KENNECOTT GREENS CREEK MINING COMPANY
GENERAL PLAN OF OPERATIONS

APPENDIX 11
ATTACHMENT C
INACTIVE SITE
MONITORING AND MAINTENANCE PLAN

TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

Numerous Production Rock and Borrow Areas have been developed as part of the Greens Creek Mine (KGCMC). The USDA Forest Service approved the use of various Production Rock Disposal and Borrow Areas in various administrative decisions, the 1983 Final Environmental Impact Statement Notice of Decision, and in the 1992 Environmental Assessment for Additional Waste Rock Disposal Capacity for the mine. Regulatory oversight of the Production Rock piles is the responsibility of the USDA Forest Service with respect to land, lease and operational issues. The Alaska Department of Environmental Conservation (ADEC) regulates non-point source discharges and reclamation as specified in the Company's General Plan of Operations (GPO) and construction or work plans presented within the GPO framework. These plans are subject to independent approval by the Forest Service. KGCMC conducts its management of the area within the context of these documents. GPO references are as follows:

- Appendix 1 -- Freshwater Monitoring Plan
- Appendix 11 -- Production Rock and ARD
- Appendix 14 -- Reclamation Plan

1.1 Purpose Of Plan

Many of the original Production Rock Piles are currently inactive (Table 1). Eventually, these piles will be re-activated, closed or removed. This plan identifies the maintenance and monitoring requirements associated with inactive sites at KGCMC. Reclamation requirements for closing the sites are described in the Reclamation Plan, Appendix 14.

Table 1. Description of Inactive Production Rock Areas and Borrow Areas at KGCMC

Site Name	Description
Area E	Area E is located at mile marker 4.6 along the B Road, about halfway between Hawk Inlet and the mine service area. Waste placement began during 1988 and continued through 1994. During placement activities a total of approximately 365,000 cubic yards of material were placed over an area of about nine acres. Area E will remain inactive.
Area D	Production Rock Disposal Area D is located downslope from the B Road between mile markers 8.0 and 8.2. The site is located within Millsite Lease Area "H". Area D was approved for active waste rock placement during 1987. Waste placement, on an intermittent basis, began during October of 1987 and continued through 1989. During placement activities a total of 300,000 cubic yards of material were placed over approximately seven acres. Waste Area D has remained inactive since 1989.
C/920 Area	Production Rock and fill has been placed in the 920 portal, millsite, and Area C since 1987. During mill development, a large amount of clayey till was removed for geotechnical reasons and was placed in Site E, with a smaller amount placed in Site D. Approximately 48.500 cubic yards of production rock and fill have been placed in Area C over a combined area of 2 acres.
960 Area	A small quantity of production rock from the 920 portal was placed along the 1350 access road just uphill from the portal. Approximately 10,000 cubic yards of rock have been placed in the 960, which covers about 1 acre.
1350 Site	The 1350 area is located approximately 1.5 road miles above the main (920) mine entrance. Waste was placed intermittently between 1978 and 1985. Approximately 100,000 cubic yards were placed over an area of 5 acres. The site has been inactive since 1985.
Pit 7	Borrow area located on the A road between Young Bay and Hawk Inlet
Pit 5	Borrow area located near the dry tailings facility
Pit 174	Borrow area located on the B road between the tailings and Site E
Pit 6	Borrow area located on the B road near Site E

Site Name	Description
Pit 405	Borrow area located on the B road near Site 23

1.2 Monitoring Objectives

Production rock materials and some borrow materials have the potential to become acidic or to release soluble metals. Final closure of the facilities will be implemented in a manner that minimizes contact of meteoric water or groundwater with mineralized rock, reduces the oxidation of rock, or both. While the sites are inactive, periodic monitoring is required to insure that:

- The sites are stable;
- Water management systems that divert surface runoff away from the sites are intact and clear of debris;
- Sediment ponds that cause suspended sediments to settle from solution are functioning;
- The exposed rock remains neutral in pH; and
- No seeps form at the facility margin, or if seeps form that they are collected and treated if required by ADEC or the Forest Service

2.0 MAINTENANCE AND MONITORING

Regular maintenance activities consist primarily of road maintenance to ensure site access until the closure process is complete. Other maintenance activities include water management systems inspection/cleaning and seasonal revegetation programs, as necessary. Also refer to GPO Appendix 5 for a description of Best Management Practices used for stormwater management and erosion control.

