

Kennecott Eagle Minerals Company's Mining and Reclamation Plan And Draft Comments From The DNR

The following document represents Kennecott Eagle Minerals Company's (Kennecott) Mining and Reclamation Plan (MRP) pursuant to the standards contained in Department of Natural Resources Metallic Minerals Lease M-00602. This MRP addresses Section J.1, Mining and Reclamation Plan of Lease M-00602, which require a MRP prior to the commencement of any mining.

The following responses are referenced below in part from the Kennecott's Application for Mining Permit (MAP), which may be found at <http://www.deq.state.mi.us/documents/deq-ogs-land-mining-metallicmining-EagleAppWeb.pdf>.

Due to many similarities in the MRP standards in the DNR Metallic Mineral Lease and in the Department of Environmental Quality (DEQ) Mining Permit Application (MPA), Kennecott developed the DNR MRP by referencing or quoting the applicable items from MAP. In some cases, Kennecott's references address issues that are beyond the scope of the lease requirements.

This document is formatted in the following manner:

- Excerpt of the required MRP element from Section J.1 of Lease M00602 shown in **teal**
- Kennecott's response to those elements identified in Kennecott's MRP (or for lengthy or repetitive passages may be referenced to the original MPA)
- Comments from the DNR, drafted in response to Kennecott's analysis, are shown throughout the document with sub-headings in **red**.

**State of Michigan
Department of Natural Resources
Metallic Minerals Lease No M-00602**

J.1.a. Mining and Reclamation Plan. No mining shall take place on leased premises without a mining and reclamation plan developed by Lessee and approved by Lessor.

Kennecott has summarized the whole of their MRP under J.1.a. as consisting of the following parts of their MPA submitted to the DEQ, which are referenced as follow: The referenced sections are not printed in full if they are cited again later in the document under more specific MRP requirements.

1 Introduction

Kennecott Eagle Minerals Company (KEMC) is proposing to develop an underground nickel and copper mine in Michigamme Township, Marquette County, Michigan. As part of the permitting process for the project, KEMC needs to apply for a Mining Permit in accordance with Part 632 of the Michigan Natural Resources and Environmental Protection Act (NREPA) (MCL §324.63201 et. seq.) and rules promulgated under R 425.101 et.seq. of the Michigan Administrative Code. This volume (Volume I) of the *Mining Permit Application* (MPA) and associated appendices contains required permit application forms; the mining, reclamation, environmental protection, and contingency; plans and financial assurance information as required in Part 632 and R 425.201(1)(a)(b)(d-h). Volume IA contains Appendices A through C that are referenced in this document. Volume IB contains Appendix D-1. Volume IC contains Appendices D-2 through D-5. Volume ID contains Appendices E through J. The *Environmental Impact Assessment* (EIA) required under Part 632 and R 425.201(1)(c) is contained in Volume II of this *Mining Permit Application*. Appendices for the EIA are contained in Volume IIA through Volume IIH.

This MPA is based on engineering and other environmental studies as they relate to the design, construction, operation, closure, reclamation, and post-closure care of the Eagle Project facilities. The material presented in this application is representative of the type and size of facilities to be constructed and operated.

1.1 Background

The Eagle deposit is a high-grade magmatic sulfide deposit containing nickel and copper mineralization and minor amounts of cobalt, and gold. The Eagle deposit was discovered in 2002 by drilling areas known to contain sulfide-bearing peridotite intrusions. The economic minerals are predominately pentlandite and chalcopyrite. KEMC is proposing to mine the Eagle deposit by underground mining methods. Extracted ore will be brought to the surface where it will be crushed and trucked off-site along an approved trucking route to a railhead. The ore will be transferred to rail cars for shipment to an off-site processor. There will be no milling or chemical processing of ore at the Eagle Project site. As such, surface facilities for the operation will be limited to those necessary for storing and crushing ore; managing development rock; water storage, treatment and discharge; mine backfilling; mine ventilation; and, other ancillary operations.

1.2 Mining Permit Application Documents

This MPA is being submitted by KEMC to request a permit to mine at the Eagle Project site in Michigamme Township, Marquette County, Michigan. This volume (Volume I and associated Appendices in Volume IA through Volume ID) of the MPA includes the following items required under Part 632 and R 425.201(1)(a)(d-h):

- ? A permit application form for the Michigan Department of Environmental Quality (MDEQ) (Appendix A) along with a checklist to facilitate MDEQ review;
- ? A Michigan Department of Natural Resources (MDNR) Land Use Application Form for leasing State Land that will be used for project surface facilities (Appendix A);
- ? A permit application fee provided under separate cover by KEMC;
- ? A mining plan, containment plan, monitoring plan, reclamation plan and environmental protection plan (Sections 4, 5, 6 and 7);
- ? A contingency plan (Section 8);
- ? A description of the amount of financial assurance that will be provided to satisfy the requirements of R 425.301 (Section 9);
- ? A listing of other applicable permits and licenses that are being applied for concurrently with this MPA (Section 1.3);
- ? KEMC's Organization Report (Appendix B); and
- ? An EIA (Volume II of this application).

This MPA includes the requirements of Part 632 of NREPA and *Nonferrous Metallic Mineral Mining* rules specified in R 425.101 et. seq. of the Michigan Administrative Code. This application is supported by tables and illustrations inserted within the narrative report and figures and appendices that follow the narrative report. The appendices contain technical reports, calculations and other data that support the designs presented in this application.

1.3 Other Permits

KEMC is concurrently applying for other permits required for operation of the Eagle Project. The anticipated permit applications are contained under separate cover in the format required by the respective regulatory agencies. These permit applications and related regulatory documents are as follows:

- ? A *Michigan Air Use Permit – Permit to Install Application* (Foth & Van Dyke, 2005a) submitted to the MDEQ for air emissions related to the proposed mine operation.
- ? A *Groundwater Discharge Permit Application* (Foth & Van Dyke, 2006) submitted to the MDEQ for the treatment and discharge to the subsurface of treated water from the Eagle Project.
- ? *Notice of Coverage* for storm water management during construction activities and a *Notice of Intent* for storm water management during operations will be submitted to the MDEQ for the potential release of non-contact storm water runoff.
- ? A *Type II Non-Transient Non-Community Water Supply Permit Application* will be submitted to the Marquette County Health Department for water consumption and use by site workers.
- ? A *Commercial Septic System Permit Application* will be submitted to the Marquette County Health Department for the treatment and discharge of sanitary wastewater generated by site workers.
- ? A *Mineral Extraction Permit Application* (Foth & Van Dyke, 2005b) submitted to Michigamme Township.
- ? Documentation will be submitted to the MDEQ, prior to construction, for certification of planned aboveground storage tanks for diesel fuel, gasoline and propane.
- ? A *Spill Prevention Control and Countermeasures Plan* (SPCC Plan) will be prepared per 40 CFR 112.

? A *Pollution Incident Prevention Plan* (PIPP) will be prepared per R 324.2001 et. seq. During operations KEMC will also file annual reports in compliance with the Federal Emergency Planning and Community Right to Know Act (EPCRA). As a result of the MDEQ's review of the EIA, it is possible that other environmental permits may be identified for the Eagle Project. If other permit requirements are identified, KEMC will submit the applications as soon as possible. KEMC will begin construction of the Eagle Project after acquiring all environmental permits needed for the Eagle Project.

1.4 Document Preparers and Qualifications

This *Mining Permit Application* was prepared by Foth & Van Dyke and Associates, Inc. under contract to KEMC. This document incorporates information prepared by other qualified professionals working under contract to Kennecott and/or Foth & Van Dyke. The following is a summary of the organizations and individuals who have contributed to the preparation of this *Mining Permit Application*.

**Table 1-1
Document Preparation – List of Contributors**

Organization	Individuals	Qualifications
BHE Environmental, Inc. 11733 Chesterdale Rd Cincinnati, OH 45246	Christopher Bergman, Ph.D. RPA	Archaeologist
ECT, Inc. 501 Avis Dr Ste 5C Ann Arbor, MI 48108	Donald Tilton, Ph.D., PWS John Freeland, Ph.D., PWS	Wetland Scientist Wetland Scientist
Fletcher Driscoll & Associates, LLC 1560 221 st Ave. NW Oak Grove, MN 55011	Tom Davis, P.G.	Professional Geologist

Organization	Individuals	Qualifications
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2 Project Location Information

2.1 Site Location

The proposed Eagle Project is located in Marquette County in the Upper Peninsula of Michigan, approximately 25 miles northwest of the city of Marquette and 10 miles southwest of the community of Big Bay. Figure 2-1 shows that the project is located on Triple A Road.

2.2 Land Use and Zoning

The Eagle Project is situated on the Yellow Dog Plains near the Salmon Trout River Main Branch. Land in the vicinity of the Eagle Project is primarily used for timber harvesting and recreational purposes. No permanent residences exist in the area. The closest populated area is Big Bay located approximately 10 miles to the northeast. The nearest known residences to the Eagle Project site are:

- ? A seasonal camp on Kennecott-owned land approximately 1.4 miles west-northwest of the mine portal.
- ? A seasonal camp known locally as Dodge City approximately 2.2 miles north of the mine portal.
- ? A permanent residence approximately 6.4 miles east of the mine portal.

The Eagle Project is located entirely in Sections 11 and 12, T50N-R29W, Township of Michigamme, Marquette County, Michigan. Figure 2-2 is a reproduction of the Michigamme Township Official Zoning Map "D/E" dated May 25, 1992 showing that the Eagle Project is

located in Michigamme Township Zoning District RP-20. On land zoned as RP-20 (Resources Production Twenty), mineral extraction is a permitted principal use (Michigamme Township, 1992/1994). As noted earlier in this report, KEMC has submitted a *Mineral Extraction Permit Application* (Foth & Van Dyke, 2005b) to Michigamme Township for the Eagle Project.

2.3 Surface and Mineral Rights Ownership

KEMC owns a 100% interest in the Eagle Project site through a mixture of private mineral titles and state mineral leases and surface ownership. Figure 2-3 and Figure 2-4 show the location of the mineral title and leases and the surface ownership and leases, respectively. KEMC owns the surface title over the mineral deposit as shown in Figure 2-4. Two surface facilities will be constructed to support the Eagle Project. The aggregate backfill surface facility and vent shaft is located on KEMC-owned land near the ore body. The main project surface facilities are located on lands owned by the State of Michigan. KEMC leases the mineral rights on these state-owned lands and through the terms of the leases has the right to obtain a land use permit from the MDNR for the construction of mining related surface facilities. A copy of the MDNR Land Use Permit Application Form is provided in Appendix A.

2.4 Conservation and Historical Preservation Easements

In the summer of 2004, and summer of 2005, archaeologists from BHE Environmental Inc. completed a Phase I Archaeological Survey in an area around the main surface facility and backfill surface facility (BHE Environmental, 2005). This document is included in the Appendices for the EIA. The BHE Environmental, Inc., Phase I Archaeological Survey information determined the following:

- ? The Phase I Archaeological Survey yielded no evidence of prehistoric or historic occupation within the facility boundaries.
- ? A visual inspection of a larger areas surrounding the proposed surface facilities did delineate a small scatter of prehistoric debris. Since the debris was discovered in a disturbed area of a utilized roadway the prehistoric context of the site could not be assessed.
- ? The Phase I Survey did not discover Paleo-Indian artifacts.
- ? The Phase I Survey did discover two historic-era occupations outside the area for the proposed surface facilities which were most likely early to mid 20th-century logging camps. Both of these camps are situated adjacent to existing roads and both contain evidence of structural foundations.

BHE Environmental, Inc. concluded that there were no cultural properties potentially eligible or eligible to the NRHP (National Register of Historic Places) that exist within the surveyed areas. There are no known conservation or historic easements within 1,320 ft of the Eagle Project facilities.

2.5 Adjacent Properties and Measures Taken to Prevent Damage

The surface facilities for the Eagle Project include the main surface facility and the backfill surface facility displayed in Figure 2-4. With respect to the properties that border these surface facilities the following is noted:

- ? The backfill surface facility is located on KEMC owned property and there are no activities proposed that would impact adjacent properties since the surface activities are limited to an area of a few acres that border the Triple A Road.
- ? As of January 1, 2006, the main surface facilities are bordered by the following property owners: State of Michigan and Plum Creek to the north; the State of Michigan and Longyear to the east; State of Michigan and KEMC property to the south; and KEMC property to the west. The measures described in this permit application are proposed to prevent damage to adjacent properties not owned by KEMC.

4.1 Project Development

The Eagle Project development will include surface and underground facilities required for the mining of the ore body. Figure 4-1 is an existing conditions map showing the location of the surface facilities and ore body. Figures 4-2 through 4-3 show the proposed Eagle Project surface facilities on a planimetric map and aerial photograph. The total surface area required for the project development is approximately 145 acres (fenced facility boundaries and access road). The project facility area (disturbed area) as shown on Figure 4-1 is approximately 92 acres. The location of the surface facilities was selected based upon:

- ? Proximity to the ore body,
- ? Minimizing disturbance to sensitive surface features and water bodies,
- ? Minimizing visual impacts from local roads,
- ? Accessibility to county and state roads, and
- ? Maintaining the natural topographic configuration of the property during operations and post-reclamation periods.

The proposed Eagle Project site includes the following facilities collectively referred to as the mine site.

? The main surface facilities that support the mine operation are located in the NW ¼ of Section 12, T50N, R29W and include the following:

- ? Assay Lab
- ? Maintenance Shop and Compressor Plant
- ? Generator Plant
- ? Propane Storage and Mine Air Heater
- ? Laydown Area for Mining Supplies
- ? Contact Water Basins # 1 and # 2 (CWBs)
- ? Non-Contact Water Infiltration Basins # 3, # 4 and # 6 (NCWIBs)
- ? Loading Dock/Warehouse
- ? Emergency Response Facility
- ? Fuel Storage Area
- ? Temporary Development Rock Storage Area (TDRSA)
- ? Coarse Ore Storage Area (COSA)
- ? Crusher Ramp, Crusher, Conveyor and Crushed Ore Storage Bins
- ? Mine Portal
- ? Septic System
- ? Mine Dry/ Office Buildings
- ? Wastewater Treatment Plant (WWTP)
- ? Treated Water Infiltration System (TWIS)
- ? Potable Water Supply Well
- ? Non-Potable Water Storage Tank
- ? Visitor and Employee Parking Area
- ? Truck Wash
- ? Truck Scale
- ? Gate House
- ? Access Road
- ? Construction Staging Area
- ? Soil Stockpile Area
- ? Storage buildings for explosives

? The backfill facility located in the NE ¼ of Section 11, T50N, R29W includes the following:

- ? Covered Aggregate Raise and Feed Hopper
- ? 110-ton Fly Ash Silo
- ? 110-ton Cement Silo
- ? Aggregate Storage Area
- ? Aggregate Raise
- ? Lined Binder Borehole
- ? NCWIB # 5
- ? Exhaust Fan Housing

The ore body is located in the N½ of Section 11, T50N, R29W. Total rock excavation including mineable resource and development rock is estimated at approximately 4,100,000 tonnes. Except for the water treatment facilities, the entire project development from construction through operations and closure is expected to take approximately 11 years depending on ore production rates. Closure of the WWTP will occur in year 17. The overall project timeline is presented on Figure 4-4.

4.1.1 Schedule for Construction

The schedule for the major activities involved in surface construction and underground development will take approximately 2 years. This schedule brings the mine on line in year 2 with full mine production occurring in year 3. The major construction activities for the Eagle Project are as follows:

Phase 1 Surface Facilities Construction

- ? Construction of perimeter fence;
- ? Preparing the construction staging area and soil stockpile areas;
- ? Clearing, grubbing and stripping and stockpiling of topsoil;
- ? Construction of the mine site access road;
- ? Construction of the TDRSA;
- ? Construction of the WWTP;
- ? Construction of CWBs #1 and #2;
- ? Construction of the TWIS, and
- ? Construction of the NCWIBs.

Phase 2 Surface Facilities Construction

- ? Construction of the generator plant and installation of the generators;
- ? Construction of the compressor plant and installation of the compressors;
- ? Construction of the maintenance shop, warehouse and office buildings;
- ? Construction of the COSA;
- ? Improvements to Triple A Road and CR 510;
- ? Construction of the surface crusher, crusher ramp and dump, conveyor and crushed ore storage bins;
- ? Construction of surface backfill system facilities and power line to the generator plant; and,
- ? Construction of miscellaneous remaining facilities, including the truck wash, scales, and fuel storage area.

Subsurface Facilities Construction

Figure 4-5 shows an overall cross-section of the underground mine workings. The sequential order of subsurface facilities construction will include:

- ? Constructing the portal, established at approximate 444 m (meters above MSL).
- ? Constructing the main decline from surface to level 263 m,
- ? Constructing the backfill plant and lower levels of the main exhaust rise,
- ? Developing the main exhaust raise from the surface to the 263 m level,
- ? Developing the main decline from the 263 m to the 143 m level,
- ? Developing the 248 m level exhaust drift,
- ? Developing the 233 m, 203 m, 188 m, 173 m and 143 m level drifts,
- ? Constructing the aggregate raise and cement boreholes,
- ? Installing the emergency escape elevator,
- ? Developing the sump and pump stations at the 188 m and 143 m levels,
- ? Developing the interlevel return air raises below the 263 m level.

4.1.2 Operations Production Rates and Mining Methods

The selected mining method proposed for the Eagle Project consists of 30 m (~98 ft) high by 10 m (~33 ft) wide and 15 m (~49 ft) high by 10 m (~33 ft) wide blasthole stoping. The length of the stope is based upon the ore cut-off grade. A small portion of the ore deposit may be mined using the blind bench mining technique. This method will be used to recover small high-grade zones outside of the designed blasthole stopes. The key criteria considered in the selection of the mining methods are as follows:

- ? Use bulk-mining methods to maintain maximum productivity;
- ? Maintaining high recovery rates of high grade ore;
- ? Minimize overall dilution rates due to the cost associated with transportation of crushed ore off-site for processing;
- ? Use a mine and backfilling process that is planned and designed to eliminate any measurable surface subsidence.

Based on an evaluation of the stope sequencing, a nominal production rate of 2,000 tonnes per day (t/d) is expected. The estimated annualized production rates are presented in Table 4-1.

Table 4-1
Annual Production Schedule

Facility Development Year	Operating Days	Annual t/yr	Daily t/d
2	63	66,024	1,048
3	251	457,271	1,822
4	250	499,982	2,000
5	250	500,000	2,000
6	250	503,862	2,015
7	251	502,000	2,000
8	250	501,287	2,005
9	250	389,027	1,556
Totals	1,815	3,419,453	1,884⁽¹⁾

g/t = grams per tonne, t/yr = tonnes per year, t/d = tonnes per day

Source: Adapted from McIntosh Engineering

⁽¹⁾ 3,419,453 t/yr/1815 days = 1883.9 t/d

Prepared by: REM
Checked by: IOS1

4.1.3 Employment Schedule

The projected personnel requirements during operations are based on an operating schedule of eleven hours per shift and two shifts per day. It is estimated that the mine will operate about 250

days per year considering holidays and snow days. On-site personnel requirements during operations are expected to begin at about 87 employees during the initial year of production with an anticipated increase to about 110 employees at full production. Table 4-2 shows the maximum expected number of employees for the Eagle Project for various professional classifications.

**Table 4-2
Projected Employment**

	Mining	Clerical/Accounting	HR	HSE	GM	Total
Salary	24	7	2	10	2	45
Hourly	65	--	--	--	--	65
Totals	89	7	2	10	2	110

HR – Human Resources
HSE – Health Safety and Environment
GM – General Management
Source: Adapted from McIntosh Engineering

Prepared by: REM
Checked by: IOS1

4.2 Development Activities

Surface activities associated with the mine development include stripping and stockpiling of soils, and development of the TDRSA, CWBs, TWIS, and other surface facilities.

4.2.1 Topsoil Stripping, Stockpiling and Stabilizing

The initial construction activities for the surface facilities will in general consist of the following:

- ? Installing erosion control devices such as siltation fences;
- ? Where necessary for facility construction, removal of marketable timber by a contractor;
- ? Removal of remaining trees and brush that will be chipped and stockpiled on-site for use in landscaping and reclamation of the mine site;
- ? Grubbing of roots and stumps that will be chipped or burned on-site;
- ? Stripping of the upper organic soil horizons (topsoil) from the area for reclamation, and
- ? Stockpiling and stabilizing the topsoil for later use in site landscaping and reclamation.

Based on the soil borings completed on the mine site, the average topsoil thickness is approximately three inches. The quantity of topsoil to be stripped from the site is estimated at approximately 28,600 cubic yards (yd³). The clearing, grubbing, topsoil stripping and stockpiling will be completed using conventional earth-moving equipment such as bulldozers, scrapers, graders and off-road trucks. Topsoil will be stockpiled in a controlled manner in the topsoil stockpile area. Topsoil and other soil stockpiles will be surrounded by silt fencing or similar erosion control devices to prevent soil erosion. In addition, topsoil stockpiles will be seeded with a Michigan Department of Transportation (MDOT), 2003 Standard Specification for Construction (MDOT, 2003) Temporary Seed Mixture 24+ (TSM 24+). TSM 24+ includes a 50/50 mixture of Perennial Ryegrass and Spring Oats. The rye and oats will quickly establish vegetation on the stockpile(s) and mitigate soil erosion and dusting until the topsoil is needed for site reclamation.

DNR Comments Seed mixtures used for stabilization cannot include invasive species. All seed mixtures must be approved by the DNR.

4.2.2 Facility Grading Plan

Upon completion of clearing and grubbing the area will be roughly graded as shown on Figure 4-6. The grading plan was designed to separate surface water runoff into zones for the main operations area and non-contact areas. The main operations area is the area of the facility that would be directly affected by mine activities. As such, storm water runoff from these areas will be collected in the CWBs. Non-contact areas are those areas which are not affected by mining activities associated with ore and development rock handling activities. Storm water runoff from these areas will be routed to the NCWIBs as shown on Figure 4-2. After rough grading is completed excavation for the TDRSA, CWBs, NCWIBs and other structures will be completed.

4.2.3 Excavation, Stockpiling and Earthwork Balance for Surface Structures

The preliminary earthwork balance is based on the design of the primary environmental protection structures that include the TDRSA, CWBs, NCWIBs and the TWIS. Note that grading for the other buildings and structures for the Eagle Project is considered incidental since these structures will, for the most part, be constructed at grade. Also, excavated rock during the mine development is not included in the earthwork balance since development rock will be temporarily stored in the TDRSA and eventually used as backfill in the mine stopes.

Table 4-3 provides the earthwork balance for the facility construction as displayed on Figure 4-2.

The cut needed to prepare the grades for the major facilities will be used to cover the TWIS and construct the soil berms. Excess soil from the site development will be placed in berms around the facility as shown on Figure 4-2. The soils placed in the berms will be used during the reclamation phase to return the mine site area to the reclamation grades. Also, if building and other structures need fill for the final design grades, this material can be removed from the stockpiled berms.

**Table 4-3
Earthwork Balance**

Structure	Cut (-) ⁽¹⁾ (yd ³)	Required Fill ⁽²⁾ (+) ⁽¹⁾ (yd ³)	Net (+/-) ⁽¹⁾ (yd ³)	Comments
Stripping/Stockpiling				
Topsoil	28,600 ⁽³⁾	11,400	+17,200	Refer to Note #3- Excess topsoil will be stockpiled
CWB #1 ⁽⁴⁾	28,800	1200	+27,600	--
CWB #2 ⁽⁴⁾	28,800	1200	+27,600	--
NCWIB #3 ⁽⁴⁾	15,700	1200	+14,500	--
NCWIB #4 ⁽⁴⁾	8,500	800	+7,700	--
NCWIB #5 ⁽⁴⁾	4,800	700	+4,100	--
NCWIB #6 ⁽⁴⁾	1,300	400	+900	--
TWIS ⁵	-----	29,800	-29,800	Five foot cover over infiltration piping
TDRSA	134,800	2,600	+132,200	--
Berms	-----	202,000	-202,000	See Figure 4-2
Total	251,300	251,300	0	

Notes:

CWB- Contact Water Basin

NCWIB- Non-Contact Water Infiltration Basin

TDRSA- Temporary Development Rock Storage Area

TWIS- Treated Water Infiltration System

⁽¹⁾ Cut, Fill and Net volumes are in cubic yards. Multiply cubic yards (yd³) by 0.7646 to get cubic meters (m³)

⁽²⁾ Cut/Fill volumes are rounded to the nearest one hundred yd³.

⁽³⁾ Topsoil quantity assumes an average of three inches across the mine and surface backfill sites. Also assumes that 40% of the total quantity will be used on-site during construction to revegetate the disturbed areas.

⁽⁴⁾ Assumes that CWB and NCWIB include a two-ft high berm around their perimeters, except the inlets, to prevent surface water run-on.

⁽⁵⁾ Five feet of cover soils placed over TWIS distribution piping.

Prepared by: REM
Checked by: JOSI

4.2.4 Development Rock Excavation and Storage

Prior to extraction of the ore, KEMC must remove rock from portals, drifts, raises, and ramps that are developed to access the ore body. This rock is referred to as development rock. Excavation of the subsurface mine facilities begins at the mine portal located on the west side of the rock outcrop as shown on Figure 4-2.

Development rock excavated to access the ore body will be hauled to the surface using lowprofile haul trucks and placed in the TDRSA and amended with limestone. Table 4-4 lists the estimated quantities in metric tons (tonnes) of development rock that will be produced during mine development and mining. Column 7 – *Backfill Rock Balance* – lists the annual rock balance based upon the backfill requirements for development rock. Excess development rock will be stored in the TDRSA for approximately 7 years. For the first 3 years of facility development, no stope backfilling is planned or required due to the sequential primary/secondary stope backfill plan which will maintain mine stability during this period. The peak tonnage of development rock to be stored in the TDRSA occurs in year 3, totaling 378,914 tonnes. Beginning with year 4, stored rock in the TDRSA will be reduced with mine backfilling.

**Table 4-4
Annual Development Rock Balance – Tonnes**

(1) Facility Development Year	(2) Excavated Development Rock	(3) Underground Road Bed Requirements	(4) Subtotal Development Rock Balance	(5) Cumulative Totals	(6) Secondary Backfill Requirements	(7) Backfill Rock Balance ⁽¹⁾ (Col 7 + Col 4 – Col 6)
1	147,557	2,819	144,738	144,738	0	+144,738
2	178,359	3,796	174,563	319,301	0	+319,301
3	60,462	849	59,613	378,914	0	+378,914
4	72,811	840	71,971	450,885	143,599	+307,287
5	45,047	712	44,335	495,220	111,092	+240,530
6	63,171	1,295	61,876	557,096	189,435	+112,971
7	79,872	1,712	78,160	635,256	146,409	+44,722
8	22,055	475	21,580	656,836	136,496	-70,194
9	6,591	88	6,503	663,339	209,388	-273,079
Totals	675,925	12,586	663,339		936,419	-273,079

Source: Adapted from McIntosh Engineering

1 tonne (metric ton) = 1.102 ton (short ton)

⁽¹⁾ Backfill deficit will be supplied by importation of aggregate

Prepared by: REM
Checked by: JOS1

4.2.5 Geology and Ore Resources

The Eagle nickel-copper sulfide mineralization is hosted in a 480-meter long, east-west-trending, ultramafic body which intrudes Proterozoic siltstones, sandstones, greywackes and slates. These sediments dip shallowly to the northeast and have been thermally metamorphosed in a 2-meter to 10-meter aureole around the ultramafic. Sediment-intrusive contacts are reasonably sharp and regular.

The intrusive is predominantly peridotite, dips sub-vertically or steeply northwards and is covered by unconsolidated fluvial-glacial till and outwash. It tapers from 100 m (~328 ft) wide at surface to a 5 m (~16 ft) to 10 m (~33 ft) wide dyke at the base. No major faults have been identified that offset the intrusive. Oxidation is negligible and primarily confined to a few tens of meters below the Quaternary sediments. A 3D representation of the deposit is shown in Illustration 4-1.

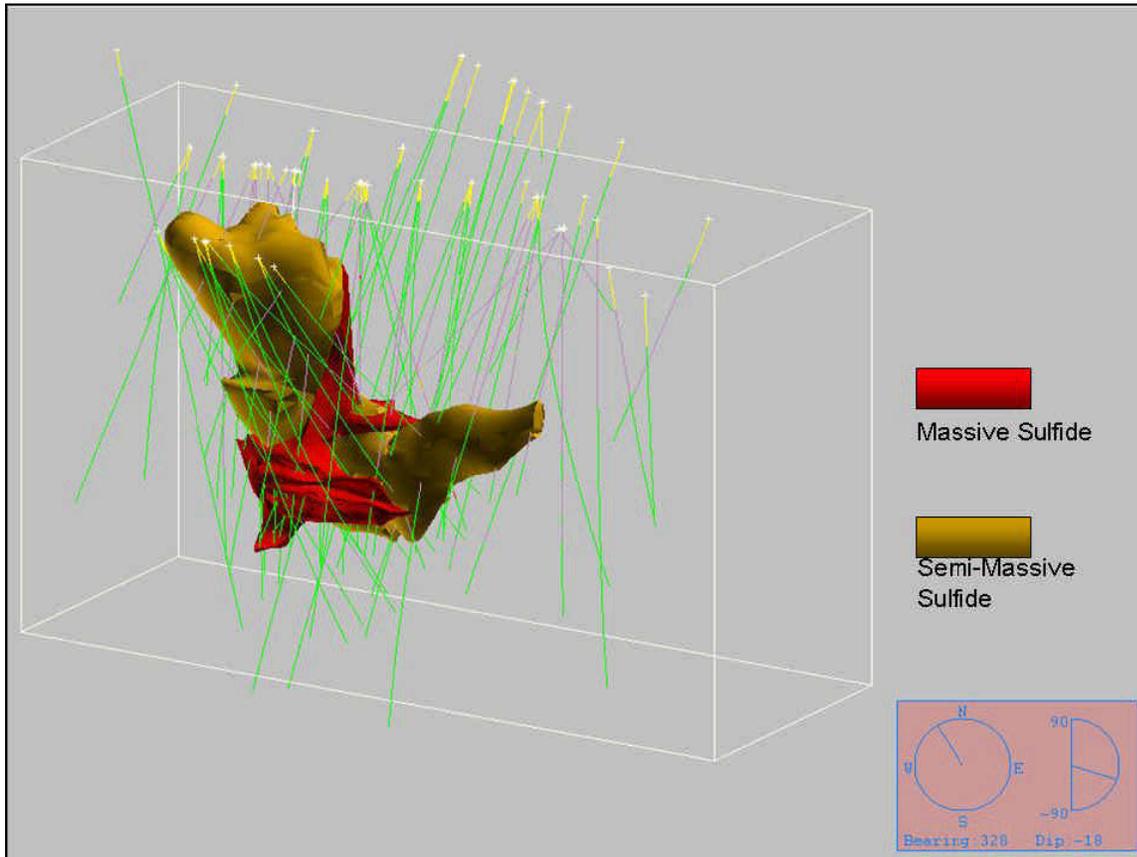


Illustration 4-1
3D Representation of the Section through Deposit looking North

Source: Kennecott Minerals Company.

