

# **GREENS CREEK MINE FINANCIAL ASSURANCE REVIEW**

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## **1.0 Introduction**

The Greens Creek mine is a joint venture between Kennecott Minerals Company (70.3%) and Hecla Mining Company (29.7%) located on Admiralty Island in the Tongass National Forest near Juneau, Alaska. This underground mine and milling operation produces bulk concentrates of silver, zinc, lead, and gold. Greens Creek mine development began in 1987 with operations commencing in 1989. Operations were suspended in 1993 and reinitiated in 1996 after completion of mine development work. The life of mine is estimated to be 17 years at the designed production rate of 1,320 tons per day.

The polymetallic ore is removed from underground workings and transported to the surface mill and concentrator facilities where 3 separate concentrates of zinc, lead, and bulk concentrate are produced in addition to gold/silver doré. Concentrates are transported by road to the Hawk Inlet, loaded onto ships and sent to smelters for further processing. Tailings and waste rock generated during metals recovery are sent back underground (approximately 50%) or to dry storage facilities including a 30 acre tailings impoundment, plus a proposed 32 acre expansion, and 44 acres of production rock sites. The potential of acid rock drainage (ARD) in the tailings area and production rock sites has been identified in the reclamation plan. The mine site also contains 68 acres (13.5 miles) of road surface including 5.7 acres of road constructed from pyritic quarry rock, and 29 acres of mine site facilities including the mill. (KGCMC 2001, USFS 2003)

Reclamation at the Greens Creek mine is planned to occur both concurrent with operations and after mining and milling have ceased. Concurrent reclamation efforts will take place on specific sites, such as production rock sites and lower portions of the tailings impoundment, as reclamation materials become available and sites are no longer needed. Final reclamation and closure monitoring will begin after mine closure. Physical reclamation tasks such as building removal, recontouring, and revegetation are planned for completion within 5 years of closure. Water treatment facilities are anticipated for use no longer than seven years after closure, and environmental monitoring will be conducted for 30 years under this reclamation plan. (KGCMC 2001)

The Greens Creek mine reclamation plan and closure cost estimates were prepared in accordance with standard engineering cost estimation procedures and are consistent with methods commonly used by industry as well as state and federal agencies. Current financial assurances are held by the United States Forest Service (USFS) for the Alaska Department of Environmental Conservation (ADEC) in the amount of \$24,400,000 to cover the cost of mine site reclamation and closure, water treatment, as well as monitoring and maintenance of reclamation work, engineered soil covers, and surrounding water quality. The proposed tailings impoundment expansion is estimated to increase the reclamation cost by \$1,770,000, which will increase the overall financial assurance amount to \$26,170,000 (USFS 2003).

Current financial assurance amounts for the Greens Creek mine held by the USFS guarantee reclamation takes place in the event of bankruptcy, or other circumstances where reclamation is not completed by Kennecott Minerals Company and Hecla Mining Company are evaluated in this report. This technical review is based on analysis of the existing reclamation plans and financial assurance cost estimates listed



in Kennecott Greens Creek Mining Company General Plan of Operations, Appendix 14, Attachment A, “Detail Reclamation Plan Cost Estimates,” November 15, 2001; and the planned tailings impoundment expansion discussed in USFS Greens Creek Tailings Disposal Draft EIS, Appendix F, ADEC Draft Waste Management Permit, Section 9.1.2, April 2003.

This evaluation was developed to ensure that the financial assurance amounts held by the USFS for the state of Alaska are adequate to cover the costs of reclamation and closure as required by Alaska statutes and regulations. The state of Alaska is required to obtain financial assurance to ensure that the approved reclamation tasks are completed in the event Kennecott Minerals Company and Hecla Mining Company fail to perform the necessary tasks as outlined in the reclamation plan.

## **2.0 Methods**

If the USFS and/or ADEC become responsible for reclamation at the Greens Creek mine it is critical that adequate funding is available for completion of the required tasks. It is well documented at other mine sites (e.g. Summitville Mine in Colorado; Zortman Landusky, Beal, and Basin Creek mines in Montana; and Brohm Mine in South Dakota) that in the event the operating company files bankruptcy costs incurred by the State to perform reclamation are significantly higher than those originally estimated (Kuipers 2000). In some cases costs incurred by state and federal agencies can be 10 to 100 times higher than those estimated in reclamation plans and financial assurance calculations (Kuipers 2000). For these reasons this review of the Greens Creek mine reclamation plan and financial assurance(s) takes a conservative approach to cost estimating.