2.1 Site Access

Access to the site will be maintained as long as is practicable or required to provide maintenance and/or monitoring access to the area. Activities will include periodic road grading and cleaning of culverts located along the site access. As closure transition progresses, access maintenance may no longer be required.

2.2 Water Management Systems

Periodic maintenance of water management features including: sediment pond cleaning, collection channel cleaning and slope stabilization will occur as needed. The KGCMC environmental staff will monitor these systems and provide maintenance work orders, as necessary, to ensure systems performance. In the event of significant maintenance requirements, an action plan will be developed to dedicate resources (equipment and labor) necessary to repair system damage.

2.3 Sediment Pond Cleaning

Pond cleaning may be required periodically to remove collected sediment. This maintenance requirement will be determined each May through closure transition and the Forest Service informed. Work, as necessary, will be scheduled when relatively dry weather is predicted for several days.

2.4 Site Inspection

Mine environmental personnel will visit the site at least once each month to evaluate and document the effectiveness of ongoing reclamation efforts and the water management system. Inspection of step channels, collection channels, curtain drain outfalls and the sediment settling pond will include checking that water flow is not impeded by accumulated debris or sediment, erosion is not occurring, and liners are not exposed or damaged. Visual inspections of the site will include making observations to detect oxidation on the surface and adverse effects to vegetation that may indicate development of acid drainage. Form 5.2 will be utilized to record the inspections.

2.5 Geotechnical Monitoring

2.5.1 Site D Background

Waste Area D was opened to place excavated overburden from the millsite during the initial construction phase of the Greens Creek project (1987-89). The overburden materials, comprised of weathered tills, clays, and organics, were typically saturated at the time of placement within the Area D footprint. These materials are relatively slow draining and stability concerns were realized as the volume placement exceeded the material's drainage capacity. To alleviate stability concerns, procedures were developed including the blending of overburden with freer draining coarse waste rock generated from concurrent mine development activity. A series of piezometers were also installed to monitor water pressure trends within the pile.

Inactive since 1989, excepting investigative work and sediment control revegetation, Waste Rock Disposal Area D remains stable. With short-term pile stability concerns diminished, KGCMC has conducted tests, investigations and characterization work to provide a basis for engineered plans to initiate site closure.

2.5.1.1 Site D Operational History

Localized pile behavior led to Area D being described as having two distinct zones, the east and west. Piezometers and movement hubs were installed, as appropriate for each zone, to monitor pile stability and establish pore water pressure trends within the pile. The data produced was utilized as an integral part of site and zone operational plans. In summary, the collected data indicates:

- With the exception of very minor displacements, at a few localized areas during early operations, the site is stable;
- The areas where displacement has been observed are very local and typically resulted from stacking of material too steeply;
- In all instances, signs of movement ceased when the waste material slopes were flattened and/or equipment moved from the active area allowing a dewatering period; and
- Piezometric levels remain substantially below peak levels.

As stated, the site is considered as having two distinct zones; the eastern zone (approximately two-thirds of the area) and the western zone (the remaining third). The east zone placement guidelines are common to both zones; the west zone guidelines are additional. The key historic operational guidelines for each zone are briefly presented.