The sulfide mineralization is divided into massive (>80% sulfide), semi-massive (30-80% sulfide) and disseminated (<30% sulfide) types. The massive sulfide and semi-massive sulfide are distinct phases of mineralization. The geologic resource model is based on information from exploration drill holes, and uses separate wire-framed bodies for the massive sulfide, the semi-massive sulfide and the ultramafic intrusion. Metal grades and densities were interpolated using an inverse-distance-squared (IDS) averaging routine. The total geologic resources based upon this modeling are shown in Tables 4-5 and 4-6. The projected mineable resource as presented in Table 4-1 is 3,419,453 tonnes which is approximately 42% of the total geologic resource (peridotite) and approximately 84% at the massive and semi-massive sulfide units.

**Table 4-5
Geologic Resource by Zone**

Zone	Tonnes (million)	Cu %	Ni %	Au g/t	Co g/t
Massive Sulfide	1.477	4.15	6.11	0.32	0.17
Semi-Massive Sulfide					
Western Zone	1.914	2.33	2.09	0.28	0.05
Eastern Zone	0.659	1.80	2.18	0.23	0.06
Total Semi-Massive Sulfide	2.573	2.19	2.12	0.27	0.06
Total MSU and SMSU	4.050	2.91	3.57	0.28	0.10
Peridotite	8.064	0.41	0.54	0.05	0.02

g/t = grams per tonne, % = percent
Source: Kennecott

Prepared by: REM
Checked by: JOS1

**Table 4-6
Geologic Resource by Class**

Class	Tonnes (million)	Cu (%)	Ni (%)	Au (g/t)	Co (%)
Indicated	3.585	3.00	3.75	0.29	0.10
Inferred	0.465	2.20	2.21	0.22	0.06
Total	4.050	2.91	3.57	0.28	0.10

g/t = grams per tonne, % = percent
Source: Kennecott

Prepared by: REM
Checked by: JOS1

4.2.6 Geochemistry of Ore, Waste Rock and Peripheral Rock

A detailed description of the geochemistry of the Eagle deposit is provided in the Eagle Project Phase I and Phase II geochemistry reports prepared by Geochimica, Inc. (2004 and 2005). Copies of these reports are provided in Appendix D. Descriptions of the geochemical analysis of the water pumped from the mine and TDRSA during operations, and post-reclamation underground water quality in the reclaimed mine are also provided in Appendix D.

4.2.7 Plans to Limit Access to the Facility

Access to the facility will be limited by the following design features:

- ? The Eagle Project surface facilities will be surrounded by a 8-foot high chain link fence.
- ? A single access road is proposed for the main surface facility that is gated and has a gatehouse manned during facility operation.
- ? The main surface facility is obscured from view by a tree covered rock outcrop and other tree covered areas;
- ? The excess soil berms constructed around the majority of the facility will further obscure the facilities from view and restrict site access.

4.3 Surface Facilities and Operations (see J.1.b for complete text), 4.3.1. Site Access, Parking and Roads, 4.3.2. Buildings and Structures, 4.3.3. Truck Wash and Scales, 4.3.4. Mine Portal, 4.3.5. Ore Conveying and Crushing, 4.3.6 Coarse Ore Storage Area, 4.3.7. Ore Transportation, 4.3.8. Ventilation Shaft, Section 4.5.2. 4.3.9. Temporary Development Rock Storage Area, 4.3.10. Storm Water Management Systems, 4.3.10.1 Operations Area Storm Water, 4.3.10.2. Non-Contact Storm Water, 4.3.10.3. Soil Erosion and Sediment Control Plan, 4.3.10.4. Soil Erosion and Sediment Control Plan During Construction, 4.3.10.5. Soil Erosion and Sediment Control During Operations, 4.3.11. Site Utilities, 4.3.11.1. Electric Service, 4.3.11.2. Mine and Surface Facilities Heating, 4.3.11.3. Telephone Service, 4.3.11.4 Potable Water, 4.3.11.5. Sanitary System, 4.3.12. Water Usage, Treatment and Discharge, 4.3.13 Backfill Aggregate Stockpiles, 4.3.14 Security and Access Control, 4.3.15 Aesthetics and Landscaping, 4.3.16 Fuel Handling and Chemical Storage, 4.3.17 Blasting Materials Handling and Storage, 4.3.18 Spill Prevention and Countermeasures Plan.

4.4 Underground Mine Description (see J.1.c.(1c) for complete text) 4.4.1 Mine Design and Layout, 4.4.2 Mine Access, 4.4.3 Transverse Blasthole Stopping, 4.4.4 Production Drilling and Blasting, 4.4.4.1 Production Drilling, 4.4.4.2 Production Blasting, 4.4.5 Level Development and Stope

Sequence 4.5 Underground Facilities (see J.1.c.(1c) for complete text) 4.5.1 Mine Dewatering System 4.5.2 Mine Ventilation Systems, 4.5.3 Underground Ore Handling Systems, 4.5.4 Communication Systems, 4.5.5 Sanitation Systems, 4.5.6 Underground Electric Supply 4.5.7 Compressed Air System, 4.5.8 Mine Utility Water

4.6 Mine Backfill

Mine backfilling will be conducted in mined out stopes concurrent with the mining of new stopes. The primary stopes will be backfilled using cemented aggregate. The secondary stopes will be backfilled either with limestone amended development rock or other aggregate fill material. The estimated amount of material for secondary backfilling is 936,419 tonnes (Table 4-4). Table 4-9 summarizes the total required primary and secondary backfill tonnage. will feed the aggregate silo. The capacity of the silo is approximately 800 tonnes. If needed, aggregate will be stockpiled at the surface near the raise. Cement and fly ash storage silos will be located on the surface providing 110 tonnes of capacity each. Once the cement/fly ash is thoroughly blended, the mix will be discharged to an underground binder bin via a cased 250 mm (~10 in) diameter borehole, feeding a colloidal mixer. It is estimated that cement binder will be approximately 6% by weight. The binder mix is estimated to be a 50:50 proportion of cement and Class C fly ash.

**Table 4-9
Mine Backfill Requirements**

Backfill Type	Quantity (tonnes)
Primary Backfill	1,766,867
Secondary Backfill	936,419 ⁽¹⁾
Total	2,103,288

⁽¹⁾ Excluding 12,586 tonnes placed as underground roadbed during mine operations
Adapted from McIntosh Engineering

Prepared by: JOS1
Checked by: SVD1

4.6.1 Mine Stability and Subsidence Prevention

Golder Associates conducted mine stability and ground surface subsidence modeling as documented in Appendix C. Both plastic and elastic deformation of the crown pillar rock mass were evaluated. Plastic deformation is defined as the collapse and subsequent unraveling and bulking of the displaced rock mass. Elastic deformation is the displacement of the rock mass by “bending” over a void space. Plastic and elastic deformation are both a function of the effectiveness of the backfilling plan. The analyses presented in Appendix C show that plastic deformation will not occur with the proposed stope backfilling plan. Plastic deformation of the crown pillar will be limited to no more than 2 cm at the bedrock/alluvial contact. Given this small displacement, movement at the ground surface will not be measurable. KEMC will conduct subsidence monitoring during operations and during the 20 year post-reclamation monitoring period.

The mine decline stability was also assessed by Golder Associates and determined to be stable without backfilling. As such, backfill of the mine decline will only occur at specific locations to prevent interconnection of different groundwater regimes as described in the reclamation plan in Section 7. As needed, rock support mechanisms such as roof bolting may be employed to stabilize the decline roof at discrete locations.

DNR Comments

While subsidence monitoring will be performed, no plan of monitoring is proposed. DNR requires a plan for monitoring subsidence during the mining, reclamation, and post reclamation periods.

5 Treatment and Containment Plan for Mine Related Material

This treatment and containment plan has been prepared in accordance with R 425.203(h) and R 425.409. This plan describes measures to prevent impacts to groundwater and surface water and applies to all reactive earthen materials. Treatment and containment facilities as part of this plan will include the TDRSA and COSA. Plans for addressing the potential for leaching of mining related constituents from the peripheral rock to the aquifer at the site is addressed in the reclamation plan for the underground mine in Section 7 and the contingency plan in Section 8. Note that the treatment and containment plan for the TDRSA and COSA as well as the reclamation of the underground mine is designed to protect groundwater in aquifers per the definition of an aquifer in R425.102(1)(c). As such, protection of groundwater quality in the alluvial aquifer consisting of glacial outwash and till and its associated surface water systems are the design objective for the treatment and containment plan.

5.1 Temporary Development Rock Storage Area

The TDRSA is designed to temporarily store development rock generated during mine development from the decline, drifts, levels, raises and other underground workings needed to access the ore body. Table 4-4 provides a list of the quantity of development rock removed each year and temporarily stored in the TDRSA. The development rock will be hauled to the surface and placed in the TDRSA. The size of the TDRSA is based on the mine planning and operations information developed by KEMC and the geochemical analysis completed by Geochimica, Inc. (Appendix D). This information forms the basis of the design and includes the following:

- ? The TDRSA is a temporary facility that will be operated for a period of about seven years;
- ? The maximum quantity of development rock that will be stored in the TDRSA is 189,500 m³ (247,900 yd³).
- ? The development rock that is stored in the TDRSA will be amended with approximately 7,800 tonnes of high calcium limestone to:

 - ? Add additional neutralizing capacity to the TDRSA.
 - ? Reduce the concentration of pH sensitive metals in the contact water that is collected in the contact water collection system of the TDRSA.

5.1.1 Design Objectives of the TDRSA

The primary function of the TDRSA is to provide for environmentally secure surface storage of development rock generated during the mining process until the rock can be returned to the mine as backfill. The major design objectives for the TDRSA are:

- ? To design, construct and operate the facility using sound engineering practices and in compliance with the standards prescribed in R 425.203(h) and R 425.409.
- ? To locate the facility to avoid impacts to wetlands and surface water bodies and achieve isolation from groundwater and protection of groundwater quality in the regional alluvial aquifer.
- ? To size the facility to accommodate excess development rock to be generated throughout the Eagle Project life.
- ? To limit oxidation of the development rock to the extent practicable over the life of the facility with the following design features.
- ? Treat the development rock with high-calcium limestone to reduce the potential for development of ARD;
- ? Design and construct the base liner system and contact water collection system to effectively contain the development rock and contact water that drains from the rock.
- ? Cover the areas of the TDRSA that are filled to grade with a temporary geomembrane cover to minimize development rock contact with precipitation.

The location and design of the TDRSA are described below along with a discussion of the rationale for selecting each of the components.

5.1.2 Facility Location

The location of the TDRSA was selected with the goals of minimizing impacts to the environment and maintaining the aesthetics of the view corridors from the Triple A Road. Figure 4-2 and 4-3 show the location of the TDRSA in relation to other site features. The following are some of the separation distances and design features regarding the facility location:

- ? The TDRSA is located in an area where groundwater in the alluvial aquifer flows northeast, away from the Salmon Trout River Main Branch.
- ? The TDRSA is located approximately 731 m (~2,400 ft) northeast of the closest surface water body, the Salmon Trout River Main Branch;
- ? The TDRSA is located approximately 518 m (~1,700 ft) north of the closest wetland that is located south of Triple A Road.
- ? The subgrade (bottom of the proposed composite liner system) of the TDRSA is approximately 13.7 m (~45 ft) above the groundwater in the glacial alluvium.
- ? The majority of the TDRSA is located in an existing open clear-cut area.
- ? The TDRSA is located approximately 290 m (~950 ft) north of the Triple A Road at its closest point.

5.1.3 Design Volume

Table 4-4 presents the volume of development rock that will be stored in the TDRSA over the nine year life of the facility. The maximum anticipated volume based on the expected mine development schedule is 189,500 m³ (~247,900 yd³). To account for variable development rock quantities and the addition of limestone, a contingency volume of 15% is included, resulting in a design volume of 217,925 m³ (~285,000 yd³). This volume includes the limestone that will be added to the development rock. If additional volume is required the final surface slopes can be steepened without compromising the stability of the facility. The capacity of the TDRSA is the volume derived from the difference between the base grades, Figure 5-1, and the final grades, Figure 5-2.

5.1.4 Subgrade Design

The TDRSA subgrade and perimeter berm are the earthen structures on which the liner and contact water collection system are placed. Figure 5-1 shows the TDRSA basegrade which is the top of the composite liner. The subgrade of the TDRSA is founded in medium dense fine to medium, medium, and medium to coarse sands with typically less than 5% passing the number 200 sieve (P200). These soils are typically poorly graded sand (SP) per the Unified Soil Classification System (USCS). The subgrade has been designed to comply with R 425.409(a)(i)(C) to limit the head on the liner (except for the leachate collection sump) to one foot or less. The base grade configuration shown on Figure 5-1 includes the following: ? 2% slope from the interior sideslopes to the leachate collection pipes. ? 0.5% slope on the leachate collection system piping to the leachate collection sump. ? 3:1 (H:V) inside sidewall slope to the floor. During excavation for the TDRSA the subgrade surface will be observed by a qualified field technician. Any observed unacceptable subgrade areas will be over-excavated and reconstructed with compacted fill soil.

5.1.5 Composite Liner

A composite liner system as shown on Figure 5-3 was selected for the TDRSA consisting of the components listed below from bottom to top: ? A prepared subgrade as described previously; ? A geosynthetic clay liner (GCL). The GCL consists of granular bentonite clay encased within two non-woven geotextile fabrics. The GCL is an alternative to a 3-ft thick compacted clay layer as prescribed under R 425.409(a)(i)(B). This component has a saturated hydraulic conductivity of 1×10^{-10} cm/sec; less than the 1×10^{-7} cm/sec prescriptive requirement for the clay liner. ? A 60-mil high density polyethylene (HDPE) geomembrane. A 60 mil HDPE is selected because of its very low permeability and compatibility with contact water chemistry.

5.1.5.1 Geosynthetic Clay Liner (GCL) Equivalence

Pursuant to R 425.409(a)(i)(B), KEMC is proposing an alternative liner design consisting of a 60-mil HDPE geomembrane liner underlain by a GCL. A water balance model using the Hydrologic Evaluation of Landfill Performance (HELP) model evaluated the equivalency of the proposed liner design to the prescriptive liner components specified in R 425.409(a)(i)(A). Based upon the analysis presented in Appendix F, the proposed alternative design provides better protection to the environment than the prescriptive design. Based on HELP model analysis of the prescriptive requirements in R 425.409 and the alternative design proposed here, the theoretical leakage through the alternative liner design is 0.000511 inches per acre-day compared to the prescriptive liner design of 0.01022 inches per acre-day, which is 20 times less than the prescriptive design. The proposed design will also provide greater collection efficiency for contact water collection. The HELP model is an analytical tool that evaluates the theoretical water balance through the system. HELP model predicted leakage rates should only be evaluated on a comparative basis considering different liner systems. It is KEMC's intent to design a system that will not leak. Actual experience with the use of GCLs over the last 10 years has been very favorable for such applications. The MDEQ permits the use of GCLs for municipal solid waste landfill liner systems which have a potential to be in contact with a much more concentrated mixture of chemicals. The successful use of GCLs for mining and landfill applications is well documented around the U.S. by numerous state agencies including the MDEQ solid waste staff.

5.1.5.2 Liner Stability Analysis

Stability analysis of the TDRSA was conducted to evaluate the strength of the liner components for the following operational conditions. ? Interim filling where the TDRSA is active and filling is occurring, which results in the steepest interim slope; and, ? Final build-out configuration where the TDRSA is filled to its design capacity. The analyses were conducted using the PC STABLE computer program which evaluates potential failure surfaces using limit equilibrium methods. Based upon published shear strength test results for similar liner system components (referenced in Appendix G) the analysis used a minimum interfacial friction of 18° ($\phi = 18^\circ$). Both random and block failure surfaces were investigated to determine the critical factor of safety. Water levels were also introduced in the analysis assuming the TDRSA under the CWBs contingency plan would temporarily store excess pretreated water. Water level elevations were assumed to be 15 ft deep (top of perimeter berm at final build-out) and 4 ft and 9 ft deep (1 ft below the top of rock work working level) for interim conditions. Results of the analysis are presented in Table 5-1.

**Table 5-1
Summary of TDRSA Stability Analysis**

Condition	Factor of Safety			
	w/o Water		w/Water ⁽⁴⁾	
	Block	Random	Block	Random
Interim ⁽¹⁾				
• 5' (rock on floor) ⁽²⁾	1.23	2.02	1.13	1.96
• 10' (rock on floor) ⁽³⁾	1.36	1.91	1.36	1.78
Final Build-Out ⁽⁴⁾	3.64	5.18	3.05	3.97

⁽¹⁾ Interim slope is 1:1 (H:V)

⁽²⁾ 5 ft of rock present on base having a maximum outslope differential height of 35 ft.

⁽³⁾ 10 ft of rock on the base having a maximum outslope differential height of 45 ft.

Prepared by: JOS1
Checked by: SVD1

The stability calculations are provided in Appendix G. Results of the analyses indicate that the TDRSA will be stable and the liner system has adequate strength under the anticipated loading conditions. Under interim conditions, to maintain a factor of safety greater than 1.1, it is recommended that at least five feet of development rock be initially placed across the base. Under this condition, the maximum interim differential height should not exceed 35 ft above the top of rock on the base. If ten feet of development rock is initially placed across the base, the differential height should not exceed 45 ft. These analyses assume the foundation soils will be stable based upon the construction practices described in Section 5.1.4. Review of data from soil borings completed within the vicinity of the TDRSA shows the subsoils generally consist of medium to medium dense sands. The relative density of these soils would relate to a shear strength (i.e. friction angle) greater than the liner system components. As such any critical failure surface would have to propagate between the liner components having lower shear strength. Stability of the liner system was also conducted during simulated operations when loaded low profile haul trucks ramp down to the TDRSA floor. Because of the weight of these vehicles, stress to the underlying liner system was evaluated to verify stable conditions. This stability analysis of the liner system was evaluated using infinite slope concept whereby the calculated factor of safety against instability is a function of the liner system resistive forces divided by the driving forces. Results of this analysis are presented Table 5-2.

**Table 5-2
Summary of Stability Analysis
for Liner System**

Condition	Factor of Safety
Static Slope	2.8
Vehicle Load	2.5

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Checked by: SVD1

Because the calculated factor of safety exceeds a minimum allowable design factor of safety of 1.1, it is determined that the liner system below the access ramp will be stable during operations. Results of this analysis are also presented in Appendix G. Details of the access ramp are shown on Figure 5-4.

5.1.5.3 Chemical Compatibility of the TDRSA Liner System and Contact Water

Chemical deterioration of TDRSA geomembrane liner due to contact water is expected to be negligible due to the benign chemistry of the contact water and due to the short design life of the facility. Unless the geomembrane has leaks, no contact water will reach the GCL. Therefore, potential modes of chemical deterioration of the liner system for the TDRSA are focused on the chemical compatibility of the TDRSA water with the bentonite material in the GCL. Analysis of the expected water chemistry of the contact water in the TDRSA filled with limestone amended development rock is provided in Appendix D-3. Considering a wide range of permeants, potential modes of deterioration of bentonite are generally associated with chemical interactions that hinder the natural swelling of the bentonite when hydrated. Chemical factors include double layer compression. This can occur from: ? Permeants with high electrical conductivity. ? Permeants with high ionic strength. ? Permeants with ionic exchange of sodium (the cation that promotes swelling) with calcium or other divalent cations.

Deterioration can occur with permeants of extremely high or low pH ($12 < \text{pH} < 2$). Based upon the water chemistry analysis conducted for the TDRSA contact water, pH will be neutral, around 6. However, the effect is greatly reduced when there is pre-hydration of the bentonite (Ruhl and Daniel, 1997). Chemical deterioration caused by organic solvents can occur because of dielectric modification. However, no solvents are expected in the TDRSA contact water and this effect is greatly reduced when the primary liquid is water and the organics are miscible (Shackelford 1994). Chemical compatibility of the Permeant and the GCL is also highly dependent on the level of percolation expected. The level of percolation may be measured by pore volumes of flow, the volume of percolation normalized to the pore volume within the bentonite clay. The damaging effects of more aggressive permeants may occur after several pore volumes of flow. More moderate incompatibility effects, such as cation exchange with moderate concentrations of calcium and other divalent metals, may require many pore volumes of flow. For the case of the proposed TDRSA contact water drainage and liner system, total theoretical percolation would not be measurable. Estimates for liner percolation and drainage system performance were developed using Visual HELP Version 2.2.0.3 (Waterloo Hydrogeologic, Inc., Waterloo, Ontario). Using conservative assumptions for the buildup of head in the drainage layer, the model outcome for total theoretical percolation over the 7-yr period of operation was 0.004 cm (0.0014 in). Assuming a bentonite-layer thickness of 0.91 cm (0.030 ft) and a total porosity of 0.75, the total theoretical percolation is less than 1/100th of a pore volume of the GCL. As such, physical characteristics of the GCL such as permeability will not be altered. Since the TDRSA water will be composed of modest concentrations of ions and is expected to have a near-neutral pH, the potential for deterioration of the liner systems is negligible. In addition, the amount of percolation is so minimal that, if there was a potential for deterioration, the deterioration of the composite liner performance is unlikely because the opportunity for permeant contact and fluid exchange is greatly limited.

5.1.6 Water Collection System

Details of the contact water collection system are shown on Figure 5-5. The contact water collection system overlying the TDRSA composite liner consists of the following components: ? A 12-in. thick granular drainage material having a minimum hydraulic conductivity of 1×10^{-3} cm/sec. ? A geocomposite drainage fabric consisting of a geonet encased between two 10 oz/yd² non-woven geotextiles sloping 2% toward a 6-in diameter perforated HDPE collection pipe. ? A 6-in diameter perforated HDPE pipe sloping 0.5% to the collection sump. Surrounding the 6-in diameter HDPE collection pipe will be a coarse aggregate envelope having a minimum hydraulic conductivity of 1×10^{-1} cm/sec. Details of the collection pipe trench are shown on Figure 5-5. Pursuant to Rule 425.409 (a)(i)(E), a water balance analysis was completed using the Hydrological Evaluation of Landfill Performance (HELP) model to demonstrate the proposed water collection system will maintain less than one-foot of head on the TDRSA liner (excluding the collection sump). HELP model results are presented in Appendix F. The HELP model evaluated a worst case precipitation (peak precipitation recorded for Houghton, Michigan over a 7 year period) when the TDRSA facility is open, without the cover system in place. The maximum daily precipitation during this period is 3.21 inches (1991). Based upon the results of the HELP analysis for this severe condition, the proposed collection system will provide approximately 100 percent collection efficiency, having no more than 0.175 inches of head build-up on liner during a peak daily event, less than the 12-in requirement. System water collection efficiency is the total amount of water collected and removed by drainage layer divided by the total water coming to drainage layer. The strength of the 10 oz/yd² geotextile casing of the geocomposite was evaluated for burst resistance, tensile strength and tear resistance based upon the peak vehicular loads. These analyses assumed a worst case tire contact pressure of 100 psi applied to a ¾-in stone particle size. The calculated strength factor of safeties (FS) for the geotextile are summarized in Table 5-3:

Table 5-3
Summary of Geotextile Strength Calculations

Condition	Calculated F.S.	Minimum Design F.S.
Burst Resistance	16.8	1.3
Tensile Strength	24.4	1.3
Tear Resistance	8.8	1.3

Prepared by: JOS1
Checked by: SVD1

For this design evaluation, a minimum factor of safety of 1.3 is applicable based upon consequence of failure and accepted engineering practice. The calculated factor of safeties exceed the minimum design criteria. As such the 10 oz/yd² geotextile will have adequate strength for the anticipated peak stress imposed by high vehicular contact pressures. Because the geotextile has adequate strength,

the encased geonet will not be influenced by stone penetration. The geotextile calculations are provided in Appendix H.

Pipe strength calculations were performed to demonstrate that the proposed 6-in diameter SDR- 11 HDPE collection pipe will remain stable under the proposed overburden of the amended development rock. The analysis was conducted using the modified Spangler equation which evaluates the maximum pipe deflection due to the overburden pressure. Based upon this analysis, pipe deflection under the peak overburden pressure will not exceed 3.5 percent, less than the manufacturer's allowable deflection of 5 percent. In addition, pipe wall buckling analysis was performed using the Von Mises Formula. The analysis shows that the pipe wall strength is three times greater than the peak stress due to the development rock overburden. As such, the 6-in diameter HDPE pipe will be stable under the maximum loading conditions in the TDRSA. The pipe strength calculations are provided in Appendix H.

5.1.7 Contact Water Extraction System

The contact water extraction system consists of the following components: ? A collection sump measuring approximately 10-ft by 10-ft by 3-ft deep, having a 1,900-gallon capacity. ? 18-in diameter perforated HDPE extraction riser, approximately 50 ft long. ? 50-gpm pump installed down the riser. Design calculations for the pump capacity are presented in Appendix H. Details of the contact water extraction system are presented in Figure 5-6. The collection sump has a capacity of 1,900 gallons. From HELP analysis, the peak flow rate (based upon the maximum daily precipitation during a peak 7 year event recorded at Houghton, Michigan) through the collection system to the sump will be 10.5 gpm. Assuming a drained sump, the time to fill the sump would be 178 minutes. Under this flow condition, a 50 gpm pump has been selected for use in the TDRSA primary extraction sump. Because this is a worst case flow condition (i.e., the facility open without the cover geomembrane installed) a smaller pump may be installed when the temporary cover has been placed. The pump sizing calculations are provided in Appendix H.

5.1.7.1 Collection Pipe Clean Out

Part of the contact water collection system will be sideslope clean-out risers for periodic cleaning of the 6-in diameter contact water collection line. The clean-out risers will be directly connected to the collection line to allow cleaning by high pressure water jet of the perforated collection line. Clean-out access will be provided at both north and south ends of the TDRSA to facilitate pipe cleaning from two sides of the TDRSA. Upon construction of the TDRSA the 6-in diameter SDR-11 HDPE collection line will be initially jetted to remove any sediments collected in the line during construction.

5.1.8 Leak Detection System

A leak detection system (LDS) is included in the design of the TDRSA to provide early warning of potential water leakage through the composite liner system. The LDS is provided at the low point of the TRDSA below the contact water collection sump as shown in Figure 5-6. The rationale for the LDS design is as follows: ? The TDRSA is a temporary containment facility to be in service for about seven years. As such there are no concerns over potential long-term leakage from the TDRSA. ? The TDRSA composite liner will be subjected to a rigorous quality assurance and quality control process that includes a leak location survey prior to use. The leak location survey tests the water tightness of the geomembrane after installation. As such the liner is tested under conditions that are expected to exist during operation of the TDRSA. ? The contact water collection sump is the low point in the liner system and will have a head on it the majority of the time. As such this location reflects the worst case conditions for the composite liner as related to potential leakage. ? A comprehensive groundwater monitoring program around the TDRSA is proposed in Section 6. The groundwater monitoring program consists of monitoring wells within 150 ft of the TDRSA that are monitored on a regular basis in accordance with R 425.406. The LDS for the TDRSA consists of the following components: ? An 18-in diameter HDPE extraction riser with a submersible sideslope riser pump. ? A collection sump measuring 10-ft by 8-ft by 2-ft deep, having a capacity of approximately 1,200 gallons. ? An underlying liner system to prevent release of detection liquid that will consist of a 60-mil HDPE underlain by a GCL. Construction QA/QC procedures for the entire TDRSA composite liner system including the subgrade, LDS, and liner will be conducted in accordance with the CQA plan provided in Appendix I.

DNR Comments There is no indication of a plan to address what Kennecott will do if a leak is detected. DNR believes there needs to be an approved leak detection response plan in place.

5.2 TDRSA Operations

The TDRSA will be operated to minimize generation of ARD through a combination of efficient filling sequence, amending the development rock with limestone, and placement of a temporary cover.

5.2.1 Filling Sequence

The filling sequence for the TDRSA is illustrated in Figure 5-7. Initially an access ramp will be developed to access the TDRSA bottom. Development rock having a typical 3-in to 4-in particle size will be unloaded at the base of the access ramp and graded two feet thick across the entire floor area. A five to 10-foot layer of development rock will then be placed entirely across the base before filling progresses to the peak build-out elevation. Filling will then proceed from north to south to the design grades as illustrated in Figure 5-7. During the filling sequence the outslope of the active face (outslope of unloaded rock) shall not exceed 1:1 (H:V). Table 5-4 shows the development rock quantities relative to the TDRSA filling sequence. Figure 5-7 illustrates the traffic pattern for entering and leaving the TDRSA. The traffic pattern may be modified based upon operational sequencing of filling and rock removal.

**Table 5-4
TDRSA Development Rock Filling**

Development Rock Generation Tonnes ⁽¹⁾	Development Rock Balance m ³ ⁽²⁾	Development Rock Balance yd ³ ⁽²⁾	Filling Sequence	Facility Development Year	Comments
144,738	72,400	94,700	1	1	Filling across floor area to 5 to 10 ft.
319,301	159,650	208,800	2	2-3	Filling progressing from north to south
378,913	189,500	247,900	3	4	Filling complete in year 4, 90% of facility has temporary cover installed
378,913	189,500	247,900	4	4	Temporary cover installation complete

Notes:

- 1) Development rock quantities from McIntosh Engineers.
- 2) Cubic meters and cubic yards rounded to the nearest hundred.

Prepared by: JOSI/REM
Checked by: SVD1

5.2.2 Temporary Cover

TDRSA will be a temporary storage facility for mine development rock. As in facility timeline shown in Table 4-4, the TDRSA will be at final grade in year 3. Rock removal for mine backfilling will begin in year 4. There will only be a short period of time (no more than 1 year) where the facility will be entirely capped with the temporary geomembrane cover. Because of the temporary and short term nature of this facility, a cover system has been designed that will not only limit precipitation contact with the development rock but will also provide KEMC with operational flexibility. A temporary cover will be placed over the development rock once final rock elevations have been achieved. Cover installation may occur in two phases, dependent upon fill rates. If fill rates are higher such that the TDRSA is filled to capacity in less than two years, then cover installation could occur in one sequence. The proposed temporary cover system for the TDRSA will consist of the following components from bottom to top.

? A geotextile fabric (if needed) will be placed on top of the development rock to prevent loss of the bridging layer into the development rock. ? A bridging layer (if needed) of smaller sized development rock (typically 3-in to 4-in. particle size) to bridge the larger rock yields. ? A 4-in to 6-in grading layer of select site soils or geotextile for geomembrane placement. ? A geomembrane consisting of a 30-mil PVC liner. ? A ballast system consisting of tethered sand bags will be anchored to the geomembrane. Details of the cover system in Figure 5-3. Cross sections of the TDRSA showing proposed cover elevation in Figures 5-8 and 5-9. Initially a non-woven geotextile may be placed over the development rock to prevent loss of the bridging layer into the development rock mass. A bridging layer will then be placed directly over the geotextile to support the sand grading layer (if needed). On-site soils will be used for the sand grading layer, placed 4-inches to 6-inches thick. Once the grading layer is placed, the geomembrane will be installed and will follow the construction quality control procedures specified in the CQA plan contained in Appendix I. Sand bags will be used as weights over the geomembrane. Because the TDRSA is a short term facility, a cover system comprised of permanent layered earth is not needed. As such, a ballast system comprised of tethered sand bags will be used to secure the geomembrane.

