Appendix B

Mine Water Sources and Characteristics

(Section 4 and Appendices E-1, F-1, F-2 and G of Application sent to MDEQ)

1. Description of Mine Water Sources and Characteristics

The Eagle Project will have an extensive water management program. Figure 1 shows the locations of the main water management facilities including the contact water basins (CWB), the wastewater treatment plant (WWTP), and the treated water infiltration system (TWIS). Mine water streams 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.

1.1 Operational Water Sources and Characteristics

1.1.1 Mine Drainage

Sources of water inflow to the mine will include groundwater infiltration into the mine, water vapor contained in ventilation air, utility water used in mining operations, and water contained in the mine backfill material. The flows from the mine will include mine drainage, water vapor contained in ventilation air exiting the mine, and water retained in the ore brought to the surface for processing.

The mine drainage water will primarily consist of a composite of groundwater that infiltrates into the mine and utility water used in the mine for dust suppression and for operation of mining equipment. 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 into the upper mining levels. The upper bedrock groundwater is expected to be encountered during both the mine development and mine operation phases and will represent the bulk of the water pumped from the mine. The second source of groundwater is saline water, that is contained within weakly connected and widely spaced fractures in the lower bedrock formation, and which is expected to be encountered most significantly during development of the mine.

For WWTP design purposes it has been assumed that 250 gpm of groundwater will be flowing into the mine. This inflow rate exceeds the upper bound or peak inflow estimate (of 215 gpm).

The chemical characteristics of the groundwater in the area of the Eagle Project were determined from background groundwater sampling and analysis work conducted by Golder Associates, Ltd. and is provided in Attachment 1. Analysis of samples from exploration holes open to the upper bedrock and yielding non-saline water derived from the upper bedrock were used to determine the chemical characteristics for the upper bedrock groundwater. Samples from testing of deep exploration holes were used to determine the chemical characteristics of the stored saline water in weakly connected and widely spaced fractures in the lower bedrock. Table 1-1 summarizes the groundwater sampling data for both the upper bedrock groundwater and the stored saline groundwater in the lower bedrock.

Table 1-1
Mine Drainage Water Characteristics

Parameter	Upper Bedrock Groundwater (1)	Lower Bedrock Groundwater (2)	Composite Groundwater (3)	Incremental Change (4)	Composite Mine Drainage (6)
Percentage of Total Mine Groundwater Inflow	55%	45%	na	na	na
Aluminum, μg/l	83	50	68	88	156
Antimony, μg/l	5.0	5	5.0	16	21
Arsenic, μg/l	2.0	19	10	17.0	27
Barium, μg/l	28	20	24	4.0	28
Beryllium μg/l,	1.0	1.0	1.0	na	1.0
Boron, μg/l	2,397	5,900	3,973	70	4,043
Cadmium, μg/l	0.5	5.0	2.5	10.0	13
Calcium, μg/l	15,983	76,000	42,991	4,000	46,991
Chloride, μg/l	41,367	2,000,000	922,752	1,580	924,332
Chromium, μg/l	5.0	5.0	5.0	4.5	10
Cobalt, μg/l	10.0	10.0	10.0	720	730
Copper, μg/l	5.0	5.0	5.0	150	155
Fluoride, μg/l	333	1,000	633	98	731
Iron, μg/l	67	1,800	847	6,400	7,247
Lead, μg/l	1.0	1.0	1.0	9.0	10
Lithium, μg/l	15	130	67	26	93
Magnesium, μg/l	2,897	61,000	29,043	5,000	34,043
Manganese, μg/l	20	68	42	950	992
Mercury, μg/l	0.00183	0.00021	0.00110	0.04	0.0411
Molybdenum, μg/l	10	10	10	13	23
Nickel, μg/l	26	25	25	36,400	36,425
Nitrogen (Ammonia)[5], μg/l	85	260	163	10,000	10,163
Nitrogen (Nitrate), μg/l	50	50	50	0	50
Phosphorus, total	22	15	18	na	18
Potassium, μg/l	4,350	9,200	6,533	1,000	7,533
Selenium, μg/l	1.0	17	8	20.0	28
Silver, μg/l	0.2	0.5	0.3	4.5	4.8
Sodium, μg/l	38,833	970,000	457,858	1,000	458,858
Strontium, μg/l	131	4,800	2,232	20	2,252
Sulfate, μg/l	10,317	5,000	7,924	110,000	117,924
Thallium, μg/l	not analyzed	not analyzed	not analyzed	8.0	8.0
Vanadium, μg/l	not analyzed	not analyzed	not analyzed	7.0	7.0
Zinc, μg/l	11	19	15	150	165

