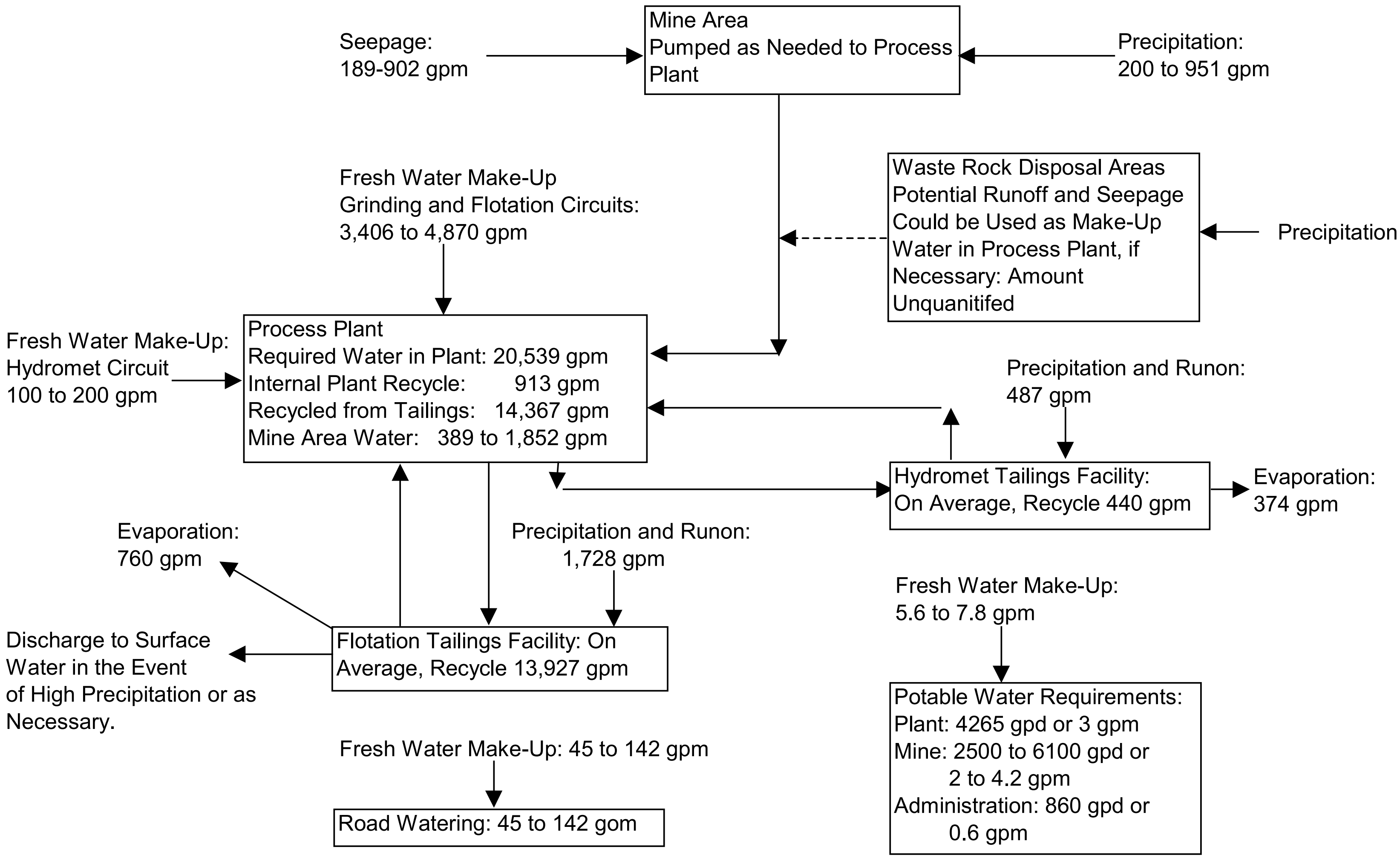


Figure 10-1 **NorthMet Project Conceptual Water Balance**

11.0 WATER SUPPLY

The iron mines in northeastern Minnesota, with one exception, use existing pit lakes and water from pit dewatering as their water supply. The only exception was LTV that used Colby Lake in nearby Hoyt Lakes for their water supply. None of the mines use water wells as a source of water. It is assumed for this study that it will be possible to reach an agreement with one of the nearby mines to use water from one of their pits. The most likely candidate would be LTV because that facility is shut down, and because they did not use pit water even while operating. The LTV pits are 3 to 4 miles from the NorthMet property. The other possible source would be Northshore Mining, which is about 1 mile north of NorthMet. Northshore is an operating mine and may not have excess water to distribute. Neither of the mines has been approached as to the availability of water at this time.

The plant/infrastructure capital cost estimate for this study includes a 4 mile pipeline for the fresh water supply.

12.0 PERMITTING AND ENVIRONMENT

12.1 INTRODUCTION

The regulatory climate in northern Minnesota is quite favorable to mining due primarily to the long-term presence of large iron mines in the vicinity of the NorthMet Project. Although the NorthMet Project will be different from the iron mining operations, the regulatory agencies are familiar with mining and have indicated a willingness to work with operators to ensure timely permitting of new facilities. However, permitting of a new operation will require a substantial investment of both time and money. The estimated permitting time frame is 3 to 3.5 years at an estimated cost of $6 to $6.5 million. The estimated costs and the time frames for completing the environmental work are shown on Tables 12-1 and 12-2 and Figure 12-1, respectively.

Although it is fairly early in the process and limited environmental studies have been completed, the time frames, costs and discussions presented in this section are based on meetings with the regulatory agencies, limited data gathering and experience permitting in similar settings. The time frames, informational requirements, and costs could change, but the estimates presented here are considered conservatively realistic for the NorthMet Project.

In addition, the political climate in Minnesota is quite favorable for permitting of a new mining operation. Many of the mines in northern Minnesota are experiencing cutbacks and/or closure resulting in economic impacts in the area. Officials throughout the Minnesota state government, including the governor, have indicated a desire to replace the lost income and jobs and a commitment of resources necessary to assist in getting new economic development going in the area.

The following discussions of permitting and environmental requirements are divided into requirements for baseline resource data gathering and the permitting process that will need to be followed in order to receive approval to operate the NorthMet Project. More detailed discussions of the baseline studies and individual permits are included in the Environmental Report, under separate cover.

12.2 BASELINE RESOURCE DATA GATHERING

Baseline studies are conducted to establish existing conditions at the site. This information is then compared to expected impacts on these existing conditions as a result of the mining operations. Some baseline studies require a long lead-time while others can be completed fairly quickly. In addition, some baseline study areas, such as soils, do not require ongoing study; while other areas, such as surface water quality, will require continuous study throughout the life of the operation. Some discussions have been held with the regulatory agencies on the requirements of the baseline studies and some preliminary work has been completed in certain resource areas. No agreements have been reached with any agency on the nature and extent of any study. As such, this document represents our best understanding at this time. In several cases, as discussed in the details which follow, the scope and associated cost takes the most conservative approach and, if the agencies are agreeable, a less conservative and less costly approach may be appropriate. The scopes and budgets may change as we gain a better understanding of the site environmental conditions and the project components. In addition, there are several items which are somewhat to highly dependent on having the various project facilities, such a waste rock and tailings disposal sites, located and/or designed before the work can proceed to completion. If the locations or design change, it could require new or additional baseline data collection.

As a final note, the scopes and budgets presented are for completing environmental baseline studies for the EIS for the NorthMet Project. A separate EIS will be required for the land swap with the U.S. Forest Service. It will be easy (and cost effective) to add additional areas to the baseline studies to cover those areas which are part of the land swap and are near to the NorthMet Project area. The results can then also be used in developing the EIS for the land swap.

Baseline studies that will be required for the NorthMet Project are listed below. The estimated costs for completing the baseline studies are included in Table 12-1 with the timing for each study shown on Figure 12-1. Each baseline study area is separately discussed in the Environmental Report.

- Wildlife and Plant Surveys
- Aquatic Resources
- Cultural Resources
- Wetlands
- Surface Water Monitoring
- Ground Water Monitoring
- Ore Geochemistry
- Waste Rock Geochemistry
- Air Quality
- Climatology
- Soils
- Socioeconomics
- Noise
- Blasting
- Transportation
- Visual
- Ground Water/Geochemical Modeling

12.3 PERMITS AND PERMITTING

The major and minor environmental permits required for the NorthMet Project are listed below and discussed in the Environmental Report. Estimated costs to complete each permit are shown on Table 12-2 with timing shown on Figure 12-1. As previously discussed, the political climate is excellent for obtaining timely permit decisions, but the permitting itself will still require a significant investment of both time and money in order to ensure that it proceeds smoothly and that any issues that arise during the process are quickly addressed and resolved. The permitting discussions in the following sections are based on information which has been obtained from preliminary meetings with the permitting agencies and on experience in permitting similar projects in other places in the United States. The permitting requirements could change somewhat, but are not expected to change dramatically from that described below, except in the instance where the U.S. Forest Service lands are exchanged and this agency is no longer involved in the permitting process.

In addition to permitting requirements, it is important to note that although mining is prevalent in northern Minnesota where the NorthMet Project is located most of the mines were in existence long before the environmental regulations were enacted. The NorthMet Project also represents a different type of operation from the iron ore industry found in the region. As such, regulators will require some education on the processing to be used for the NorthMet Project and in the behavior of sulfide ore bodies. The key issues are likely to be, in order of relative concern, acid generation from the ore and waste rock, processing chemicals and products, and wetlands mitigation.

Key permits include the following:

- Plan of Operations/Environmental Impact Statement
- 404 Permit (Wetlands/Waters of the US)
- State Wetlands Review (RGU/SWCD)
- Minnesota Nonferrous Mine Permit and Five Year Operating Plan
- Mine Reclamation Permit
- Air Quality Permit
- Air Toxics Review
- NPDES Permit
- Storm Water Permit
- 401 Water Quality Certification
- Construction Dewatering Permit
- Dam Safety Permit

Other permits which may be required for the NorthMet Project, but which are expected to require less time and expense to prepare and complete the permitting process are listed below.

- License to Cross State Lands
- Hazardous Waste Generator Permit
- Aboveground Storage Tank Permits
- Permit to Work in Protected Waters or Wetlands
- Temporary Water Appropriation Permits
- Permanent Water Appropriation Permits
- Waste Tire Storage Permit
- Sanitary Wastewater Treatment Permit
- Potable Water Supply Approval
- Open Burning Permits
- Radioactive Material License

12.4 REGULATORY AGENCIES

It is anticipated that four Federal Agencies, six Minnesota State Agencies, and two local agencies will have a role in the permitting process. It is also anticipated that the lead agencies for preparation of the EIS will be the US Army Corps of Engineers and the Minnesota Department of Natural Resources. Not all agencies will have a decision making role, but rather some agencies, such as the EPA, will have a consultation role. In addition, there are likely to be many divisions within these agencies which will have differing responsibilities. For instance, within the Minnesota Department of Natural Resources there are a number of divisions which will have project responsibility including the Division of Wildlife, Division of Fisheries, Division of Lands and Minerals, the Division of Waters, and potentially the Division of Forestry and Division of Ecological Services. Following is a list of agencies expected to be involved in the permitting effort.

Federal Agencies

U.S. Forest Service

U.S. Army Corps of Engineers

U.S. Fish and Wildlife Service

U.S. Environmental Protection Agency

State Agencies

Minnesota Department of Natural Resources

Minnesota Pollution Control Agency

Minnesota Department of Health

Minnesota Forest Resources Council

Minnesota Historical Society

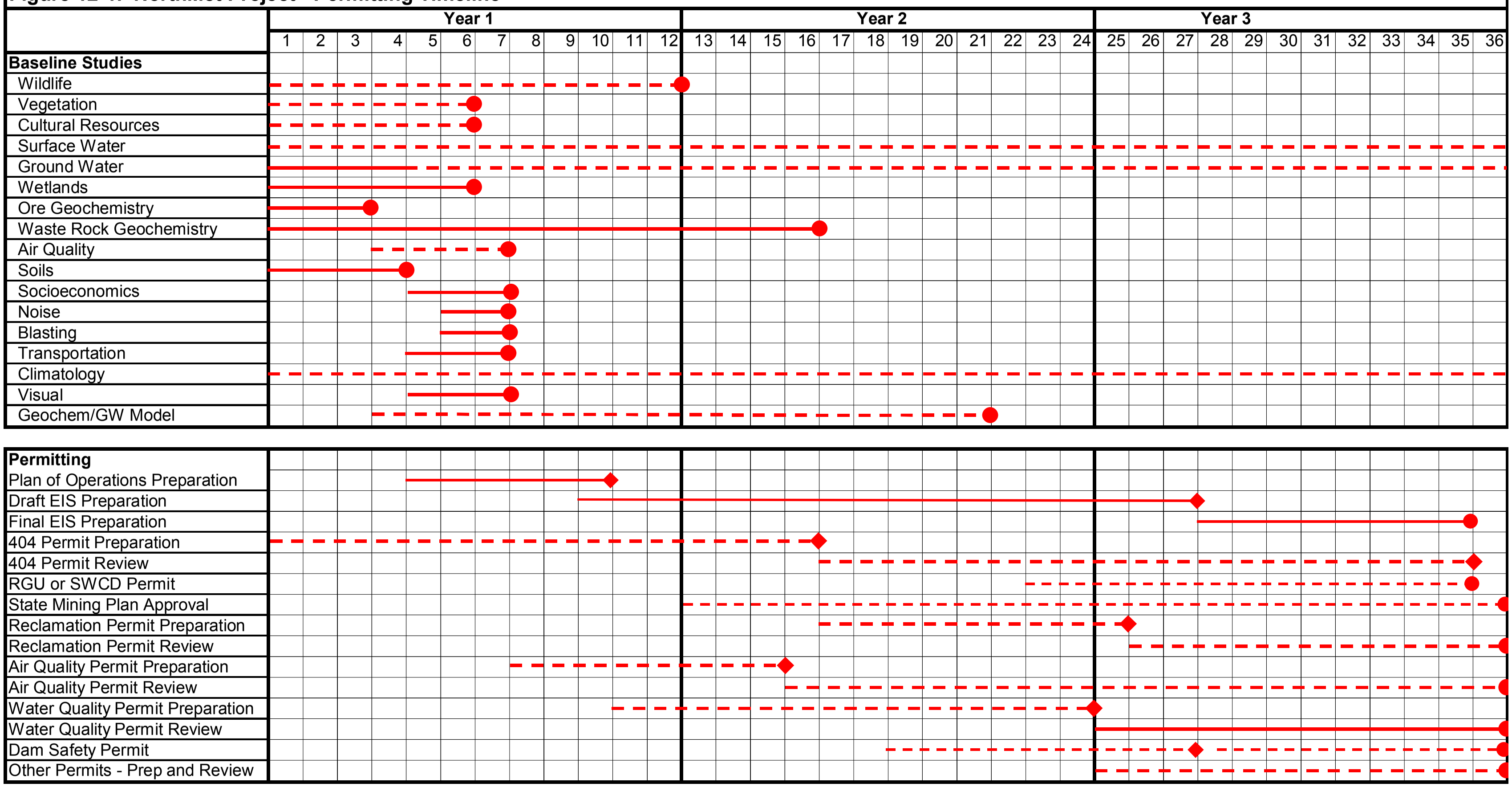
Minnesota Board of Water and Soil Resources

Local Agencies/Organizations

St. Louis County

City of Babbitt

Figure 12-1. NorthMet Project - Permitting Timeline



Some baseline studies are seasonally dependent and work could take longer if not started in the appropriate season.