5.2.3 Removal Sequence

Removal of the development rock from the TDRSA will proceed from the north side of the facility to the south. First the temporary cover will be removed in 4 staged sequences to allow access to the underlying rock. Between each cover removal sequence, the underlying development rock will be excavated and returned to the mine. After all the development rock has been removed from a stage area, the underlying

contact water collection system and liner systems will be removed and disposed. During rock removal operations, at least two feet of granular material will be maintained over all active lined areas for liner protection. It is expected that development rock removal will occur in 4 stages over a 1 to 2-year period. As discussed in Section 5.1.5.2 in order to maintain stability of the liner system the maximum the differential height of the rock face will be limited to the height presented in Table 5-1.

DNR Comments It is not clear to what extent and for how long rock contained on the TDRSA will not be covered during the filling and removal sequences. DNR would like clarification regarding the timing of filling and removing rock with respect to the portions of the TDRSA that remain uncovered during those periods.

5.3 Quality Assurance and Quality Control for Liner and Cover Construction

During installation of the various liner components of the TDRSA, quality assurance and quality control activities will be performed to ensure that the liner is constructed in accordance to project specifications and permit requirements. This testing program will include, but not be limited to: ? field testing and on-site inspections, ? laboratory testing, and ? certification report preparation.

Construction quality assurance (CQA) procedures have been developed in accordance with Michigan's Solid Waste Management Rules and are discussed below. A CQA Plan for the construction of the TDRSA is provided in Appendix I.

5.3.1 Field Testing and Inspections

A CQA technician, experienced in construction documentation of the various liner components, will be on-site during construction of the TDRSA to provide construction observation, documentation, and testing as outlined in the CQA Plan. The technician will be under the supervision of a professional engineer registered in the State of Michigan. Continuous on-site inspections will be provided during all major construction activities of the TDRSA including subgrade preparation, liner system installation, and contact collection system installation.

5.3.2 Laboratory Testing

Laboratory testing will be performed as outlined in the CQA Plan. A qualified third-party laboratory will be contracted to provide the specified laboratory soils and geosynthetics conformance testing.

5.3.3 Certification Report

Following completion of liner installation and prior to placing the TDRSA into service, a certification report will be prepared, documenting that installation of the various liner components and the contact water collection system was performed in accordance with project specifications and manufacturer's specifications. The report will be certified by a professional engineer registered in the State of Michigan. Details of the certification report are provided in the CQA Plan in Appendix I.

5.4 COSA

As described in Section 4.3.6, the COSA will be constructed to contain mined ore. The COSA building will measure approximately 1,394 m² (15,000 ft²) having a storage capacity of 3,000 m³ (3,924 yd³). This building will be enclosed on three sides and constructed of steel framing and siding. A clear plastic drop door will be installed across the open site to minimize precipitation contact with the ore and reduce fugitive dust release. The floor of the COSA will be constructed of 12 in thick reinforced concrete sloping to a catch basin for collection of contact water. Any collected contact water will be pumped to the CWBs for treatment. Because the ore will contain no significant free water, very little contact water generation is expected. The COSA design features will provide adequate containment for the mined ore and will prevent exposure of it to the environment.

DNR Comments

The TDRSA consists of surface storage, cover for the rock to limit water infiltration, a liner and an underlain drainage system along with fluid testing. The rock stored at the TDRSA will not contain metallic ore mineralization, and therefore will contain a lower concentration of sulfide minerals than the ore. High calcium limestone will be blended with the mined rock to increase its ability to buffer acid releasing reactions. The storage is temporary and the rock will be placed back into the mine as part of on-going reclamation. The metallic ore rock to be stored at the COSA has a greater potential to form acid releasing reactions if allowed to get wet and is exposed to oxygen for a period of time. The mined ore rock will be brought from the mine and stored in the COSA on a specially constructed reinforced concrete floor. The COSA has a floor drain system and is enclosed under a solid roof with three solid walls and one flexible wall. The facility will minimize any precipitation from contacting the ore and keep fugitive dust from exiting

the facility. The location of the COSA is close to the proposed mine portal. Ore will be shipped on a regular basis from the COSA. The drain system will allow testing of any accumulated fluids prior to treatment and disposal. DNR believes that a secondary system or procedure needs to be designed to minimize the opportunity and duration for fluid accumulation in the sump or to provide early detection of any potential leakage from the COSA at the sump collection area

6 Operations Monitoring Plan

The operations monitoring plan described in this section is designed to meet the requirements of R 425.203 and R 425.406. The monitoring plan includes the following elements:

- ? Monitoring the TDRSA.
- ? Monitoring the geochemistry of the water pumped from the TDRSA and underground mine.
- ? Monitoring groundwater quality surrounding the Eagle Project facilities and mine.
- ? Monitoring regional streamflow and quality.
- ? Monitoring regional groundwater elevations.
- ? Monitoring flora and fauna.
- ? Inspection of berms and embankments.
- ? Miscellaneous operational monitoring activities for environmental protection.

Per R 425.203(g) this plan does not include monitoring that will be completed in accordance with the groundwater discharge permit, air permit or storm water construction and industrial storm water permits. Post-closure monitoring is described in the reclamation plan in Section 7.

6.1 Monitoring of the Temporary Development Rock Storage Area and Mine Water

TDRSA and mine water monitoring will consist of several elements which include:

- ? Monitoring the leak detection system beneath the TDRSA.
- ? Monitoring the head levels on the TDRSA liner.
- ? Monitoring the chemistry of the water pumped from the underground mine and TDRSA to the CWBs.

Table 6-1 Leak Detection System Sump Water Quality Parameters List

**Table 6-1
Leak Detection System Sump
Water Quality Parameters List**

Parameter	Analytical Method	Reporting Limit	Units
Sulfate	EPA-375.4/9038	1.0 ⁽¹⁾	mg/l
pH	Field Measurement	--	standard pH units

⁽¹⁾ Sulfate levels of approximately 500 mg/l will be indicative of leakage from the TDRSA composite liner.

Prepared by: SVD1
Checked by: JSK

**Table 6-2
TDRSA and Mine Water
Parameter List and Sampling Frequency**

Parameter	Frequency	Analytical Method	Method Reporting	
			Limit	Units
Alkalinity, Bicarbonate	Quarterly	310.1/SM 2320 B	2.0	mg/l
Alkalinity, Carbonate	Quarterly	310.1/SM 2320 B	2.0	mg/l
Aluminum	Annual	EPA-200.7/6010B	50	ug/l
Antimony	Annual	EPA-200.8/6020	2	ug/l
Arsenic	Quarterly	EPA-200.8/6020	1.0	ug/l
Barium	Annual	EPA-200.8/6020	10	ug/l
Beryllium	Annual	EPA-200.8/6020	1.0	ug/l
Boron	Quarterly	EPA-200.8/6020	50	ug/l
Cadmium	Annual	EPA-200.8/6020	0.2	ug/l
Calcium	Annual	EPA-200.7/6010B	0.50	mg/l
Chloride	Quarterly	325.2/4599-CL E	1.0	mg/l
Chromium	Annual	EPA-200.8/6020	1.0	ug/l
Cobalt	Annual	EPA-200.8/6020	10	ug/l
Copper	Quarterly	EPA-200.8/6020	1.0	ug/l
Fluoride	Annual	SM 4500 F-C	0.10	mg/l
Iron	Quarterly	EPA-200.7/6010B	20	ug/l
Lead	Annual	EPA-200.8/6020	1.0	ug/l
Lithium	Annual	EPA-200.7/6010B	10	ug/l
Magnesium	Annual	EPA-200.7/6010B	0.50	mg/l
Manganese	Quarterly	EPA-200.8/6020	10	ug/l
Mercury	Quarterly	EPA-1631E	0.25	ng/l
Molybdenum	Annual	EPA-200.8/6020	10	ug/l
Nickel	Quarterly	EPA-200.8/6020	1.0	ug/l
Nitrate	Annual	EPA-353.2/4500 N03F	0.05	mg/l
Potassium	Annual	EPA-200.7/6010B	0.50	mg/l
Selenium	Quarterly	EPA-200.8/6020	2.0	ug/l
Silver	Annual	EPA-200.8/6020	0.2	ug/l
Sodium	Annual	EPA-200.7/6010B	0.50	mg/l
Sulfate	Quarterly	EPA-375.4/9038	1.0	mg/l
Strontium	Annual	EPA-200.8/6020	50	ug/l
Thallium	Annual	EPA-200.8/6020	2	ug/l
Vanadium	Annual	EPA-200.8/6020	10	ug/l
Zinc	Annual	EPA-200.8/6020	10	ug/l
Field pH	Quarterly	Field	--	su
Specific Conductance	Quarterly	Field	--	umhos/cm

Prepared by: SVD1
Checked by: JSK

6.2 Groundwater Quality Monitoring

Groundwater quality monitoring around various Eagle Project facilities will be completed on a quarterly and annual basis. Monitoring of groundwater surrounding the TWIS is described in the *Groundwater Discharge Permit Application* (Foth & Van Dyke, 2006). As part of the Eagle Project operations, groundwater quality will also be monitored around the TDRSA, CWBs and the underground mine. A description of the background monitoring wells and the number and location of wells for each facility is provided in Sections 6.2.1 through 6.2.5(1). Groundwater elevation will also be measured each time a sample is obtained.

6.3 Regional Hydrologic Monitoring

As part of the operations environmental monitoring plan, KEMC will implement regional hydrologic monitoring program to evaluate local and regional streamflow and quality and local and regional groundwater elevations. Sections 6.3.1 and 6.3.2 describe the hydrologic monitoring that KEMC will implement per the requirements of R 425.203(g) and R 425.406.

6.3.1 Surface Water Monitoring, surface water flow and quality

Figure 6-2 displays the location of surface water monitoring stations that were employed for the baseline hydrologic studies that will be used for monitoring potential environmental impacts to streamflow and surface water quality. Four monitoring stations are included on the Salmon Trout River Main Branch. Two monitoring stations are located on the Salmon Trout River East Branch. One monitoring station is located on the Yellow Dog River. One monitoring station is located on the Cedar River and will be monitored to collect data in a reference watershed that will not be influenced by project activities.

**Table 6-3
Groundwater Quality Monitoring Program
Parameter List and Sampling Frequency**

Parameter	Frequency	Analytical Method	Method Reporting Limit	Units
Alkalinity, Bicarbonate	Quarterly	USEPA-310.1	2.0	mg/l
Alkalinity, Carbonate	Quarterly	USEPA-310.1	2.0	mg/l
Aluminum	Annual	USEPA-6010B	50	ug/l
Antimony	Annual	USEPA-6020	5.0	ug/l
Arsenic	Quarterly	USEPA-6020	2.0	ug/l
Barium	Annual	USEPA-6020	20	ug/l
Beryllium	Annual	USEPA-6020	1.0	ug/l
Boron	Quarterly	USEPA-6010B	100	ug/l
Cadmium	Annual	USEPA-6020	0.50	ug/l
Calcium	Annual	USEPA-6010B	0.50	mg/l
Chloride	Quarterly	USEPA-325.2	1.0	mg/l
Chromium	Annual	USEPA-6020	5.0	ug/l
Cobalt	Annual	USEPA-6010B	10	ug/l
Copper	Quarterly	USEPA-6020	5.0	ug/l
Fluoride	Annual	APHA 4500-F C	0.10	mg/l
Iron	Quarterly	USEPA-6010B	20	ug/l
Lead	Annual	USEPA-6020	1.0	ug/l
Lithium	Annual	USEPA-6010B	8.0	ug/l
Magnesium	Annual	USEPA-6010B	0.50	mg/l
Manganese	Quarterly	USEPA-6010B	20	ug/l
Mercury	Quarterly	USEPA-1631E	0.25	ug/l
Molybdenum	Annual	USEPA-6020	10	ug/l
Nickel	Quarterly	USEPA-6020	25	ug/l
Nitrate	Quarterly	USEPA-353.2	0.05	mg/l
Potassium	Annual	USEPA-6010B	0.50	mg/l
Selenium	Quarterly	USEPA-6020	1.0	ug/l
Silver	Annual	USEPA-6020	0.20	ug/l
Sodium	Quarterly	USEPA-6010B	0.50	mg/l
Sulfate	Quarterly	USEPA-375.4	2.0-5.0	mg/l
Strontium	Annual	USEPA-6010B	50	ug/l
Thallium	Annual	EPA-200.8/6020	2	ug/l
Vanadium	Annual	EPA-200.8/6020	10	ug/l
Zinc	Annual	USEPA-6020	10	ug/l
Redox	Quarterly	Field	NA	meV
Field pH	Quarterly	Field	NA	su
Groundwater Elevation	Quarterly	Field	NA	ft MSL
Specific Conductance	Quarterly	Field	NA	umhos/cm
Temperature	Quarterly	Field	NA	°C
Dissolved Oxygen	Quarterly	Field	NA	mg/l

NA = not applicable

Prepared by: SVD1
Checked by: JSR

**Table 6-4
Surface Water Quality Monitoring Program
Parameter List and Sampling Frequency**

Parameter	Frequency	Analytical Method	Method Reporting Limit	Units
<i>Field</i>				
Temperature	Quarterly	Field	NA	°C
D.O.	Quarterly	Field	NA	mg/l
Specific Conductance	Quarterly	Field	NA	umhos/cm
pH	Quarterly	Field	NA	su
<i>Metals</i>				
Aluminum	Annual	EPA-200.7/6010B	50	ug/l
Lithium	Annual	EPA-200.7/6010B	10	ug/l
Antimony	Annual	EPA-200.8/6020	2.0	ug/l
Arsenic	Quarterly	EPA-200.8/6020	1.0	ug/l
Barium	Annual	EPA-200.8/6020	10	ug/l
Iron	Quarterly	EPA-200.7/6010B	20	ug/l
Beryllium	Annual	EPA-200.8/6020	1.0	ug/l
Boron	Quarterly	EPA-200.8/6020	50	ug/l
Cadmium	Annual	EPA-200.8/6020	0.2	ug/l
Chromium	Annual	EPA-200.8/6020	1.0	ug/l
Copper	Quarterly	EPA-200.8/6020	1.0	ug/l
Cobalt	Quarterly	EPA-200.8/6020	10	ug/l
Lead	Annual	EPA-200.8/6020	1.0	ug/l
Manganese	Quarterly	EPA-200.8/6020	10	ug/l
Molybdenum	Annual	EPA-200.8/6020	10	ug/l
Nickel	Quarterly	EPA-200.8/6020	1.0	ug/l
Selenium	Quarterly	EPA-200.8/6020	2.0	ug/l
Silver	Annual	EPA-200.8/6020	0.2	ug/l
Zinc	Annual	EPA-200.8/6020	10	ug/l
Mercury	Quarterly	EPA-1631E	0.25	ug/l
<i>Anions</i>				
Alkalinity, Bicarbonate	Annual	310.1/SM 2320 B	2.0	mg/l
Alkalinity, Carbonate	Annual	310.1/SM 2320 B	2.0	mg/l
Chloride	Annual	325.2/4500-CL E	1.0	mg/l
Fluoride	Annual	SM 4500 F-C	0.10	mg/l
Nitrate-N	Annual	353.2/4500 NO3F	0.05	mg/l
Sulfate	Quarterly	EPA-375.4/9038	1.0	mg/l
<i>Cations</i>				
Calcium	Annual	EPA-200.7/6010B	0.50	mg/l
Potassium	Annual	EPA-200.7/6010B	0.50	mg/l
Magnesium	Annual	EPA-200.7/6010B	0.50	mg/l
Sodium	Annual	EPA-200.7/6010B	0.50	mg/l
Total Dissolved Solids	Quarterly	EPA-160.1	50	mg/l

Prepared by: SVD1
Checked by: JS

6.3.2 Regional Groundwater Elevation Monitoring

Figure 6-3 displays the wells that, in addition to those displayed on Figure 6-1, will be employed to monitor potential groundwater elevation changes due to mine dewatering. The regional monitoring wells cover an area of approximately 14 square miles. Groundwater elevation will be monitored on a quarterly basis coinciding with the quarterly monitoring events described in Section 6.2.

6.4 Groundwater and Surface Water Sampling Procedures

The collection of groundwater samples, water samples from the TDRSA and mine, and surface water samples will be completed in accordance with the Eagle Project Quality Assurance Project Plan and Standard Operating Procedures (North Jackson, 2004a and 2004b). These quality control documents have been previously provided to MDEQ and describe the following per R 425.203:

- ? Surface water sampling procedures
- ? Groundwater sampling procedures including well purging procedures.
- ? Procedures to prevent cross contamination of samples.
- ? QA/QC program including the use of field blanks and duplicates.
- ? Procedures for the collection of groundwater and surface water field data.
- ? Sample preservation, documentation and chain-of-custody procedures.
- ? Data validation procedures.
- ? Well installation development and abandonment procedures.

During operations groundwater and surface water quality data will be statistically assessed for distributional changes as a result of site activities.

6.5 Berms Embankments and Basins

The exterior containment berms and embankments of the TDRSA, CWBs and the NCWIBs will be inspected monthly or after any rainfall event that exceeds ½ inch in a 24-hour period. These inspections will identify preventative maintenance required to maintain stability of the berms and embankments. A surface inspection log will be maintained at the Eagle Project site that documents the results of these inspections. This includes involved ditches and culverts.

6.6 Biological Monitoring

Figure 6-4 shows the locations of monitoring stations and transects that were established as part of the baseline studies for threatened and endangered species and wildlife. Also displayed are mapped wetlands and the location of identified populations of the state-listed threatened plant species the narrow-leaved gentian as determined by Wetland and Coastal Resources, Inc. (WCR) (2005a). During operations, KEMC is proposing to implement a biological to document the condition of local biological resources.

6.6.1 Threatened and Endangered Species Monitoring

As documented in the EIA in Volume II of the application, the narrow-leaved gentian has been mapped in nearby locations in wetland fringe and upland areas and is not expected to be impacted by mine dewatering operations. As such no mitigation plans are required for this species. KEMC is proposing to document on an annual basis the health of the narrow-leaved gentian communities identified along the Salmon Trout River Main Branch south of the Triple A Road. The annual evaluation will include an assessment of local climatic conditions (drought, insect infestations, precipitation, etc.), photographic documentation and a visual description of the health of the colonies relative to other colonies that have been documented in the area as described in the EIA.

6.6.2 Wetland Monitoring

Wetlands in the Eagle Project area were identified and described by WCR. WCR, (2005b, 2006) identified the approximate size and location of wetlands which are shown on Figure 6-4. Figure 6-4 shows the location of selected wetlands adjacent to the ore body and mine site that will be monitored during mine operations and include the following:

? Ore body and backfill facility – wetland areas 1, 6, 7, 8, 9, 10, 11, 12 and 13. ? Mine surface facility – wetland area 26. The monitoring and observation of the wetlands listed above will include the following: ? Monitoring of shallow groundwater levels in nested wetland piezometers shown in Figure 6-5. ? An annual visual assessment of these wetlands for wetland vegetation. The wetland data collected will be submitted with the annual monitoring report required under R 425.501. The monitoring of wetland conditions will be completed to confirm EIA predictions on wetland impacts and will not be used for compliance assessment purposes.

6.6.3 Flora/Fauna Monitoring

WCR completed a field assessment of small mammals, birds, frogs and toads, along with their preferred habitats, during spring, summer and fall of 2004. The results of the assessment have been reported by WCR (2005c) and include habitat and wildlife typical of the Upper Peninsula of Michigan. During the initial assessment, seven wildlife sampling transects were established and surveyed. These transects and transect numbers are shown on Figure 6-4. The transects include 21 wildlife sampling stations and three frog/toad sampling stations located within the various habitat types. Flora and fauna monitoring during Eagle Project operations will include the following: ? Semi-annual (spring and fall) observations along the seven transects. ? Recording observations at the 21 wildlife sampling stations. ? Recording observations at the three frog/toad sampling stations. Observations will be documented and included with the Eagle Project's annual report required under R 425.501. The flora and fauna monitoring will be completed to confirm baseline conditions and document the trends and conditions of these resources during operations. The flora and fauna monitoring will not be used for compliance assessment purposes.

6.6.4 Aquatics

Figure 6-6 shows the location of aquatic monitoring stations that were established as part of the baseline study (WCR, 2005d). During operations KEMC will continue to monitor and assess the fisheries and aquatic macro invertebrate populations at these locations. Annual assessments will take place in late summer to early fall. The annual surveys will be documented and included in the Eagle Project's annual report required under R 425.501. The aquatic monitoring will be completed to confirm baseline conditions

and document trends and conditions of these resources during operations. The aquatic monitoring will not be used for compliance assessment purposes.

6.7 Miscellaneous Monitoring Activities

During operations other miscellaneous environmentally related monitoring activities will be implemented by KEMC. These activities are summarized in the following Table 6-5.

6.8 Minimization and Mitigation of Impacts

R 425.203(k) requires that an applicant for a mining permit prepare and submit plans to prevent, minimize and mitigate adverse impacts of the proposed mining operation on flora, fish, wildlife habitat and biodiversity. KEMC's mine planning team, described in Section 1 of this document, has thoroughly studied the environment in the vicinity of the proposed Eagle Project site. In so doing, the mining plans that have been developed and described in Sections 4, 5, 7 and 8 were designed to prevent and minimize adverse impacts on the surrounding environment. Mine facilities have been located away from wetland and surface water resources. Mine facility construction will not disturb any known listed species. Facilities are located in areas that have previously been disturbed by logging and thus unique habitats and biodiversity will not be affected. While a listed plant species, the narrow-leaved gentian, was found within riparian wetlands along the Salmon Trout River Main Branch, documented abundant populations in a variety of habitats (see EIA in Volume II of this application) indicate potential secondary impacts on the local populations will not affect the viability of the local identified communities.

As such KEMC is not proposing any additional mitigation measures outside of those that are incorporated into the mining plan.

**Table 6-5
Miscellaneous Environmental Monitoring
and Maintenance Activities**

Equipment or Area	Description	Preventive Maintenance	Corrective Maintenance Procedures	Equipment Requirements	Material Needs
TDRSA Contact Water Collection System and CWBs (TDRSA)	Side Slope Riser (SSR) Pump and Piping	<ol style="list-style-type: none"> Service pumps in accordance with the manufacturer's requirements Clean pump according to the manufacturer's recommendations Clean interior piping annually (if needed) Inspect liquid level sensor as per manufacturer's O&M manual 	<ol style="list-style-type: none"> Refer to manufacturer's O&M manual 	<ol style="list-style-type: none"> Refer to O&M Manual 	Refer to O&M Manuals
	Contact Water Collection Pipe	<ol style="list-style-type: none"> Jet annually 		<ol style="list-style-type: none"> Pipe jetting equipment supplied by vendor. 	
TDRSA Berms and other facility berms	Exterior Berms	<ol style="list-style-type: none"> Revegetate bare spots and eroded areas 	<ol style="list-style-type: none"> Repair eroded areas by filling with soil to grades and adding erosion mat prior to seeding Seed, fertilize and mulch 	<ol style="list-style-type: none"> Truck, small bulldozer, seeder 	Fill soil, topsoil, seed, fertilizer, mulch and erosion matting
Storm Water Management and Erosion Control Structure	NCWBs	<ol style="list-style-type: none"> Clean sediment from ponds as required to maintain infiltration Remove debris from ditches and basin bottoms as needed. 	<ol style="list-style-type: none"> Repair eroded inlet/outlet, dikes, etc. Repair eroded or silted in areas. Clean sediment from bottom as needed. 	<ol style="list-style-type: none"> Backhoe, truck, shovel 	Fill soil, erosion control materials (e.g., riprap, erosion mat)
	Ditches, Culverts, Spillways, etc.	<ol style="list-style-type: none"> Clean sediment from ditches. Clean culverts of debris. 	<ol style="list-style-type: none"> Replace rusted or damaged culverts. Repair eroded areas and install erosion control measures to remedy erosion. 	<ol style="list-style-type: none"> Backhoe, truck, shovels 	Fill soil, erosion control materials (e.g., riprap, erosion mat)
Access Roads and Interior Roads		<ol style="list-style-type: none"> Minimize mud tracking, remove as needed. 	<ol style="list-style-type: none"> Repair ruts, pot holes, etc. 	<ol style="list-style-type: none"> Truck, shovels 	Road gravel

Equipment or Area	Description	Preventive Maintenance	Corrective Maintenance Procedures	Equipment Requirements	Material Needs
Soil Stockpiles	Topsoil and other soil stockpiles	<ol style="list-style-type: none"> Maintain silt fences. Maintain other erosion control devices. 	<ol style="list-style-type: none"> Replace or repair silt fence as needed. Repair eroded areas including regrading and revegetation. Clean ditches where silt and/or sand has accumulated. 	<ol style="list-style-type: none"> Shovel, backhoe 	Silt fencing
Environmental Monitoring Devices	Groundwater Monitoring Wells	<ol style="list-style-type: none"> Mark wells with flag to prevent damage during other maintenance. Install protector pipes 	<ol style="list-style-type: none"> Repair/replace broken protector pipes, surface seals and locks 	<ol style="list-style-type: none"> Shovel 	Protector pipes, concrete lock-key set, PVC pipe
Security Devices	Means to Control Entry (fencing/gates) Exterior Lighting	<ol style="list-style-type: none"> Repair rusted or scratched areas. Replace burnt out bulbs. 	<ol style="list-style-type: none"> Repair or replace worn or rusty fences. Repair rusty or out of order locks, etc. 		Fence/gate parts and locks

Prepared by: REM
Checked by: SVD1

DNR Comments

Kennecott will monitor leak detection below the TDRSA, geochemistry and groundwater quality of the monitoring wells, surface water quality and stream flow, and other criteria as described in this section. Much of this is required by specific permits and reported to the DEQ but there is no mention of reporting monitoring results to the DNR. DNR requires an annual summary report of all environmental monitoring, testing, and inspection reports. Each annual report shall include January through December findings and be submitted by March 31 of the following year. Detections of leaks, operations that exceed their permit limits, or water inflow into the mine, which exceeds 300 gallons per minute, shall be reported to the DNR within 10 days or in a time frame as required by the specific permit.

7 Reclamation Plan (see J.1.c(2) for complete text), 7.1 Reclamation Sequencing and Timing, 7.2 Final Land Use, 7.3 Site Construction Reclamation, Surface Facilities, 7.4.1.1 TDRSA, 7.4.1.2 Roads and Access, 7.4.1.3 Buildings and Structures, 7.4.1.4 Surface Water Management Facilities, 7.4.1.5 Site Utilities, 7.4.1.6 Sanitary System, 7.4.1.7 Potable Water System, 7.4.1.8 Water Treatment System, 7.4.1.9 Earth Grading and Topsoil Placement, 7.4.1.10 Revegetation, 7.4.1.11 Erosion Control, 7.4.2 Underground Facilities, 7.4.2.1 Mineral Extraction Areas, 7.4.2.2 Ore Handling Systems

7.4.2.8.2 Mine Portal

Portal reclamation will include the removal of salvageable equipment and installation of a two-foot thick reinforced concrete plug at the portal opening. Any portion of the concrete plug that is exposed at the surface will be constructed with stone material obtained from the outcrop when the portal was developed.

7.5 Post-Closure Care and Monitoring

7.5.1 Post-Closure Care

Post-closure care will occur for 20 years after the completion of mine reflooding and surface reclamation. This activity will primarily consist of conducting quarterly site visits, observing site conditions, and conducting post-closure monitoring. Special attention will be paid to observing soil erosion or surface water runoff rills that would require restoration. If eroded areas are noted these areas will be graded, reseeded and mulched. Erosion control fencing will be applied as needed.

7.5.2 Post-Closure Monitoring Plan

Post-closure monitoring at the Eagle Project will include the following:

- ? Monitoring of groundwater and surface water quality for 20 years.
- ? Monitoring of flora and fauna for five years.
- ? Monitoring and maintenance (if needed) of the reclaimed areas.

7.5.2.1 Post Reclamation Groundwater Monitoring Plan

Figure 7-3 shows the reclaimed mine site and the location of groundwater quality monitoring wells that KEMC is proposing to monitor during the post-closure care period. Wells that are not included in the groundwater quality monitoring program will be abandoned after mine reflooding is completed. Monitoring wells around the former TDRSA and CWBs will be monitored in accordance with Table 7-4 until project year 22 to confirm that the TDRSA and CWBs did not release measurable quantities of constituents of concern to the subsurface. Wells around the reclaimed mine will be monitored for water quality parameters for a period of 20 years following reclamation of the WWTP. Figure 7-3 notes wells that are designated compliance wells and leachate monitoring wells per the requirements of R 425.406(5). Also displayed on Figure 7-3 are the locations of bedrock piezometers that will be used to monitor vertical gradients within the bedrock (Golder Associates, Inc. 2006).

**Table 7-4
Post-Reclamation Groundwater Quality Monitoring Program
Parameter List and Sampling Frequency**

Parameter	Frequency	Analytical Method	Method	
			Reporting Limit	Units
Alkalinity, Bicarbonate	Quarterly ⁽¹⁾	USEPA-310.1	2.0	mg/l
Alkalinity, Carbonate	Quarterly ⁽¹⁾	USEPA-310.1	2.0	mg/l
Aluminum	Annual	USEPA-6010B	50	ug/l
Antimony	Annual	USEPA-6020	5.0	ug/l
Arsenic	Quarterly ⁽¹⁾	USEPA-6020	2.0	ug/l
Barium	Annual	USEPA-6020	20	ug/l
Beryllium	Annual	USEPA-6020	1.0	ug/l
Boron	Quarterly ⁽¹⁾	USEPA-6010B	100	ug/l
Cadmium	Annual	USEPA-6020	0.50	ug/l
Calcium	Annual	USEPA-6010B	0.50	mg/l
Chloride	Quarterly ⁽¹⁾	USEPA-325.2	1.0	mg/l
Chromium	Annual	USEPA-6020	5.0	ug/l
Cobalt	Annual	USEPA-6010B	10	ug/l
Copper	Quarterly ⁽¹⁾	USEPA-6020	5.0	ug/l
Fluoride	Annual	APHA 4500-F C	0.10	mg/l
Iron	Quarterly ⁽¹⁾	USEPA-6010B	20	ug/l
Lead	Annual	USEPA-6020	1.0	ug/l
Lithium	Annual	USEPA-6010B	8.0	ug/l
Magnesium	Annual	USEPA-6010B	0.50	mg/l
Manganese	Quarterly ⁽¹⁾	USEPA-6010B	20	ug/l
Mercury	Quarterly ⁽¹⁾	USEPA-1631E	0.25	ug/l
Molybdenum	Annual	USEPA-6020	10	ug/l
Nickel	Quarterly ⁽¹⁾	USEPA-6020	25	ug/l
Nitrate	Quarterly ⁽¹⁾	USEPA-353.2	0.05	mg/l
Potassium	Annual	USEPA-6010B	0.50	mg/l
Selenium	Quarterly ⁽¹⁾	USEPA-6020	1.0	ug/l
Silver	Annual	USEPA-6020	0.30	ug/l
Sodium	Quarterly ⁽¹⁾	USEPA-6010B	0.50	mg/l
Sulfate	Quarterly ⁽¹⁾	USEPA-375.4	2.0-5.0	mg/l
Strontium	Annual	USEPA-6010B	50	ug/l
Thallium	Annual	EPA-200.8-6020	2	ug/l
Vanadium	Annual	EPA-200.8-6020	10	ug/l
Zinc	Annual	USEPA-6020	10	ug/l
Radon	Quarterly ⁽¹⁾	Field	NA	mBq
Field pH	Quarterly ⁽¹⁾	Field	NA	m
Groundwater Elevation	Quarterly ⁽¹⁾	Field	NA	RMSL
Specific Conductance	Quarterly ⁽¹⁾	Field	NA	umhos/cm
Temperature	Quarterly ⁽¹⁾	Field	NA	°C
Dissolved Oxygen	Quarterly ⁽¹⁾	Field	NA	mg/l

⁽¹⁾ After project year 27, parameters will be analyzed on an annual basis.