(1) Average value based on average of sample analysis from wells 04EA-054A, 04EA-054B, 04EA-054D, 04EA-054F (Golder 2005) and 05EA-107 (18-34 m, and 97-114 m in Attachment 1)

(2) Based on sample analysis (04EA-084 86 purges, 249-302 m) documented in Attachment 1

(3) Calculated as: (Upper Bedrock Groundwater Conc.)(Upper Bedrock % of Inflow) + (Lower Bedrock Groundwater Conc.)(Lower Bedrock % of Inflow). Total mine inflow assumed to be 250 gpm.

(4) Incremental change in concentration of indicated groundwater chemical constituents due to contact with mine workings. (Attachment 2)

(5) Incremental change is estimated increase due to blasting residuals.

(6) Composite groundwater concentration plus incremental change.

na = not applicable

Prepared by: JJF1
Checked by: SVD1

The chemical characteristics of the composite mine drainage water will depend on the background characteristics of the groundwater that infiltrates into the mine and 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 of the groundwater, due to contact with the mine workings, were calculated based on geochemical characterization studies conducted by Geochimica, Inc. as described in Attachment 2 and summarized in Table 1-1.

The estimated chemical characteristics of the mine drainage water are shown in Table 1-1. The values shown were calculated as a composite of the upper bedrock groundwater and the saline groundwater in the lower bedrock using the indicated constituent concentrations for each groundwater source and using the indicated percentage of total mine inflow indicated for each groundwater source. Additionally, the mine drainage water chemical characteristics include the incremental increases in the concentrations of the individual chemical constituents due to contact of the groundwater with the mine workings. The distribution of groundwater inflow to the mine from the two groundwater sources was based on the mine inflow modeling by Golder Associates, Ltd., provided in Attachment 3 and represents the worst case condition where the stored saline water is at a maximum percentage of the total mine inflow. Table 1-1 conservatively assumes that 45% of the inflow is saline water from the deep bedrock. The mine utility water is estimated to have the same water chemistry as the composite mine drainage water.

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 ammonia and nitrate concentrations for the mine drainage water are shown in Table 1-1.

1.1.2 Water from Temporary Development Rock Storage Area

Rock removed during development of the mine access workings will be stored at the temporary development rock storage area (TDRSA) as shown on Figure 1. This material will be amended with limestone and temporarily stored during the operations of the mine. The amended development rock will ultimately be used as mine backfill material. The TDRSA will be a lined facility designed to capture any precipitation falling within the perimeter of the storage area. Any water that accumulates in the TDRSA will be transferred to the CWBs and discharged to the WWTP.

Water coming in contact with the stored development rock may contain readily soluble substances, mineral oxidation products, and colloidal materials that will result from the short-term reactions between water and rock materials. The chemical characteristics of the TDRSA contact water were calculated based on characterization studies conducted by Geochimica, Inc. and are included in Attachment 2. The chemical characteristics for the contact water from the TDRSA are shown in Table 1-2.

Table 1-2
Contact Water Characteristics

Parameter	Composite Mine Drainage [1]	TDRSA Contact Runoff [2]	Influent Wastewater[3]
Aluminum, µg/l	156	1.0	140
Antimony, µg/l	21	0.4	19
Arsenic, µg/l	27	83	33
Barium, µg/l	28	30	28
Beryllium µg/l,	1.0	not analyzed	1.0
Boron, µg/l	4,043	580	3,671
Cadmium, µg/l	13	0.2	11
Calcium, µg/l	46,991	199,000	63,345
Chloride, µg/l	924,332	10,000	825,963
Chromium, µg/l	10	0.45	8.5
Cobalt, µg/l	730	0.80	652
Copper, µg/l	155	60	145
Fluoride, µg/l	731	500	706
Iron, µg/l	7,247	2.0	6,467
Lead, µg/l	10	0.40	9.0
Lithium, µg/l	93	19	85
Magnesium, µg/l	34,043	18,000	32,317
Manganese, µg/l	992	0.5	885
Mercury, µg/l	0.04110	0.04000	0.0410
Molybdenum, µg/l	23	1.5	21
Nickel, µg/l	36,425	8,330	33,403
Nitrogen (Ammonia), µg/l	10,163	not analyzed	163
Nitrogen (Nitrate), µg/l	50	not analyzed	50
Phosphorus, total	18	not analyzed	18.5
Potassium, µg/l	7,533	29,000	9,842
Selenium, µg/l	28	4.0	26
Silver, µg/l	4.8	0.05	4.3
Sodium, µg/l	458,858	19,000	411,536
Strontium	2,252	200	2,031
Sulfate, µg/l	117,924	575,000	167,099
Thallium	8.0	0.05	7.1
Vanadium	70	0.75	6.3
Zinc, µg/l	165	1,900	351

