# STATE OF ALASKA

**SARAH H. PALIN,**
***GOVERNOR***

## DEPARTMENT OF ENVIRONMENATAL CONSERVATION

DIVISION of ENVIRONMENTAL HEALTH
SOLID WASTE and WASTEWATER PROGRAM

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# FIELD INSPECTION REPORT
# GREENS CREEK MINE

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| **Inspection Date:** | October 11, 2007 |
| **Report Date:** | December 28, 2007 |
| **Weather:** | Cloudy. Temp 48°F., Wind 7mph with gusts to 21mph |
| **Inspection Objectives:** | Routine inspection to follow up on informal site visits on May 30, 2007 and June 8, 2007 |
| **Operator Contact:** | Kerry Lear, Kennecott Greens Creek Mining Co. (KGCMC) |
| **State Personnel:** | Ed Emswiler, ADEC Solid Waste Program<br>Kenwyn George, ADEC Wastewater Program |
| **Other Personnel:** | Sarah Shoemaker, USDA Forest Service |
| **Documentation:** | Photos were taken. Additional photos to those in this report are available from ADEC in Juneau |

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## Notes

On October 11, 2007, the above listed personnel participated in a site visit at the Greens Creek facilities on Admiralty Island. The purpose of the visit was to follow up on informal site visits on May 30, 2007 and June 8, 2007 regarding the various disposal and containment facilities. Of particular interest was to understand the progress being made on the Northwest Expansion (NW) of the tailings disposal site. The site inspection included the "A" and "B" road systems, as well as the facilities along these roads. On the "A" road we inspected the 1.4-mile sandpit. On the "B" road, we inspected the 1350 area, the 920 area, Site C and pond, Site 23 disposal site, Site E, and the tailings disposal site. A USFS/Ward Air plane took us to Greens Creek at 8:30 AM, returning to Juneau at 1:00 PM. We arrived at approximately 9:00 AM where we were met at Hawk Inlet by Kerry Lear of KGCMC.

### Sand Pit - 1.4 Mile "A" Road

The site is located adjacent to the A-road (see Figure 1) between Hawk Inlet and Young Bay. Sandy material is screened for use as the bedding layer, granular interlayer, and service layer in the liner system at the northwest expansion area of the tailings facility as well as other uses around the KGCMC facilities. This pit is presently 5 acres but could be expanded to 10 acres in

order to supply sand for other applications. However, doing so may require additional permitting approval through the Forest Service.

***Figure 1: 1.4 Mile "A" Road Sand Pit***

## Pit 7 - 1.8 Mile "A" Road

This pit is located approximately 200 yards off of the "A" road at mile 1.8 between Hawk Inlet and Young Bay (see Figure 2). The pit was initially developed in 1987 to support construction of the roads and other mine facilities. Pit 7 has been partially backfilled with tree stumps and reclamation materials derived during the expansion of the tailings pile and development of the sand pit at 1.4 mile on the "A" Road. KGCMC plans to recover this material for reclamation. Most of the surfaces and banks of placed materials had been given a heavy application of hydroseed and a dense blanket of grass was growing.