Prepared by: SVD1
Checked by: JSK

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7.5.2.2 Post Reclamation Surface Water Quality Monitoring Plan

Figure 7-4 shows the location of surface water monitoring stations that KEMC will use to monitor surface water quality during the 20-year post-closure care period. These monitoring stations will be sampled in accordance with the parameter and frequency list contained in Table 7-5.

7.5.2.3 Biological Monitoring

KEMC will continue the operational biological monitoring program described in Section 6 for a period of five years after reflooding of the underground mine.

7.5.2.4 Sampling Protocols

The sampling procedures and statistical methods used in the operational monitoring plan will continue to be used during the post-closure monitoring period.

**Table 7-5
Post Reclamation Surface Water Quality Monitoring Program
Parameter List and Sampling Frequency**

Parameter	Frequency	Analytical Method	Method Reporting Limit	Units
<i>Field</i>				
Temperature	Quarterly	Field	NA	°C
D.O	Quarterly	Field	NA	mg/l
Specific Conductance	Quarterly	Field	NA	umhos/cm
pH	Quarterly	Field	NA	su
<i>Metals</i>				
Aluminum	Annual	EPA-200.7/6010B	50	ug/l
Lithium	Annual	EPA-200.7/6010B	10	ug/l
Arsimony	Annual	EPA-200.8/6020	2.0	ug/l
Arsenic	Quarterly ⁽¹⁾	EPA-200.8/6020	1.0	ug/l
Barium	Annual	EPA-200.8/6020	10	ug/l
Iron	Quarterly ⁽¹⁾	EPA-200.7/6010B	20	ug/l
Beryllium	Annual	EPA-200.8/6020	1.0	ug/l
Boron	Quarterly ⁽¹⁾	EPA-200.8/6020	50	ug/l
Cadmium	Annual	EPA-200.8/6020	0.2	ug/l
Chromium	Annual	EPA-200.8/6020	1.0	ug/l
Copper	Quarterly ⁽¹⁾	EPA-200.8/6020	1.0	ug/l
Cobalt	Quarterly ⁽¹⁾	EPA-200.8/6020	10	ug/l
Lead	Annual	EPA-200.8/6020	1.0	ug/l
Manganese	Quarterly ⁽¹⁾	EPA-200.8/6020	10	ug/l
Molybdenum	Annual	EPA-200.8/6020	10	ug/l
Nickel	Quarterly ⁽¹⁾	EPA-200.8/6020	1.0	ug/l
Selenium	Quarterly ⁽¹⁾	EPA-200.8/6020	2.0	ug/l
Silver	Annual	EPA-200.8/6020	0.2	ug/l
Zinc	Annual	EPA-200.8/6020	10	ug/l
Mercury	Quarterly ⁽¹⁾	EPA-1631E	0.25	ug/l
<i>Anions</i>				
Alkalinity, Bicarbonate	Annual	310.1/SM 2320 B	2.0	mg/l
Alkalinity, Carbonate	Annual	310.1/SM 2320 B	2.0	mg/l
Chloride	Annual	325.2/4500-CL E	1.0	mg/l
Fluoride	Annual	SM 4500 F-C	0.10	mg/l
Nitrate-N	Annual	353.2/4500 NO3F	0.03	mg/l
Sulfate	Quarterly ⁽¹⁾	EPA-375.4/9038	1.0	mg/l
<i>Cations</i>				
Calcium	Annual	EPA-200.7/6010B	0.50	mg/l
Potassium	Annual	EPA-200.7/6010B	0.50	mg/l
Magnesium	Annual	EPA-200.7/6010B	0.50	mg/l
Sodium	Annual	EPA-200.7/6010B	0.50	mg/l
Total Dissolved Solids	Quarterly ⁽¹⁾	EPA-160.1	50	mg/l

⁽¹⁾ After project year 27, parameters will be analyzed on an annual basis.

Prepared by: EVIDI
Checked by: JHK

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7.6 Reclamation Costs

Total estimated reclamation cost for the Eagle Project is \$6,738,050, including a 10% contingency. Included with this cost is \$1,415,000 for post-closure monitoring. Reclamation line item costs are provided in Table 7-6. The summary reclamation cost is presented in Table 7-7.

The unit costs are based upon "Means Building Construction Cost Data" or engineering judgment from experience, assuming a third party would perform the work. The unit costs include labor, materials, and overhead and profit.

**Table 7-6
Reclamation and Monitoring Cost Estimate**

Item	Unit	Cost/Unit		Extension
		Years 1 and 2 (Site Construction)	Year 8 (TDRSA)	
1. Regrading	16 ac	\$1,000/ac		\$16,000
2. Install Erosion Control Devices (silt fence)	4,000 lf	\$2/lf		\$8,000
3. Seed/Mulch	16 ac	\$2,500/ac		\$40,000
4. Plantings (trees/shrubs)	80	\$100/planting		\$8,000
			Annual Cost	\$72,000
Year 8 (TDRSA)				
1. TDRSA Removal			Lump Sum	\$5,000
• Remove Salvageable Materials				\$35,000
• Remove 12" Drainage Layer	10,000 yd ³	\$3.50/yd ³		\$35,000
• Remove Geosynthetic Composites (HDPE/GCL/Geotextile)	each		Lump Sum	\$10,000
2. Regrade Area	145,000 yd ³	\$3/yd ³		\$435,000
3. Topsoil	6 acres	\$2,000/ac		\$12,000
4. Install (silt fence)	2,500 lf	\$2/lf		\$5,000
5. Seed/Fertilize/Mulch	6 acres	\$2,500/ac		\$15,000
			Annual Cost	\$517,000
Year 9 (Closure)				
1. Remove Salvageable Materials from Buildings	--		Lump Sum	\$25,000
2. Remove Site Utilities	--		Lump Sum	\$35,000
3. Demolish Buildings	10 structures	\$5,000		\$50,000
4. Dispose of Regulated Materials	2,000 tons	\$40/ton		\$80,000
5. Parking Lot Removal	7,000 sq	\$4/sq		\$28,000
6. Fence Removal	11,500 lf	\$2/lf		\$23,000
7. Regrading of Basins 3 & 4	34,000 yd ³	\$3/yd ³		\$102,000
8. Regrade Building Sites	3 acres	\$1,000/ac		\$3,000
9. Seed/Mulch Disturbed Areas	10 acres	\$2,500/ac		\$25,000
10. Install Silt Fence	2,000 lf	\$2/lf		\$4,000
			Annual Cost	\$375,000
Year 10 (Closure)				
1. Remove Surface Salvageable Materials			Lump Sum	\$50,000
2. Backfill Surface Razes and Cap	6,000 yd ³	\$12/yd ³		\$72,000
3. Install Mine Plugs	1,000	\$100/yd ³		\$100,000
4. Remove Site Utilities	--		Lump Sum	\$150,000
5. Demolish Buildings (completed)	--		Lump Sum	\$100,000
6. Dispose of Regulated Materials	500 tons	\$40/ton		\$20,000
7. Regrade Building Sites	10 acres	\$1,000		\$10,000
8. Seed/Mulch Disturbed Areas	20 acres	\$2,500		\$50,000
9. Install Erosion Control Devices (silt fencing)	2,000 lf	\$2/lf		\$4,000
10. Backfill Mine Portal	17,500 yd ³	\$12/yd ³		\$194,000
11. Remove Salvageable Materials from Underground	--		Lump Sum	\$100,000
12. TDRSA Backfilling	250,000 yd ³	\$3.50/yd ³		\$875,000
13. Backfilling Slopes ⁽¹⁾	50,000 yd ³	\$20/yd ³		1,000,000
14. Install Reflooding Walls	--		Lump Sum	\$50,000
			Annual Cost	\$2,765,000
Year 11 Closure				
1. Regrading of remaining disturbed areas	10 acres	\$1,000/acre		\$10,000
2. Seed/mulch disturbed areas	10 acres	\$2,500/acre		\$25,000
3. Install erosion control devices (silt fencing)	2,000 lf	\$2/lf		\$4,000
			Annual Cost	\$39,000

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Table 7-6 (con't)

Item	Unit	Cost/Unit		Extension
		Year 17	Years 20	
1. Closure of WWTP/Generator C/WBs	--		Lump Sum	\$50,000
2. Removal of Salvageable Materials	--		Lump Sum	\$50,000
3. Disposal of Non-Salvageable Materials	50 tons	\$40/ton		\$2,000
4. Regrading Disturbed Areas	11,000 yd ³	\$3/yd ³		\$33,000
5. Seed/Mulch Disturbed Areas	6 acres	\$1,000/ac		\$6,000
			Annual Cost	\$183,000
Years 20				
1. Well Abandonment	--		Lump Sum	\$200,000
Years 12-37 (Post-closure)				
1. Grading	5 acre	\$1,000/ac		\$5,000
2. Install Silt Fence	1,000 lf	\$2/lf		\$2,000
3. Seed/Mulch	5 acres	2,500/ac		\$12,500
			Annual Cost	\$19,500
Post-Closure Monitoring				
1. Groundwater (15 well locations)				
• Years 12-27/quarterly	\$1,000 per sampling event	\$1,000 x 15 wells x 4 times/yr x 15 yrs		\$900,000
• Years 27-37/annually	\$1,000 per sampling event	\$1,000 x 9 wells x 10 yrs		\$90,000
2. Surface water (5 sampling locations)				
• Years 12-27/quarterly	\$1,000 per sampling location	\$1,000 x 5 locations x 4 times/yr		\$300,000
• Years 27-37/annually	\$1,000 x 5 locations x 1/yr x 10			\$50,000
3. Biological Monitoring Transects ⁽²⁾	Lump Sum	\$15,000 per year x 5 yrs		\$75,000
			Total Monitoring Cost:	\$1,415,000

⁽¹⁾ Based upon the mine design no more than 4 slopes will be open at any point in time. Measuring 50 m by 30 m by 10 m.

⁽²⁾ Includes cost for material procurement, transportation and backfilling.

⁽³⁾ Threatened and endangered species monitoring will be performed in conjunction with wetland monitoring.

Closing References:

- CRS Means - Building Construction Cost Data, 2004
- Relevant Engineering Experience
- Analytical laboratory costs provided by a 3rd party contractor.

Prepared by: MIP
Check by: XOS

**Table 7-7
Summary of Reclamation and Monitoring Costs**

Year	Cost
1	\$72,000
2	\$72,000
8	\$517,000
9	\$375,000
10	\$2,765,000
11	\$39,000
17	\$183,000
20	\$200,000
12-37	\$19,500 x 25 yrs = \$487,500
Subtotal	\$4,710,500
Monitoring	\$1,415,000
Subtotal	\$6,125,500
Contingency @ 10% ⁽¹⁾	\$612,550
Total Reclamation & Monitoring Cost	\$6,738,050

⁽¹⁾ Contingency based upon engineering practice.

Prepared by: JOS1
Checked by: SVD1

DNR Comments Closure methods of the mine adit portal shall be discussed with and approved by DNR and DEQ within six months of the actual closure procedure to allow the use of most current approved materials and methods. Currently, DNR prefers 15 to 20 feet of rock backfill material from floor to ceiling be placed in the adit opening prior to the proposed reinforced concrete seal with additional bedrock rubble placed in front of the sealed entrance prior to backfill to the original ground elevation.

9 Financial Assurance

KEMC will provide financial assurance pursuant to R 425.301. This section presents the financial assurance including site reclamation and post-closure monitoring costs, MDEQ administrative costs, and operating and environmental contingency costs. The financial assurance cost elements are summarized in the following Table 9-1. The total estimated financial assurance cost for the Eagle Project is \$11,370,460. KEMC will file a financial assurance instrument with the MDEQ upon issuance of project permits, and agreement with MDEQ on the financial assurance costs.

9.1 Reclamation and Post-Closure Monitoring Costs

A detailed description and cost for reclamation and post-closure monitoring are described in Section 7. The total reclamation and monitoring costs for the Eagle Project are \$6,738,050. Reclamation and post-closure monitoring costs are detailed in Table 7-6 and Table 7-7.

9.2 Administrative Costs

MDEQ administrative costs will include those activities necessary to implement remediation, reclamation and post-closure monitoring including:

- ? Contract negotiations with contractors.
- ? Staff administration.
- ? Legal expenses.
- ? Construction management and oversight.

The estimated MDEQ administrative cost is \$1,684,513.

9.3 Environmental Contingency Costs

Environmental contingency costs are those costs associated with unlikely remediation to air, surface water and groundwater. The estimated total environmental contingency cost is \$1,684,513. Note that because of the facility environmental controls and monitoring that will be conducted, potential environmental impacts are extremely remote.

9.4 Operating Contingency Costs

Operating contingency costs include those costs necessary to continue operation of the facility environmental controls such as the WWTP, site generator(s) for electricity, pumps or other site operations for a six-month period until reclamation can begin. The estimated operating

contingency cost is \$1,263,384.

**Table 9-1
Financial Assurance Costs**

• Reclamation/Monitoring	\$6,738,050
• MDEQ Administrative Oversight (25% of Reclamation and Monitoring Costs)	<u>\$1,684,513</u>
Subtotal	\$8,422,563
• Environmental Contingency Cost (20% of Reclamation/Monitoring and MDEQ Oversight Costs)	\$1,684,513
• Operating Contingency Cost (15% of Reclamation/Monitoring and MDEQ Oversight Costs)	\$1,263,384
Total Financial Assurance Cost	\$11,370,460
	Prepared by: JOS1
	Checked by: SVD1

9.5 Financial Assurance Instrument

KEMC will work with MDEQ to establish a financial assurance instrument meeting the requirement per R 425.302.

9.6 Standards for Release of Financial Assurance

KEMC proposes the following standards for release of financial assurance at the completion of reclamation. KEMC may request partial release of the financial assurance for those portions of the site that are reclaimed and have met the release criteria. Listed below are the standards for release for that portion of the financial assurance that addresses site reclamation:

- ? Seventy percent vegetation coverage of a given area not having bare spots exceeding 144 square inches.
- ? Demolition and/or removal of all facility surface buildings (except for those buildings which could potentially be donated to the local community).
- ? Demolition and/or removal of all facility utilities, including cables, generators, lines, piping, etc.
- ? General conformance to the reclamation grading plan
- ? Documentation of successful mine, portal, and raise backfilling.
- ? Documentation of successful “best management practices” to eliminate surface water erosional features.
- ? Documentation of successful reclamation of the TDRSA.

DNR Comments

Kennecott only identifies financial assurance requirements for the DEQ Mining Permit. Kennecott currently has a \$20,000 bond on file with the DNR. Paragraph E.2. of lease M00602 states:

2. The lessor shall determine, and set forth in a published schedule, the initial acceptable amount required for the performance bond. The lessor shall annually review the level of the performance bond and shall require the amount of the bond to be increased or decreased to reflect changes in the cost of future reclamation of the leased premises. A review of the performance bond shall be made within thirty (30) days of receipt of lessor of written notice of termination by the lessee and shall consider adequacy of bond for removal of personal property not desired by either lessee or lessor.

The bonding required by the DNR lease will be reviewed annually to reflect potential future costs of restoration of the excavations on State-owned minerals and protection. There is potential overlap of the DEQ and DNR bonding requirements. The amount of the bond for the mineral lease will consider potential costs of restoration of State-owned property. While Kennecott’s criteria for release of financial assurance provide guidelines for bond readjustment the evaluation will be based on remaining liability. A DNR bond will remain in effect until the lease terminates.

Closure and reclamation costs and post-reclamation costs are estimated to be \$6,738,050.00. The mineral lease bond shall be updated and coordinated with the Surface Use Lease bond to reflect potential future costs for closing and reclaiming the mine and surface facilities.

J.1.b. Lessee shall reclaim the surface of the leased premises in accord with the approved mining and reclamation plan. The reclamation shall proceed concurrently with mine production to the extent practical and shall be completed following termination of mine operation.

4.3 Surface Facilities and Operations

The surface facilities required to support the mining operations are shown on Figure 4-2 and are discussed in the following sections. Figure 4-6 shows the pre-construction-site grading plan for the surface facilities. Additional surface facilities may be added during operations if required to support mining or other operational needs.

4.3.1 Site Access, Parking and Roads

Access to the Eagle Project will be via Triple A Road. The main access road will be surfaced with gravel for all-weather use. Entrance to the mine facilities will only be permitted through the main entrance gate as shown on Figure 4-2. At the main entrance will be a gate house with visitor parking. Employee parking is provided adjacent to the office/mine dry building. On-site access to the surface facilities will be provided by all-weather gravel roads. Construction of access roads will be conducted using road grading equipment such as scrapers and dozers. Initially trees and vegetation will be grubbed. Topsoil will then be stripped from the roadways and stockpiled for future use. Once the road subgrade has been leveled, proof-rolling will be conducted to densify subsoils and identify potential loose/soft areas. If loose/soft areas are identified, weak materials will be removed and/or crushed stone will be compacted into the subgrade for added stability. Excess soil from grading will be stockpiled for future site reclamation. The main haul road from the portal to the COSA will be surfaced with 4 inches of bituminous concrete to permit efficient management of ore particulate that could drop from the ore carriers leaving the mine.

**Table 4-7
Proposed Major Surface Facility Buildings**

Building	Area	
	m ²	(ft ²)
Mine Dry/Office (2 floors)	1,263	(13,600)
Truck Wash	368	(4,000)
Assay Lab/Core Storage	316	(3,400)
Generator Plant	427	(4,600)
Mine Air Heater	269	(2,900)
Maintenance Shop/Compressor Plant	687	(7,400)
Coarse Ore Storage	1,394	(15,000)
Water Treatment Plant	500	(5,380)
Crusher Building	549	(5,810)
Total	5,764	(62,020)

Prepared by: JOSI
Checked by: SVDI

Final sizes of the buildings may change when the building designs and operational needs are finalized. It is expected that most buildings will be steel framed with either concrete block or steel siding. The main facility staging area is shown on Figure 4-2. This area will be used to stockpile topsoil and temporarily store materials and equipment such as piping and vehicles.

4.3.3 Truck Wash and Scales

All vehicles leaving the main operations area, as shown on Figure 4-2, will be required to go through a truck wash before they leave the area. The main operations area is that part of the mine site that contains truck, excavation and other equipment associated with the mine operations. The truck wash will be an enclosed system that recycles the wash water. Water that is not recyclable due to excessive sediment loading will be routed to the water treatment plant for processing. The truck scale (see Figure 4-2) is included on the truck access road within the fenced area. The primary function of the scales will be to weigh the ore in the trucks before the ore is shipped offsite for processing.

DNR Comments The design of the truck wash uses an enclosed building on a concrete floor with drainage directly to the water treatment plant. DNR believes a contingency plan should be in place in case the drainage system fails (ie from freezing or clogging).

4.3.4 Mine Portal

The Eagle Project portal will be positioned at the western face of the rock outcrop at the main surface facility. The portal will have a span of 7.2 meters (~24 ft) and a rise of 5.8 meters (~19 ft) as shown on Figure 4-7. The first 37 meters (~122 ft) will be constructed of a prefabricated steel arch, socketed into competent bedrock at the outcrop. Note that the actual portal entry into the bedrock is below existing land surface (Figure 4-7). The portal grade will be approximately 15%. To prevent icy conditions during winter months, the portal will be heated using generator exhaust heaters and propane-fired heaters as necessary.

4.3.5 Ore Conveying and Crushing

A generalized cross-section of the overall mine process is shown on Figure 4-8. The general ore flow process is as follows:

? On the lower mine levels ore will be remotely loaded from the stopes using Load-Haul-Dumps (LHDs) which will deliver the ore to low profile production trucks near the decline. ? On the upper mine levels ore will be remotely loaded using LHDs and delivered to a centrally located coarse ore grizzly. Ore will drop down a 3.0 m (~10 ft) by 3.0 m (~10 ft) ore pass to the 263 level, loading the low profile production trucks.

? Once loaded the low profile production trucks will proceed up the decline to the 3,000 m³ (3,924 yd³) COSA as shown on Figure 4-2. The COSA will have a nominal 5,000 tonnes storage capacity.

? The decline design includes passing bays which will be developed every 300 m (~984 ft) for vehicles and personnel bypass. It is estimated that two production trucks will be required to support the approximate 2,000 tonnes/day (2200 tons/day) production rate.

? From the COSA front end loaders will transfer ore to the enclosed grizzly feeding the crusher process. The grizzly openings will measure approximately 0.5 m x 0.5 m (20 in x 20 in). The grizzly will be equipped with a stationary rock breaker to process oversized ore. The ore will pass through a vibrating grizzly feeder to remove undersized material (less than six inches). This material will by-pass the crusher and be fed directly to the transfer conveyor to be routed to the crushed ore bins.

? Grizzled ore (6 in to 20 in size) will feed to a single-toggle jaw crusher having a 150 hp electric motor. Crushed ore drops onto the transfer conveyor to be routed to the crushed ore bins. The crusher will be equipped with a wet-type dust collector equipped with a 25,000 cfm fan and silencer.

? A crusher building will enclose crushing related equipment. The building will have an overhead bridge crane for installation and maintenance of equipment. In addition to the dust collection at the crusher, the building will be equipped with a baghouse to further reduce dust emissions from activities inside the building. The crusher building and process is illustrated on Figures 4-9 and 4-10.

? Crushed ore exits the crusher building on a covered transfer conveyor equipped with a walkway for inspection and maintenance. The conveyor transfers the ore to the top of two 300 tonne (330 ton) capacity crushed ore bins. The bins are equipped with chutes at the base to perform truck loading. The crushed ore bins and building are illustrated in Figure 4-11

4.3.6 Coarse Ore Storage Area

The coarse ore storage area (COSA) will be an approximately 3,000 m³ (~3,924 yd³) building for storage of approximately 5,000 tonnes of ore. The COSA will measure approximately 1394 m² (~15,000 ft²) and be approximately 7 m (~23 ft) tall. The building will be metal framed and have metal siding enclosed on three sides. The floor of the building will be reinforced concrete 0.3 m (~12 in) thick sloping toward a collection sump. The collection sump will collect contact water from stockpiled ore for pumping into the CWB for treatment.

4.3.7 Ore Transportation

Ore transport from the underground mine will include a number of different processes. LHD's will deliver ore to low profile production trucks. Production trucks will proceed up the decline to the COSA. From the COSA, the ore will be moved by front-end loader to the crusher feed. Ore that passes through the crusher will charge the transfer conveyor. The transfer conveyor will feed a second transfer conveyor which charges two crushed ore bins. From the crushed ore bins approximately 50 tonne capacity ore trucks will be loaded for transport to the railhead. It is expected that approximately 40 truck loads per day will be required to transport the ore to the railhead. During transport the ore will be covered with secured caps. All ore trucks will be washed at the truck wash before exiting the main operations area. Presently KEMC plans to use the following approved trucking route to the railhead:

? East on Triple A Road, 9 miles to CR 510,

? East on CR 510, approximately 3 miles to CR 550,

? South on CR 550 approximately 20 miles to a railhead in the vicinity of Marquette.

KEMC is continuing to study transportation routes and railhead locations, and the final transportation plan may change from that described above. The railhead facilities will include an enclosed bulk ore storage building(s) and enclosed conveyor/rail car loading equipment. All ore handling processes will be within enclosed structures to prevent release of ore.

4.3.8 Ventilation Shaft

Intake air to the mine workings will be provided via the main decline. The mine exhaust raise measuring approximately 4.3 m (~14 ft) in diameter will be located at the surface backfill facility as shown on Figure 4-2. At the exhaust raise a 600-hp exhaust fan will be installed for pulling air (induced draft) through the mine workings. The ventilation system design was completed by McIntosh Engineering based upon a minimum air flow requirement of 150 cfm per worker and equipment demand. A schematic of the main exhaust fan is displayed in Figure 4-12.

Modifications of the exhaust fan system may be required based upon final design and fabrication. Further discussion of the mine ventilation system is provided later in Section 4.5.2.

4.3.9 Temporary Development Rock Storage Area

The TDRSA will be constructed for the temporary storage of development rock. The size of TDRSA will be approximately 5.9 acres providing 219,925 m³ (~285,000 yd³) of storage capacity, based upon 378,914 tonnes of planned excess development rock. The location of the TDRSA with relation to other mine surface facilities is shown on Figure 4-2.

The design of TDRSA was completed pursuant to R 425.203 and R 425.409. The TDRSA will incorporate a geomembrane cover, a contact water collection system, a composite base liner system, and a leak detection system. Combined, these systems will minimize the generation of contact water. The leak detection system constructed below the base liner will allow for monitoring and collection (if needed) of percolation through the composite base liner system. Detail design concepts of the TDRSA are provided in Section 5 of this report.

Contact water will be collected at the base of the TDRSA using a granular soil collection medium and geocomposite drainage fabric sloping towards a collection sump. Liquid in the sumps will be pumped via a submersible pump through a side-slope riser to the CWBs for storage and eventual treatment by the on-site WWTP. In addition, the development rock that is placed in the TDRSA will be amended with approximately 7,800 tonnes of limestone. As described in Appendix D-3, the addition of readily-available high-calcium limestone will:

? Provide acid-neutralizing capacity to the TDRSA that will prevent the generation of low pH water.

? Raise the pH of the water collected in the TDRSA thereby reducing the concentrations in the contact water of pH-sensitive metals such as copper and stabilizing the ferric hydroxide that will precipitate and absorb other trace metals.

4.3.10 Storm Water Management Systems

The Eagle Project Site has been designed so that non-contact storm water runoff is collected and treated separately from storm water runoff from the operational area. Storm water systems for the project site are divided into two general areas as shown on Figure 4-2. Operations area storm water runoff will be routed to the lined CWBs for storage and eventual treatment at the WWTP prior to discharge at the TWIS. The operations area includes that portion of the mine site that will contain ore and ore-related process handling equipment and storage facilities. Within the operations area is an approximate 4.2 acre bituminous lined area. This bituminous area includes the main production haul road from the portal to the COSA and crusher area and is intended to provide effective surface management of this area during operations. The lined operations area is also shown on Figure 4.2. The lined areas will consist of 4-inches of bituminous concrete supported by 12-inches of road aggregate. Details of the lined operations area is shown on Figure 4-13. The non-contact area of the project site is that portion of the project site that will not contain any ore processing or related storage facilities. Storm water runoff in the non-contact area will not contain any mining related constituents and will be routed to NCWIBs where it will be allowed to infiltrate into the subsurface. The storm water runoff management design calculations are provided in Appendix E. The storm water runoff management facilities have been designed such that runoff will not leave the site. Both the CWBs and NCWIBs are sized to store the largest of the following storm events:

? A 100-year 24-hour rainfall event.

? A 50-year combined rainfall and snowmelt runoff event.

Appendix E provides documentation of the methodology used for sizing the storm water storage basins (operations area and non-contact area) at the Eagle Site. As described in Appendix E, the

hydrology used to size the runoff storage basins includes standard TR-55 methods to determine the peak 100-year rainfall runoff volumes, and a hydrologic procedure to estimate the runoff expected from a combined 50-year rainfall and snowmelt event. The calculations show that the 50-year combined rainfall and snowmelt event generates larger runoff volumes than the 100-year 24-hour rainfall event and, therefore, results in a more conservative design.

The methodology used as a basis of design is a very conservative approach to sizing the storm water runoff basins so that overtopping is not likely to occur, even under severe runoff conditions. For the CWBs, contingencies (see Section 8) for routing to other mine areas will prevent off-site flow of water from the main operations area. Similarly, storm water release from the NCWIBs will be limited to very infrequent runoff events. These releases from the NCWIBs, if they occur, will be permitted with an Industrial Storm Water Permit.

4.3.10.1 Operations Area Storm Water

Figure 4-2 shows the main operations area. Storm water runoff from the main operations area will be conveyed to, and collected in, the two CWBs, prior to treatment at the WWTP. Figure 4-2 shows the general configuration and size of the CWBs. The 100-year, 24-hour rainfall and 50-year combined event (rainfall and snowmelt) will produce approximately 4,700,000 gallons and 7,800,000 gallons, respectively. The design of the CWBs is based upon the more critical event having a combined operating capacity of 7,800,000 gallons. During winter months an agitator or other devices may be installed in the CWBs to prevent ice build-up.

4.3.10.2 Non-Contact Storm Water

Non-contact areas are disturbed areas of the site which will not come in contact with development rock or ore. Figure 4-2 shows the proposed non-contact areas. Non-contact storm water runoff will be conveyed to, and collected in, one of four NCWIBs, as shown on Figure 4-2. The NCWIBs are designed to retain storm water runoff allowing it to infiltrate to the subsurface. Four NCWIBs will be provided to accommodate runoff. One basin will be located in the northwest area of the main surface facility and will receive runoff from the construction staging/soil storage area. The second and third basins will be located southeast of the main site along the access road and will receive runoff from the office/warehouse and employee parking lot areas. The fourth basin will be located at the backfill surface facility and will receive runoff from the clean backfill surface facility. Figure 2 in Appendix E shows the conceptual design cross section of the NCWIBs. The areas associated with each basin, the calculated precipitation event, and the basin design capacities are summarized in Table 4-8.

Table 4-8
Design Capacity Non-Contact Water Infiltration Basins

	Area	100-yr rain event (gallons)	50-yr combined event (gallons)	Basin Design Capacity (gallons)
NCWIB #3	Southeastern portion of the main surface facility	9.85 acres	900,000	3,500,000
NCWIB #4	Northwestern portion of the main surface facility	6.03 acres	430,000	2,100,000
NCWIB #5	Backfill facility site area	3.05 acres	250,000	1,000,000
NCWIB #6	Main access road	3.03 acres	220,000	1,000,000
Total		21.96 acres		7,600,000

Prepared by: JOS1
Checked by: SVD1

4.3.10.3 Soil Erosion and Sediment Control Plan

A separate Part 91 soil erosion and sediment control (SESC) permit is not required for the Eagle Project. Rule 425.203 (c)(xxii) requires that an SESC plan that meets the requirements of Part 91 of NREPA be incorporated into the *Mining Permit Application* as presented herein. This section describes the SESC plan components for the Eagle Project to effectively reduce soil erosion and sedimentation that may impact the surrounding area. The goal of the SESC plan is to incorporate methods into the design and operation such that soil erosion due to surface activities will be mitigated. The site erosion control features will be maintained daily during construction. Permanent soil erosion control measures will be established as soon as possible after grading work has been completed, to augment or replace the temporary measures installed during construction. The SESC plan includes the following information:

- ? Construction phase erosion control plans showing areas and extent of disturbance (Figure 4-14);
- ? Operation phase erosion control plans (Figure 4-15)

- ? Reclamation plans (described in Section 7)
- ? Details of the Best Management Practices (Figures 4-16 and 4-17).