(1) Composite mine drainage water characteristics are from Table 1-1 of this report.
(2) Attachment 2
(3) Attachment 4

Prepared by: JJF1
Checked by: SVD1

1.1.3 Runoff from Other Areas of the Mine Site

The main operations area is shown on Figure 1 and includes the fuel storage area, the ore crusher area, the laydown area, the truck wash and scale area, the lab and maintenance building, and other areas in which the runoff could come in contact with process equipment and materials. Storm water runoff from the main operations area will generally contain suspended solids and other substances related to the materials stored in the area. The runoff from the main operations area will be collected in the CWBs and, for design purposes, is conservatively estimated to have the same water chemistry as the combined contact water listed in Table 1-2.

During construction and operation of the mine, non-contact storm water runoff will be generated in areas where the runoff will not come in contact with process equipment, materials, or chemicals. Non-contact storm water runoff will be generated in areas such as:

- Construction staging/soil storage area
- Roadways to and from the site
- Employee parking lot areas
- Roof of mine office and warehouse building

The non-contact runoff areas are shown on Figure 1. Four non-contact water infiltration basins (NCWIB) will be provided to accommodate runoff. One basin will be located in the northwest area of the main site 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 aggregate backfill site and will receive runoff from the clean backfill surface facility.

Note that the CWBs and NCWIBs are designed to contain peak runoff events during periods of combined rapid snow melt and spring rains. In the case of the lined CWB, enough storage capacity exists to store peak runoff from the main operations area for eventual treatment at the WWTP. In the case of the NCWIBs, the basins have been sized to accommodate peak runoff events from non-contact areas. NCWIBs are designed to allow the collected storm water to infiltrate to groundwater.

1.1.4 Potable Water Supply and Sanitary Wastewater

A potable water system will be provided to supply potable water to the site buildings, the lab, and to the mine. A well, pump, fresh water tank, and distribution system will be provided for potable water. KEMC plans to use well QAL011D (See Figure 1 in Section 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.

Sanitary waste generated by toilets, sinks and showers at the site will be routed to on-site septic system. The septic system will include settling tanks and buried infiltration fields per R 323.2210(a)(ii). KEMC plans to apply for a septic system permit from the Marquette County Health Department.

Wastewater will 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 of off-site by a qualified contractor or will be discharged to the CWBs and processed though the WWTP.

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 processed through the WWTP.

1.2 Water Balance

A detailed water balance has been developed for the Eagle Project. Water inputs for the water balance include groundwater inflow to the mine, water contained in ventilation air entering the mine, and storm water runoff from the main operations area. Water uses shown on the water balance include mine utility water, truck washing, ore crushing operations, and mine backfilling operations. Water discharges for the water balance include evaporation from the CWBs, water retained in the mine backfill material, water contained in ventilation air exiting the mine, and treated water discharged to the TWIS.

Potable water for sanitary uses will be obtained from an on-site well. Sanitary wastewater will be collected, treated, and disposed of separately from mine groundwater inflow water and storm water runoff from the main operations area.

The water balance on Figure 2 shows peak water flow conditions. The key parameters used in development of the water balance are as follows:

- The WWTP design basis groundwater inflow into the mine of 250 gpm. This exceeds the upper bound inflow of 215 gpm based on modeling by Golder Associates, Ltd. (Attachment 3).

- Annual average operations area storm water runoff is based on maximum annual precipitation of 54 in/yr for record period from 1948 to 2004; (Data source: National Weather Service, Houghton, Michigan). Precipitation data from Houghton was used since it receives similar amounts of snowfall as the Project Site.