Financial assurance estimates calculated in this review were performed in accordance with standard cost estimation procedures and are consistent with methods commonly used by state and federal regulatory agencies. Site-specific reclamation tasks and associated areas of disturbance were developed from the aforementioned financial assurance estimate. Assumptions, reclamation tasks and associated costs used in this estimate are the same as those used in the existing reclamation plan and financial assurance(s), except where noted in the explanations for each scenario.

First, the existing financial assurance estimate was replicated (as Scenario 0) in a format that allows for unit costs to be determined for specific reclamation tasks. Next, four scenarios were developed where unit costs, indirect costs, and project timelines were evaluated and varied as described in the following sections. Finally, cash flow worksheets were generated for each scenario.

Detailed estimate calculations and the resulting scenarios and assumptions are provided as Attachment 1 for the Greens Creek mine reclamation plan. Attachment 2 illustrates additional calculations made for the developed scenarios with extended water treatment and monitoring. This includes year by year costs estimated for the extended water treatment scenarios. Attachment 3 shows **CSP<sup>2</sup>** unit costs for water treatment that are utilized in this review. All attachments are Microsoft Excel spreadsheets, available to download at [www.csp2.org/Reports](http://www.csp2.org/Reports).

Table 1 below summarizes the financial assurance amounts calculated for this review. As presented in Table 1, Scenario 2 is the **CSP<sup>2</sup>** preferred alternative in this review (see Section 3.3 for a detailed explanation of Scenario 2).

**Table 1. Greens Creek Mine Financial Assurance Costs Summary**

Greens Creek Mine Reclamation Plan	Greens Creek	CSIP <sup>2</sup> Scenarios			
	Scenario 0	Scenario 1	Scenario 2 (CSIP <sup>2</sup> Preferred Scenario)	Scenario 3	Scenario 4
	Based on 2001 reclamation plan plus 2003 tailings expansion.	Based on 2001 reclamation plan plus 2003 tailings expansion with increased indirect costs.	Based on Scenario 1 with changes to unit costs.	Based on Scenario 2 with 50 years water treatment.	Based on Scenario 2 with 100 years water treatment.
Capital Costs	\$15,475,139	\$18,117,236	\$21,032,526	\$22,270,926	\$23,710,926
Operating Costs	\$10,573,961	\$12,379,271	\$14,377,271	\$72,319,447	\$125,665,735
Total	\$26,049,100	\$30,496,507	\$35,409,797	\$94,590,373	\$149,376,667

**3.0 Review of Greens Creek Mine Reclamation Plan and Financial Assurance Calculations**

**3.1 Greens Creek Scenario 0**

For Scenario 0 labor costs, equipment costs, material costs, and acreages for specific reclamation tasks used duplicate those provided in the cost estimation worksheets in the Greens Creek mine reclamation plan. Equipment costs and efficiencies are based on Caterpillar Performance Handbook standards and historical Greens Creek mine costs. Wage rates are based on the Davis Bacon Wages for Alaska. Material costs are based on contractor estimates and mine site experience.

Scenario 0 was generated to determine unit costs for specific reclamation tasks used in the Greens Creek mine cost estimate. Unit costs are evaluated and changed in subsequent scenarios. Although data inputs for Scenario 0 were derived from the Greens Creek reclamation plan and the tailings impoundment expansion (USFS 2003) slight differences in total amounts are observed. The Scenario 0 reclamation plan financial assurance amount differs by \$120,900 (\$26,170,000 - \$26,049,100). This results in less than a <0.5% difference when compared to the Greens Creek mine generated financial assurance.

Review of the Greens Creek reclamation plan and associated financial assurance calculation revealed the following observations:

- Water treatment after closure will utilize existing water treatment facilities (page 12) until compliance standards are achieved. According to the reclamation plan water treatment facilities are planned for removal within seven (7) years after closure (page 13). The Greens Creek reclamation plan does not provide assurance that ARD problems from mine workings, waste rock piles, the tailings impoundment, and roads will not continue into the future. Based on experience at other mine sites with acid generating materials, ARD impacts can be expected to continue for a significant time period following reclamation. Although conditions will most likely improve following reclamation, water treatment facilities may be needed well into the future.

Due to the significant impacts on groundwater and surface water quality ARD has been demonstrated to cause, the potential for long-term water treatment should be examined more closely. The possible need for water treatment facilities into the future is addressed in Scenarios

3 and 4 of this review where water treatment is continued for periods of 50 and 100 years respectively.