4.3.10.4 Soil Erosion and Sediment Control Plan During Construction

The site erosion and sediment control plan to be implemented during construction is shown on Figure 4-14. The following is a list of the earth work and other grading activities that are part of the construction phase. Each activity is followed by a description of the Best Management Practice that will be implemented to minimize soil erosion and site runoff. Materials and methods specified in the MDOT, 2003 Standard Specification for Construction (MDOT, 2003), where available, were used for specification of the materials proposed for soil erosion control. KEMC staff will be certified as construction and industrial storm water operators to complete the required inspections and coordinate repairs and maintenance during construction.

Surface Water Diversion - Diversion of surface water run-on to the mine site surface facilities will not be necessary since areas around the surface facilities are generally very flat with slopes less than 0.5%. In addition, the subsoils are clean sands that have a high infiltration rate which will limit run-on.

Land Clearing - Land clearing is the removal of woody and herbaceous plant material and consists of two components: clearing which is the cutting and removal of trees and grubbing which is the removal of stumps and roots. Marketable timber will be removed from the site and sold. Unmarketable timber, herbaceous plants, dead wood, stumps and other vegetation will be chipped and stockpiled on-site for use in reclamation. Stumps that are too large to be chipped will be stockpiled and burned on-site. The soil and erosion control practices that are proposed include:

- ? Clearing marketable and non-marketable trees;
- ? Completing the grubbing and removal of tree harvesting remains in a single operation to minimize disturbance; and,
- ? Construction of silt fence downgradient of the areas to be cleared and grubbed prior to the start of earth disturbance. Refer to Figure 4-14 for the approximate locations where silt fence will be installed. Details of erosion control methods are provided on Figure 4- 16 and 4-17.

Topsoil Stripping and Stockpiling - Following land clearing and grubbing, topsoil will be stripped from the mine site area as shown on Figure 4-14. Topsoil is defined as the A-horizon of the soil in which organic matter accumulates. The topsoil thickness over the mine site is typically less than three inches thick and is non-existent at many locations. A 3-inch thickness has been used to size the topsoil stockpiles.

Prior to stripping the topsoil additional silt fence will be constructed downgradient of the disturbed areas. Topsoil and any excess soil will be stockpiled in the previously prepared stockpile area with maximum side-slopes of 3 horizontal to 1 vertical (3H:1V). Silt fence will also be constructed around the soil stockpiles. Topsoil and excess soil will be stockpiled with conventional earth-moving equipment. Prior to seeding, the stockpile soil surface will be "track walked" (i.e. driving a bulldozer up and down the slope to leave a pattern of track imprints parallel to the slope contours) to create a rough surface. This rough surface will enhance the ability of the soil to withstand erosion until vegetation has developed. The stockpiles will be seeded with a mixture typically used on sandy soil for roadside restoration projects as specified in the MDOT, 2003 Standard Specifications for Construction (MDOT, 2003). Seed mixtures will include temporary species such as oats or perennial rye grass that germinate quickly and act as a nurse crop until the perennial species germinate and develop.

Site Excavation and Grading - The site will be rough-graded to the grades as shown on Figure 4-6, prior to excavation of the TDRSA, NCWIBs and CWBs. As part of the final site grading design, diversion berms and ditching will be used to separate the main operations and nonLJS\ contact areas. Excess soil will be used to build berms around the facility as shown on Figure 4-15. Once the surface facilities are under construction, disturbed areas will be seeded as soon as possible.

4.3.10.5 Soil Erosion and Sediment Control Plan During Operations

The site erosion control and sediment control to be implemented during operations is shown on Figure 4-15. Once the surface facilities are constructed and vegetation has been re-established, the main component of the SESC plan will be to maintain the storm water conveyance and storage basins as designed and constructed. This will require regular inspections after precipitation or snow melt events. Areas that show erosion or rutting will be repaired as soon as practical by filling with topsoil and seeding, as described in the previous section. The NCWIBs will be inspected for siltation which could reduce the infiltration capacity of the basins. Planned operation and maintenance activities for the facility storm water and erosion control structures are listed in the table provided on Figure 4-15. This includes maintenance and repair

of the storm water conveyance system and erosion control features described above during construction. KEMC will designate one of the technical staff to be a certified storm water operator to complete the regular inspections and coordinate repairs or maintenance during operations.

4.3.11.4 Potable Water

A potable water system will be provided to supply potable water to the site buildings, the lab, and to the mine. A well, pump, potable water tank, and distribution system will be provided for potable water. KEMC plans to use well QAL011D (see Figure 4-1) as a potable well for the project and will apply for a *Type II Non-Transient Non-Community Water Supply Permit* from the Marquette County Health Department.

4.3.11.5 Sanitary System

The Eagle Project on-site septic system (OSS) is designed based upon expected operation loading and will be permitted through the Marquette County Health Department. The design flow for the OSS is based on the number of employees. From Table 4-2, the total project employment will be 110. From Table 1 of the *Michigan Criteria for Subsurface Sewage Disposal*, the design flow for an employee at an industrial facility is approximately 35 gallons per day (gpd). Therefore, the peak design flow based upon the State of Michigan criteria for the OSS is 3,850 gpd.

The OSS includes the following components as discussed below:

- ? Septic tank
- ? Dosing pumps
- ? Soil absorption system

The septic tank system will provide a total of 4,000 gallons capacity. The volume will be split into 2 or 3 tanks or compartments. The first compartment will be a minimum of 2,000 gallons. The multiple compartment design will provide improved solids separation and treatment. The design flow for the OSS exceeds 2,000 gpd and as such is required by state code to use dosing pumps for septic tank effluent distribution. Therefore, two dosing pumps will be provided to operate on an alternating basis. The dosing pumps will be located in a separate tank with septic tank effluent flowing into the dosing tank.

The soil absorption system will consist of distribution piping placed in a shallow gravel trench. The trench width will be three feet and the trenches will be spaced with four feet between the trench walls. The distribution piping will be 1.5-in. diameter PVC or HDPE pipe with perforations typically five feet apart. The dosing pumps will provide adequate pressure to force equal flow through each perforation.

The infiltration rate of site soils has been measured as approximately 60 ft/d (Foth & Van Dyke, 2006). The loading rate (gpd/ft²) is determined based on soil types. Based upon the *Michigan Criteria for Subsurface Sewage Disposal Section IX, C, 5* the design loading rate for this type of soil is 0.5 gpd/ft².

The area required for a design flow rate of 3,850 gpd is 7,700 ft² of trench. With trenches three feet wide and spaced four feet between trenches, the total area required for soil absorption is 18,000 ft². Additional space is needed for the septic tanks and dosing pump chamber. The distribution system will be designed with three cells. Each cell will have a shut-off valve to allow one cell to rest or be repaired while the other cells are in operation.

A reserve area is required to provide a replacement of the soil absorption system without using the initial system. Figure 4-2 shows the location at the OSS. The area identified for the OSS is adequate for the initial soil absorption system and, if necessary, replacement of the soil absorption system.

During initial site development, the construction contractor will be responsible for providing temporary facilities during construction until the OSS system and the sanitary sewer piping to the OSS is operational.

During the mine operation the septic tanks will be pumped on an annual basis to remove excess solids. The dosing pumps will be inspected and maintained on a regular basis. The distribution system will be inspected several times during the year and cells rested each year. This system along with routine maintenance will provide effective sanitary wastewater treatment and disposal at the mine site.

4.3.12 Water Usage, Treatment and Discharge

The Eagle Project will have an extensive water management program. Figure 4-2 shows the locations of the main water management facilities including the CWBs, the WWTP, and the TWIS. Water requiring treatment will be generated during construction, operation, and closure of the Eagle Project. Each of the major sources of mine water is discussed in more detail below. The design of the facilities to be used for collection, treatment, and disposal of these wastewaters

is also discussed below. A more detailed description of the water sources and treatment and discharge systems is provided in the *Groundwater Discharge Permit Application* (Foth & Van Dyke, 2006).

4.3.12.1 Wastewater Sources and Characteristics

The following is a summary of the different wastewater sources that will be treated by the WWTP. Mine Drainage - Sources of water inflow to the mine will include groundwater infiltration into the mine, water vapor contained in ventilation air entering the mine, treated water pumped to the mine for use in mining operations, and water contained in the mine backfill material.

The mine drainage water will primarily consist of a composite of groundwater that infiltrates into the mine and treated water used in the mine (utility water) for dust suppression and for operation of mining equipment and operating the backfill plant. Drainage from the mine backfill material is anticipated to be negligible and is not included in the water balance. The mine drainage water will be collected in underground sumps and will be pumped to the CWBs.

Two sources of groundwater are anticipated to be encountered during development and operation of the mine. The primary source will be groundwater that flows from the upper bedrock regions into the upper mining levels. The upper bedrock water that is expected to be encountered during both the mine development and mine operation phases, will represent the bulk of the water pumped from the mine and is low in total dissolved solids (TDS). The second source of groundwater is water that is stored within the weakly connected fractures of the lower bedrock and which is expected to be encountered during initial development when the stored water in the rock drains to the mine sumps. The deeper bedrock water is more saline than the upper bedrock groundwater.

The chemical characteristics of the groundwater in the area of the Eagle Project were estimated based on background groundwater sampling and analysis work conducted by Golder Associates, Ltd. (2005b) and Golder Associates, Inc. (2006). Analysis of groundwater samples from exploration holes open to the upper bedrock and yielding non-saline water were used to determine the chemical characteristics for the upper bedrock groundwater. Groundwater samples from testing of deep exploration holes were used to determine the chemical characteristics of the water stored in fractures of the deeper bedrock. The chemical characteristics of the composite mine drainage water will depend on the background characteristics of the groundwater that infiltrates into the mine and on the impact of groundwater contact with the mine workings. The mine drainage water will contain readily soluble substances, mineral oxidation products, and colloidal materials that will result from the short-term reactions between water and materials within the mine. The incremental increases in the concentrations of the various constituents in the groundwater infiltrating into the mine, due to contact with the mine workings, are provided in Appendix D-4. The *Groundwater Discharge Permit Application* (Foth & Van Dyke, 2006) describes the methodology for combining background bedrock groundwater quality data and geochemical predictions to estimate the chemical characteristics of the mine drainage water pumped from the mine during operations.

Although ammonia and nitrates are not anticipated to occur in the groundwater in significant concentrations, they will be present in the mine drainage water as byproducts from blasting operations. Ammonia and nitrate concentrations in the mine drainage water were estimated based on information supplied by Kennecott from other representative mines. The estimated mine drainage water characteristics are provided in Table 4-1 of the *Groundwater Discharge Permit Application* (Foth & Van Dyke, 2006).

Temporary Development Rock Storage Area - Water coming in contact with the stored development rock amended with limestone may contain readily soluble substances and colloidal materials. The water will have a neutral pH. The chemical characteristics of the TDRSA contact water are provided in Appendix D. The geomembrane cover which will be installed over the TDRSA will further reduce the generation of contact water requiring treatment.

Storm Water - During construction and operation of the mine and surface facilities, storm water runoff will be collected and managed within the facility. The storm water runoff from the operational area will be collected in the CWBs and treated at the WWTP. Non-contact surface water runoff will be managed separately by NCWIBs and is not part of the influent water to the WWTP. For WWTP design purposes, operational surface water runoff from the main operations area was conservatively estimated to have the same water chemistry as the combined contact water (mine drainage water and TDRSA contact water).

Miscellaneous Sources of Wastewater - Wastewater will also be generated from the laboratory and shops. The wastewater generated in the laboratory will include small amounts of laboratory chemicals used in ore analysis and in analysis of wastewaters. Wastes generated in the laboratories will be disposed off-site by a qualified contractor or will be discharged to the CWBs and processed.

Wastewater generated in the shops will include small amounts of grease and oil, metal shavings, other particulate materials, and wash water. Most of the grease will be captured in traps. These wastewaters will be discharged to the CWBs and treated by the WWTP. Small quantities of wastewater from the truck wash and crusher system will also be discharged to the CWBs and treated by the WWTP.

4.3.12.2 Water Balance

Two water balance models have been prepared for the Eagle Project. The first water balance model (Figure 4-18A) evaluates the system water balance based upon the design basis groundwater inflow and maximum annual precipitation. For WWTP design purposes a design basis of 250 gpm of groundwater inflow was assumed. This design basis exceeds the upper bound groundwater inflow estimated of 215 gpm. The groundwater inflow modeling is provided in the EIA in Volume II of this *Mining Permit Application*. The second water balance model (Figure 4-18B) evaluates the system water balance using expected groundwater inflow (75 gpm) and average annual precipitation. The water balance determines the water inputs, water uses, and water discharges associated with the mine and the main operations area.

Potable water for sanitary uses will be obtained from an on-site well. Sanitary wastewater will be collected and disposed separately in a septic system.

The *Groundwater Discharge Permit Application* (Foth & Van Dyke, 2006) contains additional discussions on the design basis of the WWTP and the development of the water balances in Figures 4-18A and 4-18B.

4.3.12.3 Wastewater Treatment System

The WWTP will treat wastewater collected and stored in the CWBs and is designed to produce a treated effluent which will meet the effluent standards for discharge to groundwater by way of the TWIS. The WWTP will be designed to provide a level of treatment to comply with MDEQ groundwater quality standards.

The water treatment system includes the following processes:

- ? CWBs
- ? Main wastewater treatment process
- ? Concentrate reduction process
- ? Evaporation/Crystallization process
- ? Sludge handling process
- ? TWIS

Detailed descriptions of these processes are provided in the *Groundwater Discharge Permit Application* (Foth & Van Dyke, 2006).

All wastewater generated at the Eagle Project, with the exception of sanitary wastewater, will be routed to, and temporarily stored in CWBs No.1 and No.2. Appendix E provides the design capacity of the CWBs. A cross section and details of the CWBs are shown on Figure 4-19.

These basins will provide wastewater storage and equalization capacity. Wastewater will be pumped from these basins to the WWTP.

The main wastewater treatment process will include a base treatment system and an advanced treatment system. The base treatment system will include pH adjustment, metals precipitation, and filtration to substantially reduce the mass of dissolved solids present in the raw wastewater. The advanced treatment system will include a reverse osmosis system and pH adjustment as a polishing step to further reduce the concentrations of dissolved solids in the base treatment system effluent. The discharge streams from the final wastewater treatment process will include treated water, metals precipitation sludge, and reverse osmosis concentrate. The treated water will be suitable for discharge to groundwater the TWIS. The TWIS consists of series of distribution piping connecting to five subsurface infiltration cells. Within each infiltration cell will be 1.5-in diameter perforated PVC discharge piping covered with 5 ft of select soils, then topsoiled and seeded. The metals precipitation sludge will be routed to the sludge handling process for dewatering. The reverse osmosis concentrate will be routed to the concentrate reduction process (CRP) for treatment and volume reduction.

The CRP will be provided to maximize the water recovery for the WWTP and correspondingly minimize the volume of concentrate treated by the evaporator/crystallizer process. The CRP will treat the concentrate from the main wastewater treatment process reverse osmosis system. The treatment processes proposed for this system include breakpoint chlorination, softening/metals precipitation, microfiltration, pH adjustment, reverse osmosis, and ion exchange. The discharge streams from the concentrate reduction process will include treated water, microfiltration sludge, and reverse osmosis concentrate. The treated water will be suitable for discharge to groundwater by way of the TWIS. The microfiltration sludge will be routed to the sludge handling process for

dewatering. The reverse osmosis concentrate will be routed to an evaporation/crystallization process for volume reduction or incorporated with the cemented mine backfill. The sludge handling process will dewater sludge from the main wastewater treatment process metals precipitation/sedimentation system and sludge from the concentrate reduction process microfiltration system. A plate and frame filter press will be used for sludge dewatering. Filtrate from the filter press will be routed back to the head end of the concentrate reduction process for treatment. The dewatered sludge from the filter press will be managed in accordance with applicable regulations. During periods when cemented backfill is not generated, the evaporation/crystallization process is provided for volume reduction of the reverse osmosis concentrate from the CRP. Distillate from the evaporator will be discharged through the TWIS along with treated water from the main wastewater treatment process. Brine solids from the crystallizer will be managed in accordance with applicable regulations.

4.3.13 Backfill Aggregate Stockpiles

The backfill aggregate stockpile area located near the backfill raise is shown on Figure 4-2. Also present near the aggregate stockpile and backfill raise will be a 110-tonne capacity fly ash silo, and a 110-tonne capacity cement silo. During full production it is estimated that approximately 200 tonnes per day of aggregate will be required for mine backfilling operations. Clean aggregate will be supplied from a local vendor. Aggregate from the stockpile will be moved via front-end loader to the aggregate hopper feeding the 2.4 m (~8 ft) diameter aggregate raise. Surface water drainage from the aggregate stockpiles will be controlled via perimeter ditching, draining to NCWIB #5 as shown on Figure 4-2.

4.3.14 Security and Access Control

Security and access control will be maintained at all times at the Eagle Project. Surrounding the facility will be an 8-foot high chain link fence. Access to the facility will only be allowed via the main facility entrance off Triple A Road. Vehicles entering or leaving the facility must pass through the main gate. An attendant will be present at the gate house to control facility entry. In addition, the excess soil berm constructed around the facility boundary will also limit unauthorized access.

4.3.15 Aesthetics and Landscaping

The Eagle Project will be naturally obscured by the existing trees and the rock outcrop at the main surface facility. In addition, a berm of excess soil will be placed directly around the boundary of the facility to limit visibility of the site. KEMC may selectively plant trees to further obscure the mine facilities from Triple A Road. Near the entrance road landscaping will blend with the natural flora to develop a balanced natural appearance.

DNR Comments Per the Surface Use Lease, DNR will retain the right to require additional vegetative planting or berming as needed to maintain visual screening,

4.3.16 Fuel Handling and Chemical Storage

Fuel handling at the facility will include diesel to power the generators, regular unleaded gasoline for light equipment and propane for heating. The fuel storage facility will be located within the fenced and secured area shown on Figure 4-2, and will contain three diesel fuel storage tanks each having an approximate capacity of 20,000 gallons (for a total of 60,000 gallons) located within a roofed secondary containment system. One smaller tank for regular unleaded gasoline will also be provided within the containment area. Leak testing of the tanks will be conducted by the vendor upon installation to verify tank tightness. Diesel-fueled generators to supply facility electric power will be located south of the fuel storage tanks. Propane storage of an approximate capacity of 24,000 gallons will be located within the secure area of the mine property adjacent to a building that will contain a propane-fired air heating system for the mine. Fuel truck unloading will be conducted on a concrete or asphalt pad with spill protection provisions consisting of a small catch basin which drains into the secondary containment area via double walled piping. The unloading pad area will be roofed to minimize collection and treatment of precipitation. Underground fuel lines from the storage tanks that feed the electrical generators will be double walled with leak detection provisions. A discussion of the SPCC Plan is provided below. It is anticipated that diesel fuel consumption will be approximately 5,000 gallons per day. It is expected that 6 tanker trucks or approximately 30,000 gallons of diesel fuel will be delivered each week to the site. The fuel tanks will be designed in compliance with all federal, state and local requirements. A designated fueling station will be established for fueling underground vehicles using a tanker vehicle.

4.3.17 Blasting Materials Handling and Storage

The blasting and cap magazine buildings will be located at a secure location within the mine facility. The blasting and cap magazine buildings will be constructed of reinforced concrete following Mining Safety and Health Administration (MSHA) requirements. The building will have explosion proof air handling and moisture control systems. Entry into these buildings will only be allowed by certified blasting material handlers. KEMC will obtain a permit from the Bureau of Alcohol, Tobacco and Fire Arms for storage and use of the explosives for the project.

4.3.18 Spill Prevention and Countermeasures Plan

A SPCC Plan will be prepared for the fuel storage area that will incorporate the provisions set forth in 40 CFR 112. The SPCC Plan will be prepared prior to the commencement of operations at the facility. The SPCC Plan will be reviewed and certified by a Professional Engineer, maintained at the facility and reviewed and revised as required by federal, state, and local regulations. Pursuant to the SPCC Plan and regulatory requirements, tanks and secondary containment will be designed to contain a potential spill. Storage tanks and containment areas will also be installed such that prevention measures for all fuel handling and storage are incorporated into the design, including techniques that will be used to contain potential spills during loading and off-loading of vehicles.

In addition to the federal SPCC requirements, all aboveground storage tanks containing flammable or combustible materials must be in compliance with the Michigan Fire Prevention Code statute at 1941 PA 207. The statute applies not only to tanks that store liquid petroleum products, but also to storage of compressed gases, including propane. Design plans for affected storage tanks will be submitted to the MDEQ Waste and Hazardous Materials Division for approval.

In addition to the above requirements, the facility will also comply with R 324.2001 through 2009. These rules require preparation of a PIPP to address potential spillage of fuel, salt and other "polluting materials" listed under Rule 324.2009. While a portion of these rules contain requirements that are similar to the federal SPCC rules, the regulations also contain requirements to cover salt and any listed "polluting material" that is above indicated Threshold Reporting Quantities. The listed materials include numerous metal compounds, including copper and nickel. The rules state that if these materials are in solid form, they shall be stored such that they are "enclosed, covered, contained or otherwise protected to prevent run-on and runoff". Design provisions for all storage facilities at the site contain adequate measures to meet this requirement. To ensure that an overall cohesive spill prevention and pollution control plan is prepared for the site, it is anticipated that the PIPP will incorporate all requirements of the SPCC Plan as well as requirements for other regulated chemicals at the site. The PIPP will be prepared prior to commencement of operations at the site. Once the written PIPP is prepared, notice will be provided to the state and other emergency agencies that the PIPP is available. The PIPP will then be provided upon request. In accordance with state regulations, the PIPP will be reviewed every 3 years.

7 Reclamation Plan (see J.1.c(2) for complete text), 7.1 Reclamation Sequencing and Timing, 7.2 Final Land Use, 7.3 Site Construction Reclamation, Surface Facilities, 7.4.1.1 TDRSA, 7.4.1.2 Roads and Access, 7.4.1.3 Buildings and Structures, 7.4.1.4 Surface Water Management Facilities, 7.4.1.5 Site Utilities, 7.4.1.6 Sanitary System, 7.4.1.7 Potable Water System, 7.4.1.8 Water Treatment System, 7.4.1.9 Earth Grading and Topsoil Placement, 7.4.1.10 Revegetation, 7.4.1.11 Erosion Control, 7.4.2 Underground Facilities, 7.4.2.1 Mineral Extraction Areas, 7.4.2.2 Ore Handling Systems

J.1.c . A mining and reclamation plan for the leased premises shall be developed to insure to the maximum extent practicable that: waste areas and lean ore are located, designed and utilized to maximize aesthetic attractiveness and promote reclamation; mining is conducted in a manner which will prevent or mitigate hazardous conditions which result from slumping, heaving and subsidence; and that post mining uses of the premises are as or more valuable than the uses prior to mining. The mining and reclamation plan shall include the following:

J.1.c.(1) Accurate plan maps, with appropriate scale, and other supporting data showing:

J.1.c.(1a) Location of the proposed mining operation area.

Figure 2-1 Project Location

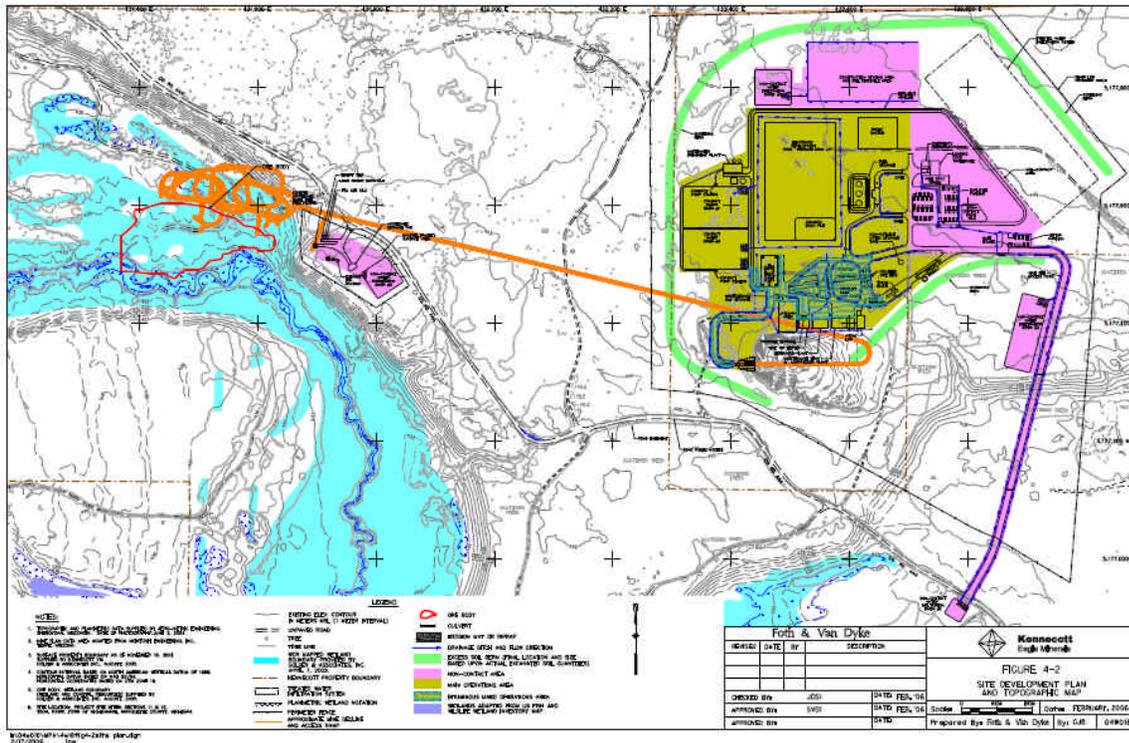
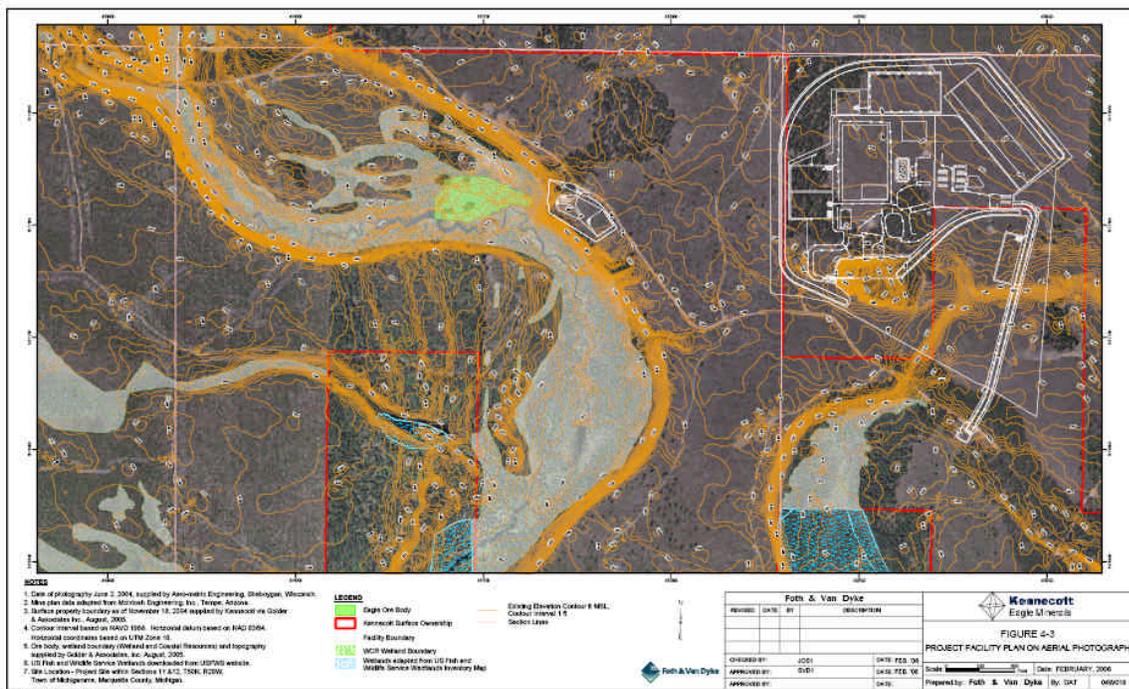


Figure 4-3 Project Facility on Aerial Photograph



J.1.c.(1c) Description of proposed development of open pit(s) and/or underground workings including materials handling and overburden stripping plans on the leased premises.

4.4 Underground Mine Description

The basic design concept for the underground mine will be to employ transverse blasthole stoping with blind benching. The mine design is based upon extracting 2,000 tonnes per day of ore. Total mineable reserves are approximately 3,419,453 tonnes. An overall section of the mine is shown in Figure 4-5.

4.4.1 Mine Design and Layout

The mine design is based upon 10 production levels as shown on Figure 4-5. Mining will progress from mine level 143 m upward to mine level 353 m. Mine level 383 m will be selectively mined based upon further geotechnical analysis conducted on the crown pillar as mining progresses upward. The geotechnical analysis conducted by Golder Associates has determined that the proposed mining plan will be stable. A copy of the Golder Associates geotechnical reports are provided in Appendix C. Additional geotechnical analysis will be conducted as part of continuous rock mass assessment performed during each level development. The mine design is based upon: 1) maintaining economic production levels by incorporating bulk-mining methods, and 2) preventing surface subsidence due to underground mining. The geotechnical analysis presented in Appendix C has determined there will be no measurable subsidence at ground surface due to the underground mine. A 3-dimensional schematic of the underground mine is displayed on Illustration 4-2.