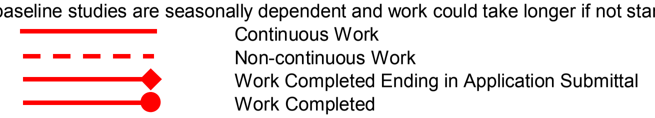


Table 12-1. Baseline Study Budget

	Year 1	Year 2	Year 3	Totals
Wildlife and Plant Surveys				
Winter Survey	$ 30,000.00			$ 30,000.00
Spring Survey	$ 50,000.00			$ 50,000.00
Summer Survey	$ 50,000.00			$ 50,000.00
Fall Survey	$ 30,000.00			$ 30,000.00
Agency Coordination	$ 6,000.00			$ 6,000.00
Report Preparation	$ 15,000.00			$ 15,000.00
Aquatic Resources				
Spring Survey	$ 18,000.00			$ 18,000.00
Summer Survey	$ 18,000.00			$ 18,000.00
Agency Coordination	$ 6,000.00			$ 6,000.00
Report Preparation	$ 10,000.00			$ 10,000.00
Cultural Resources				
Phase 1	$ 15,000.00			
Phase 2	$ 40,000.00	$ 40,000.00		
Surface Water Monitoring				
Phase 1 - Existing Data Review	$ 2,000.00			$ 2,000.00
Monitoring	$ 45,000.00	$ 20,000.00	$ 20,000.00	$ 85,000.00
Agency Coordination	$ 6,000.00	$ 2,000.00	$ 2,000.00	$ 10,000.00
Report Preparation	$ 25,000.00	$ 10,000.00	$ 10,000.00	$ 45,000.00
Ground Water Monitoring				
Drilling Program	$ 80,000.00			$ 80,000.00
Monitoring	$ 20,000.00	$ 20,000.00	$ 20,000.00	$ 60,000.00
Agency Coordination	$ 4,000.00	$ 2,000.00	$ 2,000.00	$ 8,000.00
Report Preparation	$ 25,000.00	$ 10,000.00	$ 10,000.00	$ 45,000.00
Wetlands				
Wetlands Delineation	$ 375,000.00			$ 375,000.00
Agency Coordination	$ 10,000.00	$ 5,000.00		$ 15,000.00
Report Preparation	$ 75,000.00			$ 75,000.00
Ore Geochemistry				
Laboratory Testwork	$ 80,000.00			$ 80,000.00
Agency Coordination	$ 4,000.00	$ 6,000.00		$ 10,000.00
Report Preparation	$ 60,000.00			$ 60,000.00
Waste Rock Geochemistry				
Laboratory Testwork	$ 150,000.00	$ 80,000.00		$ 230,000.00
Agency Coordination	$ 4,000.00	$ 6,000.00		$ 10,000.00
Report Preparation	$ 20,000.00	$ 40,000.00		$ 60,000.00
Air Quality	$ 10,000.00	$ 10,000.00		$ 20,000.00
Climatology	$ 140,000.00	$ 30,000.00	$ 30,000.00	$ 200,000.00
Soils				
Scoping Survey	$ 60,000.00			$ 60,000.00
Field Survey	$ 110,000.00			$ 110,000.00
Agency Coordination	$ 4,000.00			$ 4,000.00
Report Preparation	$ 40,000.00			$ 40,000.00
Socioeconomics	$ 50,000.00			$ 50,000.00
Noise	$ 30,000.00			$ 30,000.00
Blasting	$ 30,000.00			$ 30,000.00
Transportation	$ 20,000.00			$ 20,000.00
Visual	$ 30,000.00			$ 30,000.00
Ground Water Model		$ 150,000.00		$ 150,000.00
TOTALS	$ 1,797,000.00	$ 431,000.00	$ 94,000.00	$ 2,227,000.00

Table 12-2. Permitting Budget

	Year 1		Year 2		Year 3		Totals	
Project Management	$	100,000	$	100,000	$	100,000	$	300,000
Agency Coordination	$	100,000	$	100,000	$	100,000	$	300,000
Plan of Operations								
POO Preparation	$	50,000			$	30,000	$	80,000
State Personnel Costs	$	70,000	$	70,000	$	70,000	$	210,000
State Scoping	$	18,000	$	4,000	$	18,000	$	40,000
Third Party EIS	$	500,000	$	500,000			$	1,000,000
Corps of Engineers 404 Permit								
Agency Coordination	$	50,000	$	50,000	$	50,000	$	150,000
Permit Preparation	$	50,000	$	75,000	$	50,000	$	175,000
Wetlands Mitigation Plan	$	100,000	$	50,000	$	50,000	$	200,000
State Mining Plan Approval	$	10,000	$	20,000	$	20,000	$	50,000
RGU or SWCD Permit/Approvals			$	10,000	$	20,000	$	30,000
Mine Reclamation Permit	$	15,000	$	40,000	$	40,000	$	95,000
Air Quality Permit	$	100,000	$	100,000	$	40,000	$	240,000
Air Toxic Review	$	15,000					$	15,000
Water Quality/NPDES Permit	$	20,000	$	100,000	$	100,000	$	220,000
Dam Safety Permit			$	35,000	$	50,000	$	85,000
Other Permits	$	10,000			$	40,000	$	50,000
Community Relations	$	75,000	$	100,000	$	100,000	$	275,000
Legal Costs	$	75,000	$	200,000	$	200,000	$	475,000
TOTALS	$	1,358,000	$	1,554,000	$	1,078,000	$	3,990,000

13.0 CAPITAL COSTS

13.1 SUMMARY OF CAPITAL COSTS

Table 13-1 summarizes the estimated capital costs for the NorthMet Project by the various cost categories. Initial capital (Years –2 through 1) is $630.7 million. Sustaining capital for replacement of mining equipment is $185.6 million and occurs between years 2 and 21. Total capital over the project life is $816.3 million. This amounts to $1.693 per ore ton.

Table 13-1: Summary of Capital Costs ($US x 1000)

Category	Year –2	Year –1	Year 1	Yrs 2 to 21	Total
Mine Development	0	10,621	0	0	10,621
Mine Equipment	0	49,702	24,809	185,618	260,129
Plant/Infrastructure	174,370	261,554	0	0	435,924
Tailings Dam	0	24,296	0	0	24,296
Mine/Plant Buildings	3,866	5,800	0	0	9,666
Land Acquisition	3,715	3,715	0	0	7,430
Wetlands Mitigation	15,209	1,391	0	0	16,600
Owners Cost	4,378	5,280	0	0	9,658
Working Capital	0	0	42,000	0	42,000
TOTAL	201,538	362,359	66,809	185,618	816,324

All costs shown on Table 13-1 are in constant 1st quarter 2001 US dollars. They have not been escalated to the expected project start date. The plant/infrastructure and buildings capital cost includes a contingency of $74.5 million (about 20%). The tailings facilities include a contingency of $3.2 million (15%).

The capital cost for equipment does not include sales taxes. In Minnesota, the sales taxes for mining and processing equipment are collected, but are then refunded.

13.2 MINING CAPITAL

Table 13-2 summarizes the mining capital cost by time period. It includes the mine preproduction development cost, major and minor equipment, initial spare parts, shop tools, and engineering and safety equipment. Physical structures such as the mine shop, warehouse, offices, fuel and lubricant storage facilities, and explosive storage facilities are included in the plant/infrastructure capital cost. IMC wrote the specifications for these facilities and AMEC estimated the cost.

Initial mine capital (Years –1 and 1) amounts to $85.1 million. Sustaining capital for mining equipment throughout the project life is $185.6 million for a total mine capital cost of $270.8 million.

Table 13-2: Summary of Mine Capital ($US x 1000)

Category	Year –1	Year 1	Yrs 2-21	Total
Mine PreProduction Development	10,621	0	0	10,621
Mine Major Equipment	43,033	22,725	170,895	236,653
Mine Support Equipment	3,702	720	8,757	13,179
Shop Tools	1,291	682	3,875	5,848
Initial Spare Parts	1,291	682	1,386	3,359
Physical Structures	Included in Plant/Infrastructure Capital Cost			
Mine Engineering/Safety Equipment	385	0	705	1,090
TOTAL	60,323	24,809	185,618	270,750

The major and minor equipment cost results from an equipment list prepared by IMC based on the mine plan requirements and vendor quotes collected by IMC during the last year. Preproduction development cost is based on the equipment and labor required to operate the mine plan developed by IMC for the preproduction period. Shop tools and initial spare parts are factored from the major equipment (3% of major equipment for both). Mine engineering and safety equipment are also based on an equipment list.

The mine capital costs do not include a contingency. The contingency is accounted for in the difference between the equipment prices used for this study and the likely transaction prices that will apply to a fleet sale. For example, for the Caterpillar equipment (a large part of the fleet), IMC used prices of about 85% of list prices for the estimate. Purchase prices down to about 70% of list price may be achieved with a fleet purchase. The capital cost includes delivery of the equipment to the property and assembly.

13.3 PLANT/INFRASTRUCTURE CAPITAL

Tables 13-3 and 13-4 contain the plant and infrastructure capital cost by facility and by commodity or component. The total plant/infrastructure capital cost is $445.6 million, including a contingency of $74.5 million (about 20%).

The capital cost is based on detailed process flow sheets and equipment lists prepared by O'Kane and AMEC. This estimate is categorized as prefeasibility with an expected accuracy range of ±25% at the bottom line. The estimate covers the direct field costs of executing the project, plus the indirect costs associated with the design, construction and commissioning of the facilities. Major mechanical process equipment, and high/medium voltage electrical equipment costs are based on budgetary vendor quotations. Other equipment and installation costs were estimated from in-house data. Civil, structural, and building costs have been estimated based on preliminary material take-offs from project drawings and sketches. Piping, electrical and instrumentation costs are based on factors of mechanical equipment costs. All inclusive labor rates were calculated using typical wages and benefits for union contractors in Northern Minnesota. The average rate was approximately $64/hr. Indirect costs have been estimated based on factored direct costs.

It is important to note that the $445.6 million includes the buildings at $9.67 million that are itemized separately on Table 13-1. Table 13-1 shows the plant and infrastructure as $435.9 million ($445.6 million - $9.67 million).

The indirect costs include EPCM (engineering, procurement and construction management), temporary construction facilities, capital spares, first fill of consumables, vendor representative costs, freight and taxes, and start up and commissioning. Owners cost during construction are not included in the plant/infrastructure capital cost; it is itemized separately in Section 13.8 below.

It is assumed for this study that 40% of the plant/infrastructure capital cost will be in Year –2 and 60% in Year –1. This amounts to $178.2 million and $267.4 million respectively.

Table 13-3: Plant/Infrastructure Capital Cost by Facility ($US x 1000)

Facility	Labor	Materials	Other	Total
Mining	385	299	0	684
Concentrator	38,013	108,097	506	146,617
Precious Metal Recovery	3,633	14,558	4	18,195
Copper SXEW	5,569	25,611	0	31,180
Nickel/Cobalt/Zinc Recovery	16,846	31,875	947	49,669
Tailings and Reclaim Water	2,632	3,969	0	6,601
Plant Site Prep and Utility Services	5,531	14,874	1,685	22,089
Facilities	2,617	8,825	0	11,442
Indirects	1,280	17,880	65,492	84,652
Contingency	0	0	74,461	74,461
TOTAL	76,507	225,988	143,095	445,590

Table 13-4: Plant/Infrastructure Capital Cost by Commodity ($US x 1000)				
Commodity	Labor	Materials	Other	Total
Earthworks & General Civil	1,706	406	1,127	3,239
Concrete	10,815	7,177	0	17,992
Steel	7,586	11,893	0	19,480
Architectural	6,025	11,850	100	17,975
Mechanical	22,017	125,401	715	148,133
Piping	16,364	24,349	0	40,713
Electrical	9,035	20,464	1,200	30,698
Instrumentation	1,678	6,568	0	8,246
Indirects	1,280	17,880	65,492	84,652
Contingency	0	0	74,461	74,461
TOTAL	76,507	225,988	143,095	445,590

13.4 TAILINGS IMPOUNDMENT CAPITAL

Two tailings impoundment facilities are required:

1. A flotation tailings facility, and
2. A hydrometallurgical tailings facility.

Both dams will be raised almost every year during the course of the project. The construction prior to commercial production is considered a capital cost. After commercial production begins, the dam construction is considered an operating cost.

Table 13-5 summarizes the tailings impoundment capital of $24.3 million.

Table 13-5: Tailings Impoundment Capital ($US x 1000)	
Category	Cost
Flotation Dam Construction	11,462
Hydrometallurgical Dam Construction	9,054
Road Construction	461
Other Costs	150
Contingency (15%)	3,169
TOTAL	24,296

The dam construction costs are based on dam designs done by SRK. The required quantities of the various construction materials were calculated based on the designs, and unit costs collected from local contractors were applied to the quantities. Waste rock and overburden from the mine are used for much of the construction. The cost to haul this material to the impoundment area is included in the mine development capital cost. Once delivered, a contractor will place the material in the structures.

The road construction cost is based on an estimate done by IMC. It is to provide a road from the mine to the impoundment area for the mine trucks.

“Other costs” is for supervision, maintenance, and operation of the facility.

The entire capital cost will be incurred during Year –1, the second construction year of the project. The mine materials will not be available prior to that year.

13.5 MINE AND PLANT BUILDINGS

Mine and plant buildings are estimated at $9.67 million and are included in the plant/infrastructure capital costs. The buildings include the administration building, mine engineering and operations offices, mine shop and warehouse, plant shop and warehouse, the laboratory, and a guard house.

It is assumed that 40% of the cost will be in Year –2 and 60% in Year –1. This amounts to about $3.87 million and $5.80 million respectively.

13.6 LAND ACQUISITION

The mineral and surface rights to the NorthMet property have been severed and the United States Forest Service (USFS) has acquired most of the surface rights. Also, there are additional lands, particularly in the tailings area, that are desired for the project, but the land ownership has not yet been identified.

The surface rights to about 7,430 acres will have to be acquired for the project. Major property owners include the USFS, the State of Minnesota, and St. Louis County. The USFS will probably want to swap lands.

It is assumed for this study that 3,715 acres will be acquired in Year –2 and 3,715 acres in Year –1 at $1000 per acre. This gives capital costs for land acquisition of about $3.7 million each year for a total of about $7.4 million.

The document "A Minnesota Mining Tax Guide", available from the state, indicates that land in the area of interest is valued at about $650 per acre for county tax purposes.

13.7 WETLANDS MITIGATION

Of the approximately 7,400 acres required by the project, about 5,000 acres will be disturbed. Of this amount, it is estimated that about 70% will be classified as wetlands. The wetlands used by the project will be mitigated (replaced) on an acre for acre basis by either creation of new wetlands or by purchasing wetlands from other developers who have created more wetlands than required for their applications (a "wetlands bank"). It is also required that the wetlands be mitigated prior to their disturbance.

The capital cost for wetland mitigation is $16.6 million, as shown in Table 13-6. The cost of $7,500 per acre ($0.172 per square foot) is about the average cost in the project area. Actual costs for wetlands mitigation will be dependent on the type of land acquired for mitigation and the type of wetland construction or improvement that can be accomplished on that land.

Table 13-6: Wetlands Mitigation Capital Cost ($US x 1000)

	Year -2	Year –1	Total
Wetlands to Mitigate (Acres)	2,028	186	2,214
Cost Per Acre ($)	7,500	7,500	7,500
Total Mitigation Cost ($ x 1000)	15,209	1,390	16,600

Wetlands mitigated during commercial production are included in the operating costs.

13.8 OWNERS COST

Owners cost is the general and administrative (G&A) costs that are accrued prior to commercial production and are itemized on Table 13-7. It can be seen that this is estimated at $9.66 million over the two year construction period. The number of persons and salaries for the personnel cost are itemized in the G&A operating costs in Section 14.5.

Table 13-7: Summary of Owners Costs ($US x 1000)			
Category	Year –2	Year –1	Total
Personnel Costs	1,950	2,477	4,427
Site Expenses (30% of Personnel Costs)	585	743	1,328
Home Office Expenses (10% of Personnel Costs)	195	248	443
Insurance	1,500	1,500	3,000
Property Taxes	148	313	461
TOTAL	4,378	5,280	9,658

13.9 WORKING CAPITAL

Working capital is estimated at $42 million, approximately three months of typical operating costs for the project. For example, Year 2 total operating costs are estimated at $169.1 million. Year 2 is the first year of full commercial production.

14.0 OPERATING COSTS

14.1 SUMMARY OF OPERATING COSTS

Table 14-1 summarizes the operating costs for the NorthMet Project by several cost categories. It can be seen that total operating costs over the life of the project amount to $4,321.1 million ($4.32 billion) or $8.962 per ore ton. This is based on a total ore production of 482,206 ktons over the life of the project and an annual ore production rate of 20,075 ktons per year. Total operating cost for a typical production year is $179.9 million.

14-1: Summary of Operating Costs ($US x 1000)

Category	Total Cost ($US x 1000)	Cost Per Ore Ton	Typical Year ($US x 1000)
Mining	1,168,363	2.423	48,642
Crushing, Grinding, and Flotation	1,339,098	2.777	55,748
POX, Precipitation, SX, and EW	1,240,857	2.573	51,653
Tailings Embankment	118,460	0.246	4,938
General and Administrative	141,817	0.294	5,904
Wetlands Mitigation	9,514	0.020	396
US Steel Royalty	154,183	0.320	6,419
Refining, Marketing, and Metal Freight	148,769	0.309	6,203
TOTAL	4,321,061	8.962	179,903

The costs shown are all stated in 1^{st} quarter 2001 US dollars. The costs are not escalated to the expected start of the project, nor are they adjusted for anticipated inflation during the life of the project.

Sales taxes are only included for grinding media in the above estimate. Other than grinding media, the remaining mine and plant consumables are exempt from Minnesota sales taxes.

Details of the various components are contained in the following sections.

14.2 MINING

Mine operating costs are discussed in Section 6.8 of this report and are itemized by cost center (drilling, blasting, loading, hauling, etc.) on Tables 6-13 and 6-14 and by commodity (fuel, power, tires, parts, etc.) on Tables 6-15 and 6-16. All of the tables include the mine preproduction development amount of $10.6 million; this is considered a capital cost as discussed in Section 13.2.

Mine operating cost, net of preproduction development, amounts to $1,168.4 million ($1.17 billion) over the project life. This is $0.614 per total ton or $2.423 per ore ton. This is an average cost of $48.6 million per year. The annual cost ranges from a high of $68.1 million during Year 16 to a low of $27.8 million in Year 23. The first seven years of commercial operation tend to be low cost years; all are less than $40 million per year.

Table 14-2 summarizes the mine operating costs by commodity. Note that the total cost is about 67% parts and consumables and 33% labor. This is typical of a US operation. The cost of diesel fuel, one of the major consumable items, has been estimated at $0.85 per US gallon for the mining cost estimate.

The cost estimate was done by IMC and is based on the equipment and labor required to operate the mine plan developed (also by IMC) for this study.

Table 14-2: Details of Mine Operating Cost			
PARTS AND CONSUMABLES	Total ($ x 1000)	Per Ore Ton	% of Total
Electrical Power	18,340	0.038	1.57
Diesel Fuel	198,361	0.411	16.98
Tires	117,470	0.244	10.05
Lubricants, Repair Parts, Wear Items	291,560	0.605	24.95
Drill Down Hole Items	16,313	0.034	1.40
Explosives	69,450	0.144	5.94
Gen. Mine/Gen. Maint./Pumping	70,891	0.147	6.07
Subtotal Parts and Consumables	782,385	1.623	66.96
LABOR	Total ($ x 1000)	Per Ore Ton	% of Total
Salaried Staff	47,608	0.099	4.08
Hourly Labor	338,370	0.701	28.96
Subtotal Labor	385,978	0.800	33.04
TOTAL MINING COST	1,168,363	2.423	100.00

14.3 PROCESSING

14.3.1 Site Processing Costs

Site processing costs for the project life are estimated at $2,580.0 million ($2.58 billion) or about $5.350 per ore ton. This amounts to about $107.4 million for a typical year. These costs are broken down into 2 categories: 1) crushing, grinding, and flotation costs, and 2) pressure oxidation, precipitation, solvent extraction, and electrowinning costs in the following sections.