- Maintenance and monitoring is anticipated to last for a period of thirty (30) years under the Greens Creek reclamation plan. This assumes that water quality standards as well as other performance criteria are met, and no further monitoring and maintenance will be necessary. Based on experience at other mine sites with ARD characteristics, it is unlikely that all monitoring and maintenance will be completed within 30 years. At minimum, a reduced level of monitoring and maintenance should be planned beyond 30 years.

For example, the planned soil covers over ARD materials are highly engineered and will most likely require a high level of long-term maintenance to ensure optimal performance. The Greens Creek reclamation plan assumes a monitoring and maintenance period of only 5 years. Additionally, if water quality standards are not met after 7 years of water treatment a longer period of water quality monitoring will be required. These issues are addressed in Scenarios 2, 3, and 4 of this review.

- The proposed tailings impoundment expansion approximately doubles the size of the tailings impoundment footprint from 30 acres to 62 acres; however, the unit cost estimated to reclaim the expansion is not comparable to the unit cost applied for reclamation of the original 30 acre impoundment disturbance. The overall unit cost to reclaim the first 30 acres (including the engineered soil cover, revegetation, maintenance and monitoring) was calculated as \$101,483 per acre. The overall unit cost for reclamation of the additional 32 acres planned in the expansion is \$42,591 per acre.

This results in an overall unit cost of \$71,087 per acre when combining the unit costs for the original 30 acre disturbance with the 32 expansion acres, which is approximately 30% less per unit area when compared to the original cost estimate. Scenarios 2, 3, and 4 utilize the original unit cost (overall \$101,483 per acre) for the planned expansion acreage.

### 3.2 **CSP<sup>2</sup>** Scenario 1

Scenario 1 duplicates the Greens Creek mine reclamation plan (Scenario 0) financial assurance capital and operating costs with changes made to indirect costs as noted below. Scenario 0 indirect costs are calculated at 33% of the estimated contract costs, and Scenario 1 indirect costs are 44% of the estimated contract costs. The difference results from increases in Scenario 1 indirect costs to account for engineering redesign, procurement, construction management, contractor overhead, and inflation.

A financial assurance cost estimate should be performed under the assumption that reclamation is performed by a third-party under contract to the appropriate regulatory agency. Factors including contractor ownership, standby, overhead, engineering redesign, etcetera result in higher costs than those typical of reclamation costs when performed by mining companies. Indirect costs represent one of the most common areas in which financial assurance requirements are underestimated (Kuipers 2000). Indirect costs are added to this estimate to account for additional costs incurred in the event of agency management and oversight of reclamation and closure.

The Greens Creek mine cost estimate included indirect costs for contingency (10%), mobilization and demobilization (5%), and agency administration (8%). A contractor profit rate of 10% is included in the capital and operating costs for specific reclamation tasks. In this estimate, indirect costs amount to 33% of the operating and capital contract costs.

The following indirect costs were applied to **CSP** Scenario 1:

- *Contingency.* Contingency costs reflect the level of detail and completeness of the cost estimate, as well as the degree of uncertainty of factors and assumptions used in the cost estimate. A contingency amount of 10% was applied to the estimated contract costs in the Scenario 1 cost estimate, which is the same percentage used in the Greens Creek mine cost estimate.
- *Mobilization / Demobilization.* Mobilization/demobilization costs account for the transport of equipment and materials to and from the mine site, as well as infrastructure needs. A mobilization/demobilization amount of 5% was applied to contract costs estimated in Scenario 1. The Greens Creek mine cost estimate also uses 5% for mobilization / demobilization. Additional costs may be incurred for mobilization and demobilization of specialized equipment associated with reclamation of water based facilities.
- *Engineering Redesign.* Engineering redesign costs stem from a lack of detailed information and plan development in a financial assurance estimate, as well as the need to account and design for actual conditions at the time of reclamation and closure. An engineering redesign cost of 3% was applied to the estimated contract costs used in Scenario 1. The Greens Creek mine cost estimate did not include any amount for engineering redesign.
- *Engineering, Procurement, Construction Management.* This indirect cost accounts for the requirement of construction engineering, procurement, and construction management on behalf of the agencies in the event they become responsible for reclamation. An indirect cost of 5% of the contract costs was used in Scenario 1, while the Greens Creek mine cost estimate does not account for the cost of this activity.
- *Contractor Overhead.* Contractor overhead accounts for administration, management, public relations, safety, environmental, legal, performance bonding and other costs associated with doing business. A contractor overhead cost of 15% was applied to the estimated contract costs used in the Scenario 1 cost estimate. The Greens Creek mine cost estimate did not include any amount for contractor overhead.
- *Contractor Profit.* This indirect cost accounts for contractor profit. A contractor profit amount was not applied to Scenario 1 since the Greens Creek mine financial assurance estimate includes a contractor profit rate of 10% rolled into the capital and operating costs.
- *Agency Administration.* Agency administration includes costs incurred by state and federal agencies in situations where reclamation and closure are performed by regulatory agencies. Agency administration costs were accounted for as 8% of the contract costs in both Scenario 1 and the Greens Creek mine cost estimates.
- *Inflation.* Inflation indirect costs account for the difference in the dollar value between the time the estimate was generated and reclamation and closure are performed. An inflation amount of 3% was