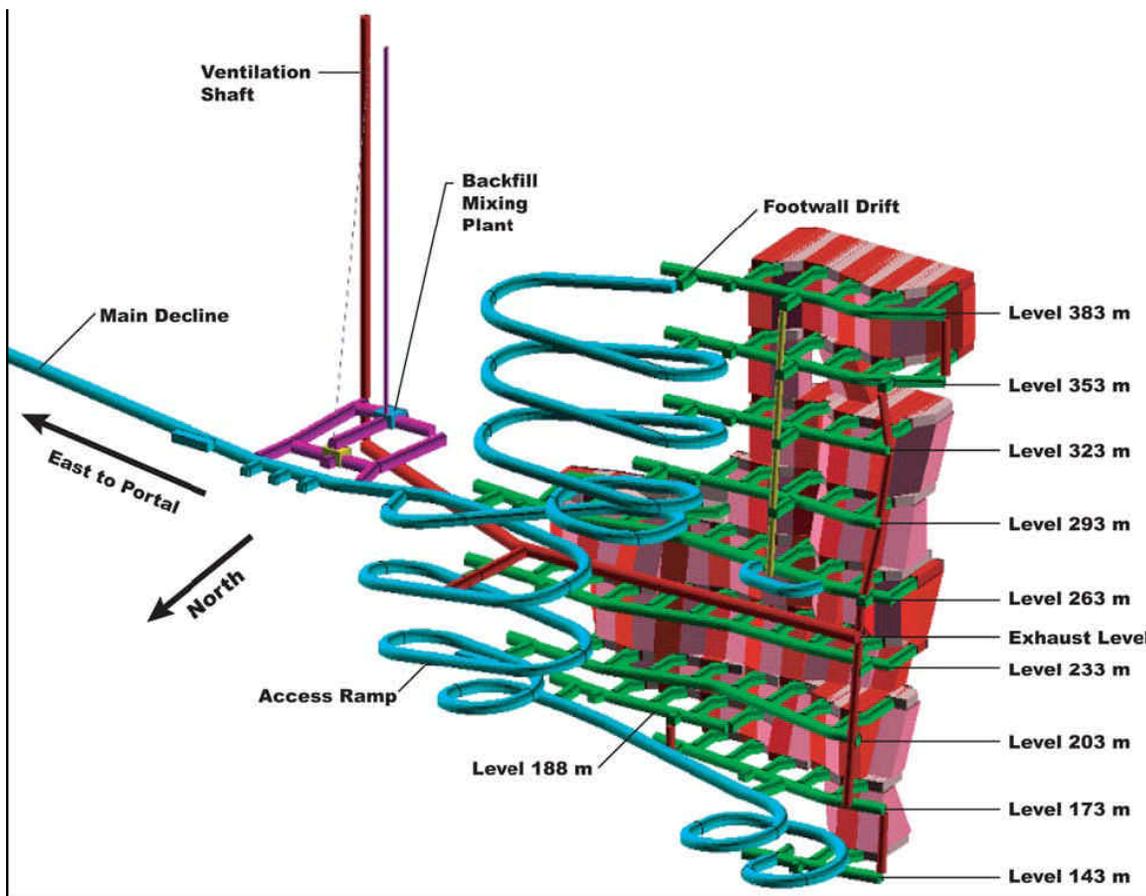


Illustration 4-2 3D Schematic of Underground Mine Source: Kennecott Minerals Company.

4.4.2 Mine Access --- Portal, Main Decline, Footwall Drift, Emergency Escape

The mining method selected for the majority of the Eagle deposit will be primarily transverse blasthole stoping with cemented and uncemented backfill. A small percentage of mining may be performed by blind benching methods. Transverse blasthole mining was chosen for the following reasons:

- ? Blasthole stoping with cemented backfill is a proven mining method.
- ? The deposit is generally vertical in nature and relatively regular along the footwall (FW) (north side) thereby allowing for greater vertical spacing between mining levels.
- ? The deposit averages approximately 35 m (~115 ft) in horizontal thickness and seldom measures less than 15 m (~50 ft) in horizontal thickness. Maximum horizontal thickness of the deposit measures approximately 75 m (~246 ft).

? The strength of the ore mass is competent thereby allowing for stopes to be opened up and bulk mining methods to be incorporated.

? The deposit is relatively thick, hanging wall (HW) to footwall (FW), allowing for the incorporation of transverse longitudinal methods.

? There is an availability of backfill material on-site for use in secondary stopes for uncemented backfill.

4.4.2 Mine Access

The mine design includes the following access developments:

? Portal

? Main Decline

? Footwall Drift

? Emergency Escape

Construction of these developments may employ the use of cement and bentonite based grout for localized control of water inflow to the mine workings.

Portal

The portal facility is located on the west side of the bedrock outcrop shown in Figure 4-2. The portal will be constructed with steel arches having a 7.2 m (~24 ft) span and 5.8 m (~19 ft) rise. The steel arch sets will extend out from the rock face approximately 37.0 m (~121 ft). The rock cut will be backfilled with compacted engineered fill after the steel plates are set. A concrete headwall will secure the steel arch plates into the bedrock. Details of the portal are shown on Figure 4-7.

Main Decline

Mine access is gained through the main decline. The decline will be at 5.5 m (~18 ft) wide by 5.0 m (~16 ft) high sloped 15.0% for 120 m (~39 ft) then reduced to -12.0%. The decline is slightly steeper initially in order to quickly access the bedrock thereby minimizing the volume of alluvium excavated and required support. Dimensions of the main decline are based on clearance criteria of the low profile production haul trucks as well as maximum ventilation velocities in the decline.

Footwall Drift

FW drifts will measure 4.5 m (~15 ft) wide by 4.5 m (~15 ft) high. The largest equipment expected to enter the FW drifts are the 5.4 m³ (~7 yd³) production LHDs. FW development is designed to maintain a minimum 20 m (~66 ft) offset from the stope FW. The FW drift provides access to the transverse blasthole stopes, sump, mine load center, exhaust raise, etc.

Emergency Escape

Emergency escape will be provided by an elevator installed in the main exhaust raise. The bottom of the elevator is located at mine level 248 m and exits the raise on surface at an air lockoff the exhaust fan housing. The elevator is installed on the wall of the raise. The elevator, shown in Figure 4-12, has a design capacity of 545 kg or approximately 5-6 persons.

A manway will also be installed in the return air raise between mining levels. The manway will have platforms spaced every 7.0 m (~23 ft). The emergency escape routes are shown on Illustration 4-3.

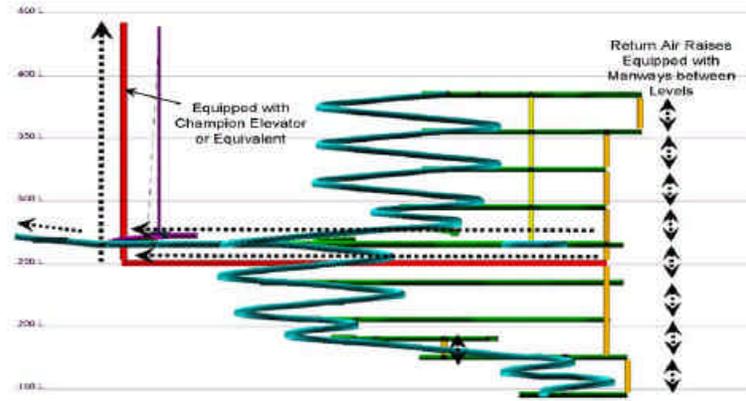


Illustration 4-3
Emergency Escape Routes

Source: Adapted from McIntosh Engineers

4.4.3 Transverse Blasthole Stoping

Two sizes of transverse stopes were developed, 30 m (~98 ft) high (sill to sill) and 15 m (~49 ft) high (sill to sill). All transverse stopes measure 10 m (~33 ft) wide, regardless of their height. The 30 m (~98 ft) high stopes have lengths, (HW to FW) ranging from approximately 15 m (~49 ft) to 70 m (~230 ft). The 15 m (~49 ft) high stopes have lengths (HW to FW) ranging from approximately 15 m (~49 ft) to 40 m (~131 ft). The 15 m (~49 ft) high stopes were designed to increase recovery. Each stope includes a top cut (or drill level) at the top of the stope and an undercut (or production level) at the bottom. Top cut and undercut levels are developed by drifting from the FW to the HW, then slashing the stope to the full 10 m (~33 ft) width.

Actual stope limits will be identified by stope definition drilling and sampling programs during operations. Current stope designs have both HW and FW planes that best follow the ore body within the capabilities of the production drills. This allows for the design of inclined HW and FW stope limits, thereby reducing waste and increasing ore recovery.

Once stope development is complete, a slot raise is developed. Slot raise cut holes are planned at 0.76 m (~30 in) in diameter, then opened up to 2.4 m (~8 ft) by 2.4 m (~8 ft). Smaller diameter slot raise cut holes are developed using the 115 mm (~4.5 in) production drill blast holes. The slot is drilled and shot in a two-row blast to the full 10 m width of the stope. The slot is designed at 4.5 m (~15 ft) long HW to FW. Illustration 4-4 shows this sequence for a typical 30 m (~98 ft) stope.

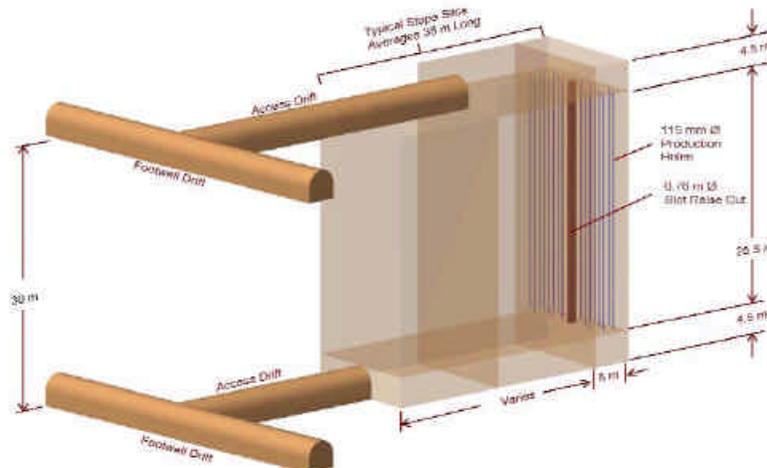


Illustration 4-4
Typical Stope Development Plan

Source: Adapted from McIntosh Engineers

4.4.4 Production Drilling and Blasting

4.4.4.1 Production Drilling

Production drilling will be performed by track-mounted drill rigs capable of drilling 89 mm (~3.5 in) to 165 mm (~6.5 in) diameter holes up to 100 m (~328 in) in length. The drills are powered using high pressure air. Typical production drilling will have the drill holes staggered in a diamond pattern alternating between four holes and three holes per row. Blasthole burden and spacing distances are estimated to be approximately 2.3 m (~7.5 ft) and 3.0 m (~9.7 ft), respectively.

4.4.4.2 Production Blasting

Production blasting will be accomplished using emulsions produced and delivered by a local explosive supplier. The maximum explosive density that can be used in 115 mm (~4.5 in) holes is 1.27 g/cc. Based upon the burden and spacing design, blasthole powder density will be 1.2 g/cc. The ability to use a higher density explosive in the future could allow for expanding the drilling pattern and therefore ultimately reducing the cost per tonne of drilling by reducing the number of holes drilled. As an alternative to emulsion, ANFO can be used. KEMC crews will perform production emulsion loading. All loading will be performed using a bulk emulsion loading system.

4.4.5 Level Development and Stope Sequence

As shown on Figure 4-5 the Eagle Project will be developed with 10 levels. Figures 4-20 through 4-30 illustrate plan views of each level development. As discussed in Section 4.4.1, mine level 383 m will be selectively mined based upon further geotechnical analysis of the crown pillar and evaluation of the appropriate mining method. Level development will begin at the lowest mining levels, progressing vertically to the upper levels. Initial production is scheduled to start on mine level 143 m and mine level 173 m. Mining during the first three and a half years will be limited to production at or below mine level 263 m. Upper mine levels will be brought on line once production below mine level 263 m declines. The mining method entails development of primary and secondary stopes. A series of four-panel production units are designed to mine 10 m (~33 ft) wide by 30 m (~98 ft) high transverse stopes with minimum ground support. The stoping sequence is illustrated in Figure 4-31. The primary stopes will be filled with engineered cemented aggregate backfill prior to mining the secondary stopes. Once the primary stopes are backfilled, mining the secondary stopes will commence. Secondary stopes will be backfilled with uncemented limestone-amended development rock. Production stopes within each level were designed to sustain a consistent production rate of 2,000 t/d once full production is achieved. The production of each of the active stopes is estimated to be 500 t/d to meet the total 2,000 t/d nominal production. Production is expected to begin in year 2, with two active stopes in production during the rampup period. Full production will be achieved in the middle of year three when two additional active stopes are brought on line. The production rate of 2,000 t/d will be sustained until the third quarter of year nine. Production at the Eagle Project is expected to be completed near the end of year nine.

DNR Comments DNR has some concern about the structural integrity and potential for increasing ground water flow into the mine as upward mining progresses. DNR concurs with DEQ that mining stopes having a 'back' (ceiling) elevation above the 327.5 meters should not proceed upward until additional rock testing demonstrates that higher mining may proceed safely.

4.5 Underground Facilities

Underground facilities to support the KEMC Eagle Project will include:

- ? Mine dewatering system,
- ? Ventilation and air heating systems,
- ? Communication system,
- ? Ore hauling system,
- ? Sanitation system,
- ? Electrical system,
- ? Compressed air system, and
- ? Emergency escape, and
- ? Emergency safe room with oxygen supplied, food and water.

The facilities are discussed in further detail in the following sections.

4.5.1 Mine Dewatering System

The mine dewatering system for the Eagle Project is designed to support a total of 600 gpm of pumping requirements during full production. Note that 600 gpm is not the rate of groundwater inflow to the mine. Based upon groundwater modeling the upper bound estimate of groundwater inflow is approximately 215 gpm. The groundwater inflow coupled with approximate operating

service requirements results in a 600 gpm mine water pumping system.

The following Illustration 4-5 shows the dewatering system flow plan. Three main dewatering pump stations are included in the dewatering system design, one located near the mine bottom, the second at mine level 173 m, and the third at the main decline at mine level 300 m. The level 173 m pump station will service the development requirements until the lower station (level 143 m) has been installed. The mine level 143 m pump station will be equipped with two 58-hp pumps to pump groundwater to mine level 173 m. At mine level 173 m, two 125-hp pumps will be installed with a 10,000-gallon agitator tank. From mine level 173 m, water will be pumped to the 300 m level pump station also employing two 125 hp pumps with an agitator tank. From mine level 300 m, water will be pumped to the surface CWBs.

DNR Comments Kennecott shall notify the DNR within 10 days if ground water inflows exceed 300 gallons per minute. Kennecott shall develop plans to respond to ground water inflow if it exceeds 300 gallons per minute

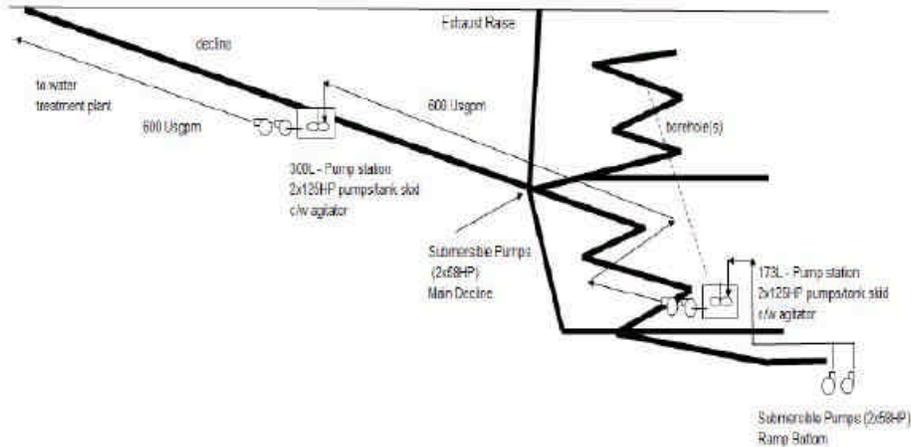


Illustration 4-5
Groundwater Dewatering System

Source: Adapted from McIntosh Engineers

4.5.2 Mine Ventilation Systems

The ventilation design is based upon providing sufficient airflow to the mine workings to maintain safe working conditions. A minimum airflow of 150 cfm per underground worker was used in the design. The total estimated ventilation requirements are 427,000 cfm including employee and equipment demand.

Intake air to the mine is provided via the main decline. Each mine level is ventilated from the decline to a dedicated return air raise. This system is referred to as single-pass ventilation which is well-suited for maintaining safe working conditions. Each return air raise will be connected to the exhaust drift on mine level 248 m.

The 600 hp main exhaust fan will pull air (induced draft) from the main decline to each operating level to achieve the ventilation requirements. Used air is then pulled through return air raises (RAR) to the exhaust drift and then to the exhaust raise. Figure 4-32 is schematic of the overall mine ventilation system.

4.5.3 Underground Ore Handling Systems

The underground ore flow process for the Eagle Project is as follows:

? On the lower mining levels, below and including mine level 263 m, ore will be remotely loaded from the stopes by production LHDs and delivered to low profile production trucks near the ramp access. If a production truck is not waiting to be loaded, the LHD dumps its bucket at an adjacent load bay and continues removing ore from the stope. When the truck arrives the LHD loads the truck from the loading bay.

? On levels above mine level 263 m, ore will be remotely loaded from the stopes by a production LHDs and delivered to a centrally located coarse ore grizzly off the FW drift. Remotely operated LHD's will be employed under these operational conditions to limit the operator's presence within the recently blasted stope. The operator will be able to

safely operate the LHD outside of the stope using this remote system. Ore drops down the ore pass to mine level 263 m where it loads the low profile production trucks. The ore pass grizzlies are equipped with dust covers to prevent dusting on the levels as well as short circuiting the ventilation. Dust covers are equipped with electric winches and operated remotely by the LHD operators.

? Once loaded, the low profile production trucks proceed up the decline to the COSA. In the decline design, passing bays are included every 300 m (~984 ft) for vehicles and personnel to allow for the loaded trucks to pass.

? The COSA will have a capacity of 3,000 m³ (~3,924 yd³). The production trucks dump their loads and proceed back underground.

The underground ore handling system is based upon “best” facility economics. Because economics are constantly changing due to market conditions, changes to the underground ore handling system may be necessary to reflect future market conditions.

4.5.4 Communication Systems

Communications through the mine will be accomplished using a digital cable system. At each level and at other designated locations, wireless routers will be installed. The main control will be in the dispatch center on surface. The base station is multi-channel and used for both voice and data communication. A computer will be integrated with the system to manage data communication. Data communication is for vehicle dispatch systems. Voice communication will be hand held or vehicle mounted radios. The cable system will have multiple vehicle-mounted radios. A tag reading system will be installed at critical areas to ensure all persons are accounted for within the mine. In addition, a manual tag out system will also be used.

Underground sanitation facilities will be provided in accordance with applicable requirements and may consist of portable toilets and sinks placed at several underground locations. Toilets will be periodically brought to the surface and cleaned or exchanged by a vendor.

4.5.6 Underground Electric Supply

Underground electrical demand will be provided by the three surface diesel generators. Only two generators will be running at any given time. The third generator will be used as back-up. Routine power needed during full mine operation will be approximately 2.63 mW. The largest loads for the Eagle Project will be from the exhaust raise fan, backfill plant and the dewatering pumps. Power will also be supplied to remote sites (backfill facility and potable well pump).

4.5.7 Compressed Air System

Compressed air is required for support of mining activities. Compressed air will be distributed from the surface air plant to mine workings using steel pipe. Compressed air requirement for the Eagle Project is 3,600 scfm based upon a line pressure requirement for equipment at 80 to 90 psig. The connection between mining levels will consist of 150 mm (~6.0 in) pipes installed in the main access ramps. Laterals across mining levels will be 100 mm (~4 in) pipes.

4.5.8 Mine Utility Water

Treated mine utility water will be supplied to both surface and underground facilities including the crusher, truck wash, drilling equipment and underground dust control equipment, etc. (see Figures 4-18A and 4-18B for water balance).

The following supplemental Figures may be found at:

<http://www.deq.state.mi.us/documents/deq-ogs-land-mining-metallicmining-EagleAppWeb.pdf>
under Application Figures

Figure 4-2 Site Development Plan and Topographic Map (map)

Figure 4-7 Portal Plan and Sections (plan drawing)

Figure 4-12 Exhaust Raise Fan (plan drawing)

Figure 4-20 Mine Layout - 383 Meter Level (plan drawing)

Figure 4-21 Mine Layout - 353 Meter Level (plan drawing)

Figure 4-22 Mine Layout - 323 Meter Level (plan drawing)

Figure 4-23 Mine Layout - 293 Meter Level (plan drawing)

Figure 4-24 Mine Layout - 263 Meter Level (plan drawing)

Figure 4-25 Mine Layout - 248 Meter Level – Exhaust Level (plan drawing)

- Figure 4-26 Mine Layout - 233 Meter Level (plan drawing)
- Figure 4-27 Mine Layout - 203 Meter Level (plan drawing)
- Figure 4-28 Mine Layout - 188 Meter Level (plan drawing)
- Figure 4-29 Mine Layout - 173 Meter Level (plan drawing)
- Figure 4-30 Mine Layout - 143 Meter Level (plan drawing)
- Figure 4-31 Mining Method - Blasthole Stope and Backfill (plan drawing)
- Figure 4-32 Mine Ventilation Schematic (plan drawing)
- Figure 4-33 Backfill Plant Flow Diagram (plan drawing)

DNR Comments

The underground mining plan follows established successful mining procedures. The portal adit in bedrock and decline tunnel to reach the mineable ore body at depth below a river and wetland area allows a safer and an environmentally preferable method to enter the ground than a straight or slightly inclined shaft closer to the ore body. Placing the portal into the bedrock outcrop below the present level of glacial overburden will later allow plugging and burying the portal area when the mine is reclaimed. This will allow the area to return to a more natural setting maintaining the aesthetic integrity of the outcrop while preventing public access to the abandoned mine. Upon final reclamation, the DNR will require large boulders placed below grade on the exterior of the sealed adit entrance to further prevent public access to it.

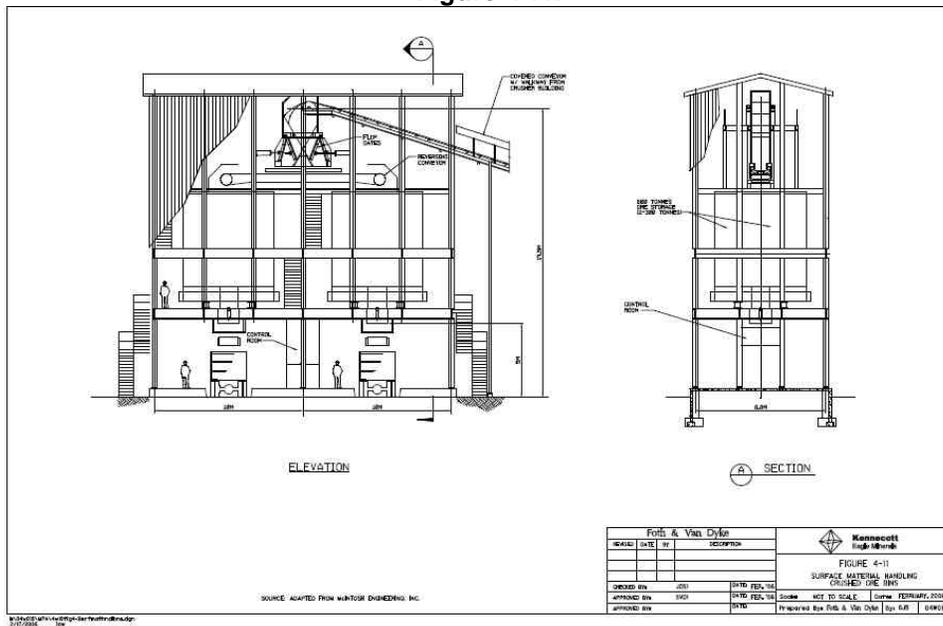
The proposed blasthole stoping mining method will allow mining from the bottom to the top area of the deposit. Importantly, this provides an opportunity to mine in stages towards the top, allowing concurrent reclamation by backfilling areas with both cemented and uncemented development rock to maintain mine integrity. Staged mining allows rock strength, water infiltration, and additional engineering measurements to be made as mining progresses from the lowest level upward.

J.1.c.(1d) Product and raw materials storage areas and loading facilities.

4.3.5 Ore Conveying and Crushing ... Bullet #8

? Crushed ore exits the crusher building on a covered transfer conveyor equipped with a walkway for inspection and maintenance. The conveyor transfers the ore to the top of two 300 tonne (330 ton) capacity crushed ore bins. The bins are equipped with chutes at the base to perform truck loading. The crushed ore bins and building are illustrated in

Figure 4-11.



4.3.6 Coarse Ore Storage Area

The coarse ore storage area (COA) will be an approximately 3,000 m3 (~3,924 yd3) building for

storage of approximately 5,000 tonnes of ore. The COSA will measure approximately 1394 m² (~15,000 ft²) and be approximately 7 m (~23 ft) tall. The building will be metal framed and have metal siding enclosed on three sides. The floor of the building will be reinforced concrete 0.3 m (~12 in) thick sloping toward a collection sump. The collection sump will collect contact water from stockpiled ore for pumping into the CWB for treatment.

4.3.7 Ore Transportation

Ore transport from the underground mine will include a number of different processes. LHD's will deliver ore to low profile production trucks. Production trucks will proceed up the decline to the COSA. From the COSA, the ore will be moved by front-end loader to the crusher feed. Ore that passes through the crusher will charge the transfer conveyor. The transfer conveyor will feed a second transfer conveyor which charges two crushed ore bins. From the crushed ore bins approximately 50 tonne capacity ore trucks will be loaded for transport to the railhead. It is expected that approximately 40 truck loads per day will be required to transport the ore to the railhead. During transport the ore will be covered with secured caps. All ore trucks will be washed at the truck wash before exiting the main operations area. Presently KEMC plans to use the following approved trucking route to the railhead:

? East on Triple A Road, 9 miles to CR 510,

? East on CR 510, approximately 3 miles to CR 550,

? South on CR 550 approximately 20 miles to a railhead in the vicinity of Marquette.

KEMC is continuing to study transportation routes and railhead locations, and the final transportation plan may change from that described above. The railhead facilities will include an enclosed bulk ore storage building(s) and enclosed conveyor/rail car loading equipment. All ore handling processes will be within enclosed structures to prevent release of ore.

4.3.9 Temporary Development Rock Storage Area

The TDRSA will be constructed for the temporary storage of development rock. The size of TDRSA will be approximately 5.9 acres providing 219,925 m³ (~285,000 yd³) of storage capacity, based upon 378,914 tonnes of planned excess development rock. The location of the TDRSA with relation to other mine surface facilities is shown on Figure 4-2.

The design of TDRSA was completed pursuant to R 425.203 and R 425.409. The TDRSA will incorporate a geomembrane cover, a contact water collection system, a composite base liner system, and a leak detection system. Combined, these systems will minimize the generation of contact water. The leak detection system constructed below the base liner will allow for monitoring and collection (if needed) of percolation through the composite base liner system. Detail design concepts of the TDRSA are provided in Section 5 of this report.

Contact water will be collected at the base of the TDRSA using a granular soil collection medium and geocomposite drainage fabric sloping towards a collection sump. Liquid in the sumps will be pumped via a submersible pump through a side-slope riser to the CWBs for storage and eventual treatment by the on-site WWTP. In addition, the development rock that is placed in the TDRSA will be amended with approximately 7,800 tonnes of limestone. As described in Appendix D-3, the addition of readily-available high-calcium limestone will:

? Provide acid-neutralizing capacity to the TDRSA that will prevent the generation of low pH water. ? Raise the pH of the water collected in the TDRSA thereby reducing the concentrations in the contact water of pH-sensitive metals such as copper and stabilizing the ferric hydroxide that will precipitate and absorb other trace metals.

4.3.13 Backfill Aggregate Stockpiles

The backfill aggregate stockpile area located near the backfill raise is shown on Figure 4-2. Also present near the aggregate stockpile and backfill raise will be a 110-tonne capacity fly ash silo, and a 110-tonne capacity cement silo. During full production it is estimated that approximately 200 tonnes per day of aggregate will be required for mine backfilling operations. Clean aggregate will be supplied from a local vendor. Aggregate from the stockpile will be moved via front-end loader to the aggregate hopper feeding the 2.4 m (~8 ft) diameter aggregate raise. Surface water drainage from the aggregate stockpiles will be controlled via perimeter ditching, draining to NCWIB #5 as shown on Figure 4-2 (above).

5.2 TDRSA Operations

The TDRSA will be operated to minimize generation of ARD through a combination of efficient filling sequence, amending the development rock with limestone, and placement of a temporary cover.

5.2.1 Filling Sequence

The filling sequence for the TDRSA is illustrated in Figure 5-7. Initially an access ramp will be developed to access the TDRSA bottom. Development rock having a typical 3-in to 4-in particle size will be unloaded at the base of the access ramp and graded two feet thick across the entire floor area. A five to 10-foot layer of development rock will then be placed entirely across the base before filling progresses to the peak build-out elevation. Filling will then proceed from north to south to the design grades as illustrated in Figure 5-7. During the filling sequence the outslope of the active face (outslope of unloaded rock) shall not exceed 1:1 (H:V).

Table 5-4 shows the development rock quantities relative to the TDRSA filling sequence. Figure 5-7 illustrates the traffic pattern for entering and leaving the TDRSA. The traffic pattern may be modified based upon operational sequencing of filling and rock removal.

**Table 5-4
TDRSA Development Rock Filling**

Development Rock Generation Tonnes ⁽¹⁾	Development Rock Balance m ³ ⁽²⁾	Development Rock Balance yd ³ ⁽²⁾	Filling Sequence	Facility Development Year	Comments
144,738	72,400	94,700	1	1	Filling across floor area to 5 to 10 ft.
319,301	159,650	208,800	2	2-3	Filling progressing from north to south
378,913	189,500	247,900	3	4	Filling complete in year 4, 90% of facility has temporary cover installed
378,913	189,500	247,900	4	4	Temporary cover installation complete

Notes:

- 1) Development rock quantities from McIntosh Engineers.
- 2) Cubic meters and cubic yards rounded to the nearest hundred.

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Checked by: SVD1

5.2.2 Temporary Cover

As discussed previously, the TDRSA will be a temporary storage facility for mine development rock. Based upon the facility timeline shown in Table 4-4, it is expected that the TDRSA will be at final grade in year 3. Rock removal for mine backfilling will begin in year 4. As such there will only be a short period of time (no more than 1 year) where the facility will be entirely capped with the temporary geomembrane cover. Because of the temporary and short term nature of this facility, a cover system has been designed that will not only limit precipitation contact with the development rock but will also provide KEMC with operational flexibility.

A temporary cover will be placed over the development rock once final rock elevations have been achieved. It is anticipated that cover installation may occur in two phases, dependent upon fill rates. If fill rates are higher such that the TDRSA is filled to capacity in less than two years, then cover installation could occur in one sequence.

The proposed temporary cover system for the TDRSA will consist of the following components from bottom to top.

- ? A geotextile fabric (if needed) will be placed on top of the development rock to prevent loss of the bridging layer into the development rock
- ? A bridging layer (if needed) of smaller sized development rock (typically 3-in to 4-in particle size) to bridge the larger rock yields.
- ? A 4-in to 6-in grading layer of select site soils or geotextile for geomembrane placement.
- ? A geomembrane consisting of a 30-mil PVC liner.
- ? A ballast system consisting of tethered sand bags will be anchored to the geomembrane.

Details of the cover system are provided on Figure 5-3. Cross sections of the TDRSA showing proposed cover elevation are shown in Figures 5-8 and 5-9.

Initially a non-woven geotextile may be placed over the development rock to prevent loss of the bridging layer into the development rock mass. A bridging layer will then be placed directly over the geotextile to support the sand grading layer (if needed). On-site soils will be used for the sand grading layer, placed 4-inches to 6-inches thick. Once the grading layer is placed, the geomembrane will be installed. The geomembrane installation will follow the construction quality control procedures specified in the CQA plan contained in Appendix I. Sand bags will be used as weights over the geomembrane. Because the TDRSA is a short term facility, a cover system comprised of permanent layered earth is not needed. As such, a ballast system comprised of tethered sand bags will be used to secure the geomembrane.