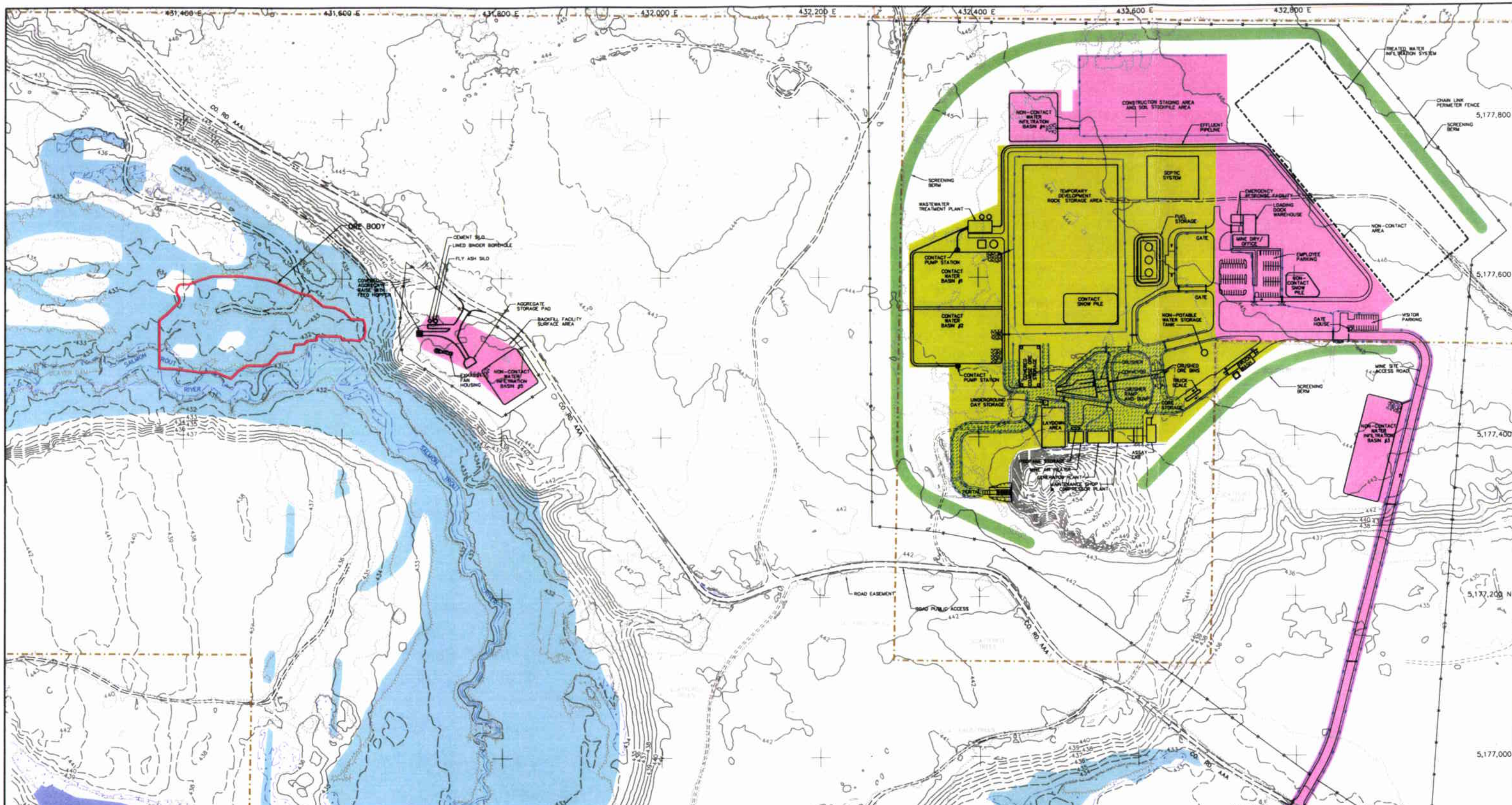
- Average annual evaporation losses from CWBs based on average annual free water surface evaporation of 19 in/yr; (Average Annual Evaporation for Marquette County, Data Source: USDA, Natural Resources Conservation Service). Marquette County evaporation rates were used as they are likely the most representative of annual evaporation losses at the site.

- Mine ventilation inflow and exhaust water rates.