applied to the contract costs estimated in Scenario 1. Inflation was not accounted for in the Greens Creek mine estimate.

Application of these indirect costs in Scenario 1 results in an overall increase of 17% over Scenario 0. The Greens Creek mine reclamation plan costs were estimated as \$28,533,931 under Scenario 1. Indirect costs for Scenario 1 amount to 44% of the estimated operating and capital contract costs, while indirect costs were 33% for Scenario 0.

### 3.3 **CSP** Scenario 2

Scenario 2 includes the addition of indirect costs as described for Scenario 1, as well as changes to unit costs and reclamation tasks as described below. In general the Greens Creek mine reclamation plan unit costs seem adequate for specific reclamation tasks such as contouring, construction of engineered soil covers, application of growth media, hydroseeding, etcetera. This cost estimate also includes costs for highly specialized reclamation tasks specific to the Greens Creek mine due to the proximity of the mine site to coastal areas.

Capital costs for the tailings impoundment were increased in this scenario to reflect the unit costs estimated for tailings impoundment closure before the planned expansion. In this case, the 32 acres of disturbance planned for the tailings expansion were added to the unit costs associated with the original 30 acres. Therefore tailings impoundment reclamation and closure under this scenario is estimated to cost \$6,291,884 for the 62 acres at a unit cost of \$101,482 per acre. The Greens Creek reclamation plan estimates \$4,407,377 for the 62 acres at an overall unit cost of \$71,087 per acre.

The only capital cost added under this scenario is related to water treatment facilities. The existing reclamation plan for Greens Creek indicates that sludge disposal into the tailings impoundment will be unavailable within the first two years due to closure of the tailings impoundment. Therefore a unit cost of \$20,000/year for sludge disposal, including transport, was assumed in Scenario 2. With seven years of water treatment a cost of \$140,000 was included.

Maintenance and monitoring of the engineered soil covers over acid generating materials (waste rock and tailings) was increased to 30 years on an annual basis under Scenario 2 for reasons previously discussed. For the first 5 years a cost of \$82,800/year, based on the Greens Creek reclamation plan estimate, is applied. After the first five years it is assumed that maintenance costs for repairs to engineered soil covers will reduce to \$55,500/year. This value is based on an approximate reduction in anticipation of reduced maintenance needs, since information on long-term cover maintenance costs is not provided in the reclamation plan. This results in a total cost of \$1,801,500 under this scenario, compared to a cost of \$414,000 in the Greens Creek reclamation plan.

Application of these additional costs in Scenario 2 results in an increase of the current financial assurance amount by 36%. The Greens Creek mine reclamation plan costs were estimated as \$35,409,797 under Scenario 2.

Scenario 2 is the **CSP** preferred alternative presented in this review. This scenario includes additional indirect costs and extended water quality and reclamation monitoring, increased reclamation costs for the proposed tailings impoundment expansion, and a minor increase in water treatment costs. It must be strongly noted that in recommending this scenario, the duration of water treatment must match the Greens Creek assumption that water treatment will not be required beyond 7 years – an assumption that has scant

technical justification, and places the public at significant financial risk if it is wrong. For this reason, **CSIP**<sup>2</sup> has developed Scenarios 3 and 4 to evaluate the costs of longer-term water treatment.

### 3.4 **CSIP**<sup>2</sup> Scenario 3

Scenario 3 utilizes the same assumptions and changes made in Scenario 2, with the addition of 50 years of water treatment. As previously discussed, the Greens Creek mine reclamation plan does not include adequate detail regarding water quality, quantity, and acid rock drainage impacts to assess the adequacy of the estimated maximum 7 years of water treatment and 30 years of monitoring and maintenance.