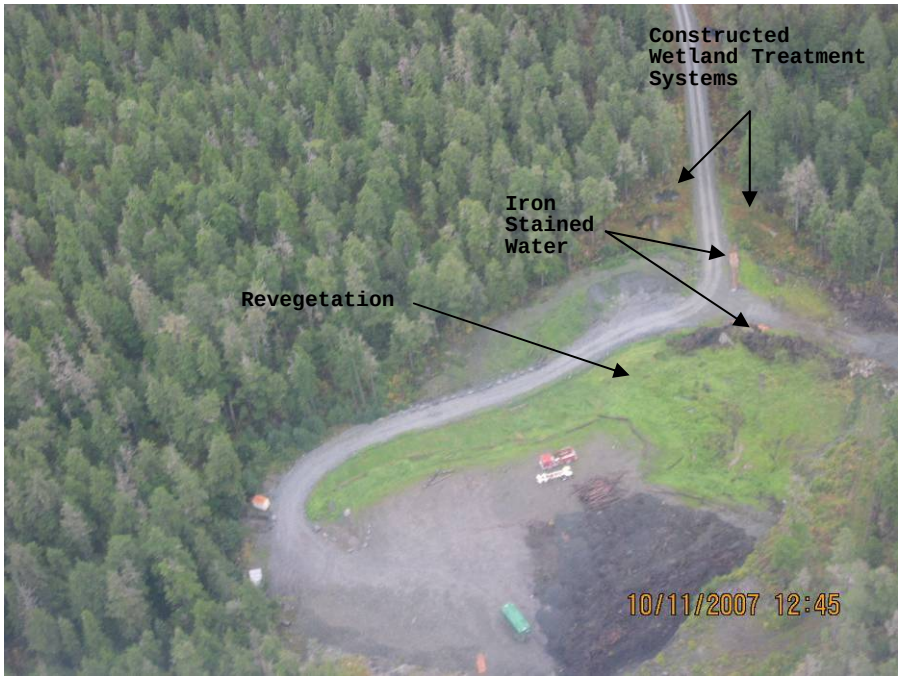


***Figure 2: Pit 7: Note Hydroseed, Iron Stained Water and Constructed Wetland Treatment System***

Iron staining was observed adjacent to road prisms and in water passing through stored overburden material (see Figure 3). The iron staining observed in the drainage from the pit is most likely due to dissolution of iron-rich oxide in the peat and gravel fill rather than from the pit walls (where iron staining has also been observed). Information from previous annual reports show relatively low sulfate concentrations and low metal values indicating limited sulfate oxidation.

***Figure 3: Pit 7 Iron Stained Water Before Wetland Treatment System***

Dissolution of iron and manganese oxides in the overburden stored in the pit has produced elevated concentrations of these metals and lead in the drainage.

Two small wetlands constructed at opposite sides of the road to the entrance of the pit treat the water before it enters a water of the U.S. One constructed wetland has two ponds (see Figure 4). Oxidation of the drainage waters and precipitation of the metals is expected in the constructed wetlands. Presently storm water monitoring occurs at the outlet to the wetlands. However, the water then runs down grassy ditch extensions of the constructed wetland areas which provide additional treatment prior to entering a small stream considered to be "waters of the U.S." by EPA. EPA and Greens Creek are in the process of relocating the storm water compliance point to the outlet of the constructed wetland just prior to the discharge entering the stream.

*Figure 4: Constructed Wetland Treatment Systems at Pit 7*

## Storm Water System Along "A" and "B" Road System

As per recommendation from Dr. Richard Warner (June 14, 2007 site visit) KGCMC has begun to experiment with rock check dams and "burrito wraps" as a means of further reducing sediment from roads. Burrito wraps are rock check dams wrapped in filter fabric to reduce the passage of sediment through the dam. Effective use of the dams allows sediment to precipitate by gravity before the water passes over and through the dams. Historically, straw bales were used. However, straw bales were not considered as effective as the rock dams as they degrade quickly and are less permanent. The check dams and "burrito wraps" have generally been given a favorable report thus far; however the burrito wraps tend to clog with sediment rather rapidly and so do not work quite as originally intended. The rock dams without fabric are also becoming filled with sediment, so it is early to tell how effective these are in the long term, and what maintenance will be required. Both check dam configurations were noted to have produced sediment capture in their up-stream pools (see Figures 5, 6, & 8).

*Figure 5: Rock check dams on "B" Road*

*Figure 6: "Burrito Wrap" check dam at Site 1350*

Proper placement, construction and maintenance of the check dams were reported as critical to the success of the dams. The dams becoming sealed with sediment is an on-going maintenance issue. During low flow situations, sediment drops out in the ponds behind the dams. However, sediment-laden waters may flow over the dams at times of high flows especially when they are not maintained or are not constructed adequately. Some ponds were observed to be full of sediment. Internal KGCMC monitoring has shown that greater attention to cleaning ponds and maintaining dams will be necessary and KGCMC staff has been alerted to this. KGCMC has purchased a suction truck to help with ditch maintenance as well as other sediment clean-up around the site. According to Kerry Lear, the rock dams will need to be replaced routinely (approximately every 3 years).

KGCMC plans other actions to reduce sediment from roads. Additional culverts have been installed to conduct stream flows beneath the road, rather than down ditches, combining with road runoff and picking up sediment in the ditch that has come from the roads. KGCMC propose installing approximately three times as many culverts across the road to reduce the flow into ditch section/sediment control device. They will also try revegetating ditches to further trap and remove fine material; however as sediment builds up, the ditches will need to be cleaned, and the grass cover may need to be re-established. Additionally, chip-seal may be used along certain high sediment sections of the road to reduce the sediment load produced by the breakdown of road rock surfacing material by heavy equipment.