14.3.2 Crushing, Grinding, and Flotation Cost

Crushing, grinding, and flotation costs for the project life are estimated at $1,339.1 million ($1.34 billion) or about $2.777 per ore ton. This amounts to an annual cost of about $55.7 million for a typical year. Table 14-3 shows the details of the estimate. The cost of pumping the flotation tails to the tailings facility are also included in the cost.

Table 14-3: Details of Crushing, Grinding, and Flotation Operating Cost

PARTS AND CONSUMABLES	Total ($ x 1000)	Per Ore Ton	% of Total
Grinding Media	560,771	1.163	41.88
Reagents/Other Consumables	197,325	0.409	14.74
Power	363,375	0.754	27.13
Plant Operating Supplies	7,494	0.015	0.56
Maintenance Supplies	49,962	0.104	3.73
Subtotal Parts and Consumables	1,178,927	2.445	88.04
LABOR	Total ($ x 1000)	Per Ore Ton	% of Total
Salaried Staff and Hourly Labor	160,171	0.332	11.96
Subtotal Labor	160,171	0.332	11.96
TOTAL CRUSH, GRIND, FLOAT COST	1,339,098	2.777	100.0

14.3.3 Pressure Oxidation, Precipitation, and SXEW Cost

Pressure oxidation, precipitation, solvent extraction, and electrowinning costs for the project life are estimated at $1,240.9 million ($1.24 billion) or about $2.573 per ore ton. This amounts to an annual cost of about $51.7 million for a typical year. Table 14-4 shows the details of the estimate. The cost of pumping the hydrometallurgical tails to the tailings facility are also included in the cost.

Table 14-4: Details of POX, Precipitation, and SXEW Operating Costs

PARTS AND CONSUMABLES	Total ($ x 1000)	Per Ore Ton	% of Total
Reagents and Consumables	774,885	1.607	62.45
Power	265,108	0.550	21.36
Plant Operating Supplies	6,918	0.014	0.56
Maintenance Supplies	46,118	0.096	3.72
Subtotal Parts and Consumables	1,093,029	2.267	88.09
LABOR	Total ($ x 1000)	Per Ore Ton	% of Total
Salaried Staff and Hourly Labor	147,828	0.306	11.91
Subtotal Labor	147,828	0.306	11.91
TOTAL POX, PRECIP, SXEW COST	1,240,857	2.573	100.0

14.3.4 Basis of Processing Cost Estimate

AMEC provided IMC the plant operating cost for a typical year as shown in Table 14-5. The cost per ton is based on 20,075 ore ktons per year. AMEC also provided detailed costs for reagents and other consumables by plant area, power consumption by plant area, and a labor cost table.

Table 14-5: Processing Operating Cost Summary Provided by AMEC

Cost Item	Cost per Year ($US)	Cost per Ton ($US)
Reagents and Consumables	63,820,219	3.179
Labor	12,701,072	0.633
Power	26,164,559	1.303
Plant Operating Supplies	600,000	0.030
Maintenance Supplies	4,000,000	0.199
TOTAL AMEC TYPICAL YEAR COST	107,285,850	5.344

Based on the information provided by AMEC, IMC sub-divided the costs into the two categories discussed in the previous sections. This was done as follows:

1. Reagents, grinding media, and power could easily be put in the appropriate cost categories based on details provided by AMEC. These costs were distributed about 52% to crushing, grinding, flotation, and 48% to POX, precipitation, and SXEW.

2. IMC distributed the labor cost, plant operating supplies, and plant maintenance to the cost categories in the same 52%/48% ratio.

3. IMC also made some adjustments for the 1st and last year of production where the production rate is less than most of the operating years.

14.3.5 Processing Costs by Year

Table 14-6 shows an estimate of annual plant operating costs per ore ton that was prepared by O'Kane Associates. It is based on the mine production schedule and accounts for the differences in sulfur grade, copper grade, and nickel grade by year. The table includes the fixed and variable portions of the operating cost. It shows the variability of processing costs by year , but this variability was not incorporated into the cashflow model for the following reasons:

1. The amount of fluctuation of the cost by year is relatively small.
2. The costs are not broken down in a manner to allow sensitivity analysis to the various components of the cost (grinding media, reagents, etc.).
3. The costs also are not broken down in the manner required for tax calculations for the mineral depletion allowance.

Table 14-6: Process Plant Operating Cost Per Year								
		$/ton ore						
Year	Ore		Costs Dependent on					
	ktons	Fixed	Ore	Sulfur	Copper	Nickel	Total
0	1,308						
1	15,693	$ 1.018	$ 3.479	$ 0.290	$ 0.164	$ 0.461	**$ 5.411**
2	20,075	0.862	3.479	0.337	0.193	0.547	**5.418**
3	20,075	0.862	3.479	0.311	0.202	0.530	**5.384**
4	20,075	0.862	3.479	0.328	0.213	0.495	**5.377**
5	20,075	0.862	3.479	0.325	0.221	0.466	**5.353**
6	20,075	0.862	3.479	0.353	0.183	0.466	**5.343**
7	20,075	0.862	3.479	0.322	0.194	0.490	**5.347**
8	20,075	0.862	3.479	0.272	0.191	0.472	**5.276**
9	20,075	0.862	3.479	0.287	0.176	0.449	**5.253**
10	20,075	0.862	3.479	0.295	0.173	0.461	**5.270**
11	20,075	0.862	3.479	0.306	0.177	0.449	**5.273**
12	20,075	0.862	3.479	0.296	0.188	0.455	**5.280**
13	20,075	0.862	3.479	0.288	0.191	0.438	**5.257**
14	20,075	0.862	3.479	0.311	0.157	0.420	**5.229**
15	20,075	0.862	3.479	0.350	0.191	0.466	**5.348**
16	20,075	0.862	3.479	0.368	0.190	0.478	**5.377**
17	20,075	0.862	3.479	0.369	0.205	0.490	**5.404**
18	20,075	0.862	3.479	0.268	0.155	0.420	**5.184**
19	20,075	0.862	3.479	0.383	0.196	0.490	**5.410**
20	20,075	0.862	3.479	0.433	0.208	0.490	**5.471**
21	20,075	0.862	3.479	0.456	0.184	0.461	**5.442**
22	20,075	0.862	3.479	0.339	0.147	0.432	**5.259**
23	20,075	0.862	3.479	0.315	0.184	0.495	**5.335**
24	20,075	0.862	3.479	0.394	0.202	0.536	**5.473**
25	3,480	0.862	3.479	0.565	0.263	0.610	**5.780**
TOTAL	482,207	0.867	3.479	0.335	0.188	0.474	**5.343**

14.4 TAILINGS EMBANKMENT

After completion of the starter dam embankments for the flotation and hydrometallurgical facilities during Year –1, the remaining dam construction costs are considered as an operating cost. Table 9-3 in Section 9.10 shows the details of the cost estimate for the facilities by project year, including preproduction.

The operating costs for the tailings facilities during commercial production amounts to \$118.5 million or \$0.246 per ore ton. This averages about \$4.9 million per operating year. The cost is spread fairly evenly over production years 1 through 23.

The operating cost estimate is based on the dam designs done by SRK. The required quantities of the various construction materials were calculated based on the designs, and unit costs collected from local contractors were applied to the quantities.

14.5 GENERAL AND ADMINISTRATIVE

Table 14-7 shows the details of the G&A cost by year and includes personnel, site expenses, home office expenses, insurance, property taxes, and reclamation accrual.

The Years –2 and –1 costs of about \$9.7 million are carried as Owners Cost in the capital cost estimate (Section 13-8).

The G&A cost during commercial operation over the life of the project is \$141.8 million or about \$0.294 per ore ton. This amounts to about \$5.9 million during a typical operating year.

The reclamation accrual of \$462,000 per year is the sinking fund amount to obtain a future value of \$22 million by the end of the project life at an interest rate of 5%. The \$22 million represents the estimated closure cost of the project as shown in Table 14-8.

Table 14-7: General and Administrative Personnel and Cost ($ x 1000)

JOB TITLE	Annual Cost ($US)	YEAR -2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	TOTAL	Comm. Prod.
G&A PERSONNEL:																															
General Manager	143,000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0		
Secretary/Reception	39,000	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0		
Chief Accountant	91,000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0		
Accountants	71,500	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0		
Safety Superintendent	91,000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0		
Safety Staff	45,500	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0		
Human Resource Manager	71,500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0		
Human Resource Staff	45,500	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0		
Marketing Manager	84,500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0		
Marketing Staff	45,500	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0		
Environmental Manager	110,500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0		
Environmental Engineer	84,500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0		
Environmental Technician	52,000	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0		
Public Relations Manager	58,500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0		
Purchasing Manager	65,000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0		
Purchasing Staff	45,500	0	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0		
Training Coordinator	71,500	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Mechanical Engineer	65,000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Electrical Engineer	65,000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
AutoCad Operator	39,000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Security Chief	71,500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Security Guards	45,500	10	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15			
Construction Staff	91,000	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
TOTAL PERSONNEL		31	42	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	0		
G&A COST:	Units																														
Partial Year Factor		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.5			
Personnel Cost	($ x 1000)	1,950	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	2,477	1,238	0	65,101	60,674
Site Expenses at 30.0%	($ x 1000)	585	743	743	743	743	743	743	743	743	743	743	743	743	743	743	743	743	743	743	743	743	743	743	743	743	743	371	0	19,530	18,202
Home Office at 10.0%	($ x 1000)	195	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	124	0	6,510	6,067
Insurance	($ x 1000)	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	0	40,500	37,500
Property Taxes	($ x 1000)	148	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	313	0	6,153	5,812
Reclamation Accrual	($ x 1000)	0	0	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	0	11,550	11,550
TOTAL G&A COST	($ x 1000)	4,378	5,280	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	4,008	0	151,475	141,817
Ore Production	kt			17,001	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	3,480	0	482,206	482,206
G&A Cost Per Ore Ton	$US/t			0.338	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	1.152		0.314	0.294

Table 14-8: Estimated Closure Costs ($US x 1000)	
Facility	Closure Cost ($ x 1000)
Mine and Plant Closure	10,349
Tailings Impoundment Closure	8,559
Subtotal	18,908
Contingency at 15%	2,836
TOTAL CLOSURE COST	21,744

14.6 WETLANDS MITIGATION

Wetlands mitigation was discussed briefly in Section 13.7 as a capital cost. In addition to the wetlands mitigated during preproduction, another 1,269 acres of wetlands will be mitigated during commercial operation. At the estimated wetlands mitigation cost of $7500 per acre this amounts to $9.5 million or about $0.020 per ore ton. This amounts to an average of about $396,000 per year. $6.6 million of this amount occurs in the first three years of commercial production.

14.7 US STEEL ROYALTY

US Steel has a royalty interest in the project. The royalty is based on a percentage of the NSR (net of smelting and refining) value of the ore, as follows:

Table 14-9: US Steel Royalty Terms	
NSR Value of Ore:	Royalty
NSR Value of Ore Less Than $30 Per Ton	3% of NSR
NSR Value Between $30 and $35 Per Ton	4% of NSR
NSR Value Greater Than $35 Per Ton	5% of NSR

The NSR value of the NorthMet ore will always be less than $30 per ton if production is averaged over a month or longer period of time; the 3% of NSR applies to all the production.

For this study, all costs down stream of the concentrator have been considered as "smelting and refining" charges for the purpose of NSR calculation. Pressure oxidation, precipitation, solvent extraction, electrowinning, refining, marketing, and metal freight costs have been deducted from the gross revenue to calculate the NSR value of the ore. This is consistent with the definition of mining and post-mining costs in the US Federal tax code for calculation of the minerals depletion allowance.

By the start of commercial operation about $1 million in lease payments will have been paid to US Steel. Under the terms of the royalty agreement these payments are considered as advance royalty payments and will be deducted from the Year 1 royalty.

The US Steel royalty amounts to $154.2 million over the life of the project (net of the advance royalties) or about $0.320 per ore ton. This amounts to about $6.4 million during a typical operating year.

14.8 REFINING, MARKETING, AND FREIGHT

Post-property refining, marketing, and metal freight charges have been calculated using the terms described in Section 15.0 of this report. These costs amount to $148.8 million over the life of the project or about $0.309 per ore ton. This amounts to about $6.2 million during a typical operating year.

For copper and nickel these costs reflect only the freight cost of $35 per ton, since metal is produced on the property. For cobalt, the cost includes shipping the concentrate (precipitate) to a cobalt smelter. For palladium, platinum, and gold the cost includes refining and marketing costs.

14.9 COSTS PRORATED TO METAL PRODUCTION

Operating costs per unit of metal were calculated. The approach used for the calculation was to prorate all shared costs to the various metals according to the metals percent contribution to revenue (gross revenue less marketing, sales, and off-site refining costs).

The operating costs were classified as follows for the calculation. Note that percentages refer to the percentage of the combined pressure oxidation, precipitation, solvent extraction, and electrowinning costs. The breakouts shown were calculated by IMC based on the reagent and power usage for each process.

Costs Shared by All Metals

Mining
Crushing, Grinding, and Flotation
Tailings Embankment
General and Administrative
Wetlands Mitigation
US Steel Royalty
Pressure Oxidation (24.2% of combined POX/Precip/SX/EW Cost)
Solid/Liquid Separation (2.1%)
Utilities (1.5%)

Costs Shared by Palladium, Platinum, and Gold

PGM Recovery (2.7%)

Costs Specific to Copper

Neutralization (5.0%)
Copper SXEW (19.9%)

Costs Shared by Cobalt and Nickel

Iron/Aluminum Precipitation (1.5%)
Copper Sulfate Precipitation (1.0%)
Cobalt/Zinc Solvent Extraction (13.7%)

Cost Specific to Cobalt

Cobalt Precipitation (1.2%)

Costs Specific to Nickel

Zinc Precipitation (3.4%)
Nickel SXEW (23.8%)

Table 14-10 summarizes the operating costs by metal. Table 14-11 shows the contribution to revenue for each unit of payable metal at the base case prices used for this study.

Table 4-10: Summary of Operating Costs Per Unit Payable Metal (Life of Project)

Metal	Payable Units	Operating Costs ($x1000)	Percent of Total	Unit Cost ($US)
Copper (lbs x 1000)	2,680,718	1,521,688	35.2%	0.568 / lb
Nickel (lbs x 1000)	534,204	1,430,872	33.1%	2.679 / lb
Cobalt (lbs x 1000)	24,356	139,182	3.2%	5.715 / lb
Palladium (oz x 1000)	3,027.9	928,318	21.5%	306.6 / oz
Platinum (oz x 1000)	868.0	240,694	5.6%	277.3 / oz
Gold (oz x 1000)	397.5	60,305	1.4%	152.4 / oz
TOTAL		4,321,059	100.0%	

Table 4-11: Contribution to Net Revenue Per Unit of Payable Metal				
Metal	Unit	Base Price /Unit	Unit Cost	Net Revenue Per Unit
Copper	(lb)	$0.85	$0.568	$0.282
Nickel	(lb)	$3.25	$2.679	$0.571
Cobalt	(lb)	$8.00	$5.715	$2.285
Palladium	(tr oz)	$550	$306.6	$243.4
Platinum	(tr oz)	$500	$277.3	$222.7
Gold	(tr oz)	$275	$152.4	$122.6

15.0 MARKETING

The refining, marketing, and metal freight costs are as follows for each metal:

Copper

Copper will be produced as LME Grade A quality cathode. It will be shipped in bundles, likely to US customers. The selling price will be the LME or New York exchange price prevailing at the time of shipment. No other costs should be incurred except for freight. $35/ton of copper is included in the cash flow analysis for freight.

Nickel

Nickel will also be produced as cathode and likely sold as chopped cathode in drums or pallet boxes to the US steel industry. The cathode will easily qualify as Class 1 nickel. The selling price will be the prevailing price on one of the major metals exchanges prevailing at the time of shipment. Again, the allowance for freight is $35/ton of nickel in the cash flow analysis.

Gold and PGM's

Gold and PGM's will be produced as a minimum 30% concentrate, which would be air freighted to a custom PGM refiner in the US or in Europe.

Payment will be 100% of the value, at the prevailing price at the time of shipment, less the deductions shown on Table 15-1:

Table 15-1
PGM Refining and Marketing Costs

Metal	Refining Charge ($/oz)	Selling Cost ($/oz)
Palladium	$15.00	1.5% of Price
Platinum	$16.00	$2.00
Gold	$9.00	$0.50

Cobalt

Cobalt will be produced as a cobalt sulfide precipitate and likely sold to a Canadian or Finnish cobalt refiner.

Sulfide precipitate containing 30% cobalt was produced from pilot plant liquor. The concentrate contained about 2.5% nickel and 0.4% zinc. While these impurities will not incur a penalty, neither is it likely that a credit will be obtained. The precipitate also contained about 1.5% manganese, which is not desirable. It should be possible to reduce the manganese content with more metallurgical testing. Pending tests and specific price indications from potential purchasers, it is prudent to allow for some discount from the expected payment of 65% of the contained cobalt. 60% payable is used for this study and the cash flow calculations.

The sulfide concentrate would be shipped in bulk bags or pallet boxes at 12% moisture. The freight allowance is $60.00/wet ton of material for this study.

Zinc

Zinc can be precipitated as a carbonate and shipped in bulk bags to a zinc refinery in the eastern USA or Canada. The concentrate would contain about 26% zinc and would be produced as a 50% moisture filter cake.

The carbonate will contain about 0.2% cobalt, generally an undesirable element in a zinc refinery. However, the quantity is likely to be so small that the cobalt will not cause a problem.

Pricing for zinc is lumped in with “Other Metals” below.

Other Metals

There are expected to be several other minor revenue contributors as per the pilot plant results. An allowance of $0.30 per ore ton is made for these minor metals, as shown in Table 15-2.

Table 15-2: Revenue Credits Due to Other Metals

Metal	Basis	Credit Per Ore Ton ($US)
Silver	Pay $0.022 oz/ore ton at $4.50 per oz	$0.10
Zinc	Pay $0.24 lbs/ore tons at $0.25 per lb	$0.06
Other PGM’s	Pay $0.135 per ore ton	$0.135
TOTAL		$0.295

16.0 FINANCIAL ANALYSIS

16.1 INTRODUCTION

The economic evaluation of the NorthMet Project was performed on an annual cash flow basis using a conventional pro-forma income statement format. These cash flow analyses represent economic quantification of the various project parameters that directly or indirectly impact the economic viability of the project.