5.2.3 Removal Sequence

Removal of the development rock from the TDRSA will proceed from the north side of the facility to the south. First the temporary cover will be removed in 4 staged sequences to allow access to the underlying rock. Between each cover removal sequence, the underlying development rock will be excavated and returned to the mine. After all the development rock has been removed from a stage area, the underlying contact water collection system and liner systems will be removed and disposed. During rock removal operations, at least two feet of granular material will be maintained over all active lined areas for liner protection. It is expected that development rock removal will occur in 4 stages over a 1 to 2-year period. As discussed in Section 5.1.5.2 in order to maintain stability of the liner system the maximum the differential height of the rock face will be limited to the height presented in Table 5-1.

5.4 COSA

As described in Section 4.3.6, the COSA will be constructed to contain mined ore. The COSA building will measure approximately 1,394 m² (15,000 ft²) having a storage capacity of 3,000 m³ (3,924 yd³). This building will be enclosed on three sides and constructed of steel framing with steel siding. A clear plastic drop door will be installed across the open site to minimize precipitation contact with the ore and reduce fugitive dust release. The floor of the COSA will be constructed of 12 in thick reinforced concrete sloping to a catch basin for collection of contact water. Any collected contact water will be pumped to the CWBs for treatment. Because the ore will contain no significant free water, very little contact water generation is expected. The COSA design features will provide adequate containment for the mined ore and will prevent exposure of it to the environment.

J.1.c.(1e) Proposed and alternative locations where feasible, and designs of waste and lean ore piles, and tailings basins.

4 Alternatives Evaluation

This section provides an evaluation of feasible and prudent alternatives for key mining activities, in accordance with R 425.202(1)(c). The following features of the Eagle Project were considered for this alternatives evaluation: ? Mining method ? Ore Processing ? Transportation ? Power supply ? Surface facilities location ? Treated water discharge, and ? End use.

For each of these major components of the project, the alternatives evaluation includes a description of feasible and prudent alternatives, a description of alternatives considered but not carried forward for further evaluation and a description of why the chosen alternatives are preferred.

4.1 Mining Method

Early in the evaluation of the Eagle Project, various mining methods were considered, taking into account environmental impacts and economics. Generally, the choice of mining methods depends on the geological and geotechnical characteristics of the ore body, the type of country rock and the depth of overburden, taking into consideration environmental impacts and overall economics. The mine production capability generally depends on the selected mining method and the geometry of the ore body, which generally drives economics. A preliminary assessment of open pit mining early on in the evaluation process resulted in a determination that open pit mining would result in a significantly larger environmental footprint and reduced economics. This is primarily related to the depth of the ore body and overburden thickness. Since the ore body is located beneath wetlands and a stream, these existing surface features would have to be relocated in order for the open pit concept to be viable. In addition, the open pit concept would include stripping of overburden soils and stockpiling for reclamation. The footprint of the open pit would be larger than the footprint of the ore body such that additional overburden and country rock would have to be removed to allow for complete removal of the ore due to the development of benches and stepping of the pit sidewalls. This would result in the substantial removal of overburden and development rock. Given the additional disturbance of an open pit mining method, it was dropped from consideration early in the development of the mining concept and the proposed underground methods described in Volume I of this *Mining Permit Application* were selected.

4.2 Ore Processing

Both transportation and ore processing are closely related and influence the overall project operations. This section provides a description of ore processing alternatives. The transportation alternatives are discussed in the next section. Early in the feasibility evaluation of the Eagle Project, two different ore processing alternatives were considered as follows: ? Milling and flotation of coarse ore on-site to generate a Ni/Cu concentrate for shipping to an off-site processor. ? Transport by rail of coarse ore to an off-site mill in

Canada. Because of the resource and capital requirements for a mill on a greenfield site, on-site processing was not selected. The selected alternative for mineral processing includes the direct shipment of the coarse ore to Canada by rail. This decision was made based on the ore grade, transportation requirements and the relatively short timeframe of the project. Direct ship involving intermodal transportation involving trucks, rail and ships is not economical. Direct ship to Canada via trucks is also not an economically viable alternative.

4.3 Transportation

As discussed in the previous section, ore processing and transportation are closely related. For the evaluation of transportation alternatives, it was assumed that ore primary crushing at the mine site. From the mine site, coarse ore would then be transported by truck on approved county roads to a yet to be identified railhead site near Marquette. From the railhead, coarse ore will be shipped by rail to a mill in Canada. Once the decision was made to transport crushed ore from the mine site to a railhead, an evaluation of alternative transportation routes was undertaken. Several transportation routes and railhead locations were screened, based on the overall condition of the roadway and infrastructure (subgrade conditions, drainage, bridges, etc.). Overall costs to upgrade portions of the route, along with potential environmental concerns were also considered in this evaluation. Five alternative routes were evaluated, as shown in Figure 2-6, and described below:

? Triple A Road to Peshekee Grade – Transport the ore via the Triple A Road to Peshekee Grade to a railhead in Michigamme Township. Dropped due to road improvement costs.

? CR 510 Option - Triple A Road ? CR 510-Midway Drive ? US 41 to a railhead in the vicinity of Marquette. This option was not selected as the best option based on initial construction improvement requirements and trucking costs.

? Logging Road Option - Triple A Road ? CR 510 ? Private Logging Road ? CR550 ? to a railhead in the vicinity of Marquette. This option was not selected as the best option based on initial construction improvement requirements.

? CR 550 Option - Triple A Road ? CR 510 ? CR 550 ? to a railhead in the vicinity of Marquette. This route is the recommended alternative.

? The south transportation route - Create a road to a railhead in the vicinity of Highway 41. This option is dependent on the successful negotiation of road easements with private land owners. This option is not feasible due to lack of connecting easements at this time although discussions are ongoing.

Based on a detailed review of overall economics, the preferred choice of transportation was identified as the “550 option”, as described above. The evaluation considered capital improvements required to the Triple A Road and portions of the CR 510. Maintenance costs such as snow removal were also taken into consideration.

4.4 Power Supply

Facility power will be provided by a set of three diesel generators, each capable of delivering 1825 kW of power. Each generator will be equipped with selective catalytic reduction (SCR) units installed on individual exhaust stacks. SCR units can reduce the concentration of NOx in the generator exhaust by 90%. Three generators will be provided, however, only two will be operating at any given time. This provides redundancy and regular periods of downtime for maintenance. The generators will be operated equally throughout the year with relatively equal loading, depending on maintenance requirements. The maximum routine power needed during full mine operation will be approximately 2.6 mW. The generators will be fueled with low sulfur, No. 2 diesel-fuel with a sulfur content of less than 0.5%. Heat for the mine ventilation system will be supplied by waste heat from the diesel generators augmented by heat from propane fired heaters, as needed to raise the mine intake air to above 32 degrees F. The alternative to on-site generators would be to bring electric power to the site from the nearest grid connection. Key criteria used in the evaluation of the electrical power supply to the site included the following:

? Life of the project ? Capital costs ? Operating costs ? Reliability, and ? Environmental impact

The location of the nearest connection to an electric transmission line is as follows:

? Twenty-eight miles south to a three phase line near Champion. ? About 13 miles to a single-phase line that services Big Bay.

The single phase-line will not meet the needs of the project. Given the relatively short duration of the project and the distance to the grid connection point near Champion, the most sensible alternative was determined to be use of on-site generators. Reliability will be provided by having a backup generator available, as discussed above. Natural gas-fired or propane generators are also commercially available. Due to the lack of natural gas pipelines in the area, this alternative was not considered to be viable. Propane, like diesel would have to be trucked to the mine site. Due to the higher capital and operations of propane operations, cost of diesel fired generators was selected over propane-fired units. Environmental impacts will be minimized by the addition of SCR units and through the use of low sulfur diesel fuel.

4.5 Location of Surface Facilities

The location of the surface facilities are shown on Figure 2-3. The location of the surface facilities was selected, based on the following primary considerations: ? Accessibility and proximity to the mine ? Avoidance of direct impacts to wetlands ? Minimization of surface disturbance including site grading and vegetation ? Minimizing visibility from the Triple A road, and ? Accessibility to off site transportation routes. The selected location for the surface facilities became quite obvious once the access to the mine and portal location were selected based on the mining method and overall mine layout. Potential locations to the south of the portal would be more visible from the Triple A Road. The selected location provides good accessibility from the mine and Triple A road, while minimizing environmental disturbance associated with the surface facilities.

4.6 Treated Water Discharge

The Eagle Project will have an extensive water management program. Mine water streams will be generated during construction, operation, and closure of the Eagle Project. The main water management facilities include the CWBs, the WWTP, and the TWIS. The primary alternative to discharging wastewater to groundwater would be direct discharge to a surface water body. The receiving water would likely be the Salmon Trout River, located to the south of the surface facilities.

The alternative for discharge of treated water to surface water was evaluated, but considered less than optimal because of the overall water balance concerns. Since most of the treated water is expected to come from groundwater inflow to the mine, infiltration back into the groundwater system is the preferred discharge option. Another goal of the overall water balance strategy is to minimize acute alteration of aquatic habitats caused by a point source discharge to surface water.

4.7 End use

The final land use of the Eagle Project property will be open green space and areas of natural vegetation. The proposed land use is consistent with surrounding land uses and is also consistent with local zoning. The goal of the current end use plan is to promote a diverse plant community and provide habitat for a variety of indigenous wildlife species, similar to pre-mining conditions. As an alternative to the selected end use, KEMC may choose to establish a passive recreational end use for all or portions of the property that would also be consistent with surrounding land uses and is self sustaining. If KEMC decides to promote recreational uses for site after mining and reclamation, additional discussion with the local government, public, MDEQ and MDNR will occur prior to requesting this change.

DNR Comments

The mining method selected, based upon the ore grade, depths, surface environment, wetlands, etc., led to the proposed plan to access an underground mine via a decline from a portal at a higher elevation than a straight shaft or an open-pit mine would use. DNR agrees underground mining is preferable to open pit mining at this site. Ore processing on-site and off-site were considered. The applicant, for economic and environmental reasons prefers hauling ore to an off-site milling and smelting processor. Eliminating on-site ore processing from this project is desirable environmentally as there is a greatly reduced opportunity for ore and processing materials to be released into the environment. Five transportation routes for carrying ore by truck to railhead were considered. Kennecott selected the CR 550 Option primarily based on road construction improvement costs. All proposed transportation routes present some obstacles. From a natural resource perspective, the proposed route seems similar to the other options on existing roads. Kennecott has proposed an alternate route for snowmobile use while the AAA road is plowed and used for transporting ore. There may be additional resource implications if a new road is constructed. There are few options for electric power supply. The multiple generator option eliminates the need to run 28 miles of power lines. The portal and main surface facilities could use a variety of locations. Kennecott prefers to locate the facility on DNR land for the following reasons: It is at a distance from the ore body allowing a more gradual descent to the ore body, it is at a relatively high elevation, it is an adequate distance from surface water, entering the mine through the rock outcrop provides a more competent adit then entering through unconsolidated sediments, and there is natural tree screening present over a portion of the facility. The DNR concurs that the proposed site is the best available in the area. In addition, the Surface Use Lease potentially affords greater protection to the surface property. A couple of treated water discharge options were considered. The DNR agrees using a discharge to the groundwater is preferred instead of discharging to the nearby river. End use options suggested are returning used lands to green space similar to pre-mining and possibly some infrastructure left for recreational groups. The DNR believes the end use of the property should be the same as its current use. If opportunities arise in the future to utilize structures on the site for public use, those opportunities will be weighed in terms of their natural resource value and benefit to the public.

J.1.c.(1f) Existing and proposed buildings, utility corridors, railroads, roads and auxiliary facilities to be used and/or constructed on leased lands.

4.3.1 Site Access, Parking and Roads

Access to the Eagle Project will be via Triple A Road. The main access road will be surfaced with gravel for all-weather use. Entrance to the mine facilities will only be permitted through the main entrance gate as shown on Figure 4-2. At the main entrance will be a gate house with visitor parking. Employee parking is provided adjacent to the office/mine dry building. On-site access to the surface facilities will be provided by all-weather gravel roads. Construction of access roads will be conducted using road grading equipment such as scrapers and dozers. Initially trees and vegetation will be grubbed. Topsoil will then be stripped from the roadways and stockpiled for future use. Once the road subgrade has been leveled, proof-rolling will be conducted to densify subsoils and identify potential loose/soft areas. If loose/soft areas are identified, weak materials will be removed and/or crushed stone will be compacted into the subgrade for added stability. Excess soil from grading will be stockpiled for future site reclamation. The main haul road from the portal to the COSA will be surfaced with 4 inches of bituminous concrete to permit efficient management of ore particulate that could drop from the ore carriers leaving the mine.

4.3.2 Buildings and Structures

The surface facilities will include the building and structures as shown on Figure 4-2. Planned major surface buildings are listed in Table 4-7.

Table 4-7
Proposed Major Surface Facility Buildings

Building	Area	
	m ²	(ft ²)
Mine Dry/Office (2 floors)	1,263	(13,600)
Truck Wash	368	(4,000)
Assay Lab/Core Storage	316	(3,400)
Generator Plant	427	(4,600)
Mine Air Heater	269	(2,900)
Maintenance Shop/Compressor Plant	687	(7,400)
Coarse Ore Storage	1,394	(15,000)
Water Treatment Plant	500	(5,380)
Crusher Building	549	(5,810)
Total	5,764	(62,020)

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Checked by: SVD1

4.3.3 Truck Wash and Scales

All vehicles leaving the main operations area, as shown on Figure 4-2, will be required to go through a truck wash before they leave the area. The main operations area is that part of the mine site that contains truck, excavation and other equipment associated with the mine operations. The truck wash will be an enclosed system that recycles the wash water. Water that is not recyclable due to excessive sediment loading will be routed to the water treatment plant for processing.

The truck scale (see Figure 4-2) is included on the truck access road within the fenced area. The primary function of the scales will be to weigh the ore in the trucks before the ore is shipped offsite for processing.

4.3.11 Site Utilities

The site utilities for the Eagle Project surface facilities will include electrical, heating, telephone, water and sanitary systems. A utility water system will be provided for operation needs including the crusher system and underground drilling equipment, etc. A fire water system will also be provided that will distribute water to the mine and surface facilities at designated locations for fire protection.

4.3.11.1 Electric Service

Facility electric power is provided by a set of three diesel generators, each capable of delivering 1825 kW of power. Each generator will be equipped with selective catalytic reduction (SCR) units installed on individual exhaust stacks. SCR units will reduce the concentration of NOx in the generator exhaust.

Three generators will be provided, however, only two will be operating at all times. This provides redundancy and regular periods of downtime for maintenance. The generators will be operated equally throughout the year with equal loading, barring malfunction. The maximum routine power needed during full mine operation will be approximately 2.63 mW. The generators will be fueled with No. 2 diesel fuel with a sulfur content of less than 0.5%. The electrical distribution system will provide power to the main surface facilities, the backfill surface facilities, the potable well, and underground facilities.

4.3.11.2 Mine and Surface Facilities Heating

Captured generator exhaust heat will heat the portal to a temperature above 32° F. Four propane heaters having a combined capacity of 16,000,000 Btu/hr will also be provided to augment heating needs to keep the portal above 32°F. Combustion by-products from the propane heaters will be vented through stacks or will be directly vented into the mine through duct work to the portal. Electrical base board heaters will be provided in office spaces and other surface facilities requiring heat.

4.3.11.3 Telephone Service

Currently, landline telephone service is not available to the Eagle Project site. During all phases of the project, communications will be provided through the use of satellite telephones or other means. A separate communication system will be provided for underground operations employing a base station with a multi-channel system for both voice and data communication.

4.3.11.4 Potable Water

A potable water system will be provided to supply potable water to the site buildings, the lab, and to the mine. A well, pump, potable water tank, and distribution system will be provided for potable water. KEMC plans to use well QAL011D (see Figure 4-1) as a potable well for the project and will apply for a *Type II Non-Transient Non-Community Water Supply Permit* from the Marquette County Health Department.

4.3.11.5 Sanitary System

The Eagle Project on-site septic system (OSS) is designed based upon expected operation loading and will be permitted through the Marquette County Health Department. The design flow for the OSS is based on the number of employees. From Table 4-2, the total project employment will be 110. From Table 1 of the *Michigan Criteria for Subsurface Sewage Disposal*, the design flow for an employee at an industrial facility is approximately 35 gallons per day (gpd). Therefore, the peak design flow based upon the State of Michigan criteria for the OSS is 3,850 gpd.

The OSS includes the following components as discussed below:

- ? Septic tank
- ? Dosing pumps
- ? Soil absorption system

The septic tank system will provide a total of 4,000 gallons capacity. The volume will be split into 2 or 3 tanks or compartments. The first compartment will be a minimum of 2,000 gallons. The multiple compartment design will provide improved solids separation and treatment. The design flow for the OSS exceeds 2,000 gpd and as such is required by state code to use dosing pumps for septic tank effluent distribution. Therefore, two dosing pumps will be provided to operate on an alternating basis. The dosing pumps will be located in a separate tank with septic tank effluent flowing into the dosing tank.

The soil absorption system will consist of distribution piping placed in a shallow gravel trench. The trench width will be three feet and the trenches will be spaced with four feet between the trench walls. The distribution piping will be 1.5-in. diameter PVC or HDPE pipe with perforations typically five feet apart. The dosing pumps will provide adequate pressure to force equal flow through each perforation.

The infiltration rate of site soils has been measured as approximately 60 ft/d (Foth & Van Dyke, 2006). The loading rate (gpd/ft²) is determined based on soil types. Based upon the *Michigan Criteria for Subsurface Sewage Disposal Section IX, C, 5* the design loading rate for this type of soil is 0.5 gpd/ft².

The area required for a design flow rate of 3,850 gpd is 7,700 ft² of trench. With trenches three feet wide and spaced four feet between trenches, the total area required for soil absorption is 18,000 ft². Additional space is needed for the septic tanks and dosing pump chamber. The distribution system will be designed with three cells. Each cell will have a shut-off valve to allow one cell to rest or be repaired while the other cells are in operation.

A reserve area is required to provide a replacement of the soil absorption system without using the initial system. Figure 4-2 shows the location at the OSS. The area identified for the OSS is

adequate for the initial soil absorption system and, if necessary, replacement of the soil absorption system.

During initial site development, the construction contractor will be responsible for providing temporary facilities during construction until the OSS system and the sanitary sewer piping to the OSS is operational.

During the mine operation the septic tanks will be pumped on an annual basis to remove excess solids. The dosing pumps will be inspected and maintained on a regular basis. The distribution system will be inspected several times during the year and cells rested each year. This system along with routine maintenance will provide effective sanitary wastewater treatment and disposal at the mine site.

4.3.7 Ore Transportation

Ore transport from the underground mine will include a number of different processes. LHD's will deliver ore to low profile production trucks. Production trucks will proceed up the decline to the COSA. From the COSA, the ore will be moved by front-end loader to the crusher feed. Ore that passes through the crusher will charge the transfer conveyor. The transfer conveyor will feed a second transfer conveyor which charges two crushed ore bins. From the crushed ore bins approximately 50 tonne capacity ore trucks will be loaded for transport to the railhead. It is expected that approximately 40 truck loads per day will be required to transport the ore to the railhead. During transport the ore will be covered with secured caps. All ore trucks will be washed at the truck wash before exiting the main operations area. Presently KEMC plans to use the following approved trucking route to the railhead:

? East on Triple A Road, 9 miles to CR 510,

? East on CR 510, approximately 3 miles to CR 550,

? South on CR 550 approximately 20 miles to a railhead in the vicinity of Marquette.

KEMC is continuing to study transportation routes and railhead locations, and the final transportation plan may change from that described above. The railhead facilities will include an enclosed bulk ore storage building(s) and enclosed conveyor/rail car loading equipment. All ore handling processes will be within enclosed structures to prevent release of ore.

DNR Comments

No building or utility infrastructure exists at the current site. A variety of buildings, facilities, and on-site roads need to be built for the mining operation. Kennecott will construct approved alternate snowmobile routes along portions of the Triple A road. Telephone and electric service and potable water and a sanitary system will be constructed per local permitting requirements. Most of the buildings are proposed to be constructed of steel and concrete and after the mining project was completed they will be removed, with the possible exception of using a building or two for public recreational use. The DNR retains the right to approve or deny the retention of on-site buildings and roads for public use.

J.1.c.(2) A description of proposed reclamation of the mining operation area on the leased premises including [(a) (b) (c) as follow]:

7 Reclamation Plan

This section presents the Eagle Project Reclamation Plan pursuant to R 425.204 and R 425.407. The goal of the reclamation plan is to establish a self sustaining ecosystem that is consistent with local end use goals. A self sustaining ecosystem will simulate the natural biodiversity of the flora and fauna through the reclaimed areas. Reclamation of the property will consist of restoring approximately 90 acres of surface area and the underground mine workings. The proposed reclamation plan will restore the property to a condition commensurate with premining landscape using native vegetation to promote enhancement of wildlife habitat. The final land use of the site will be compatible with existing uses on adjacent properties. Included with the Reclamation Plan are procedures and time lines for closure of both surface and underground facilities and estimated costs. Post-closure monitoring is discussed in Section 7.5. Reclamation of the railhead facility will be assessed upon-site selection and preliminary design. Because the railhead facility will be entirely enclosed, little if any reclamation would be required. Site structures would remain standing and sold to other potential railhead users. At the end of mining operations, KEMC may consider donating one or more Eagle Project structures to the local community for civic use. MDNR and MDEQ will be notified regarding changes in building ownership and uses.

7.1 Reclamation Sequencing and Timing

Reclamation activities related to the proposed development will commence during initial construction activities at the site and will continue through facility closure into the post-closure care period. Reclamation sequencing has been established based upon three different site development events as presented in Table 7-1.

**Table 7-1
Reclamation Sequence**

Sequence	Event	Facility Development Year
1	Site Construction	1-2
2	Closure ⁽¹⁾	8 ⁽¹⁾ , 9-11
3	Post-Closure	12-37 ⁽²⁾

⁽¹⁾TDRSA closure.

⁽²⁾ Wastewater treatment system will close the 5th year of post-closure, year 17.

Prepared by: JOS1

Checked by: SVD1

Sequence 1 will occur concurrent with site construction, and will include reclaiming areas disturbed during site construction as soon as practical after construction is completed for a particular area. At facility closure after mining activities cease, (Sequence 2) unnecessary site infrastructure will be decommissioned and the property restored to pre-mining conditions. Postclosure reclamation (Sequence 3) will occur after closure for a period of 20 years. Table 7-2 lists significant activities associated with each reclamation sequence.

**Table 7-2
Reclamation Activities**

Sequence	Event	Time Period (yrs)	Reclamation Activity
1	Site construction reclamation	Year 1-2	<ul style="list-style-type: none"> - Main site and backfill site: grade, seed vacant disturbed areas - Access Road: seed disturbed areas between shoulder and R.O.W. - Seed soil stockpiles.
2	Closure reclamation	8, 9 through 11	<ul style="list-style-type: none"> - Removal of TDRSA - Remove site structures no longer needed - Complete site final grading - Seed and mulch disturbed areas - Install erosion control features - Remove underground equipment - Remove site utilities and generators (1 generator to remain for WWTP contingency plan) - Install post-closure monitoring devices - Reclaim the underground mine workings
3	Post-Closure reclamation	Years 12 through 37	<ul style="list-style-type: none"> - Conduct incidental grading - Install erosion control features - Seed and mulch remaining disturbed areas - Monitor groundwater and surface water to year 37 - Monitor flora and fauna for 5 years after completion of reclamation - Removed WWTP, CWBs, and electrical generator, year 17.

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Checked by: SVD1

7.2 Final Land Use

The final land use of Eagle Project property will be open green space and forested areas. The proposed land use is consistent with surrounding land uses and is also consistent with Michigamme Township zoning. The long-term goal of the reclamation plan is to allow ecological succession to occur in all reclaimed areas. To enhance the establishment of a variety of woody plant species, selected plantings of mixed hardwoods and coniferous species may be provided by KEMC. The goal is to promote a diverse plant community and provide habitat for a variety of indigenous wildlife species.

KEMC may choose to establish a passive recreational end use for all or portions of the property

that would also be consistent with surrounding land uses. If KEMC decides to promote recreational uses for the site after mining and reclamation, additional discussion with the local government, public and MDEQ will occur prior to requesting the change of end-use. The final site grading plan is shown on Figure 7-1. The grading plan was developed based upon property end use that is consistent with the goals discussed above. The proposed reclamation plan is consistent with pre-development topography gently sloping towards the west/southwest. The groundwater at the site generally flows towards the northeast.

7.3 Site Construction Reclamation

During site construction reclamation will be performed concurrently for disturbed areas surrounding the facilities under construction. Reclamation of these areas will include proper grading and applying seeding and mulching. Storm water management facilities including grading, ditches and detention basins will be constructed at the start of construction. Silt fences and other erosion control devices will be installed as necessary.

7.4 Closure Reclamation

7.4.1 Surface Facilities

Closure for the surface facilities will occur at different times during the life of the facility beginning with the closure of the TDRSA in operating year 8. Closure of the remaining surface facilities and underground facilities is expected to be completed in year 11. However, the CWBs, WWTP and one generator will remain in operation for the first 5 years of post-closure as a contingency for treatment of mine water. It is expected these facilities will close in year 17.

7.4.1.1 TDRSA

Closure of the TDRSA is expected to begin in operating year 8. As presented in Section 4 development rock will be returned to the mine as part of the underground reclamation. Upon removal of the development rock, the underlying water collection system and liner will be removed. The water collection drainage layer may be used as backfill in the mine or disposed off-site in accordance with applicable regulations. Geosynthetic liner components including the geomembrane liners, geotextiles and GCL will be removed and disposed of underground or at an approved off-site landfill. Mechanical components such as pumps or other salvageable materials will be removed from the property. Upon removal of all facility components, the area will be regraded to allow efficient use of the area during continued mining operation.

Table 7-3 provides a breakdown of materials and quantities required for reclamation of the TDRSA.

**Table 7-3
TDRSA Reclamation**

Component	Quantity	Disposal
Collection Sand	~9,700 yd ³	Mine Backfill ¹
Collection Piping	~660 lin ft	Salvage
Collection Pump(s)	2 ea	Landfill ¹
Geomembrane Liner	~262,000 ft ²	Landfill ¹
Geotextile/GCL	~262,000 ft ²	Landfill ¹
Cover Geomembrane	~263,000 ft ²	Landfill ¹

¹Or other approved method.

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Checked by: SVD1

7.4.1.2 Roads and Access

Reclamation of facility roads is expected to begin in year 9 and 10. With the exception of the main site access roads, internal site roads will be graded to provide a natural pre-development condition. A minimum number of roads will be maintained to allow access to post-closure monitoring devices. Roads to be reclaimed will be graded consistent with surrounding ground slopes, topsoiled and revegetated. Any gravel surface material will be disposed of underground or removed from the site.

7.4.1.3 Buildings and Structures

With the exception of the WWTP and generator buildings, closure of facility buildings is expected to begin in year 9 starting with the decommissioning of the assay/lab and core storage buildings. Over the following 2 years the remainder of the site buildings are anticipated to be closed and the area reclaimed as described previously. The estimated timeframe for closure of

all the site buildings and structures is about 2 years.

Reclamation activities for the surface buildings will follow a similar approach. Initially all salvageable materials will be removed from the buildings. This could include doors, cabinets, lighting fixtures, plumbing fixtures, pumps, cables and conduits, etc. After salvageable materials have been removed the structures will be demolished. Designated demolition debris will be removed from the site and disposed at an approved off-site disposal facility. All regulated materials, if any, will be disposed in a manner consistent with state and federal regulations. After the framing of the buildings are demolished and removed, the concrete foundations and floor slabs will be broken up. Broken concrete may be used as backfill for the mine reclamation. After removal of all debris the building areas will be graded to eliminate ponding and to promote surface water drainage. KEMC may enter into an agreement with the Michigan Township or Marquette County for civic uses of some of the buildings. If this occurs, KEMC will donate the buildings and provide access easements to these structures. The MDNR and MDEQ will be notified of any building ownership change.

7.4.1.4 Surface Water Management Facilities

Reclamation for the surface water management facilities will include removal of the contact and non-contact water basins, removal of hard structures, such as pumps, culverts and risers, and revegetating. In order to maintain surface water and erosion control across the property during other reclamation activities, closure of the NCWIBs will be at the end of closure Sequence 3. Closure of the CWBs will occur as discussed previously, depending on the timing of decommissioning of the WWTP. Salvage materials such as pumps, and other mechanical systems will be removed. Culverts will be removed and ditches regraded to conform to the reclamation grading plan. After hard structures are removed the areas will be regraded and vegetated.

7.4.1.5 Site Utilities

The majority of the site utilities will be closed and areas reclaimed in year 9. One generator will remain in operation until the WWTP is decommissioned in year 17. Reclamation will include removal of cables, piping, generators and electrical transformers for storage. After removal of salvage materials, the disturbed areas will be regraded consistent with the reclamation grading plan. Waste items will be disposed in a manner consistent with applicable regulations. Disturbed areas will then be revegetated.

7.4.1.6 Sanitary System

Reclamation of the sanitary systems will include removal of septic holding tanks, pipes and valves, including all pipes in the drain field. Most of sanitary components will not be salvageable and will require disposal at an approved off-site landfill. The disturbed areas will then be regraded consistent with the reclamation grading plan and revegetated.

7.4.1.7 Potable Water System

Reclamation of the potable water system will include removal of pressure tanks, piping, treatment systems, and piping. The potable well will be abandoned pursuant to MDEQ well abandonment requirements.

7.4.1.8 Water Treatment System

The TWIS will be decommissioned at the end of year 12 when the underground mine is reclaimed. Reclamation of the TWIS will include removal of all piping and mechanical systems and regrading the infiltration cell areas. Plastic pipe will either be disposed underground or at an approved landfill. The water treatment system will remain in operation for 5 years into the post-closure period (approximately year 17) as part of the contingency plan for the underground mine. In year 17 the WWTP, CWBs, and the generator building will be decommissioned and the areas reclaimed. Salvageable items such as pumps, conduits, duct work, etc., will be removed. The buildings will be demolished and the area graded consistent with the reclamation grading plan and seed, fertilizer and mulch will be applied.

7.4.1.9 Earth Grading and Topsoil Placement

Earth grading and topsoil placement will begin in year 9 with the majority completed in year 11. Topsoil material will be natural on-site topsoil stockpiled during site development. In year 17, the WWTP, CWB and generator building areas will be regraded and topsoiled. After the surface facilities have been removed, the disturbed areas will be final graded and topsoiled. Stockpiled excess soils will be graded across the site in lifts not exceeding 18 to 24 in. After placement of each lift the soil will be compacted and the subsequent lift of soils will be placed. Approximately 200,000 cubic yards of stockpiled soil will be required to achieve the reclamation grades. Grading of stockpiled

soils will be accomplished using scrapers and dozers. After completion of site grading, topsoil will be placed. Topsoil will be reclaimed from the onsite stockpile. Generally topsoil material will be graded to approximately 3 in. thick, consistent to predevelopment thickness. Estimated total quantity of topsoil required for the property reclamation is approximately 28,600 yd³. Placement of topsoil will be conducted using scrapers and dozers to reach the desired thickness.