Therefore, Scenario 3 was developed to determine the cost differences should water treatment, monitoring, and maintenance need to be extended for 80 years (50 years water treatment plus 30 years monitoring and maintenance). In this case, water treatment plant operation and maintenance costs were increased to reflect an operational period of 50 years. This includes a sludge disposal cost of \$1,000,000 for 50 years of water treatment. Water treatment plant capital replacement costs totaling \$7,228,000 were also assumed. For capital replacement costs, a water treatment plant capital cost of \$5,228,000 was assumed based on the **CSIP**<sup>2</sup> water treatment plant capital unit cost of \$6,535/gpm and a water treatment plant capacity of 800 gpm. See Attachment 3 for additional details on **CSIP**<sup>2</sup> unit costs related to water treatment.

Monitoring and maintenance under this scenario is performed as described in the reclamation plan with the time period extended. See Attachment 2 for detailed calculations and assumptions made in regard to extending water treatment and monitoring. General site operation and maintenance costs (labor, power, and service expenses) were increased to \$34,722,543; and long-term operation and maintenance expenses increased to \$10,479,851. Under this scenario surface and groundwater monitoring is conducted annually for 52 years, biannually for 10 years, every three years for 10 years, and every 5 years for 10 years. Reclamation monitoring will be conducted twice annually for 52 years, then biannually for 10 years, and every five years for 20 years. Reclamation maintenance of engineered soil covers and other sites as necessary will be conducted on the same schedule of reclamation monitoring. Again, the annual cost of reclamation maintenance for engineered soil covers was reduced from \$82,800 to \$55,500 after the first five years of maintenance for reasons discussed in Scenario 2.

Application of these additional costs in Scenario 3 results in an increase of the current financial assurance amount by 263%. The Greens Creek mine reclamation costs were estimated as \$94,590,373 under this scenario.

### 3.5 **CSIP**<sup>2</sup> Scenario 4

Scenario 4 utilizes the same assumptions as Scenario 2, with the addition of 100 years of water treatment to mitigate acid generating drainage. This scenario was developed to determine the cost difference if water quality standards were not met for 100 years after closure. Monitoring and maintenance under this scenario continue for 130 years, or 30 years after water quality standards have been met.

In this case, water treatment plant operation and maintenance costs were increased to reflect an operational period of 100 years. Water treatment plant capital replacement costs of \$7,228,000 were assumed. Sludge disposal costs for 100 years of treatment were estimated at \$2,000,000.

Monitoring and maintenance under this scenario is performed as described in the reclamation plan with the time period extended to a total of 130 years. See Attachment 2 for detailed calculations and assumptions made in regard to extending water treatment and monitoring. General site operation and maintenance costs (labor, power, and service expenses) were increased to \$65,359,926; and long-term operation and maintenance expenses increased to \$16,888,501. Under this scenario surface and groundwater monitoring is conducted annually for 102 years, biannually for 10 years, every three years for 10 years, and every 5 years for 10 years. Reclamation monitoring will be conducted twice annually for 52 years, then biannually for 10 years, and every five years for the remainder. Reclamation maintenance of engineered soil covers and other sites as necessary will be conducted on the same schedule of reclamation monitoring. Again, the annual cost of reclamation maintenance for engineered soil covers was reduced from \$82,800 to \$55,500 after the first five years of maintenance for reasons discussed in Scenario 2.

Application of these additional costs in Scenario 4 results in an increase of the current financial assurance amount by 473%. The Greens Creek mine reclamation plan costs were estimated as \$149,376,667 under Scenario 4.

#### **4.0 Conclusions**

As illustrated by this review, the Greens Creek mine financial assurance, plus tailings impoundment expansion costs, of \$26,170,000 currently established may not be adequate to cover the costs of reclamation and closure incurred when these tasks are performed by a regulatory agency. In the event water quality standards are met within the assumed timeframe of 7 years, reclamation and closure costs could increase from between 17% and 36% as shown in Scenarios 1 and 2. If water treatment is required for 50 years the financial assurance amount could increase by 263%, and by 473% if water treatment is required for 100 years. This results in a potential increase of the overall financial assurance amount to between \$30,049,100 and \$149,376,667.

#### **5.0 References**

KGCMC. November, 15, 2001. *Kennecott Greens Creek Mining Company General Plan of Operations Appendix 14 Attachment A Detail Reclamation Plan Cost Estimates*. Kennecott Minerals: Juneau, Alaska. 25 pages.

Kuipers, JR. February 2000. *Hardrock Reclamation Bonding Practices in the Western United States*. Boulder: National Wildlife Federation.

USFS. April 2003. *Greens Creek Tailings Disposal Draft EIS*. USDA Forest Service.

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