2.5.1.2 Site D - Eastern Zone

Waste placement was placed in this zone has been according to the following guidelines:

- Only rock materials that could be spread and compacted were placed. The most free-draining production rock was placed near the outside face of the pile;
- Less permeable production rock was placed near the back of the rock pile, adjacent to natural ground. Development was from the bottom up. Excessively loose and wet material was transported to Waste Area E;
- The waste was placed in lifts not exceeding four feet in thickness;
- At least two passes with a dozer were used to compact the production rock;
- Each lift was developed over the largest possible working surface of this zone;
- Slopes of the downstream face of the production rock pile did not exceed 4H:1V except for brief periods prior to spreading;

- Equipment operators working checked for signs of distress or movement on a regular basis (several times per shift);
- At the first sign of any significant movements, cracks or bulging, production rock placement was discontinued in the area and KGCMC staff notified. If excessive lift thickness or slope configuration are the source of the problem the material was redistributed to a safe area;
- The final slope configuration conformed to drawings approved by the USFS.

2.5.1.3 Site D - Western Zone

Of the total waste area, this zone experienced the most significant displacements in 1987. This portion of the site also has the greater presence of groundwater. Accordingly, initial drainage measures were maximized in this area.

2.5.1.4 Site D - Stability Drains

As part of the requirements for placing additional wastes in the Western zone the following measures were instituted during 1987:

- A rock drain was established at the natural backslope where a significant spring was observed;
- A pipe was installed between the rock drain and a previously installed pipe. This directs water off the waste area and to the pond at the south side of the pile;
- A layer of filter fabric was placed over the zone; and
- A two-to-three foot lift of free draining waste rock was placed over the filter fabric.

2.5.1.5 Site D Western Zone Production Rock Placement Guidelines

Waste placement over the Western zone has been according to the following guidelines in addition to those established for the eastern zone:

- Subsequent lifts will consist of free-draining material;
- Each lift area will be maximized to cover the entire placement area within the zone;

- Successive lifts will not exceed two feet in thickness;
- Lifts will be compacted with at least two passes with a dozer's tracks; and
- Lifts will be placed no more frequently than once every two weeks.

2.5.2 Monitoring Requirements

2.5.2.1 All Sites

KGCMC will conduct a visual inspection of each Production Rock site once per month looking for cracks, bulges, and signs of stress. When appropriate, photographs of the site will be taken. KGCMC will maintain a written record of the inspection findings. In addition, equipment operators working at the site will make regular visual observations during the course of their work at the site to check for cracks, signs of distress, or production rock and soil movement. At completion of capping operations, visual inspection by operators will discontinue.

2.5.2.2 Site D

Monitoring of the Site D Production Rock Pile will be conducted to meet the following objective:

- Assure that the pile, surrounding area and diversionary channels are maintained in a stable condition over the short and long term.

Supplementary to the Work Plan submittal, KGCMC commissioned a geotechnical review of Waste Area D operating guidelines and stability monitoring procedures. The recommendations are incorporated in the monitoring plans for the site; procedures are as follows:

- Piezometer readings will be on the standard monthly frequency except during capping operations. While capping KGCMC will monitor piezometers in the west zone prior to placing a lift, daily during lift placement and every third day after completing a lift; and
- Survey hubs will be reestablished to monitor mass pile behavior of the western zone. An array of six hubs will be placed on the shoulder of the access road. Prior to capping operations the hubs will be placed and location established by survey, the hubs will be surveyed after each third lift until capping is complete and then on an annual basis until the measurements are no longer required.

2.6 Inactive Site Environmental Monitoring Program (ISEMP)

The Freshwater Monitoring Plan (GPO Appendix 1) was established to monitor the environmental performance of the facilities during operation. Monitoring sites have been established to periodically measure surface and groundwater quality outside the perimeter of the production rock facility. Measurement and evaluation of hydrologic and geochemical processes that occur within the inactive facilities is conducive to better understanding the behavior of the production rock and their potential interaction with the environment. Consequently, an Inactive Site Environmental Monitoring Program (ISEMP) will be conducted for this purpose. It is important to remember that water quality data collected as part of the internal monitoring program represent "mine water" that is either retained as interstitial water within the site or is contained, collected and treated prior to discharge under a NPDES permit. As a result, data are not to be compared to compliance levels established for ambient surface and groundwater adjacent to the site.