The input parameters for the variables incorporated in the annual cash flow analyses and the corresponding assumptions associated therewith follow.

16.1.1 Economic Input Parameters

Capital and operating cost estimates for the various project parameters incorporated in the annual cash flow analyses largely result from the testing and engineering design work set forth in the appendices to this document. For example, the various metallurgical recoveries, etc., utilized to calculate annual revenues results from actual pilot plant operational values, as are the operating costs for reagent consumption, power and so on. Other metallurgical-related costs result from the design of the flowsheet and the estimated capital and operating costs associated therewith.

In some cases the economic impacts of certain project parameters could not be estimated based on design parameters entirely. Where possible these cost estimates were derived from the experiences of other mine operators in the immediate vicinity of the project, local practices and similar sales transactions, cost estimates from various suppliers and contractors, etc. The costs associated with land acquisition, wetlands mitigation, environmental and permitting-related activities are good examples of utilizing this approach to estimating costs for these items in the study.

In yet other cases, cost estimates for some variables (i.e., insurance, marketing-related transactions, etc.) are the result of engineering judgements/experiences and file information from the qualified persons working on this study. Every attempt was made to minimize these types of cost estimates whenever actual testing or design-based data were available.

Finally, other costs contained in the annual cashflow analyses are the results of defined or specified calculation procedures and not directly associated with engineering and/or design specifications. Examples of these costs are those associated with the State of Minnesota and the U.S. Federal tax codes, as applied to the NorthMet Project.

Table 16-1 summarizes the base case metal prices used for the economic analyses. The table also shows the quantity of payable metal and the gross revenue from each for the project life. Given the life of project ore production of 482.2 million tons, the gross revenue amounts to $13.61 per ore ton.

Table 16-1: Summary of Payable Metal and Base Case Commodity Prices

Metal	Payable Quantity	Base Case Price	Gross Revenue
Copper	2,680,718 klbs	$0.85	$2,278.6 Million
Nickel	534,204 klbs	$3.25	$1,736.2 Million
Cobalt	24,356 klbs	$8.00	$194.8 Million
Palladium	3,027.9 koz	$550	$1,665.3 Million
Platinum	868.0 koz	$500	$434.0 Million
Gold	395.7 koz	$275	$108.8 Million
Credit for Silver, Zinc, and Other PGM's at $0.30 Per Ore Ton			$144.7 Million
TOTAL GROSS REVENUE			$6,562.4 Million

16.1.2 Basic Assumptions

Discounted net annual cashflow analyses were calculated in accordance with some fundamental assumptions. These basic assumptions pertaining to the economic analyses of the NorthMet Project follow:

- NorthMet is an operating unit contained within a corporate structure that consists of other profitable operations. As such, whereever possible, expenditures are expensed rather than capitalized or amortized. Preproduction development expenditures are an exception.
- NorthMet is evaluated on a 100% equity basis.
- Economic analyses are in 1st quarter 2001 constant U.S. dollars. Inflation is not incorporated into the analyses, nor are costs escalated to the expected project start date.
- State taxes are calculated using current State of Minnesota tax code for domestic mining operations.
- Federal taxes are calculated using U.S. Federal tax code for domestic mining operations.
- Project years designated -2 and -1 in the cashflow analyses represent the project construction period immediately following the record of decision to proceed with project development and subsequent mine production.
- All expenditures prior to the record of decision to proceed with mine development are considered "sunk costs" and are reflected in the cashflow calculations only to the extent of their tax implications.
- A discount rate of 10% is utilized in calculating investment decision parameters.

16.2 TYPE OF ECONOMIC ANALYSES

Two types of economics analyses were performed on the NorthMet Project.
These analyses were calculated to provide meaningful information to two distinctly different needs within the financial and investment communities. The two types of analyses follow.

16.2.1 Before-Tax Model

The decision was made to calculate project economics on the basis of cash earnings before any deductions for interest, taxes, depreciation and depletion allocations due to:

- the complex, and somewhat project-specific, nature of state and Federal taxation and the resulting impact on overall project economics,

- the desire of the financial community to ascertain the magnitude of annual earnings available to service debt and other obligations, and

- the difficulty in precisely modeling project-specific or company-specific after-tax cashflow analyses.

As seen in Table 16-2, the detailed before-tax cashflow statement, the item of interest is designated at Net Operating Income. It represents earnings before income taxes and represents project revenues from the disposition of saleable products minus all associated cash costs. The financial appendix to this report shows the backup calculations for this statement. This includes the details of capital and operating costs. Also, depreciation and depletion calculations, and US Federal and Minnesota State income tax calculations are included for the after-tax cases (discussed below).

Table 16-2 also shows the results of this analysis for the NorthMet Project. At a 10% discount rate, the pertinent results normally of interest to the financial community are as follows (Table 16-3):

Table 16-3: Financial Results for Before-Tax Cashflow Analysis	
Net Present Value @ 10% Discount Rate	$171.1 Million
Internal Rate of Return (IRR)	14.09%
Payback Period (Undiscounted) from Beginning of Commercial Production	5.4 Years

16.2.2 After-Tax Model

In order to reflect more accurately the actual cash that might be generated from investment in the NorthMet Project, a discounted, after-tax cashflow analysis was conducted. The analyses reflects the basic assumptions articulated in Section 16.1.2 of this chapter.

Table 16-4 shows the detailed cashflow statement. The calculated number of interest is the Net Annual Cashflow, and represents the cashflow after the payment of applicable US Federal and Minnesota State taxes.

Table 16-5 summarizes the financial results.

Table 16-5: Financial Results for After-Tax Cashflow Analysis	
Net Present Value @ 10% Discount Rate	$79.6 Million
Internal Rate of Return (IRR)	12.00%
Payback Period (Undiscounted) from Beginning of Commercial Production	6.2 Years

Table 16-2: Base Case Before-Tax Cashflow

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PRO-FORMA PRE-TAX CASHFLOW	Units	-2	-1	1	2	3	4	5	6	7	8	9
METAL PRICES:												
Copper	$US/lb	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Nickel	$US/lb	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25
Cobalt	$US/lb	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Palladium	$US/tr oz	550	550	550	550	550	550	550	550	550	550	550
Platinum	$US/tr oz	500	500	500	500	500	500	500	500	500	500	500
Gold	$US/tr oz	275	275	275	275	275	275	275	275	275	275	275
PRODUCTION INFORMATION:												
Ore Ktons	ktons			17,001	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075
NSR Grade	$US			12.21	12.33	12.75	12.76	12.52	10.54	11.50	11.40	10.93
Copper Grade	%			0.310	0.310	0.324	0.341	0.355	0.293	0.311	0.306	0.282
Nickel Grade	%			0.094	0.095	0.092	0.086	0.081	0.081	0.085	0.082	0.078
Cobalt Grade	ppm			67.63	67.94	65.02	62.09	60.96	69.13	65.90	62.98	62.20
Palladium Grade	ppm			0.319	0.321	0.330	0.322	0.299	0.235	0.281	0.290	0.287
Platinum Grade	ppm			0.077	0.083	0.101	0.107	0.104	0.072	0.077	0.075	0.077
Gold Grade	ppm			0.040	0.043	0.050	0.053	0.053	0.037	0.041	0.040	0.039
Total Ktons	ktons		18,850	70,000	70,000	70,000	70,000	70,000	70,010	70,000	100,000	100,000
Strip Ratio				3.12	2.49	2.49	2.49	2.49	2.49	2.49	3.98	3.98
GROSS REVENUE:												
Combined Copper Recovery/Payable	%			91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%
Combined Nickel Recovery/Payable	%			66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%
Combined Cobalt Recovery/Payable	%			23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%
Combined Palladium Recovery/Payable	%			74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%
Combined Platinum Recovery/Payable	%			73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%
Combined Gold Recovery/Payable	%			66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%
Copper Payable Pounds	klbs			96,889.1	114,407.9	119,574.7	125,848.6	131,015.4	108,133.9	114,776.9	112,931.6	104,074.2
Nickel Payable Pounds	klbs			21,370.0	25,502.5	24,697.1	23,086.4	21,744.2	21,744.2	22,818.0	22,012.6	20,938.9
Cobalt Payable Pounds	klbs			533.1	1,054.0	1,008.7	963.3	945.7	1,072.5	1,022.4	977.1	965.0
Palladium Payable Ounces	koz			117.98	140.19	144.12	140.62	130.58	102.63	122.72	126.65	125.34
Platinum Payable Ounces	koz			27.89	35.50	43.20	45.77	44.49	30.80	32.94	32.08	32.94
Gold Payable Ounces	koz			13.27	16.85	19.59	20.77	20.77	14.50	16.07	15.67	15.28
Copper Gross Revenue	$ x 1000			82,356	97,247	101,638	106,971	111,363	91,914	97,560	95,992	88,463
Nickel Gross Revenue	$ x 1000			69,453	82,883	80,266	75,031	70,669	70,669	74,158	71,541	68,051
Cobalt Gross Revenue	$ x 1000			4,265	8,432	8,070	7,706	7,566	8,580	8,179	7,817	7,720
Palladium Gross Revenue	$ x 1000			64,890	77,103	79,265	77,343	71,819	56,446	67,495	69,657	68,936
Platinum Gross Revenue	$ x 1000			13,947	17,752	21,602	22,885	22,244	15,399	16,469	16,041	16,469
Gold Gross Revenue	$ x 1000			3,650	4,633	5,388	5,711	5,711	3,987	4,418	4,310	4,202
Credit for Silver, Zinc, and Other PGM's	$ x 1000			5,100	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023
TOTAL GROSS REVENUE	$ x 1000			243,661	294,073	302,251	301,670	295,393	253,017	274,302	271,380	259,864
OPERATING COSTS:												
Mining Cost Per Total Ton	$US/t		0.563	0.472	0.508	0.513	0.553	0.552	0.548	0.566	0.581	0.568
Mining Cost Per Ore Ton	$US/t			1.943	1.770	1.789	1.930	1.923	1.910	1.972	2.896	2.831
Crushing, Grinding, Flotation Per Ore Ton	$US/t			2.842	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774
Tailings Embank Cost Per Ore Ton	$US/t			0.275	0.233	0.233	0.233	0.233	0.312	0.312	0.312	0.305
POX/SXEW/Precip Cost Per Ore Ton	$US/t			2.634	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570
G&A Cost Per Ore Ton	$US/t			0.338	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286
Wetlands Mitigation Per Ore Ton	$US/t			0.069	0.121	0.151	0.000	0.033	0.000	0.000	0.047	0.032
USX Royalty Per Ore Ton	$US/t			0.282	0.352	0.364	0.363	0.354	0.293	0.324	0.319	0.302
Refining/Marketing Per Ore Ton	$US/t			0.324	0.330	0.346	0.349	0.339	0.273	0.305	0.306	0.296
Total Cost Per Ore Ton	$US/t			8.706	8.436	8.513	8.505	8.513	8.418	8.543	9.511	9.397
Mining Cost	$ x 1000			33,037	35,539	35,920	38,744	38,607	38,341	39,586	58,123	56,838
Crushing, Grinding, and Flotation Cost	$ x 1000			48,324	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686
Tailings Embankment Cost	$ x 1000			4,669	4,669	4,669	4,669	4,669	6,271	6,271	6,271	6,121
Subtotal Direct Costs to Concentrate	$ x 1000			86,030	95,894	96,275	99,099	98,962	100,297	101,543	120,080	118,644
POX/SXEW/Precip Cost	$ x 1000			44,775	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601
Copper Freight Cost	$ x 1000			1,696	2,002	2,093	2,202	2,293	1,892	2,009	1,976	1,821
Nickel Freight Cost	$ x 1000			374	446	432	404	381	381	399	385	366
Cobalt Freight Cost	$ x 1000			60	118	113	108	106	120	115	109	108
Palladium Refining/Marketing	$ x 1000			2,743	3,259	3,351	3,270	3,036	2,386	2,853	2,945	2,914
Platinum Refining/Marketing	$ x 1000			502	639	778	824	801	554	593	577	593
Gold Refining/Marketing	$ x 1000			126	160	186	197	197	138	153	149	145
Subtotal POX/SXEW/Refining Costs	$ x 1000			50,276	58,226	58,553	58,606	58,414	57,072	57,722	57,743	57,549
G&A Cost	$ x 1000			5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742
Wetlands Mitigation	$ x 1000			1,166	2,420	3,024	0	667	0	0	950	646
USX Royalties	$ x 1000			4,802	7,075	7,311	7,292	7,109	5,878	6,497	6,409	6,069
TOTAL OPERATING COSTS	$ x 1000			148,015	169,358	170,905	170,739	170,895	168,990	171,504	190,925	188,650
NET OPERATING INCOME	$ x 1000			95,646	124,715	131,346	130,932	124,499	84,027	102,798	80,456	71,214
OPERATING CASH FLOW	$ x 1000	0	0	95,646	124,715	131,346	130,932	124,499	84,027	102,798	80,456	71,214
CAPITAL COSTS:												
Mine Development Capital	$ x 1000	0	10,622									
Mine Equipment Capital Cost	$ x 1000		49,702	24,808	5,794	32	6,589	153	1,180	517	37,187	422
Plant/Infrastructure Capital Cost	$ x 1000	174,370	261,554	0	0	0	0	0	0	0	0	0
Tailings Dam Capital Cost	$ x 1000	0	24,296	0	0	0	0	0	0	0	0	0
Mine and Plant Buildings	$ x 1000	3,866	5,800	0	0	0	0	0	0	0	0	0
Land Acquisition	$ x 1000	3,715	3,715	0	0	0	0	0	0	0	0	0
Owners Cost (Preproduction G&A)	$ x 1000	4,378	5,280									
Wetlands Mitigation	$ x 1000	15,209	1,391									
Working Capital	$ x 1000			42,000								
TOTAL CAPITAL	$ x 1000	201,539	362,360	66,808	5,794	32	6,589	153	1,180	517	37,187	422
NET CASH FLOW	$ x 1000	-201,539	-362,360	28,838	118,921	131,314	124,343	124,346	82,847	102,281	43,269	70,792
Net Present Value at 6.0% 461,900	$ x 1000	-201,539	-341,849	25,665	99,848	104,013	92,916	87,659	55,098	64,172	25,611	39,530
Net Present Value at 8.0% 295,390	$ x 1000	-201,539	-335,518	24,724	94,403	96,520	84,626	78,359	48,341	55,259	21,645	32,790
Net Present Value at 10.0% 171,081	$ x 1000	-201,539	-329,418	23,833	89,347	89,689	77,207	70,190	42,514	47,715	18,360	27,293
DCFROI 14.09% 0	$ x 1000	-201,539	-317,616	22,156	80,084	77,511	64,333	56,391	32,932	35,637	13,214	18,950
Cummulative Cash Flow	$ x 1000	-201,539	-563,899	-535,061	-416,140	-284,826	-160,484	-36,138	46,709	148,990	192,259	263,051
Payback Period 5.4	Years								5.4			