The water balance on Figure 3 shows average annual precipitation and expected case mine inflow conditions. The key parameters used in development of the average inflow water balance are as follows:

- Expected groundwater inflow into the mine of 75 gpm based on modeling by Golder Associates, Ltd. (Attachment 3).
- Annual average operations area storm water runoff is based on average annual precipitation of 33 in/yr for record period from 1948 to 2004; (Data source: National Weather Service, Houghton, Michigan). Precipitation data from Houghton was used since it receives similar amounts of snowfall as the Project Site.
- Average annual evaporation losses from CWBs based on average annual free water surface evaporation of 19 in/yr; (Average Annual Evaporation for Marquette County, Data Source: USDA, Natural Resources Conservation Service). Marquette County evaporation rates were used as they are likely the most representative of annual evaporation losses at the site.
- Mine ventilation inflow and exhaust water rates.

Water flows associated with precipitation and runoff from non-contact areas of the site have been excluded from the water balances because these flows are solely dependent on precipitation and will be routed to natural drainage ways at the site. The small amounts of evapotranspiration from the site have been excluded from the site water balance because these flows are minor compared to the other water flows described previously and would not significantly affect the site water balance.



LEGEND

(contour line)	EXISTING ELEV. CONTOUR IN METERS MSL (1 METER INTERVAL)
(dashed double line)	UNPAVED ROAD
	TREE
	TREE LINE
(light blue)	WCR MAPPED WETLAND BOUNDARY PROVIDED BY GOLDER & ASSOCIATES, INC. APRIL 7, 2005.
	KENNECOTT PROPERTY BOUNDARY
	TREATED WATER INFILTRATION SYSTEM
	PLANIMETRIC WETLAND NOTATION
	PERIMETER FENCE
(red outline)	ORE BODY
	CULVERT
	EROSION MAT OR RIPRAP
	DRAINAGE DITCH AND FLOW DIRECTION
(green)	EXCESS SOIL BERM (FINAL LOCATION AND SIZE BASED UPON ACTUAL EXCAVATED SOIL QUANTITIES)
(pink)	NON-CONTACT AREA
(yellow)	MAIN OPERATIONS AREA
	BITUMINOUS LINED OPERATIONS AREA
(purple)	WETLANDS ADAPTED FROM US FISH AND WILDLIFE WETLAND INVENTORY MAP

NOTES:

1. TOPOGRAPHIC AND PLANIMETRIC DATA SUPPLIED BY AERO-METRIC ENGINEERING, SHEBOYGAN, WISCONSIN. DATE OF PHOTOGRAPHY: JUNE 2, 2004.
2. MINE PLAN DATA AREA ADAPTED FROM MCINTOSH ENGINEERING, INC., TEMPE, ARIZONA.
3. SURFACE PROPERTY BOUNDARY AS OF NOVEMBER 18, 2004 SUPPLIED BY KENNECOTT VIA GOLDER & ASSOCIATES INC., AUGUST, 2005.
4. CONTOUR INTERVAL BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988. HORIZONTAL DATUM BASED ON NAD 83/94. HORIZONTAL COORDINATES BASED ON UTM ZONE 16.
5. ORE BODY, WETLAND BOUNDARY (WETLAND AND COASTAL RESOURCES) SUPPLIED BY GOLDER & ASSOCIATES, INC. AUGUST, 2005.
6. SITE LOCATION: PROJECT SITE WITHIN SECTIONS 11 & 12, T50N, R29W, TOWN OF MICHIGAMME, MARQUETTE COUNTY, MICHIGAN.

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JOS1	DATE: MAR. '07
APPROVED BY:	SVD1	DATE: MAR. '07
APPROVED BY:		DATE:

Kennecott Eagle Minerals

FIGURE 1

SITE DEVELOPMENT PLAN AND TOPOGRAPHIC MAP

Scale: 0 60M 120M | Date: MARCH, 2007

Prepared By: JRB2 | Project No. 04W018

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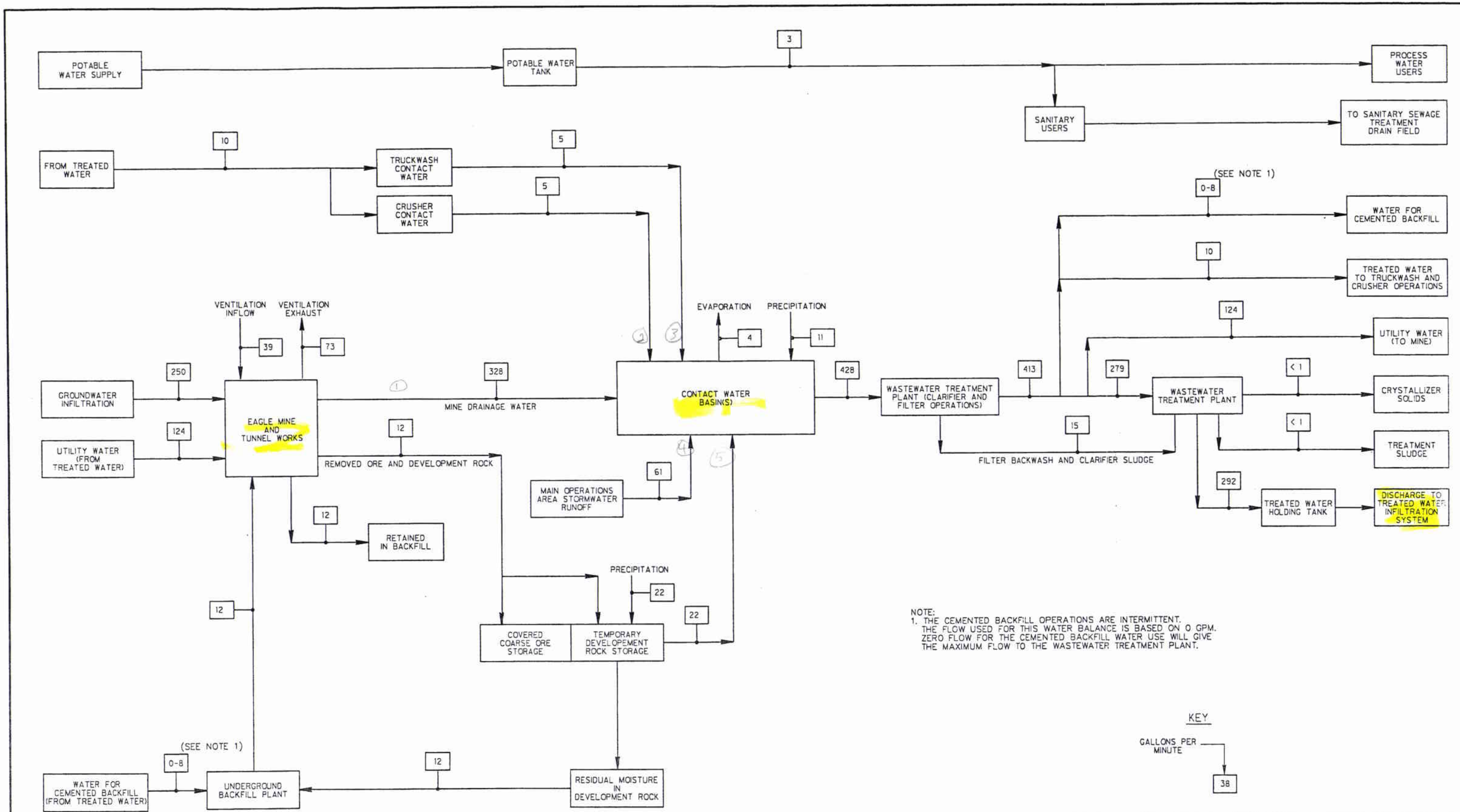
3/10/2007 dat



Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION
CHECKED BY:	JJF1	DATE: MAR. '07	
APPROVED BY:	SVD1	DATE: MAR. '07	
APPROVED BY:		DATE:	