Hydrologic and geochemical processes are important factors that define the success of the management of the production rock facility. Operational techniques and closure approaches were designed to prevent acidification, minimize infiltration of oxygen and water, and to reduce metal loading from the facility. Short-term control of metal loading relies on minimizing ARD and metal release and on the collection and treatment of contact water. Long-term control measures will emphasize the minimization of acidification, oxidation, and infiltration of meteoric water. As a result, ISEMP will provide information about geochemical behavior of production rock and exposed borrow material excavations in inactive areas.

2.6.1 Geochemistry of Production Rock

The net neutralization potential (NNP) and the paste pH of materials within inactive Production Rock and Borrow Areas will be measured on samples that are collected from representative locations within each facility (Table 2). The sampling and testing requirements are outlined below.

Each calendar year, the number of samples shown in Table 2 will be collected for analysis of paste pH. Samples should be aerially distributed across each facility so that samples are obtained from portions of the facility that vary in age. The samples should be collected as composites from the top 6-inch depth. A composite sample should consist of not less than 4 subsamples, of approximately equal size, that are combined and mixed. The number of samples shown below refer to composite samples, not subsample locations. The location (mine coordinates) of each sample will be recorded. One of every 5 paste pH samples will be randomly selected to be analyzed for NNP value. Additionally, each sample with a paste pH of less than 6 will also be analyzed for NNP values. Static tests will be determined using the modified Sobek Method used for analysis of prior samples (1994 and 1999 grab samples). The NNP will be calculated on the basis of the Sobek acid neutralization potential in tons per 1,000 tons as calcium carbonate minus the non-sulfate sulfur (pyritic sulfur found by summing the nitric acid extractable and the residual S fraction) times 31.25.

All results will be provided in an annual monitoring report submitted to the USFS. Data will be graphed in a manner that compares the ANP (x axis) and AGP (y axis) values, and the NNP (x axis) versus the paste pH (y axis). If more than 10% of the paste pH values are below 5 in any one facility, than an expert in ARD will be asked to review the information, and if necessary, to develop a suitable management plan.

Table 2. Required Number of Geochemical Samples Annually from Each Inactive Site or Borrow Area

Site Name	Number of Samples	Comments
Area E	15 samples	Collect at least 12 of the 15 samples from exposed production rock
Area D	10 samples	Collect representative samples that are spatially distributed across the pile
Area C/920 Area	10 samples	Collect representative samples that are spatially distributed across the pile
960 Area	8 samples	Collect representative samples that are spatially distributed across the pile

Site Name	Number of Samples	Comments
1350 Site	10 samples	Collect representative samples that are spatially distributed across the pile
Pit 7	3 samples	If after 3 years, all samples have less than 0.2% S, then monitoring can be terminated.
Pit 5	3 samples	If after 3 years, all samples have less than 0.2% S, then monitoring can be terminated.
Pit 174	3 samples	If after 3 years, all samples have less than 0.2% S, then monitoring can be terminated.
Pit 6	3 samples	If after 3 years, all samples have less than 0.2% S, then monitoring can be terminated.
Pit 405	3 samples	Conduct a more intensive site investigation in 2001 and reclaim site if acid generating material is found

2.6.2 Pore Water Chemistry

Water that contacts production rock and percolates through the pile or runs off of the pile is managed so that surrounding receiving waters are protected. Runoff from Site C is managed as stormwater, for example. Additionally, runoff and seepage from the millsite is collected in Pond A and is treated. Also, runoff and seepage from Site D is collected in the D pond and is treated. The remaining production rock piles are assumed to have minimal seepage.