PRO-FORMA PRE-TAX CASHFLOW	10	11	12	13	14	15	16	17	18	19	20
METAL PRICES:											
Copper	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Nickel	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25
Cobalt	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Palladium	550	550	550	550	550	550	550	550	550	550	550
Platinum	500	500	500	500	500	500	500	500	500	500	500
Gold	275	275	275	275	275	275	275	275	275	275	275
PRODUCTION INFORMATION:											
Ore Ktons	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075
NSR Grade	11.15	11.42	12.08	11.84	9.80	11.01	11.19	12.23	9.83	11.76	11.94
Copper Grade	0.278	0.284	0.302	0.306	0.251	0.306	0.304	0.328	0.248	0.315	0.334
Nickel Grade	0.080	0.078	0.079	0.076	0.073	0.081	0.083	0.085	0.073	0.085	0.085
Cobalt Grade	62.52	62.64	62.50	60.48	67.09	69.25	72.21	66.99	62.62	68.90	70.40
Palladium Grade	0.301	0.310	0.328	0.304	0.240	0.257	0.265	0.311	0.251	0.286	0.278
Platinum Grade	0.083	0.093	0.108	0.114	0.073	0.072	0.075	0.088	0.072	0.088	0.088
Gold Grade	0.041	0.042	0.046	0.048	0.037	0.040	0.041	0.047	0.037	0.042	0.042
Total Ktons	100,000	100,000	83,289	89,741	100,017	100,000	100,000	90,000	90,000	82,899	65,195
Strip Ratio	3.98	3.98	3.15	3.47	3.98	3.98	3.98	3.48	3.48	3.13	2.25
GROSS REVENUE:											
Combined Copper Recovery/Payable	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%
Combined Nickel Recovery/Payable	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%
Combined Cobalt Recovery/Payable	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%
Combined Palladium Recovery/Payable	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%
Combined Platinum Recovery/Payable	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%
Combined Gold Recovery/Payable	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%
Copper Payable Pounds	102,598.0	104,812.4	111,455.4	112,931.6	92,633.5	112,931.6	112,193.5	121,050.9	91,526.3	116,253.1	123,265.2
Nickel Payable Pounds	21,475.8	20,938.9	21,207.3	20,402.0	19,596.6	21,744.2	22,281.1	22,818.0	19,596.6	22,818.0	22,818.0
Cobalt Payable Pounds	969.9	971.8	969.6	938.3	1,040.8	1,074.3	1,120.3	1,039.3	971.5	1,068.9	1,092.2
Palladium Payable Ounces	131.45	135.38	143.24	132.76	104.81	112.24	115.73	136.82	109.62	124.90	121.41
Platinum Payable Ounces	35.50	39.78	46.20	48.76	31.23	30.80	32.08	37.64	30.80	37.64	37.64
Gold Payable Ounces	16.07	16.46	18.02	18.81	14.50	15.67	16.07	18.42	14.50	16.46	16.46
Copper Gross Revenue	87,208	89,091	94,737	95,992	78,738	95,992	95,364	102,893	77,797	98,815	104,775
Nickel Gross Revenue	69,796	68,051	68,924	66,306	63,689	70,669	72,414	74,158	63,689	74,158	74,158
Cobalt Gross Revenue	7,759	7,774	7,757	7,506	8,327	8,595	8,962	8,314	7,772	8,551	8,737
Palladium Gross Revenue	72,299	74,461	78,784	73,020	57,647	61,731	63,652	74,701	60,289	68,696	66,775
Platinum Gross Revenue	17,752	19,891	23,099	24,382	15,613	15,399	16,041	18,821	15,399	18,821	18,821
Gold Gross Revenue	4,418	4,526	4,957	5,172	3,987	4,310	4,418	5,064	3,987	4,526	4,526
Credit for Silver, Zinc, and Other PGM's	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023
TOTAL GROSS REVENUE	265,256	269,816	284,281	278,401	234,024	262,718	266,874	289,975	234,956	279,591	283,816
OPERATING COSTS:											
Mining Cost Per Total Ton	0.567	0.566	0.599	0.574	0.549	0.627	0.681	0.679	0.631	0.774	0.837
Mining Cost Per Ore Ton	2.823	2.818	2.486	2.585	2.737	3.125	3.391	3.045	2.831	3.195	2.717
Crushing, Grinding, Flotation Per Ore Ton	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774
Tailings Embank Cost Per Ore Ton	0.305	0.277	0.277	0.277	0.277	0.277	0.277	0.224	0.224	0.224	0.224
POX/SXEW/Precip Cost Per Ore Ton	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570
G&A Cost Per Ore Ton	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286
Wetlands Mitigation Per Ore Ton	0.000	0.000	0.000	0.000	0.000	0.000	0.032	0.000	0.000	0.000	0.000
USX Royalty Per Ore Ton	0.310	0.317	0.338	0.329	0.265	0.307	0.313	0.346	0.266	0.331	0.338
Refining/Marketing Per Ore Ton	0.305	0.315	0.337	0.328	0.260	0.288	0.294	0.331	0.264	0.313	0.316
Total Cost Per Ore Ton	9.374	9.356	9.067	9.129	9.169	9.628	9.937	9.677	9.215	9.694	9.225
Mining Cost	56,677	56,565	49,900	51,500	54,949	62,743	68,083	61,135	56,831	64,137	54,552
Crushing, Grinding, and Flotation Cost	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686
Tailings Embankment Cost	6,121	5,551	5,551	5,551	5,551	5,551	5,551	4,505	4,505	4,505	4,505
Subtotal Direct Costs to Concentrate	118,484	117,802	111,137	112,737	116,186	123,980	129,320	121,326	117,022	124,328	114,743
POX/SXEW/Precip Cost	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601
Copper Freight Cost	1,795	1,834	1,950	1,976	1,621	1,976	1,963	2,118	1,602	2,034	2,157
Nickel Freight Cost	376	366	371	357	343	381	390	399	343	399	399
Cobalt Freight Cost	109	109	109	105	117	120	125	116	109	120	122
Palladium Refining/Marketing	3,056	3,148	3,330	3,087	2,437	2,610	2,691	3,158	2,549	2,904	2,823
Platinum Refining/Marketing	639	716	832	878	562	554	577	678	554	678	678
Gold Refining/Marketing	153	156	171	179	138	149	153	175	138	156	156
Subtotal POX/SXEW/Refining Costs	57,729	57,931	58,364	58,183	56,818	57,391	57,501	58,245	56,895	57,892	57,936
G&A Cost	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742
Wetlands Mitigation	0	0	0	0	0	0	641	0	0	0	0
USX Royalties	6,226	6,357	6,777	6,607	5,316	6,160	6,281	6,952	5,342	6,651	6,776
TOTAL OPERATING COSTS	188,180	187,832	182,021	183,268	184,063	193,272	199,484	192,265	185,001	194,613	185,198
NET OPERATING INCOME	77,075	81,985	102,260	95,133	49,961	69,445	67,389	97,710	49,956	84,978	98,617
OPERATING CASH FLOW	77,075	81,985	102,260	95,133	49,961	69,445	67,389	97,710	49,956	84,978	98,617
CAPITAL COSTS:											
Mine Development Capital											
Mine Equipment Capital Cost	16,930	15,011	9,827	1,710	7,465	16,826	21,792	20,817	1,400	17,366	4,417
Plant/Infrastructure Capital Cost	0	0	0	0	0	0	0	0	0	0	0
Tailings Dam Capital Cost	0	0	0	0	0	0	0	0	0	0	0
Mine and Plant Buildings	0	0	0	0	0	0	0	0	0	0	0
Land Acquisition	0	0	0	0	0	0	0	0	0	0	0
Owners Cost (Preproduction G&A)											
Wetlands Mitigation											
Working Capital											
TOTAL CAPITAL	16,930	15,011	9,827	1,710	7,465	16,826	21,792	20,817	1,400	17,366	4,417
NET CASH FLOW	60,145	66,974	92,433	93,423	42,496	52,619	45,597	76,893	48,556	67,612	94,200
Net Present Value at 6.0% 461,900	31,684	33,284	43,336	41,321	17,732	20,713	16,933	26,939	16,048	21,082	27,710
Net Present Value at 8.0% 295,390	25,795	26,596	33,987	31,807	13,397	15,359	12,324	19,242	11,251	14,506	18,713
Net Present Value at 10.0% 171,081	21,081	21,340	26,774	24,601	10,173	11,452	9,021	13,830	7,939	10,060	12,729
DCFROI 14.09% 0	14,112	13,774	16,663	14,762	5,886	6,388	4,852	7,172	3,969	4,845	5,917
Cummulative Cash Flow	323,196	390,170	482,602	576,026	618,522	671,141	716,739	793,632	842,187	909,799	1,004,000
Payback Period 5.4											

PRO-FORMA PRE-TAX CASHFLOW	21	22	23	24	25	26	27	28	29	30	Total
METAL PRICES:											
Copper	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Nickel	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25
Cobalt	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Palladium	550	550	550	550	550	550	550	550	550	550	550
Platinum	500	500	500	500	500	500	500	500	500	500	500
Gold	275	275	275	275	275	275	275	275	275	275	275
PRODUCTION INFORMATION:											
Ore Ktons	20,075	20,075	20,075	20,075	3,480						482,206
NSR Grade	10.92	9.41	11.75	12.19	14.31						11.49
Copper Grade	0.295	0.236	0.295	0.324	0.422						0.302
Nickel Grade	0.080	0.075	0.086	0.093	0.106						0.083
Cobalt Grade	71.90	68.84	67.47	72.77	73.58						66.31
Palladium Grade	0.262	0.230	0.312	0.306	0.329						0.289
Platinum Grade	0.076	0.066	0.084	0.074	0.080						0.084
Gold Grade	0.037	0.032	0.041	0.039	0.046						0.042
Total Ktons	58,459	59,222	39,671	47,260	6,653						1,921,266
Strip Ratio	1.91	1.95	0.98	1.35	0.91						2.98
GROSS REVENUE:											
Combined Copper Recovery/Payable	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%
Combined Nickel Recovery/Payable	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%
Combined Cobalt Recovery/Payable	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%
Combined Palladium Recovery/Payable	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%
Combined Platinum Recovery/Payable	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%
Combined Gold Recovery/Payable	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%
Copper Payable Pounds	108,872.0	87,097.6	108,872.0	119,574.7	26,997.9						2,680,718
Nickel Payable Pounds	21,475.8	20,133.5	23,086.4	24,965.6	4,932.7						534,204
Cobalt Payable Pounds	1,115.5	1,068.0	1,046.7	1,129.0	197.9						24,355.7
Palladium Payable Ounces	114.42	100.45	136.26	133.64	24.91						3,027.9
Platinum Payable Ounces	32.51	28.23	35.93	31.65	5.93						868.0
Gold Payable Ounces	14.50	12.54	16.07	15.28	3.12						395.7
Copper Gross Revenue	92,541	74,033	92,541	101,638	22,948						2,278,610
Nickel Gross Revenue	69,796	65,434	75,031	81,138	16,031						1,736,164
Cobalt Gross Revenue	8,924	8,544	8,374	9,032	1,583						194,845
Palladium Gross Revenue	62,931	55,245	74,941	73,500	13,699						1,665,327
Platinum Gross Revenue	16,255	14,116	17,966	15,827	2,966						433,980
Gold Gross Revenue	3,987	3,448	4,418	4,202	859						108,815
Credit for Silver, Zinc, and Other PGM's	6,023	6,023	6,023	6,023	1,044						144,662
TOTAL GROSS REVENUE	260,457	226,843	279,294	291,360	59,131	0	0	0	0	0	6,562,404
OPERATING COSTS:											
Mining Cost Per Total Ton	0.802	0.749	0.700	0.674	0.855						0.614
Mining Cost Per Ore Ton	2.335	2.210	1.383	1.587	1.635						2.423
Crushing, Grinding, Flotation Per Ore Ton	2.774	2.774	2.774	2.774	2.872						2.777
Tailings Embank Cost Per Ore Ton	0.224	0.205	0.205	0.000	0.000						0.246
POX/SXEW/Precip Cost Per Ore Ton	2.570	2.570	2.570	2.570	2.661						2.573
G&A Cost Per Ore Ton	0.286	0.286	0.286	0.286	1.152						0.294
Wetlands Mitigation Per Ore Ton	0.000	0.000	0.000	0.000	0.000						0.020
USX Royalty Per Ore Ton	0.303	0.254	0.331	0.349	0.419						0.320
Refining/Marketing Per Ore Ton	0.288	0.247	0.318	0.323	0.373						0.309
Total Cost Per Ore Ton	8.782	8.547	7.868	7.888	9.111						8.961
Mining Cost	46,874	44,370	27,768	31,853	5,690						1,168,362
Crushing, Grinding, and Flotation Cost	55,686	55,686	55,686	55,686	9,996						1,339,098
Tailings Embankment Cost	4,505	4,115	4,115	0	0						118,480
Subtotal Direct Costs to Concentrate	107,066	104,171	87,568	87,539	15,686	0	0	0	0	0	2,625,920
POX/SXEW/Precip Cost	51,601	51,601	51,601	51,601	9,259						1,240,857
Copper Freight Cost	1,905	1,524	1,905	2,093	472						46,913
Nickel Freight Cost	376	352	404	437	86						9,349
Cobalt Freight Cost	125	120	117	126	22	0	0	0	0	0	2,728
Palladium Refining/Marketing	2,660	2,335	3,168	3,107	579	0	0	0	0	0	70,398
Platinum Refining/Marketing	585	508	647	570	107	0	0	0	0	0	15,623
Gold Refining/Marketing	138	119	153	145	30	0	0	0	0	0	3,759
Subtotal POX/SXEW/Refining Costs	57,390	56,560	57,995	58,079	10,556	0	0	0	0	0	1,389,626
G&A Cost	5,742	5,742	5,742	5,742	4,008	0	0	0	0	0	141,817
Wetlands Mitigation	0	0	0	0	0	0	0	0	0	0	9,513
USX Royalties	6,092	5,108	6,639	6,998	1,457	0	0	0	0	0	154,183
TOTAL OPERATING COSTS	176,290	171,581	157,944	158,358	31,707	0	0	0	0	0	4,321,059
NET OPERATING INCOME	84,167	55,262	121,350	133,002	27,423	0	0	0	0	0	2,241,345
OPERATING CASH FLOW	84,167	55,262	121,350	133,002	27,423	0	0	0	0	0	2,241,345
CAPITAL COSTS:											
Mine Development Capital											10,622
Mine Equipment Capital Cost	185	0	0	0	0						260,130
Plant/Infrastructure Capital Cost	0	0	0	0	0						435,924
Tailings Dam Capital Cost	0	0	0	0	0						24,296
Mine and Plant Buildings	0	0	0	0	0						9,666
Land Acquisition	0	0	0	0	0						7,430
Owners Cost (Preproduction G&A)											9,658
Wetlands Mitigation											16,601
Working Capital					-42,000						0
TOTAL CAPITAL	185	0	0	0	-42,000	0	0	0	0	0	774,327
NET CASH FLOW	83,982	55,262	121,350	133,002	69,423	0	0	0	0	0	1,467,019
Net Present Value at 6.0% 461,900	23,306	14,467	29,971	30,989	15,260	0	0	0	0	0	461,900
Net Present Value at 8.0% 295,390	15,448	9,412	19,137	19,421	9,386	0	0	0	0	0	295,390
Net Present Value at 10.0% 171,081	10,317	6,172	12,320	12,276	5,825	0	0	0	0	0	171,081
DCFROI 14.09% 0	4,623	2,667	5,133	4,931	2,256	0	0	0	0	0	0
Cummulative Cash Flow	1,087,982	1,143,243	1,264,593	1,397,595	1,467,019	1,467,019	1,467,019	1,467,019	1,467,019	1,467,019	
Payback Period 5.4											