Kennecott Eagle Minerals

FIGURE 2

WATER BALANCE MAXIMUM ANNUAL PRECIPITATION AND MINE INFLOW

Scale: NONE	Date: MARCH, 2007
Prepared By: JRB2	Project No. 04W018

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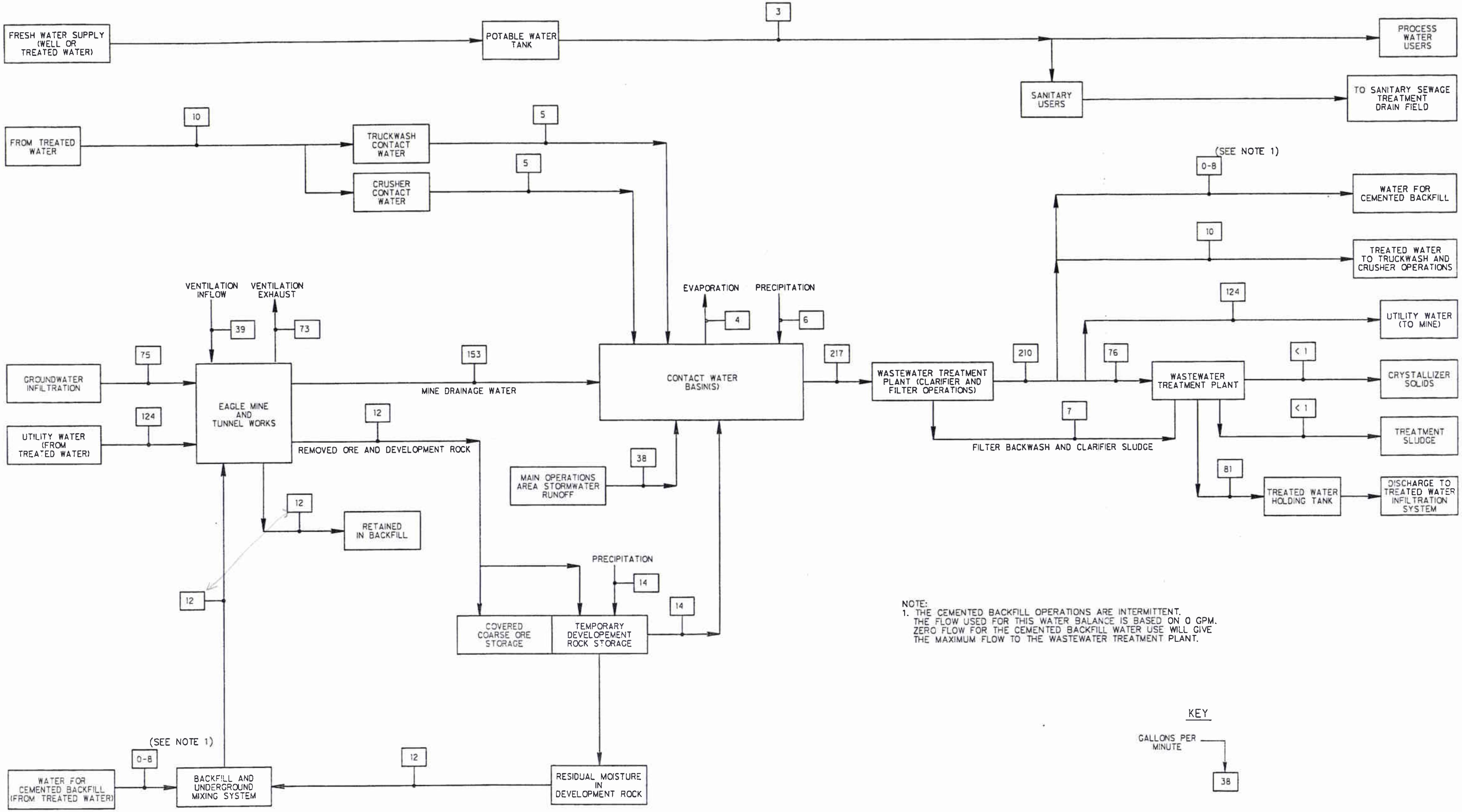

NOTE:
1. THE CEMENTED BACKFILL OPERATIONS ARE INTERMITTENT. THE FLOW USED FOR THIS WATER BALANCE IS BASED ON 0 GPM. ZERO FLOW FOR THE CEMENTED BACKFILL WATER USE WILL GIVE THE MAXIMUM FLOW TO THE WASTEWATER TREATMENT PLANT.

Foth Infrastructure & Environment, LLC

REVISED	DATE	BY	DESCRIPTION

CHECKED BY:	JJF1	DATE: MAR. '07
APPROVED BY:	SVD1	DATE: MAR. '07
APPROVED BY:		DATE:

Kennecott Eagle Minerals

FIGURE 3

WATER BALANCE AVERAGE ANNUAL PRECIPITATION AND EXPECTED CASE MINE INFLOW

Scale:	NONE	Date:	MARCH, 2007
Prepared By:	JRB2	Project No.	04W018

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