The sampling program to determine interstitial water chemistry and seepage rate has two components; a seepage survey, and sampling of internal surface and groundwaters at selected sites. Sampling at Site D is described in Attachment B, the operating Plan for Site 23 because of the physical proximity of these sites.

2.6.2.1 Seepage Survey

Once each quarter, the entire perimeter of each pile and borrow area should be inspected for evidence of seeps or springs. The location of each seep or spring should be noted on sketches of the site. A sample of each visible flow should be collected and analyzed for common ions, and selected trace metals (Table 3.) The flow rate, temperature, field pH and specific conductance, and dissolved oxygen should also be measured. A mitigation plan is required for all seeps or springs with sustained flow that have elevated metal concentration and that are not collected or treated. The plan will be submitted to the Forest Service and ADEC for their review and approval.

2.6.2.2 Sampling and Analysis of Interstitial Water

Appreciable flows of water that contacts inactive production rock and either runs off of the site or is collected in subsurface drains, is collected and treated during mine operation (or is managed as stormwater as in the C pond). Smaller piles (such as the 960 and 1350 areas) are not assumed to have sustained seepage. After closure of these facilities, surface water will no longer contact production rock as occurs now. Consequently, only interstitial water within the pile will contact production rock. After closure, the long-term net infiltration through the engineered cover will determine the quantity of contact water that may exit the site. The chemistry of contact water is therefore important in determining long-term mass loads of metals that may be released.

Data Quality Objectives

Data quality objectives (DQO’s) define the amount, kind, and quality of data that are required to make relevant decisions. In the context of the ISEMP, data on the chemistry, and, if applicable, flow rate of contact water are required to develop a mass balance model. Additionally, water chemistry data will be used to identify significant trends in the chemistry of contact water. Such trends could reflect changes in the geochemical nature of the production rock by processes such as acidification.

The DQO's developed for the contact water include a constituent list, recommended analytical minimum levels for trace constituents, monitoring frequency, and quantitative limits for precision and accuracy of laboratory data and completeness.

Constituents to be analyzed consist of a series of "indicator parameters" (Table 3). Based on review of existing data from KGCMC collected through the Freshwater Monitoring Plan, some or all of these constituents will always be found in contact waters, Therefore, changes in their concentrations will identify changes in the amount or chemical nature of contact water that is detected at a monitoring station. Indicate. In addition to the indicator parameters (suite H from the FWMP), common ions will also be analyzed.

Table 3. Analyte Suites

Suite H		
Conductivity	Dissolved Arsenic	Dissolved Mercury
pH, Temperature[1] & Hardness	Dissolved Cadmium	Dissolved Zinc
Sulfate	Dissolved Copper	
Total Alkalinity	Dissolved Lead	
Common ions		
Dissolved Calcium	Dissolved Magnesium	Dissolved Sodium
Dissolved Potassium	Nitrate plus nitrite	Bicarbonate
Silica	Chloride	

Samples will be collected from each station monthly.

The analytical minimum level is defined as the concentration of a constituent at which it can be reliably quantified according to the precision and accuracy DQO's. Generally, the minimum level occurs at a concentration that is 3.18 times higher than the minimum detection level reported for the method of analysis. The minimum levels for use in the ISEMP are identified for trace constituents in Table 4. The method minimum level is developed based on low concentrations of the analyte added to reagent grade water. In contact waters, the matrix-specific ML may be higher than the value in Table 4 due to matrix interference. Such data quality issues will be considered when developing QA/QC repots for the data collected in the ISEMP.

Precision is a measure of the ability to replicate an analysis and is expressed as the relative percent difference (RPD). The RPD criterion for water samples is ±20% and is only applicable when the analyte concentration is more than 5 times the MDL, and as long as the native amount is not greater than 4 times the spiked amount.

Accuracy is a measure of how close the analytical result is to the true concentration of the analyte, and is expressed as percent recovery (%R). The Matrix Spike/Matrix Spike Duplicate (MS/MSD) criteria are 75-125 %R for all metals. The criteria are only applicable for analyses as long as the native amount is not greater than 4 times the spiked amount. The accuracy limits for the Laboratory Control Sample (LCS) are method dependent.