Table 16-4: Base Case After-Tax Cashflow

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PRO-FORMA AFTER TAX CASHFLOW	Units	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total
METAL PRICES:																																		
Copper	$US/lb	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Nickel	$US/lb	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25
Cobalt	$US/lb	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Palladium	$US/tr oz	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550	550
Platinum	$US/tr oz	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Gold	$US/tr oz	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275	275
PRODUCTION INFORMATION:																																		
Ore Ktons	ktons			17,001	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	20,075	3,480						482,206
NSR Grade	$US			12.21	12.33	12.75	12.76	12.52	10.54	11.50	11.40	10.93	11.15	11.42	12.08	11.84	9.80	11.01	11.19	12.23	9.83	11.76	11.94	10.92	9.41	11.75	12.19	14.31						11.49
Copper Grade	%			0.310	0.310	0.324	0.341	0.355	0.293	0.311	0.306	0.282	0.278	0.284	0.302	0.306	0.251	0.306	0.304	0.328	0.248	0.315	0.334	0.295	0.236	0.295	0.324	0.422						0.302
Nickel Grade	%			0.094	0.095	0.092	0.086	0.081	0.081	0.085	0.082	0.078	0.080	0.078	0.079	0.076	0.073	0.081	0.083	0.085	0.073	0.085	0.085	0.080	0.075	0.086	0.093	0.106						0.083
Cobalt Grade	ppm			67.63	67.94	65.02	62.09	60.96	69.13	65.90	62.98	62.20	62.52	62.64	62.50	60.48	67.09	69.25	72.21	66.99	62.62	68.90	70.40	71.90	68.84	67.47	72.77	73.58						66.31
Palladium Grade	ppm			0.319	0.321	0.330	0.322	0.299	0.235	0.281	0.290	0.287	0.301	0.310	0.328	0.304	0.240	0.257	0.265	0.311	0.251	0.286	0.278	0.262	0.230	0.312	0.306	0.329						0.289
Platinum Grade	ppm			0.077	0.083	0.101	0.107	0.104	0.072	0.077	0.075	0.077	0.083	0.093	0.108	0.114	0.073	0.072	0.075	0.088	0.072	0.088	0.088	0.076	0.066	0.084	0.074	0.080						0.084
Gold Grade	ppm			0.040	0.043	0.050	0.053	0.053	0.037	0.041	0.040	0.039	0.041	0.042	0.046	0.048	0.037	0.040	0.041	0.047	0.037	0.042	0.042	0.037	0.032	0.041	0.039	0.046						0.042
Total Ktons	ktons		18,850	70,000	70,000	70,000	70,000	70,000	70,010	70,000	100,000	100,000	100,000	100,000	83,289	89,741	100,017	100,000	100,000	90,000	90,000	82,899	65,195	58,459	59,222	39,671	47,260	6,653						1,921,266
Strip Ratio				3.12	2.49	2.49	2.49	2.49	2.49	2.49	3.98	3.98	3.98	3.98	3.15	3.47	3.98	3.98	3.98	3.48	3.48	3.13	2.25	1.91	1.95	0.98	1.35	0.91						2.98
GROSS REVENUE:																																		
Combined Copper Recovery/Payable	%			91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%	91.92%
Combined Nickel Recovery/Payable	%			66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%	66.86%
Combined Cobalt Recovery/Payable	%			23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%	23.18%
Combined Palladium Recovery/Payable	%			74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%	74.59%
Combined Platinum Recovery/Payable	%			73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%	73.06%
Combined Gold Recovery/Payable	%			66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%	66.92%
Copper Payable Pounds	klbs			96,889.1	114,407.9	119,574.7	125,848.6	131,015.4	108,133.9	114,776.9	112,931.6	104,074.2	102,598.0	104,812.4	111,455.4	112,931.6	92,633.5	112,931.6	112,193.5	121,050.9	91,526.3	116,253.1	123,265.2	108,872.0	87,097.6	108,872.0	119,574.7	26,997.9						2,680,718
Nickel Payable Pounds	klbs			21,370.0	25,502.5	24,697.1	23,086.4	21,744.2	21,744.2	22,818.0	22,012.6	20,938.9	21,475.8	20,938.9	21,207.3	20,402.0	19,596.6	21,744.2	22,281.1	22,818.0	19,596.6	22,818.0	22,818.0	21,475.8	20,133.5	23,086.4	24,965.6	4,932.7						534,204
Cobalt Payable Pounds	klbs			533.1	1,054.0	1,008.7	963.3	945.7	1,072.5	1,022.4	977.1	965.0	969.9	971.8	969.6	938.3	1,040.8	1,074.3	1,120.3	1,039.3	971.5	1,068.9	1,092.2	1,115.5	1,068.0	1,046.7	1,129.0	197.9						24,355.7
Palladium Payable Ounces	koz			117.98	140.19	144.12	140.62	130.58	102.63	122.72	126.65	125.34	131.45	135.38	143.24	132.76	104.81	112.24	115.73	135.82	109.62	124.90	121.41	114.42	100.45	136.26	133.64	24.91						3,027.9
Platinum Payable Ounces	koz			27.89	35.60	43.20	45.77	44.49	30.80	32.94	32.08	32.94	35.50	39.78	46.20	48.76	31.23	30.80	32.08	37.64	30.80	37.64	37.64	32.51	28.23	35.93	31.65	5.93						868.0
Gold Payable Ounces	koz			13.27	16.85	19.59	20.77	20.77	14.50	16.07	15.67	15.28	16.07	16.46	18.02	18.81	14.50	15.67	16.07	18.42	14.50	16.46	16.46	14.50	12.54	16.07	15.28	3.12						395.7
Copper Gross Revenue	$ x 1000			82,356	97,247	101,638	106,971	111,363	91,914	97,560	95,992	88,463	87,208	89,091	94,737	95,992	78,738	95,992	95,364	102,893	77,797	98,815	104,775	92,541	74,033	92,541	101,638	22,948						2,278,610
Nickel Gross Revenue	$ x 1000			69,453	82,883	80,266	75,031	70,669	70,669	74,158	71,541	68,051	69,796	68,051	68,924	66,306	63,689	70,669	72,414	74,158	63,689	74,158	74,158	69,796	65,434	75,031	81,138	16,031						1,736,164
Cobalt Gross Revenue	$ x 1000			4,265	8,432	8,070	7,706	7,566	8,580	8,179	7,817	7,720	7,759	7,774	7,757	7,506	8,327	8,595	8,962	8,314	7,772	8,551	8,737	8,924	8,544	8,374	9,032	1,583						194,845
Palladium Gross Revenue	$ x 1000			64,890	77,103	79,265	77,343	71,819	56,446	67,495	69,657	68,936	72,299	74,461	78,784	73,020	57,647	61,731	63,652	74,701	60,289	68,696	66,775	62,931	55,245	74,941	73,500	13,699						1,665,327
Platinum Gross Revenue	$ x 1000			13,947	17,752	21,602	22,885	22,244	15,399	16,469	16,041	16,469	17,752	19,891	23,099	24,382	15,613	15,399	16,041	18,821	15,399	18,821	18,821	16,255	14,116	17,966	15,827	2,966						433,980
Gold Gross Revenue	$ x 1000			3,650	4,633	5,388	5,711	5,711	3,987	4,418	4,310	4,202	4,418	4,526	4,957	5,172	3,987	4,310	4,418	5,064	3,987	4,526	4,526	3,987	3,448	4,418	4,202	869						108,815
Credit for Silver, Zinc, and Other PGM's	$ x 1000			5,100	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	6,023	1,044						144,662
TOTAL GROSS REVENUE	$ x 1000			243,661	294,073	302,251	301,670	296,393	253,017	274,302	271,380	259,864	265,256	269,816	284,281	278,401	234,024	262,718	266,874	289,975	234,956	279,591	283,816	260,457	226,843	279,294	291,360	59,131	0	0	0	0	0	6,562,404
OPERATING COSTS:																																		
Mining Cost Per Total Ton	$US/t		0.563	0.472	0.508	0.513	0.553	0.552	0.548	0.566	0.581	0.568	0.567	0.566	0.599	0.574	0.549	0.627	0.681	0.679	0.631	0.774	0.837	0.802	0.749	0.700	0.674	0.855						0.614
Mining Cost Per Ore Ton	$US/t			1.943	1.770	1.789	1.930	1.923	1.910	1.972	2.895	2.831	2.823	2.818	2.486	2.565	2.737	3.125	3.391	3.045	2.831	3.195	2.717	2.335	2.210	1.383	1.587	1.635						2.423
Crushing, Grinding, Flotation Per Ore Ton	$US/t			2.842	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.774	2.872						2.777
Tailings Embank Cost Per Ore Ton	$US/t			0.275	0.233	0.233	0.233	0.233	0.312	0.312	0.312	0.305	0.305	0.277	0.277	0.277	0.277	0.277	0.277	0.224	0.224	0.224	0.224	0.224	0.205	0.205	0.000	0.000						0.246
POX/SXEW/Precip Cost Per Ore Ton	$US/t			2.634	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.570	2.661						2.573
G&A Cost Per Ore Ton	$US/t			0.338	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	1.152						0.294
Wetlands Mitigation Per Ore Ton	$US/t			0.069	0.121	0.151	0.000	0.033	0.000	0.000	0.047	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000						0.020
USX Royalty Per Ore Ton	$US/t			0.282	0.352	0.364	0.363	0.354	0.293	0.324	0.319	0.302	0.310	0.317	0.338	0.329	0.265	0.307	0.313	0.346	0.266	0.331	0.338	0.303	0.254	0.331	0.349	0.419						0.320
Refining/Marketing Per Ore Ton	$US/t			0.324	0.330	0.346	0.349	0.339	0.273	0.305	0.306	0.296	0.305	0.315	0.337	0.328	0.260	0.288	0.294	0.331	0.264	0.313	0.316	0.288	0.247	0.318	0.323	0.373						0.309
Total Cost Per Ore Ton	$US/t			8.706	8.436	8.513	8.505	8.513	8.418	8.543	9.511	9.397	9.374	9.356	9.067	9.129	9.169	9.628	9.937	9.577	9.215	9.694	9.225	8.782	8.547	7.868	7.888	9.111						8.961
Mining Cost	$ x 1000			33,037	35,539	35,920	38,744	38,607	38,341	39,586	58,123	56,838	56,677	56,565	49,900	51,500	54,949	62,743	68,083	61,135	56,831	64,137	54,562	46,874	44,370	27,768	31,853	5,690						1,168,362
Crushing, Grinding, and Flotation Cost	$ x 1000			48,324	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	55,686	9,996						1,339,098
Tailings Embankment Cost	$ x 1000			4,669	4,669	4,669	4,669	4,669	6,271	6,271	6,271	6,121	6,121	5,551	5,551	5,551	5,551	5,551	5,551	4,505	4,505	4,505	4,505	4,505	4,115	4,115	0	0						118,460
Subtotal Direct Costs to Concentrate	$ x 1000			86,030	95,894	96,275	99,099	98,962	100,297	101,543	120,080	118,644	118,484	117,802	111,137	112,737	116,186	123,980	129,320	121,326	117,022	124,328	114,743	107,066	104,171	87,568	87,539	15,686	0	0	0	0	0	2,625,920
POX/SXEW/Precip Cost	$ x 1000			44,775	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	51,601	9,259						1,240,857
Copper Freight Cost	$ x 1000			1,696	2,002	2,093	2,202	2,293	1,892	2,009	1,976	1,821	1,795	1,834	1,950	1,976	1,621	1,976	1,963	2,118	1,602	2,034	2,157	1,905	1,524	1,905	2,093	472						46,913
Nickel Freight Cost	$ x 1000			374	446	432	404	381	381	399	385	366	376	366	371	357	343	381	390	399	343	399	399	376	352	404	437	86						9,349
Cobalt Freight Cost	$ x 1000			60	118	113	108	106	120	115	109	108	109	109	109	105	117	120	125	116	109	120	122	125	120	117	126	22	0	0	0	0	0	2,728
Palladium Refining/Marketing	$ x 1000			2,743	3,259	3,351	3,270	3,036	2,386	2,853	2,945	2,914	3,056	3,148	3,330	3,087	2,437	2,610	2,691	3,158	2,549	2,904	2,823	2,660	2,335	3,168	3,107	579	0	0	0	0	0	70,398
Platinum Refining/Marketing	$ x 1000			502	639	778	824	801	554	593	577	593	639	716	832	878	562	554	577	678	554	678	678	585	508	647	570	107	0	0	0	0	0	15,623
Gold Refining/Marketing	$ x 1000			126	160	186	197	197	138	153	149	145	153	156	171	179	138	149	153	175	138	156	156	138	119	153	145	30	0	0	0	0	0	3,759
Subtotal POX/SXEW/Refining Costs	$ x 1000			50,276	58,226	58,553	58,606	58,414	57,072	57,722	57,743	57,549	57,729	57,931	58,364	58,183	56,818	57,391	57,501	58,245	56,895	57,892	57,936	57,390	56,560	57,995	58,079	10,556	0	0	0	0	0	1,389,626
G&A Cost	$ x 1000			5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	4,008	0	0	0	0	0	141,817
Wetlands Mitigation	$ x 1000			1,166	2,420	3,024	0	667	0	0	950	646	0	0	0	0	0	0	641	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9,513
USX Royalties	$ x 1000			4,802	7,075	7,311	7,292	7,109	5,878	6,497	6,409	6,069	6,226	6,357	6,777	6,607	5,316	6,160	6,281	6,952	5,342	6,651	6,776	6,092	5,108	6,639	6,998	1,457	0	0	0	0	0	154,183
TOTAL OPERATING COSTS	$ x 1000			148,015	169,358	170,905	170,739	170,895	168,990	171,504	190,925	188,650	188,180	187,832	182,021	183,268	184,063	193,272	199,484	192,265	185,001	194,613	185,198	176,290	171,581	157,944	158,358	31,707	0	0	0	0	0	4,321,059
NET OPERATING INCOME	$ x 1000			95,646	124,715	131,346	130,932	124,499	84,027	102,798	80,456	71,214	77,075	81,985	102,260	95,133	49,961	69,445	67,389	97,710	49,956	84,978	98,617	84,167	55,262	121,350	133,002	27,423	0	0	0	0	0	2,241,345
TAX CALCULATIONS:																																		
Depreciation	$ x 1000	25,642	92,728	118,525	89,088	64,542	51,689	51,192	42,749	19,396	8,129	10,515	10,048	11,716	11,821	11,092	10,220	10,553	12,749	15,569	13,825	12,194	12,166	10,206	7,913	5,338	3,267	2,271	1,433	461	256	247	247	737,778
Amortization	$ x 1000	1,521	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	1,201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27,222
Depletion Allowance	$ x 1000	0	0	768	15,849	30,926	36,942	34,073	18,544	38,912	33,556	28,686	32,339	33,905	41,915	40,564	19,150	28,405	26,347	39,646	17,404	35,119	41,428	35,694	22,832	41,098	43,156	8,906	0	0	0	0	0	746,164
Net After Depreciation, Depletion, Amort.	$ x 1000	-27,163	-95,450	-26,370	17,056	33,156	39,578	36,511	20,012	41,768	36,049	30,811	34,689	36,363	48,524	43,477	20,591	30,487	28,294	42,505	18,727	37,665	45,024	38,267	24,517	74,914	86,579	16,246	-1,433	-461	-256	-247	-247	730,181
Minnesota State Taxes	$ x 1000	0	0	0	1,207	2,230	2,635	2,438	1,468	2,856	2,493	2,125	2,350	2,458	3,168	2,913	1,441	2,083	1,947	2,858	1,323	2,546	3,003	2,574	1,686	4,323	4,891	963	0	0	0	0	0	57,978
Federal Income Taxes	$ x 1000	0	0	657	7,706	14,040	14,701	14,043	7,211	10,254	5,934	4,232	5,722	6,864	10,375	10,184	5,184	9,908	9,163	13,895	5,993	12,133	14,450	12,292	7,651	19,560	21,766	3,426	0	0	0	0	0	247,344
NET AFTER TAXES	$ x 1000	-27,163	-95,450	-27,027	8,143	16,886	22,241	20,030	11,333	28,657	27,622	24,454	26,617	27,041	34,981	30,380	13,967	18,496	17,184	25,751	11,411	22,986	27,571	23,401	15,182	51,031	59,922	11,868	-1,433	-461	-256	-247	-247	424,858
CASH FLOW CALCULATIONS:																																		
Add Back Depreciation	$ x 1000	25,642	92,728	118,525	89,088	64,542	51,689	51,192	42,749	19,396	8,129	10,515	10,048	11,716	11,821	11,092	10,220	10,553	12,749	15,569	13,825	12,194	12,166	10,206	7,913	5,338	3,267	2,271	1,433	461	256	247	247	737,778
Add Back Amortization	$ x 1000	1,521	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	2,722	1,201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27,222
Add Back Depletion	$ x 1000	0	0	768	15,849	30,926	36,942	34,073	18,544	38,912	33,556	28,686	32,339	33,905	41,915	40,564	19,150	28,405	26,347	39,646	17,404	35,119	41,428	35,694	22,832	41,098	43,156	8,906	0	0	0	0	0	746,164
OPERATING CASH FLOW	$ x 1000	0	0	94,988	115,802	115,076	113,596	108,018	75,348	89,687	72,029	64,857	69,003	72,662	88,717	82,037	43,337	57,454	56,279	80,957	42,640	70,298	81,165	69,301	45,926	97,467	106,345	23,035	0	0	0	0	0	1,936,023
CAPITAL COSTS:																																		
Mine Development Capital	$ x 1000	0	10,622																															10,622
Mine Equipment Capital Cost	$ x 1000		49,702	24,808	5,794	32	6,589	153	1,180	517	37,187	422	16,930	15,011	9,827	1,710	7,465	16,826	21,792	20,817	1,400	17,366	4,417	185	0	0	0	0						260,130
Plant/Infrastructure Capital Cost	$ x 1000	174,370	261,554	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						435,924
Tailings Dam Capital Cost	$ x 1000	0	24,296	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						24,296
Mine and Plant Buildings	$ x 1000	3,866	5,800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						9,666
Land Acquisition	$ x 1000	3,715	3,715	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						7,430
Owners Cost (Preproduction G&A)	$ x 1000	4,378	5,280																															9,658
Wetlands Mitigation	$ x 1000	15,209	1,391																															16,601
Working Capital	$ x 1000			42,000																								-42,000						0
TOTAL CAPITAL	$ x 1000	201,539	362,360	66,808	5,794	32	6,589	153	1,180	517	37,187	422	16,930	15,011	9,827	1,710	7,465	16,826	21,792	20,817	1,400	17,366	4,417	185	0	0	0	-42,000	0	0	0	0	0	774,327
NET CASH FLOW	$ x 1000	-201,539	-362,360	28,180	110,008	115,044	107,006	107,865	74,168	89,170	34,842	64,435	52,073	57,651	78,890	80,327	35,872	40,628	34,487	60,140	41,240	52,932	76,748	69,116	45,926	97,467	106,345	65,035	0	0	0	0	0	1,161,696
Net Present Value at 6.0% 323,555	$ x 1000	-201,539	-341,849	25,080	92,365	91,126	79,961	76,040	49,326	55,946	20,623	35,980	27,432	28,651	36,986	35,528	14,968	15,993	12,807	21,070	13,630	16,505	22,576	19,180	12,023	24,072	24,778	14,295	0	0	0	0	0	323,555
Net Present Value at 8.0% 184,025	$ x 1000	-201,539	-335,518	24,160	87,328	84,561	72,827	67,973	43,276	48,176	17,430	29,846	22,333	22,894	29,008	27,348	11,308	11,869	9,321	15,050	9,656	11,357	15,246	12,713	7,822	15,370	15,528	8,793	0	0	0	0	0	184,025
Net Present Value at 10.0% 79,629	$ x 1000	-201,539	-329,418	23,290	82,650	78,577	66,442	60,887	38,060	41,599	14,776	24,842	18,251	18,369	22,851	21,152	8,588	8,842	6,823	10,817	6,743	7,868	10,371	8,491	5,129	9,896	9,815	5,457	0	0	0	0	0	79,629
DCFROI 12.00% 0	$ x 1000	-201,539	-323,542	22,466	78,306	73,118	60,724	54,654	33,554	36,020	12,567	20,750	14,973	14,801	18,084	16,441	6,556	6,629	5,025	7,823	4,790	5,489	7,107	5,714	3,390	6,424	6,259	3,417	0	0	0	0	0	0
Cummulative Cash Flow	$ x 1000	-201,539	-563,899	-535,718	-425,711	-310,666	-203,660	-95,796	-21,628	67,542	102,384	166,819	218,892	276,543	355,433	435,759	471,632	512,260	546,747	606,887	648,127	701,059	777,807	846,923	892,849	990,316	1,096,661	1,161,696	1,161,696	1,161,696	1,161,696	1,161,696	1,161,696	
Payback Period 6.2	Years									6.2																								

16.3 SENSITIVITY ANALYSES

To quickly ascertain the impact on project economics resulting from changes in key project variables, a simplified project sensitivity analysis was performed. It was decided to measure the sensitivity of overall project economics to changes from the base case estimates for three key variables: 1) commodity prices, 2) capital costs, and 3) operating costs.

For each variable, plus and minus 10% of the base case value was used for the sensitivity analyses. Tables 16-6, 16-7, and 16-8 show the results of before-tax sensitivity analyses on the Net Present Value at 10%, the Internal Rate of Return (IRR), and Payback Period, respectively. Tables 16-9, 16-10, and 16-11 show the same information for the after-tax cases.

16.3.1 Copper, Nickel and Palladium Price

Copper, nickel, and palladium collectively account for about 87% of the total gross revenue of the project. The first three lines on each of Tables 16-6 through 16-11 show the results of plus and minus 10% changes of the price of each metal separately. The fourth line on each table shows plus and minus 10% change for all three metals simultaneously.

The financial results are most sensitive to the copper price, though there was not a large amount of difference between the three metals. For before-tax IRR (Table 16-7), the range of results for the copper variable is 12.34% to 15.77%. The response to changes to nickel and palladium prices are very similar (12.76% to 15.38% for nickel and 12.82% to 15.32% for palladium for the before-tax case). Based on interpolations of the +/-10% results from the before-tax model, a 1% change in IRR requires a 5 cent change to the copper price, or a 25 cent change to the nickel price, or a $44 change to the palladium price.

When all three metal prices are changed simultaneously, the range of IRR’s is from 9.57% to 18.19% for the before-tax case. Similarly, for the after-tax case, the range of IRR’s is from 8.11% to 15.50% (Table 16-10).

16.3.2 Capital Costs

The base case total life-of-mine capital cost is \$816.3 million. Plus and minus 10% of this amount is \$898.0 million and \$734.7 million respectively. In terms of before-tax IRR (Table 16-7), a range of 12.44% to 16.04% (base case of 14.09%) results from the sensitivity analysis to capital costs. In terms of after-tax IRR (Table 16-10), the range is from 10.52% to 13.76%.