7.4.1.10 Revegetation

Revegetation consisting of native grasses will begin in year 2 (areas disturbed during site development) and in years 9 through 11, and year 17. The proposed planting plan will include species indigenous to the area, promoting a self sustaining plant community. Seeding will be performed using either broadcast, hydro-seeding and/or drill-seeding. Seeding rates will be established upon final selection of ground cover. Native grass planting will follow the procedures outlined in the Natural Resources Construction Service (NRCS), Native Grass Planting Conservation Reserve Enhancement Program, CREP-CP2. A copy of this manual is provided in Appendix J. This document provides seed lists and application rates of native grasses based upon land use. Figure 7-1 shows approximate area of revegetation at final reclamation. Prior to vegetation, topsoil will be analyzed for proper nutrients including pH, nitrogen and organic content. Fertilizer will be applied at an appropriate rate based on topsoil nutrient testing.

7.4.1.11 Erosion Control

Erosion control procedures will be implemented continuously through the life of the facility and into post-closure. Erosion control methods outlined in Section 4 are also applicable during reclamation. During reclamation, erosion control practices will include:

- ? Applying mulch to all ground cover areas
- ? Installing silt fence
- ? Installing erosion control fabric on slopes steeper than 8%
- ? Installing straw bale check dams or rock filled gabions in drainage ditches
- ? Using of sized riprap in ditches to reduce water velocity

During reclamation temporary silt control basins will be constructed to contain surface water runoff. These structures will be strategically placed during final site grading to better control surface water runoff during site reclamation activities. After completion of site grading the temporary basins will be filled in and restored to the surrounding topography.

7.4.2 Underground Facilities

7.4.2.1 Mineral Extraction Areas

Reclamation of stopes will be conducted concurrent with mining of new stopes. Stope backing is planned to commence in year 4. Reclamation of the mined stopes will be conducted using sequential backfill methods. The primary stopes will be backfilled using cemented aggregate. The secondary stopes will be backfilled initially using limestone-amended development rock followed by quarried aggregate. Expected quantities of backfill materials are presented in Table 4-5 and 4-9.

Backfilling of the stopes will not only stabilize the mine for continued ore extraction but also prevent surface subsidence. Surface subsidence modeling completed for the project shows that the backfilled mine will result in no measurable surface displacement (Appendix C).

7.4.2.2 Ore Handling Systems

The ore handling systems reclamation will occur in years 9 through 10. Reclamation of the underground ore handling systems will involve salvaging production equipment including the LHD's and the low profile production trucks. These vehicles will be removed from underground and delivered to the surface for salvage. Other equipment such as the grizzlies and ore chutes will either be salvaged or left in place.

7.4.2.3 Ventilation Systems

Reclamation of the ventilation shaft will occur in years 9 through 10. Reclamation of the ventilation shaft will include removal and salvage of the fan. Backfill consisting of aggregate will be placed into the shaft to a point approximately 3 m (~10 ft) from the surface. At designated locations, cement will be mixed with the aggregate (see Figure 7-2). A concrete plug will be set to the ground surface. The ventilation systems reclamation will occur in years 9 through 11. Reclamation of the underground ventilation systems will include removing salvageable materials such as electrical cables, auxiliary fans and portable duct work. Non-salvageable equipment will be left in-place.

7.4.2.4 Electrical and Other Utilities

Reclamation of the majority of electrical and other utilities will be completed in years 9 through 11. Reclamation of electrical and other utilities will include removal of salvageable materials such as cables and communication systems and transformers. Equipment not salvageable will be left in-place. In year 17 the remaining electrical utilities will be removed from the site as part of the WWTP, CWBs and remaining generator reclamation.

7.4.2.5 Sanitary Systems

Underground sanitation will include portable toilets and sinks that will be provided by a contract vendor. Reclamation of the sanitary systems will involve removal of all portable toilets and sinks.

7.4.2.6 Dewatering Systems

Reclamation of the mine dewatering system will likely begin as early as year 10. However, it is possible that certain components of the dewatering system may remain active for several years after completion of mining. Reclamation of the dewatering system will include removal of salvageable items such as pumps, cables, pipes and conduits. Those items not salvageable will be left in-place.

7.4.2.7 Mechanical Equipment

Mechanical equipment reclamation will begin in year 9 and be completed in year 11. Mechanical equipment such as drills, temporary lighting structures, air hammers and other portable equipment will be removed.

7.4.2.8 Underground Openings and Portal

Reclamation of the underground workings, portal and vent shaft will be among the final reclamation activities completed at the site. The goal for this aspect of the reclamation plan is to:

- ? Reclaim the underground openings in a fashion that will minimize the potential for migration of mining related constituents from the underground openings upward into the alluvial aquifer.
- ? Remove the vent shaft equipment and seal the vertical opening and aggregate raises for long term safety and environmental protection.
- ? Reclaim the mine portal and restore the rock face of the outcrop.

7.4.2.8.1 Reclamation of Underground Openings

The bedrock characterization work completed by Golder Associates Ltd. (2005b) and Golder Associates, Inc. (2006) has documented two hydrologic characteristics of the bedrock system around the Eagle deposit that are relevant to the reclamation of the underground workings.

- ? The upper bedrock above 335 m MSL is characterized by low permeability bedrock that contains non-saline water.
- ? The lower bedrock below 335 m MSL is characterized by rock that exhibits matrix permeability and infrequent fracture dominated hydraulic features. In addition, the lower bedrock contains saline water.
- ? There is no pattern of upward vertical hydraulic gradients within the bedrock. Thus there is little, if any, potential for migration of water in and around the mine up into the alluvial aquifer.

Based on these features and the expected water chemistry of the water in the reflooded underground mine (see Appendix D-5) KEMC is proposing plans for reclaiming the underground openings that will:

- ? Seal the openings so that there is no vertical mining related connections between the upper and lower bedrock.
- ? Accelerate reflooding of the underground openings through two new wells that will pump water into the mine workings in the upper and lower bedrock (see Figures 7-2 and 7-3 for approximate well locations).
- ? Monitor the workings and surrounding bedrock vertical gradients (see bedrock piezometer locations on Figure 7-3) to confirm that there is no potential for approximate upward migration of mining related constituents after reflooding is completed.
- ? As a contingency plan, KEMC will leave the WWTP and associated infrastructure in place for five years after reflooding is complete. If monitoring indicates there is the potential for upward migration of mining related constituents associated with the underground openings, KEMC will pump water out of the upper bedrock workings, treat it at the WWTP and recirculate the treated water back into the upper bedrock workings.

This process of flushing the upper bedrock workings with clean water will continue for a period of several years until water quality conditions in the upper workings are protective of groundwater in the regional aquifer. Note this is not a perpetual care contingency. Figure 7-2 displays a section through the mine workings and denotes the location of backfill aggregate and cemented aggregate that will seal the mine workings as prescribed above. In addition, Figure 7-2 shows the conceptual location of two wells that will be used for pumping clean water into the open workings to accelerate reflooding thereby terminating

sulfide oxidation of minerals in the exposed wall rock. Water for accelerating the reflooding process will be obtained from the potable well (QAL011D) or a well installed elsewhere on KEMC controlled property.

DNR Comments It appears that Kennecott may be placing a limit on the time necessary to return ground water chemistry to an acceptable standard. The DNR believes the requirement should be performance based without a time limitation. All surface recontouring, revegetation or seeding on areas of State-owned land must be done with the prior approval of the DNR. (Note, under 'Revegetation' the agency name quoted is incorrect, it is the U.S. Natural Resources Conservation Service.)

As state previously, the DNR retains the authority for approving any alternative reclamation end-use or possible retention of buildings on State-owned land

7.4.2.8.2 Mine Portal

Portal reclamation will include the removal of salvageable equipment and installation of a two-foot thick reinforced concrete plug at the portal opening. Any portion of the concrete plug that is exposed at the surface will be constructed with stone material obtained from the outcrop when the portal was developed.

7.5 Post-Closure Care and Monitoring

7.5.1 Post-Closure Care

Post-closure care will occur for 20 years after the completion of mine reflooding and surface reclamation. This activity will primarily consist of conducting quarterly site visits, observing site conditions, and conducting post-closure monitoring. Special attention will be paid to observing soil erosion or surface water runoff rills that would require restoration. If eroded areas are noted these areas will be graded, reseeded and mulched. Erosion control fencing will be applied as needed.

7.5.2 Post-Closure Monitoring Plan

Post-closure monitoring at the Eagle Project will include the following:

- ? Monitoring of groundwater and surface water quality for 20 years.
- ? Monitoring of flora and fauna for five years.
- ? Monitoring and maintenance (if needed) of the reclaimed areas.

7.5.2.1 Post Reclamation Groundwater Monitoring Plan

Figure 7-3 shows the reclaimed mine site and the location of groundwater quality monitoring wells that KEMC is proposing to monitor during the post-closure care period. Wells that are not included in the groundwater quality monitoring program will be abandoned after mine reflooding is completed. Monitoring wells around the former TDRSA and CWBs will be monitored in accordance with Table 7-4 until project year 22 to confirm that the TDRSA and CWBs did not release measurable quantities of constituents of concern to the subsurface. Wells around the reclaimed mine will be monitored for water quality parameters for a period of 20 years following reclamation of the WWTP. Figure 7-3 notes wells that are designated compliance wells and leachate monitoring wells per the requirements of R 425.406(5). Also displayed on Figure 7-3 are the locations of bedrock piezometers that will be used to monitor vertical gradients within the bedrock (Golder Associates, Inc. 2006).

**Table 7-4
Post-Reclamation Groundwater Quality Monitoring Program
Parameter List and Sampling Frequency**

Parameter	Frequency	Analytical Method	Method Reporting Limit	Unit
Alkalinity, Bicarbonate	Quarterly ⁽¹⁾	USEPA-310.1	2.0	mg/l
Alkalinity, Carbonate	Quarterly ⁽¹⁾	USEPA-310.1	2.0	mg/l
Aluminum	Annual	USEPA-6010B	50	ug/l
Antimony	Annual	USEPA-6020	5.0	ug/l
Arsenic	Quarterly ⁽¹⁾	USEPA-6020	2.0	ug/l
Barium	Annual	USEPA-6020	20	ug/l
Beryllium	Annual	USEPA-6020	1.0	ug/l
Boron	Quarterly ⁽¹⁾	USEPA-6010B	100	ug/l
Cadmium	Annual	USEPA-6020	0.50	ug/l
Calcium	Annual	USEPA-6010B	0.50	mg/l
Chloride	Quarterly ⁽¹⁾	USEPA-325.2	1.0	mg/l
Chromium	Annual	USEPA-6020	5.0	ug/l
Cobalt	Annual	USEPA-6010B	10	ug/l
Copper	Quarterly ⁽¹⁾	USEPA-6020	5.0	ug/l
Fluoride	Annual	APHA 4500-F C	0.10	mg/l
Iron	Quarterly ⁽¹⁾	USEPA-6010B	20	ug/l
Lead	Annual	USEPA-6020	1.0	ug/l
Lithium	Annual	USEPA-6010B	8.0	ug/l
Magnesium	Annual	USEPA-6010B	0.50	mg/l
Manganese	Quarterly ⁽¹⁾	USEPA-6010B	20	ug/l
Mercury	Quarterly ⁽¹⁾	USEPA-1631E	0.25	ug/l
Molybdenum	Annual	USEPA-6020	10	ug/l
Nickel	Quarterly ⁽¹⁾	USEPA-6020	25	ug/l
Nitrate	Quarterly ⁽¹⁾	USEPA-353.2	0.05	mg/l
Potassium	Annual	USEPA-6010B	0.50	mg/l
Selenium	Quarterly ⁽¹⁾	USEPA-6020	1.0	ug/l
Silver	Annual	USEPA-6020	0.30	ug/l
Sodium	Quarterly ⁽¹⁾	USEPA-6010B	0.50	mg/l
Sulfate	Quarterly ⁽¹⁾	USEPA-375.4	2.0-5.0	mg/l
Strontium	Annual	USEPA-6010B	50	ug/l
Thallium	Annual	EPA-200.8-6020	2	ug/l
Vanadium	Annual	EPA-200.8-6020	10	ug/l
Zinc	Annual	USEPA-6020	10	ug/l
Radon	Quarterly ⁽¹⁾	Field	NA	mBq
Field pH	Quarterly ⁽¹⁾	Field	NA	m
Groundwater Elevation	Quarterly ⁽¹⁾	Field	NA	RMSL
Specific Conductance	Quarterly ⁽¹⁾	Field	NA	umhos/cm
Temperature	Quarterly ⁽¹⁾	Field	NA	°C
Dissolved Oxygen	Quarterly ⁽¹⁾	Field	NA	mg/l

⁽¹⁾ After project year 27, parameters will be analyzed on an annual basis.

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7.5.2.2 Post Reclamation Surface Water Quality Monitoring Plan

Figure 7-4 shows the location of surface water monitoring stations that KEMC will use to monitor surface water quality during the 20-year post-closure care period. These monitoring stations will be sampled in accordance with the parameter and frequency list contained in Table 7-5.

7.5.2.3 Biological Monitoring

KEMC will continue the operational biological monitoring program described in Section 6 for a period of five years after reflooding of the underground mine.

7.5.2.4 Sampling Protocols

The sampling procedures and statistical methods used in the operational monitoring plan will continue to be used during the post-closure monitoring period.

**Table 7-5
Post Reclamation Surface Water Quality Monitoring Program
Parameter List and Sampling Frequency**

Parameter	Frequency	Analytical Method	Method Reporting Limit	Units
<i>Field</i>				
Temperature	Quarterly	Field	NA	°C
D.O	Quarterly	Field	NA	mg/l
Specific Conductance	Quarterly	Field	NA	umhos/cm
pH	Quarterly	Field	NA	su
<i>Metals</i>				
Aluminum	Annual	EPA-200.7/6010B	50	ug/l
Lithium	Annual	EPA-200.7/6010B	10	ug/l
Arsimony	Annual	EPA-200.8/6020	2.0	ug/l
Arsenic	Quarterly ⁽¹⁾	EPA-200.8/6020	1.0	ug/l
Barium	Annual	EPA-200.8/6020	10	ug/l
Iron	Quarterly ⁽¹⁾	EPA-200.7/6010B	20	ug/l
Beryllium	Annual	EPA-200.8/6020	1.0	ug/l
Boron	Quarterly ⁽¹⁾	EPA-200.8/6020	50	ug/l
Cadmium	Annual	EPA-200.8/6020	0.2	ug/l
Chromium	Annual	EPA-200.8/6020	1.0	ug/l
Copper	Quarterly ⁽¹⁾	EPA-200.8/6020	1.0	ug/l
Cobalt	Quarterly ⁽¹⁾	EPA-200.8/6020	10	ug/l
Lead	Annual	EPA-200.8/6020	1.0	ug/l
Manganese	Quarterly ⁽¹⁾	EPA-200.8/6020	10	ug/l
Molybdenum	Annual	EPA-200.8/6020	10	ug/l
Nickel	Quarterly ⁽¹⁾	EPA-200.8/6020	1.0	ug/l
Selenium	Quarterly ⁽¹⁾	EPA-200.8/6020	2.0	ug/l
Silver	Annual	EPA-200.8/6020	0.2	ug/l
Zinc	Annual	EPA-200.8/6020	10	ug/l
Mercury	Quarterly ⁽¹⁾	EPA-1631E	0.25	ug/l
<i>Anions</i>				
Alkalinity, Bicarbonate	Annual	310.1/SM 2320 B	2.0	mg/l
Alkalinity, Carbonate	Annual	310.1/SM 2320 B	2.0	mg/l
Chloride	Annual	325.2/4500-CL E	1.0	mg/l
Fluoride	Annual	SM 4500 F-C	0.10	mg/l
Nitrate-N	Annual	353.2/4500 NO3F	0.03	mg/l
Sulfate	Quarterly ⁽¹⁾	EPA-375.4/9038	1.0	mg/l
<i>Cations</i>				
Calcium	Annual	EPA-200.7/6010B	0.50	mg/l
Potassium	Annual	EPA-200.7/6010B	0.50	mg/l
Magnesium	Annual	EPA-200.7/6010B	0.50	mg/l
Sodium	Annual	EPA-200.7/6010B	0.50	mg/l
Total Dissolved Solids	Quarterly ⁽¹⁾	EPA-160.1	50	mg/l

⁽¹⁾ After project year 27, parameters will be analyzed on an annual basis.

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7.6 Reclamation Costs

Total estimated reclamation cost for the Eagle Project is \$6,738,050, including a 10% contingency. Included with this cost is \$1,415,000 for post-closure monitoring. Reclamation line item costs are provided in Table 7-6. The summary reclamation cost is presented in Table 7-7.

The unit costs are based upon "Means Building Construction Cost Data" or engineering judgment from experience, assuming a third party would perform the work. The unit costs include labor, materials, and overhead and profit.

**Table 7-6
Reclamation and Monitoring Cost Estimate**

Item	Unit	Cost/Unit		Extension
		Years 1 and 2 (Site Construction)	Year 8 (TDRSA)	
1. Regrading	16 ac	\$1,000/ac		\$16,000
2. Install Erosion Control Devices (silt fence)	4,000 lf	\$2/lf		\$8,000
3. Seed/Mulch	16 ac	\$2,500/ac		\$40,000
4. Plantings (trees/shrubs)	80	\$100/planting		\$8,000
			Annual Cost	\$72,000
Year 8 (TDRSA)				
1. TDRSA Removal			Lump Sum	\$5,000
• Remove Salvageable Materials				
• Remove 12" Drainage Layer	10,000 yd ³	\$3.50/yd ³		\$35,000
• Remove Geosynthetic Composites (HDPE/GCL/Geotextile)	each		Lump Sum	\$10,000
2. Regrade Area	145,000 yd ³	\$3/yd ³		\$435,000
3. Topsoil	6 acres	\$2,000/ac		\$12,000
4. Install (silt fence)	2,500 lf	\$2/lf		\$5,000
5. Seed/Fertilize/Mulch	6 acres	\$2,500/ac		\$15,000
			Annual Cost	\$517,000
Year 9 (Closure)				
1. Remove Salvageable Materials from Buildings	--		Lump Sum	\$25,000
2. Remove Site Utilities	--		Lump Sum	\$25,000
3. Demolish Buildings	10 structures	\$5,000		\$50,000
4. Dispose of Regulated Materials	2,000 tons	\$40/ton		\$80,000
5. Parking Lot Removal	7,000 sq	\$4/sq		\$28,000
6. Fence Removal	11,500 lf	\$2/lf		\$23,000
7. Regrading of Basins 3 & 4	34,000 yd ³	\$3/yd ³		\$102,000
8. Regrade Building Sites	3 acres	\$1,000/ac		\$3,000
9. Seed/Mulch Disturbed Areas	10 acres	\$2,500/ac		\$25,000
10. Install Silt Fence	2,000 lf	\$2/lf		\$4,000
			Annual Cost	\$375,000
Year 10 (Closure)				
1. Remove Surface Salvageable Materials			Lump Sum	\$50,000
2. Backfill Surface Razes and Cap	6,000 yd ³	\$12/yd ³		\$72,000
3. Install Mine Plugs	1,000	\$100/yd ³		\$100,000
4. Remove Site Utilities	--		Lump Sum	\$150,000
5. Demolish Buildings (completed)	--		Lump Sum	\$100,000
6. Dispose of Regulated Materials	500 tons	\$40/ton		\$20,000
7. Regrade Building Sites	10 acres	\$1,000		\$10,000
8. Seed/Mulch Disturbed Areas	20 acres	\$2,500		\$50,000
9. Install Erosion Control Devices (silt fencing)	2,000 lf	\$2/lf		\$4,000
10. Backfill Mine Portal	17,500 yd ³	\$12/yd ³		\$194,000
11. Remove Salvageable Materials from Underground	--		Lump Sum	\$100,000
12. TDRSA Backfilling	250,000 yd ³	\$3.50/yd ³		\$875,000
13. Backfilling Slopes ⁽¹⁾	50,000 yd ³	\$20/yd ³		1,000,000
14. Install Reflooding Walls	--		Lump Sum	\$50,000
			Annual Cost	\$2,765,000
Year 11 Closure				
1. Regrading of remaining disturbed areas	10 acres	\$1,000/acre		\$10,000
2. Seed/mulch disturbed areas	10 acres	\$2,500/acre		\$25,000
3. Install erosion control devices (silt fencing)	2,000 lf	\$2/lf		\$4,000
			Annual Cost	\$39,000

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Table 7-6 (con't)

Item	Unit	Cost/Unit		Extension
		Year 17	Years 20	
1. Closure of WWTP/Generator C/WBs	--		Lump Sum	\$50,000
2. Removal of Salvageable Materials	--		Lump Sum	\$50,000
3. Disposal of Non-Salvageable Materials	50 tons	\$40/ton		\$2,000
4. Regrading Disturbed Areas	11,000 yd ³	\$3/yd ³		\$33,000
5. Seed/Mulch/Disturbed Areas	6 acres	\$1,000/ac		\$6,000
			Annual Cost	\$183,000
Years 20				
1. Well Abandonment	--		Lump Sum	\$200,000
Years 12-37 (Post-closure)				
1. Grading	5 acre	\$1,000/ac		\$5,000
2. Install Silt Fence	1,000 lf	\$2/lf		\$2,000
3. Seed/Mulch	5 acres	2,500/ac		\$12,500
			Annual Cost	\$19,500
Post-Closure Monitoring				
1. Groundwater (15 well locations)				
• Years 12-27/quarterly	\$1,000 per sampling event	\$1,000 x 15 wells x 4 times/yr x 15 yrs		\$900,000
• Years 27-37/annually	\$1,000 per sampling event	\$1,000 x 9 wells x 10 yrs		\$90,000
2. Surface water (5 sampling locations)				
• Years 12-27/quarterly	\$1,000 per sampling location	\$1,000 x 5 locations x 4 times/yr		\$300,000
• Years 27-37/annually	\$1,000 x 5 locations x 1/yr x 10			\$50,000
3. Biological Monitoring Transects ⁽²⁾	Lump Sum	\$15,000 per year x 5 yrs		\$75,000
			Total Monitoring Cost:	\$1,415,000

⁽¹⁾ Based upon the mine design no more than 4 slopes will be open at any point in time. Measuring 50 m by 30 m by 10 m.

⁽²⁾ Includes cost for material procurement, transportation and backfilling.

⁽³⁾ Threatened and endangered species monitoring will be performed in conjunction with wetland monitoring.

Closing References:

- CRS Means - Building Construction Cost Data, 2004
- Relevant Engineering Experience
- Analytical laboratory costs provided by a 3rd party contractor.

Prepared by: MIP
Check by: XSI

**Table 7-7
Summary of Reclamation and Monitoring Costs**

Year	Cost
1	\$72,000
2	\$72,000
8	\$517,000
9	\$375,000
10	\$2,765,000
11	\$39,000
17	\$183,000
20	\$200,000
12-37	\$19,500 x 25 yrs = \$487,500
Subtotal	\$4,710,500
Monitoring	\$1,415,000
Subtotal	\$6,125,500
Contingency @ 10% ⁽¹⁾	\$612,550
Total Reclamation & Monitoring Cost	\$6,738,050

⁽¹⁾ Contingency based upon engineering practice.

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J.1.c.(2a) A description of the capacity of the land to support its anticipated use or uses following reclamation, including a discussion of the capacity of the reclaimed land to support alternative uses.

7.2 Final Land Use

The final land use of Eagle Project property will be open green space and forested areas. The proposed land use is consistent with surrounding land uses and is also consistent with Michigamme Township zoning. The long-term goal of the reclamation plan is to allow ecological succession to occur in all reclaimed areas. To enhance the establishment of a variety of woody plant species, selected plantings of mixed hardwoods and coniferous species may be provided by KEMC. The goal is to promote a diverse plant community and provide habitat for a variety of indigenous wildlife species.

KEMC may choose to establish a passive recreational end use for all or portions of the property that would also be consistent with surrounding land uses. If KEMC decides to promote recreational uses for the site after mining and reclamation, additional discussion with the local government, public and MDEQ will occur prior to requesting the change of end-use. The final site grading plan is shown on Figure 7-1. The grading plan was developed based upon property end use that is consistent with the goals discussed above. The proposed reclamation plan is consistent with pre-development topography gently sloping towards the west/southwest. The groundwater at the site generally flows towards the northeast.

DNR Comments

While the DNR agrees with the stated objective the discussion does not seem specific to the requirement in the lease. The existing soil parameters are discussed in Appendix A but further examination of the soil and subsoil structure is needed in addition to examination of the effects of soil removal and storage. Additional treatment of the reclaimed soil may be needed to return it to its previous level of productivity. The DNR does not at this time plan or support alternate uses of this property after reclamation.

J.1.c.(2b) Provisions for grading, establishing self-sustaining re-vegetation and stabilization that will minimize erosion and sedimentation and public health and safety problems of pit banks, waste and lean ore piles, roads and tailings basins during and upon completion of the mining phase.

7.4.1.9 Earth Grading and Topsoil Placement

Earth grading and topsoil placement will begin in year 9 with the majority completed in year 11. Topsoil material will be natural on-site topsoil stockpiled during site development. In year 17, the WWTP, CWB and generator building areas will be regraded and topsoiled. After the surface facilities have been removed, the disturbed areas will be final graded and topsoiled. Stockpiled

excess soils will be graded across the site in lifts not exceeding 18 to 24 in. After placement of each lift the soil will be compacted and the subsequent lift of soils will be placed. Approximately 200,000 cubic yards of stockpiled soil will be required to achieve the reclamation grades. Grading of stockpiled soils will be accomplished using scrapers and dozers. After completion of site grading, topsoil will be placed. Topsoil will be reclaimed from the onsite stockpile. Generally topsoil material will be graded to approximately 3 in. thick, consistent to predevelopment thickness. Estimated total quantity of topsoil required for the property reclamation is approximately 28,600 yd³. Placement of topsoil will be conducted using scrapers and dozers to reach the desired thickness.

7.4.1.10 Revegetation

Revegetation consisting of native grasses will begin in year 2 (areas disturbed during site development) and in years 9 through 11, and year 17. The proposed planting plan will include species indigenous to the area, promoting a self sustaining plant community. Seeding will be performed using either broadcast, hydro-seeding and/or drill-seeding. Seeding rates will be established upon final selection of ground cover. Native grass planting will follow the procedures outlined in the Natural Resources Construction Service (NRCS), Native Grass Planting Conservation Reserve Enhancement Program, CREP-CP2. A copy of this manual is provided in Appendix J. This document provides seed lists and application rates of native grasses based upon land use. Figure 7-1 shows approximate area of revegetation at final reclamation. Prior to vegetation, topsoil will be analyzed for proper nutrients including pH, nitrogen and organic content. Fertilizer will be applied at an appropriate rate based on topsoil nutrient testing.

7.4.1.11 Erosion Control

Erosion control procedures will be implemented continuously through the life of the facility and into post-closure. Erosion control methods outlined in Section 4 are also applicable during reclamation. During reclamation, erosion control practices will include:

- ? Applying mulch to all ground cover areas
- ? Installing silt fence
- ? Installing erosion control fabric on slopes steeper than 8%
- ? Installing straw bale check dams or rock filled gabions in drainage ditches
- ? Using of sized riprap in ditches to reduce water velocity

During reclamation temporary silt control basins will be constructed to contain surface water runoff. These structures will be strategically placed during final site grading to better control surface water runoff during site reclamation activities. After completion of site grading the temporary basins will be filled in and restored to the surrounding topography.

DNR Comments

Revegetation during operations and during reclamation is performance-based per EXHIBIT B VEGETATION RESTORATION REQUIREMENTS as part of the Surface Use Lease. The site must be revegetated to the approval of the DNR's on-site representative. Topsoil is expected to be thin in this area, additional topsoil may need to be added to the system. The existing topsoil may require conditioning and fertilizer treatments to successfully grow native species.

J.1.c.(2c) Provisions for buffer areas, landscaping and screening.

4.3.15 Aesthetics and Landscaping

The Eagle Project will be naturally obscured by the existing trees and the rock outcrop at the main surface facility. In addition, a berm of excess soil will be placed directly around the boundary of the facility to limit visibility of the site. KEMC may selectively plant trees to further obscure the mine facilities from Triple A Road. Near the entrance road landscaping will blend with the natural flora to develop a balanced natural appearance.

DNR Comments

The rock outcrop and existing trees present on state-owned surface will screen many of the operations located on state surface, which are visible from the road. The berm around the facility may also add additional screening. The DNR reserves the right, to require Kennecott to plant additional vegetation around the facility, if needed, to provide satisfactory screening.

J.1.c.(c3) Estimated timetables necessary for accomplishing the events contained in the mining and reclamation plan.

7.1 Reclamation Sequencing and Timing

Reclamation activities related to the proposed development will commence during initial construction activities at the site and will continue through facility closure into the post-closure care period. Reclamation sequencing has been established based upon three different site development events as presented in Table 7-1.

**Table 7-1
Reclamation Sequence**

Sequence	Event	Facility Development Year
1	Site Construction	1-2
2	Closure ⁽¹⁾	8 ⁽¹⁾ , 9-11
3	Post-Closure	12-37 ⁽²⁾

⁽¹⁾TDRSA closure.

⁽²⁾ Wastewater treatment system will close the 5th year of post-closure, year 17.

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Sequence 1 will occur concurrent with site construction, and will include reclaiming areas disturbed during site construction as soon as practical after construction is completed for a particular area. At facility closure after mining activities cease, (Sequence 2) unnecessary site infrastructure will be decommissioned and the property restored to pre-mining conditions. Postclosure reclamation (Sequence 3) will occur after closure for a period of 20 years. Table 7-2 lists significant activities associated with each reclamation sequence.

**Table 7-2
Reclamation Activities**

Sequence	Event	Time Period (yrs)	Reclamation Activity
1	Site construction reclamation	Year 1-2	<ul style="list-style-type: none"> - Main site and backfill site: grade, seed vacant disturbed areas - Access Road: seed disturbed areas between shoulder and R.O.W. - Seed soil stockpiles
2	Closure reclamation	8, 9 through 11	<ul style="list-style-type: none"> - Removal of TDRSA - Remove site structures no longer needed - Complete site final grading - Seed and mulch disturbed areas - Install erosion control features - Remove underground equipment - Remove site utilities and generators (1 generator to remain for WWTP contingency plan) - Install post-closure monitoring devices - Reclaim the underground mine workings
3	Post-Closure reclamation	Years 12 through 37	<ul style="list-style-type: none"> - Conduct incidental grading - Install erosion control features - Seed and mulch remaining disturbed areas - Monitor groundwater and surface water to year 37 - Monitor flora and fauna for 5 years after completion of reclamation - Removed WWTP, CWBs, and electrical generator, year 17.

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Checked by: SVD1

7.3 Site Construction Reclamation

During site construction reclamation will be performed concurrently for disturbed areas surrounding the facilities under construction. Reclamation of these areas will include proper grading and applying seeding and mulching. Storm water management facilities including grading, ditches and detention basins will be constructed at the start of construction. Silt fences and other erosion control devices will be installed as necessary.

DNR Comments

The timing of the events needed for final reclamation of the surface and mine workings is consistent with existing plans to commence mining, decommission the mine and surface, and perform final reclamation. Reclamation will proceed concurrently with site preparation and mining where feasible.