Completeness is a measure of how many planned analyses for all analytes actually resulted in usable data, defined as all data that is not rejected, and is expressed in percent (%). The completeness criterion is 95% for a water year, which is October 1st through September 30th. Samples that cannot be collected due to restricted winter access or to low flow are not counted as planned samples in the determination of completeness.

Table 4. Recommended Minimum Levels for Trace Constituents

ANALYTE	AWQS[1]	MDL[3]	ML[4]
Arsenic, T, µg/l	50 l	50	160
Cadmium, TR, µg/l	0.52, 0.38	1.0	3.2
Copper, TR, µg/l	5.1, 3.6	10	31
Lead, TR, µg/l	0.90, 0.54	2	6.4
Mercury, TR, µg/l	0.012	0.2	0.64
Silver, TR, µg/l	0.73,0.37[2]	5	16
Sulfate, mg/l	250	50	160
Zinc, TR, µg/l	45.6, 32.7	10	32

T = measured and reported as total, TR = measured and reported as total recoverable

1. *If AWQS is hardness dependent, two numbers are listed for the purposes of calculating the ML and MDL. First number listed is based on a hardness value of 37 to represent the 25th percentile of surface water hardness values, the second number listed is based on a hardness value of 25 to represent the 25th percentile of groundwater hardness values. AWQS is for chronic conditions unless otherwise noted. The actual hardness dependent AWQS for that constituent will depend on the actual hardness of the sample, not on the number that appears in this table.*
2. *AWQS is a 24 hour average (acute).*
3. *MDL is the minimum detection level for laboratory analysis. The value selected will allow detection of significant changes in the chemistry of contact water.*
4. *ML based on MDL times 3.18, rounded to not more than 2 significant digits.*

The chemistry of contact water will be determined by sampling surface water at selected internal stations. Surface runoff from selected stations in the inactive production rock areas will be collected from the following stations on a monthly basis (Table 5). Samples will be analyzed for the constituents in Table 4. All analyses will be in a dissolved form.

Table 5. Internal Sampling Locations

Station	Measurements	Frequency	Comments
Seeps	Flow and chemistry	Quarterly	If flow is greater than 0.5 gpm in seeps near margin of any inactive pile
1320 Adit	Flow and chemistry	Monthly	If flow is present
Pond C	Water level and chemistry	Monthly	

All water quality data collected will be transmitted in annual reports to the USFS and ADEC. There are no specific compliance levels for these data, but information should be presented on graphs of concentration vs. time to graphically illustrate trends in the data, if any.

2.7 Mitigation of ARD or Metals Release

If any inactive Production Rock or Borrow Areas are found to produce acid or release elevated levels of metals, control measures may be required. The preferred approach for preventing releases of metals or acidity is to reclaim the piles (GPO Appendix 14, Reclamation Plan). Alternatively, runoff or seepage from the piles could be collected and treated, the piles could be removed and placed underground or consolidated with an active facility.

KGCMC has investigated the effectiveness and feasibility of implementing an in situ treatment process to reduce ARD potential and metals leaching from Production Rock Sites (Condon 1999). The process entails application of a polymer that binds soluble zinc, with or without application of lime or limestone for pH control. The treatment process has been proven to be effective for specific short-term applications as a mean of reducing the mobility of zinc. The treatment has not been shown to be suitable for long-term control of ARD or metals leaching. Consequently, polymer and lime or limestone will not be added to the production rock pile on a routine basis. If particular zones within the production rock piles require treatment to control the release of metals or become acidic before an engineered cover can be placed, then polymer and lime or limestone may be added as a spot treatment to control metals leaching.

2.8 Reporting

All data collected as part of the routine monitoring program should be submitted to the USFS, ADEC and ADNR in annual reports.