16.3.3 Operating Costs

The base case life-of-mine operating cost is \$4,321.0 million (\$4.32 billion). Plus and minus 10% of this amount is \$4,753.2 million and \$3,889.0 million. In terms of before-tax IRR, a range of 10.70% to 17.17% results from the sensitivity analysis to operating costs. In terms of after-tax IRR, the range is from 9.06% to 14.64%.

It can be seen that the project is more sensitive to operating cost than capital cost. The sensitivity of the project to capital cost is similar to the sensitivity of the change in one of the key metal prices. The sensitivity of the project to the operating cost is similar to the sensitivity of all three prices simultaneously.

Table 16-6: Sensitivity Analysis of Project Net Present Value ($ x 1000). Before-Tax Case.						
Sensitivity Parameter	Parameter Values			NPV at 10%		
	-10%	Base Case	+10%	-10%	Base	+10%
Copper Price ($/lb)	0.765	0.85	0.935	95,613	171,081	246,548
Nickel Price ($/lb)	2.925	3.25	3.575	113,457	171,081	228,705
Palladium Price ($/oz)	495	550	605	116,262	171,081	225,899
Cu, Ni, Pd Price	0.77,2.93,495	0.85,3.25,550	0.94,3.58,605	-16,829	171,081	358,991
	+10%	Base Case	-10%	+10%	Base	-10%
Capital Cost ($ x 1000)	897,960	816,327	734,694	110,307	171,081	231,855
Operating Cost ($ x 1000)	4,753,165	4,321,059	3,888,953	27,641	171,081	314,562

Table 16-7: Sensitivity Analysis of Project IRR (%). Before-Tax Case.						
Sensitivity Parameter	Parameter Values			DCFROI (%)		
	-10%	Base Case	+10%	-10%	Base	+10%
Copper Price ($/lb)	0.765	0.85	0.935	12.34%	14.09%	15.77%
Nickel Price ($/lb)	2.925	3.25	3.575	12.76%	14.09%	15.38%
Palladium Price ($/oz)	495	550	605	12.82%	14.09%	15.32%
Cu, Ni, Pd Price	0.77,2.93,495	0.85,3.25,550	0.94,3.58,605	9.57%	14.09%	18.19%
	+10%	Base Case	-10%	+10%	Base	-10%
Capital Cost ($ x 1000)	897,960	816,327	734,694	12.44%	14.09%	16.04%
Operating Cost ($ x 1000)	4,753,165	4,321,059	3,888,953	10.70%	14.09%	17.17%

Table 16-8: Sensitivity Analysis of Project Payback Period (Years). Before-Tax Case.						
Sensitivity Parameter	Parameter Values			Payback Period		
	-10%	Base Case	+10%	-10%	Base	+10%
Copper Price ($/lb)	0.765	0.85	0.935	6.1	5.4	4.9
Nickel Price ($/lb)	2.925	3.25	3.575	6.0	5.4	5.0
Palladium Price ($/oz)	495	550	605	5.9	5.4	5.0
Cu, Ni, Pd Price	0.77,2.93,495	0.85,3.25,550	0.94,3.58,605	7.8	5.4	4.4
	+10%	Base Case	-10%	+10%	Base	-10%
Capital Cost ($ x 1000)	897,960	816,327	734,694	6.1	5.4	4.8
Operating Cost ($ x 1000)	4,753,165	4,321,059	3,888,953	6.6	5.4	4.7

Table 16-9: Sensitivity Analysis of Project Net Present Value ($ x 1000). After-Tax Case.						
Sensitivity Parameter	Parameter Values			NPV at 10%		
	-10%	Base Case	+10%	-10%	Base	+10%
Copper Price ($/lb)	0.765	0.85	0.935	19,219	79,629	139,902
Nickel Price ($/lb)	2.925	3.25	3.575	33,479	79,629	125,744
Palladium Price ($/oz)	495	550	605	35,734	79,629	123,492
Cu, Ni, Pd Price	0.77,2.93,495	0.85,3.25,550	0.94,3.58,605	-70,891	79,629	228,635
	+10%	Base Case	-10%	+10%	Base	-10%
Capital Cost ($ x 1000)	897,960	816,327	734,694	22,674	79,629	136,577
Operating Cost ($ x 1000)	4,753,165	4,321,059	3,888,953	-35,328	79,629	192,901

Table 16-10: Sensitivity Analysis of Project IRR (%). After-Tax Case.						
Sensitivity Parameter	Parameter Values			DCFROI (%)		
	-10%	Base Case	+10%	-10%	Base	+10%
Copper Price ($/lb)	0.765	0.85	0.935	10.49%	12.00%	13.44%
Nickel Price ($/lb)	2.925	3.25	3.575	10.85%	12.00%	13.11%
Palladium Price ($/oz)	495	550	605	10.91%	12.00%	13.06%
Cu, Ni, Pd Price	0.77,2.93,495	0.85,3.25,550	0.94,3.58,605	8.11%	12.00%	15.50%
	+10%	Base Case	-10%	+10%	Base	-10%
Capital Cost ($ x 1000)	897,960	816,327	734,694	10.52%	12.00%	13.76%
Operating Cost ($ x 1000)	4,753,165	4,321,059	3,888,953	9.06%	12.00%	14.64%

Table 16-11: Sensitivity Analysis of Project Payback Period (Years). After-Tax Case.						
Sensitivity Parameter	Parameter Values			Payback Period		
	-10%	Base Case	+10%	-10%	Base	+10%
Copper Price ($/lb)	0.765	0.85	0.935	6.8	6.2	5.7
Nickel Price ($/lb)	2.925	3.25	3.575	6.7	6.2	5.8
Palladium Price ($/oz)	495	550	605	6.6	6.2	5.9
Cu, Ni, Pd Price	0.77,2.93,495	0.85,3.25,550	0.94,3.58,605	9.0	6.2	5.0
	+10%	Base Case	-10%	+10%	Base	-10%
Capital Cost ($ x 1000)	897,960	816,327	734,694	6.9	6.2	5.5
Operating Cost ($ x 1000)	4,753,165	4,321,059	3,888,953	8.1	6.2	5.3

16.4 OTHER COMMENTS

The Minnesota Mining Tax Guide (October 2000 Version, page 56) states that Economic Development Incentives in the form of grants and loans are available from the State for new mine or processing facilities subject to the net proceeds tax. The maximum amount available for a new project is $65 million. These possible incentives have not been included in the above economic analyses.

The economic analyses indicate that the difference between before-tax and after-tax financial analysis is generally only about 2% IRR in most cases. This is probably because during most years the US Federal income tax paid is the Alternative Minimum Tax.

17.0 PROJECT TIMETABLE

The timetable for the NorthMet Project to move from pre-feasibility through permitting and construction to full operations is estimated to be six years. Permitting and the development of the Environmental Impact Study (EIS) will take about 3.0 to 3.5 years and plant construction 1.5 years. It is assumed that the US Forest Service land swap, additional drilling and the bankable feasibility study will be completed within the three years permitting timetable. Detailed engineering will extend six months beyond the permitting timetable, followed by financing, construction and project start up.

Figure 17-1 shows the estimate of the project timetable.

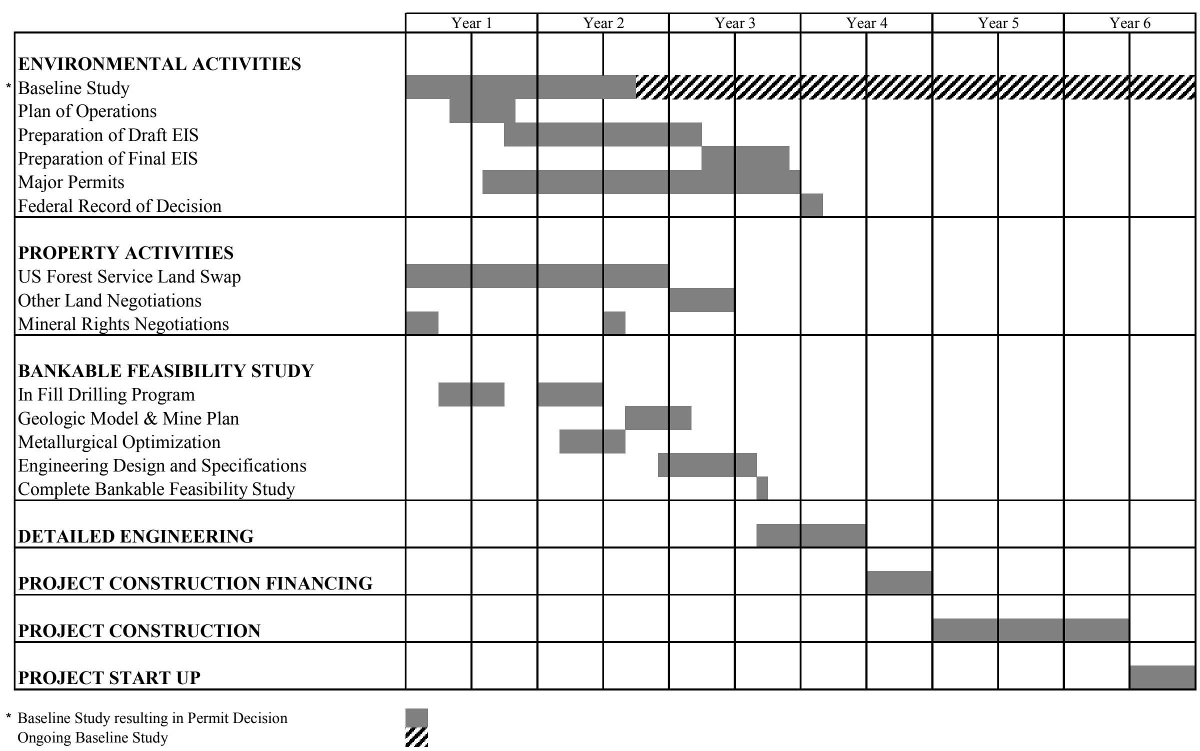

Figure 17-1 Project Timetable

18.0 ADDITIONAL OPPORTUNITIES

The scope of this pre-feasibility document does not address the potential beneficial impact from further optimization of certain major project variables, nor does it adequately assess the potential additional revenue streams that could result from mining the NorthMet Project. The final bankable feasibility study should investigate the following project parameters:

- Mine Production Rate. Optimizing production rates and grades versus capital and operating costs over the entire mine life.

- Potential Underground Mining. The mineralized material at the southwest end of the pit is higher grade and appears to dip gently to the southeast. Once Phase 3 of mining is completed, it may be possible to start underground operations from the bottom of the pit directly into the remaining ore. Additional drilling will be necessary to define the trend of the mineralization and the structures that affect it.

- Power Plant Facility. With the rising cost of electric power, the benefits from construction of an on-site power plant should be investigated. Excess power could be sold into the existing grid for additional project revenue.

- Gypsum Usage. The NorthMet mine will produce about 950 tons of gypsum per day. Either Polymet or another independent company could use the gypsum in wallboard manufacture or possibly for other uses. An additional benefit would be the new employment opportunities in the Iron Range, which is experiencing significant job reductions.

- Aggregate Production. Waste rock could be crushed and shipped by existing rail lines to Lake Superior and then to metropolitan areas that have high demand for aggregate.

- Carbon Dioxide Production. The metallurgical process plant could include a carbon dioxide plant. Carbon dioxide is used in the beverage and processed foods industries and a demand exists in Minnesota and nearby parts of Canada.

- Smaller Cu-Ni-PGM occurrences exist near the NorthMet Project. These deposits, which may not be large enough to support the capital cost of process facilities, may be an additional source of feed material for the NorthMet hydrometallurgical process plant.

19.0 FUTURE WORK

All aspects of the NorthMet Project presented in this report will require additional work as the project advances through feasibility and into production. Table 19-1 shows an estimate of the cost for the work resulting in a bankable feasibility study. Listed below are future work topics that have been identified to date by the various project disciplines.

Table 19-1: Funding Requirements to Complete the Bankable Feasibility Study

	$ in Millions
In-Fill Drilling of 69 Holes (121,000 feet) at $26/ft.	3.10
Geological Model and Mine Planning	0.75
Engineering Design and Specifications (15-20% accuracy)	1.95
Metallurgical Optimization	1.50
Environmental Impact Statement Study and Permitting	6.00
US Forest Service Land Swap and Other Land Purchases (7,430 total acres)	3.50
Legal and Other Consultants	0.25
Funding Costs	0.70
Management and Administration Costs	0.25
TOTAL	18.00

Geologic Model

1) Infill drilling is required for better definition of the geologic controls and provide additional confidence to the grade model estimation. This should reduce the amount of inferred resource included in the grade model of the deposit.
2) Assay the un-assayed intervals of the USX drilling with the first priority being the missing intervals internal to and on the periphery of the ore zones. Some of the intervals away from the ore zones should be assayed for the purpose of waste characterization.

3) Down hole surveys should be done for all future drilling and for any existing holes that might be still accessible.
4) Additional quality control work should be done including: a) check assays from remaining core or coarse rejects, b) assay 50 or so samples (remaining core or coarse rejects) from the USX drilling using the present assaying lab and procedures to confirm the Fleck (early PolyMet) re-assays, c) improve the quality of the prepared standards.

Mining

1) The mining schedule will be revised once the new resource model is developed incorporating the new drillings. On going metallurgical optimization may also impact the next mine production schedule.
2) The waste rock characteristics will need to be modeled in order to determine if any segregation of the various units will be required in the waste dumps.
3) The design and sequencing of the waste dumps can be revised to reduce the initial acreage for the dumps and thus delay some of the wetlands mitigation requirements. The revised sequencing will also address any issues arising from the waste rock characterization study.

Metallurgy and Process Design

1) Future testwork is required to confirm the representativeness of the samples collected for the completed metallurgical test work to the overall NorthMet deposit. To complete a final feasibility study and confirm the flowsheet design, testwork will be needed to evaluate any variability (or lack of variability) in the metal recovery process based on ore head grades (particularly in the grade range below the test work head grades) and geologic location within the NorthMet deposit.
2) Additional definition of the physical properties of the tailings products will be needed.
3) Additional crushing and grinding testwork is needed.
4) Process trade-off studies should be done to evaluate alternatives that could improve the project economics. One recommended process change for evaluation is the production of nickel sulfide instead of nickel metal as the saleable product. This change could reduce both capital and operating costs related to nickel recovery.

Tailings Disposal

1) Perform optimization studies of the floatation tailings facility to evaluate the potential reduction of costs and facilitate more efficient surface water diversion.
2) Perform optimization of the hydrometallurgical tailings facility to evaluate the potential of reducing its footprint by raising the dam height.
3) Future work needs to address the geotechnical characterization of the tailing dam sites and tailings facilities.
4) Future work needs to address the geochemical characterization of the tailings and waste rock used for dam construction.

Water Sources and Overall Water Balance

1) As other areas of the project are revised, the overall project water balance will have to be re-done.
2) Further identification of make up water sources will have to be done and agreements made for the use of the water sources.

Land Ownership and Land Swaps

1) The surface land ownership for all land (approximately 7,430 acres) will have to be researched and verified.
2) A land trade with the US Forest Service will have to be proposed, negotiated and completed.
3) The purchase of the non-US Forest Service lands will have to be negotiated and completed.

Mineral Rights

1) The mineral rights ownership will have to be verified.
2) Royalty or purchase agreements for the mineral rights of owners other than USX will have to be negotiated.

Environmental Permitting and Testing

1) The EIS will have to be completed (estimated to be 3 to 3 ½ years).
2) As part of the EIS and for input to other areas of the Feasibility Study, the waste rock will need characterization, the impacts of water discharge will need to be evaluated, flotation tailings will need further evaluation with respect to requiring a lined facility.

20.0 CONCLUSIONS

20.1 PROJECT MANAGEMENT

IMC is the overall project consultant for the NorthMet Pre-Feasibility Study. IMC has provided project coordination between the other consultants and PolyMet and has assembled the overall Pre-Feasibility Summary Report. This report is based on input received from all of the other members of the project team. IMC has reviewed the information provided by the other consultants for consistency between all aspects of the project and believes that the level of work provided by each consultant has sufficient detail to support the conclusions in this report.

Three project meetings (December 2000, January 2001, March 2001) were held during the course of the project to review the needs of each of the consultants and who would provide the requested information. The December meeting was held at the project office in Aurora, Minnesota and was attended by representatives of PolyMet and all the consultants (with the exception of Call & Nicholas, who had basically completed all of its project work and had visited the site earlier). The second and third meetings were held at the PolyMet offices in Golden, Colorado. At each meeting, the consultants presented completed and work in progress to the other attendees for discussion and review. In addition, IMC personnel met with AMEC personnel on two other occasions to review the process and plant work including the plant flow sheets and equipment lists.

Each consultant was selected for the project team because of his or her expertise in certain areas of the project. IMC does not claim to have detailed knowledge of each of the other consultant's field of expertise, but IMC has spent enough time with each of them to understand the logic and information each consultant incorporated into their aspect of the project. It is the opinion of IMC that the work completed by each consultant is sufficient to support the conclusions presented in this pre-feasibility study.

20.2 RECOMMENDATION

The results of the NorthMet Pre-Feasibility Study show a 14.09% before-tax IRR and a NPV of $171 million at a 10% discount rate. It is IMC's judgement that the NorthMet project should be carried forward based on the technical and economic analysis and related interpretations developed for this pre-feasibility study, and based on comparisons with other mining projects evaluated by IMC in recent years. The expenditure of the estimated US$18-20 million to advance the project to the next level of decision making, which would be based on the completion of the bankable feasibility study, is warranted. The preparation of the final feasibility study should address the "Recommendations for Future Work" listed in Section 19 of this document, in addition to other subject areas normally included in a bankable feasibility study.

Appendix 1-1

NorthMet Project – List of Available Information

NORTHMET DRILLING INFORMATION

Year	#	Company	DH Name	Type	Prep Lab	Assay Lab
1969-1974	112	USX	26xxx	BQ	USX, Lerch Brothers, Chemex	USX, Acme, Chemex
1991	2	Nerco	26xxxA	BQ	Acme	Acme
1998	14	PolyMet	98-xxx	RC - 6"	Lerch Brothers	Acme
Fall 1999/Winter 2000	38	PolyMet	99-xxxB, 00-xxxB	RC - 6"	Lerch Brothers, Chemex	Chemex
	19		99-xxxC, 00-xxxC	BTW	Lerch Brothers, Chemex	Chemex
	3		99-xxxBC	RC and ATW	Lerch Brothers, Chemex	Chemex
Fall 2000	13	PolyMet	00-361C to 00-373C	NTW	Chemex	Chemex
Total	201					

DH Name	Material Remaining/Location
26xxx	Full (unassayed) and half core/CMRL All rejects, USX pulps/CMRL Other pulps at Acme or Chemex
26xxxA	Full (unassayed) and half core/CMRL Rejects, pulps/Acme
98-xxx	2 - 5 gallon buckets of low grade material stored on-site Rejects/Lerch Bros Pulps/Acme
99-xxxB, 00-xxxB	2 - 5 gallon buckets of low grade material stored on-site Rejects/Prep Lab Pulps/Acme
99-xxxC, 00-xxxC	Half core in Aurora Office Rejects/Prep Lab Pulps/Chemex
99-xxxBC	As above
00-361C to 00-373C	Half core in Aurora Office Rejects/Chemex Pulps/Chemex

	Elements Assayed
USX	Cu, Ni, Fe, S
Acme	Cu, Ni, Co as part of 32 element ICP package; Pt, Pd, Au Fire Assay
Chemex	Cu, Ni, Co as part of 32 element ICP package; Pt, Pd, Au Fire Assay

	Information Logged	
USX	Original	Rock description, sulfide percent
	NRRI	Re-logging with rock types, mineral %, sulfide %, units, major structures
Nerco		Not available
PolyMet	Core	Rock description, grain size, mineral %, sulfide %, relative abundance cp/po, alteration, rock type, unit
		Geotechnical - recovery, RQD, hardness, # fractures/orientation/filling/roughness, broken zones
	RC (98)	Rock description, sulfide %
	RC(99, 00)	Rock description, grain size, mineral %, sulfide %, relative abundance cp/po, alteration, rock type, unit

CMRL = Coleraine Minerals Research Laboratory, Coleraine, Minnesota
NRRI = Natural Resources Reasearch Institute, University of Minnesota, Duluth
Chemex Prep Laboratory, Thunder Bay, Ontario
Chemex and Acme Assay Labs, Vancouver, British Columbia
Lerch Brothers, Hibbing, Minnesota

METALLURGY

Lakefield	16-Aug-00	LR10054-001	A Laboratory Investigation of The Recovery of Copper and Nickel from NorthMet Samples Variability Tests: Progress Report No. 1 DRAFT
Lakefield	17-Aug-00	LR10054-002	A Pilot Plant Investigation of The Recovery of Copper, Nickel and PGMS from the NorthMet Deposit Summary: Progress Report No. 2
Lakefield	04-Oct-00	LR10054-003	Flotation Pilot Plant Products Environmental Investigation and Air Testing from NorthMet Samples Progress Report 1 DRAFT
Lakefield	02-Oct-00	LR10054-003	Hydromet Pilot Plant Products Environmental Investigation and Air Testing Progress Report 2 DRAFT
Lakefield	28-Sep-00	LR10054-005	A Pilot Plant Investigation into the Recovery of Copper, Nickel, Gold and PGMS from NorthMet Bulk Concentrate, Volume 1: Part 1: The recovery of Cu, Au and PGM's. Main Text
Lakefield	28-Sep-00	LR10054-005	A Pilot Plant Investigation into the Recovery of Copper, Nickel, Gold and PGMS from NorthMet Bulk Concentrate, Volume 2: Part 1: The recovery of Cu, Au and PGM's. Appendix 1,2,3
Lakefield	20-Sep-00	LR10054-005	A Pilot Plant Investigation into the Recovery of Copper, Nickel, Gold and PGMS from NorthMet Bulk Concentrate, Volume 3: Part 1: The recovery of Cu, Au and PGM's. Appendix 4
Lakefield	28-Sep-00	LR10054-005	A Pilot Plant Investigation into the Recovery of Copper, Nickel, Gold and PGMS from NorthMet Bulk Concentrate, Volume 4: Part 1: The recovery of Cu, Au and PGM's. Appendix 5,6,7,8
Lakefield	28-Sep-00	LR10054-005	A Pilot Plant Investigation into the Recovery of Copper, Nickel, Gold and PGMS from NorthMet Bulk Concentrate, Volume 5: Part 1: The recovery of Cu, Au and PGM's. Appendix 9
Lakefield	28-Sep-00	LR10054-005	A Pilot Plant Investigation into the Recovery of Copper, Nickel, Gold and PGMS from NorthMet Bulk Concentrate, Volume 6: Part 1: The recovery of Cu, Au and PGM's. Appendix 10,11
Lakefield	01-Feb-01	LR10054-007	A Pilot Plant Investigation into the Recovery of Copper, Nickel, Gold and PGMS from NorthMet Bulk Concentrate, Bleed Stream Treatment for FE, Al and Cu Removal
Lakefield	13-Apr-99	LR5349	A Laboratory Investigation of The Recovery of Copper and Nickel from Dunka Road Samples Progress Report No. 1
Lakefield	23-Mar-99	LR5349	A Pilot Plant Investigation of The Recovery of Copper and Nickel from Dunka Road Samples Progress Report No. 2
Lakefield	Jun-99	LR5428	The Recovery of Base Metals, Gold and PGMs from NorthMet Bulk Concentrate Samples - Progress Report No. 1
Lakefield	Aug-99	LR5502	The Recovery of Base Metals, Gold and PGMs from NorthMet Bulk Concentrate Samples - Progress Report No. 2
Lakefield	19-Jul-91	LR4134	An Investigation of The Recovery of Copper and Nickel from Dunka Road project Samples submitted by NERCO Exploration Company: Progress Report No. 1
Lakefield	31-Jul-91	LR4134	An Investigation of The Recovery of Copper and Nickel from Dunka Road project Samples Appendix to Progress Report No. 1
Lakefield	17-Oct-94	LR4617	An Investigation of The Recovery of Copper and Nickel from Dunka Road project Samples submitted by Phelps Dodge Corp: Progress Report No. 1
NRRI	04-Dec-98		Metallurgical Testing of Copper-Nickel Bearing Material from the Duluth Gabbro Project Final Report, Volume 1
NRRI	04-Dec-98		Metallurgical Testing of Copper-Nickel Bearing Material from the Duluth Gabbro Project Final Report, Volume 2
PolyMet	May-99		High Temperature Pressure Oxidation - prepared by O'Kane Consultants
PolyMet	Nov-98		Metallurgical Screening Studies
PolyMet	Nov-98		Metallurgical Screening Studies - Appendix
PolyMet	Jul-99		High Temperature Pressure Oxidation - prepared by O'Kane Consultants
BacTech	Jul-99		BioLeaching Investigation of NorthMet Sulphide Concentrate Phase 1 - Process Amenability testwork & Preliminary Process design Study
Signet	Aug-99		Process Design and Cost Study for Bacterial Oxidation as part of a Hybrid Oxidation Circuit
Pearse Western	01-Sep-99		An Evaluation of the Metallurgical Plans for the Development of PolyMet Mining Corp's NorthMet Project

MAPS, AERIAL PHOTOGRAPHS

Geologic Cross-sections
- 10 foot composites, Cu, Pd, Rock type, May 2000
- 20 foot composites, Cu equivalent, Cu, Rock type, September 2000

Drill hole Location Map
Copper Grade Thickness Map

General site Arrangement Map - Pit and dump, IMC, January 2001
Floating Cone, Measured, Indicated, IMC, November 2000
Floating Cone, Measured, Indicated and Inferred, IMC, November 2000
Tailings Site Alternatives - SRK, January 2000

Model Cross-sections, November 2000
- NSR
- Pd, Pt
- Ni, Co

Bench Maps - NSR and Cu, November 2000

Various Dighem Geophysical Maps, including resistivity and Magnetics
Dighem survey for Fleck Resources Ltd - Dunka Road Property, Minnesota, April 1997

USGS Topographic Maps

Map compiled by North Mining of Surface Owners
Map compiled by North Mining of Mineral Owners

Air Photos - Foth and Van Dyke, Sections 1,2,3,4,9,10,11,12, Scale 1 in = 200 ft
Topographic Maps - as above

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Preliminary Data Analysis - Dunka Road Copper-Nickel Deposit, St. Louis County, Minnesota
A.J. Erickson, Jr., September 29, 1998

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Fluor Daniel Wright, October 1991

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Call & Nicholas

The Report on the Mining Simulation Project
MDNR, MPCA, El.K. Lehmann and Associates, Inc, Janaury 1990

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Babbitt, MN: prepared for Nerco Minerals Company, September 1992
SEC Donohue Environment and Infrastructure in association with Golder Associates

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Foth & Van Dyke

Preliminary Wetlands Map - ENSR, March 2000

March 2000 Wildlife Survey Report, April 3, 2000
Scope of Work and Cost Estimate for Initial Cultural Resources Survey, August 25, 2000
Scope of Work and Cost Estimate for Summer 2000 Wildlife Study, July 31, 2000
Scope of Work and Cost Estimate for General Project Management 9/2000 through 7/2001, August 22, 2000
Scope of Work and Cost Estimate for Reconnaissance Level Soils Survey, August 28, 2000
Scope of Work and Cost Estimate for Fall 2000 Wildlife Survey, August 14, 2000
Scope of Work and Cost Estimate for Baseline Surface Water Investigation, August 27, 2000
Scope of Work and Budget for Geohydrology Studies, February 1, 2000
Scope of Work and Cost Estimate for Preliminary Air Quality Evaluation, February 14, 2000
Draft Geochemical Work Plan (Waste Rock Characterization), January 6, 2000
PolyMet Humidity Cell Results – Update of Work Completed to Date, December 15, 2000

LEGAL

Lease Agreement with USX - 1/4/89
First Amendment to Agreement - 12/19/94

Alfers & Carver Title Report - 10/15/99
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North/PolyMet Joint Venture II
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J.D. Miller, Jr. and E.M. Ripley
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APPENDIX 10-1

ASSUMPTIONS USED IN WATER BALANCE

Assumptions Used in Water Balance

Pit Inflows

Based on table 9-26: Pumping Operating Costs Per Year.

Pit inflows will be collected and pumped to process plant as long as capacity exists in the plant.

Annual precipitation estimated to range from 104,696,000 gallons/year in Years 1 and 2 to 499,661,000 gallons/year in Years 10 through 15. Average in gallons per minute ranges from 200 gpm to 951 gpm.

Annual seepage estimated to range from 99,338,000 gallons/year in Years 1 and 2 to 474,091,000 gallon/year in Years 10 through 15. Average in gallons per minute ranges from 189 gpm to 902 gpm.

Process Plant

Based on information from Brian Kennedy of AMEC.

Required Water in Grinding and Flotation Circuit is 20,539 gpm.

Estimated fresh water make-up to the hydromet circuit is 100 to 200 gpm.

Internal recycling within the process plant is estimated to be 913 gpm.

Recycle from the flotation tailings to the grinding and flotation circuits is taken from the flotation tailings water balance by SRK and is estimated to be 13,927 gpm.

Recycle from the hydromet tailings to the grinding and flotation circuits is taken from the hydromet tailings water balance by SRK and is estimated to be 440 gpm.

Based on these numbers, approximately 3,406 to 4,870 gpm of fresh water make-up will be required in the grinding and flotation circuit and 100 to 200 gpm in the hydromet circuit.

Waste Rock

There is a potential that runoff and seepage from the waste rock disposal areas will need to be treated prior to discharge or captured. Based on the make-up water requirements, it may be possible to take some, or all, of this water into the processing plant as make-up water. The exact quantities have not been defined, but the waste rock disposal area is shown on Figure 10-1 as a potential source of water to the plant.

Tailings Areas

Information on the tailings water balance was obtained from SRK.

Average precipitation directly on the flotation tailings area is estimated at 1,548,000 cubic meters per year and the average runon from areas surrounding the tailings area is estimated at 1,890,000 cubic meters. This converts to a total inflow of 1,728 gpm.

The average annual recycle back to the process plant from the flotation tailings is 27,707,000 cubic meters per year. This converts to approximately 13,927 gallons per minute.

Average precipitation directly on the hydromet tailings area is estimated at 762,000 cubic meters per year and the average runon from areas surrounding the tailings are is estimated at 207,000 cubic meters per year. This converts to approximately 487 gpm.

The average annual recycle back to the process plant from the hydromet tailings is 874,000 cubic meters per year. This converts to approximately 440 gallons per minute.

These numbers have been used in the process plant water balance discussed above.

Potable Water (Water for Sinks/Toilets/Showers)

Potable water needs were determined based on estimated site personnel from Independent Mining Consultants, Inc. for the mine and administrative personnel and from AMEC for the plant personnel.

The estimated water usage per person per shift is 20 gallons without showers or 35 gallons with showers.

Administrative personnel are estimated at 43, all on dayshift, no shower facilities necessary, for a total of 860 gallons per day of water.

There are 198 plant personnel. Of these, 82 are dayshift only with no showers necessary for a total water usage of 1,640 gallons per day. Estimated shift workers are 25 per shift for three shifts per day for a total of 75 people per day with showers. The total for water usage for the shift workers is 2,625 gallons per day.

Mine salary, dayshift personnel number 32. These workers will require no shower facilities, so estimated total water usage is 640 gallons per day. Mine hourly personnel range from 31 to 91 per shift for three shifts a day. These workers will not have shower facilities. The total water usage from the hourly group is estimated at 1860 to 5460 gallons per day.

Road Watering

Annual road watering needs were estimated by Independent Mining Consultants, Inc. as ranging from 23,608,000 gallons per year to 74,685,000 gallons per year.

This converts to an average of between 45 and 142 gallons per minute. Based on seasonal road watering variations, an average annual conversion may not accurately reflect actual road watering needs, but provides an estimate of amount of water necessary.

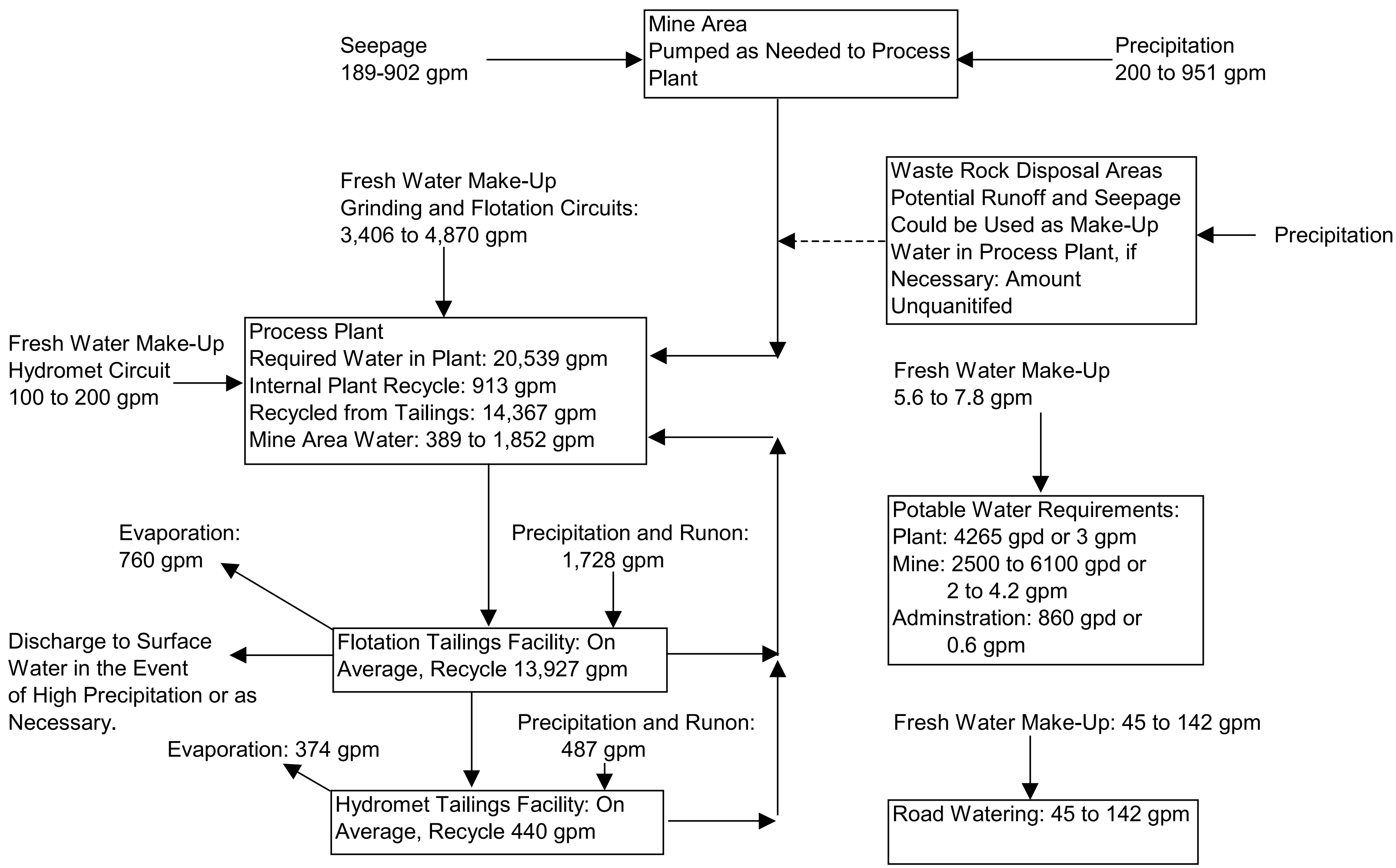

Figure 10-1 **NorthMet Project - Conceptual Water Balance**