## Site 1350

At approximately 10:25am we arrived at Site 1350. Site 1350 contains approximately 40,000 – 60,000 cubic yards of material from development of the 1350 exploration portal, which began in 1978 and continued intermittently through 1985. Some of the waste disposed here has acid generating and metals leaching characteristics. At the time of this inspection some waste has been excavated from the area of the dump nearest the 1350 portal (see Figure 9). This area of the dump was selected for removal because drainage from the area could be redirected through the 1350 portal (see Figure 6 and 8) into the mine water collection system which is contained, and eventually treated and discharged through the permitted NPDES discharge outfall in Hawk Inlet. The drainage from the site is reported to be near neutral in pH although there is a sulfate load with low metal concentration and localized iron staining noted in routine KGCMC monitoring.


*Figure 7: 920 remuck pad with site 1350 waste and inert construction wastes for placement underground*

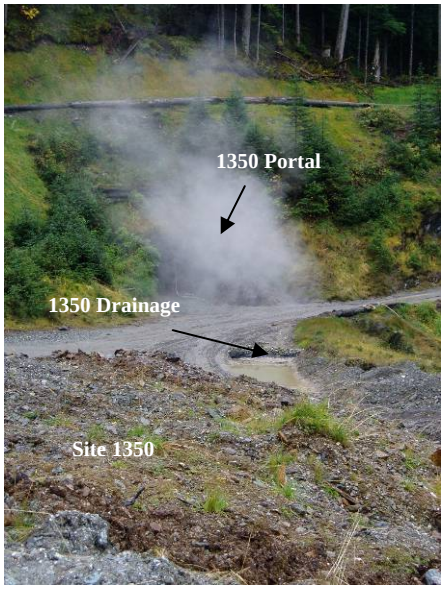


*Figure 8: Contained stormwater from site 1350 and 1350 portal*

Approximately 2,500 tons of this waste was stored at the 920 remuck pad awaiting placement underground (see Figure 7). Approximately 10% of the waste at this site has been removed thus far and approximately 60,000 tons have yet to be removed. The class 2 material from the site will be disposed at Site 23. The area will be cleaned up and excavation will stop this year due to winter conditions. Removal of the waste will resume in the spring when conditions are favorable.

*Figure 9: Area of Site 1350 excavation*

## Site C and Pond

Site "C" is located near the end of the "B" road just below the 920 mill/concentrator facilities. The site received production rock in 1987 and 1988 and currently contains approximately 50,000 cubic yards of waste some of which is potentially acid generating and metals leaching. The 860 safety building and assay lab have been constructed on this site. Flow from the site is low (generally less than 1gpm), remains near neutral, with elevated manganese concentrations, and moderate sulfate, zinc, cadmium and iron concentrations. Sporadic fluctuations in lead concentrations in Greens Creek below Site C has been noted and may be related to sediments contributed from the storm water ditch that sheds water from the B road between the 920 area and Site C.

KGCMC completed installation of a pumpback system in 2007 to facilitate the recovery of collected stormwater to the pond. The recently installed sump facilitates return of these pond waters to the mine water collection and treatment system. However, during high flows, some seepage occurs on the downstream face of the pond and flows to Greens Creek. KGCMC proposes to place low hydraulic conductivity glacial till material on the downstream face to prevent this seepage.

Final reclamation bonding for Site C includes the use of an engineered cover system leaving the disposed material in place. Because of the close proximity of the site to Greens Creek, disposal underground with less hazardous portions disposed at Site 23 should be considered.


***Figure 10: Pond "C", Note: sump which pumps water to containment***

## Site 23/D

As a necessary part of the mining process, underground operations extract non-ore bearing rock, referred to as "production rock" or "waste rock". Some of this rock material has the potential to cause Acid Rock Drainage (ARD) and Metals Leaching (ML) conditions. Much of this waste cannot be placed back underground due to materials placement constraints consistent with the progression of the mine plan. Therefore, the production rock must be placed in facilities on the surface that are engineered for disposal of this material under the WMP. Production Rock Site 23 and the adjacent Production Rock Site D are two such facilities. These facilities are engineered and managed for geotechnical stability, minimizing acid generation and metals leaching, and water management. Site D was operational from approximately 1987 to 1995, but is no longer an active placement area. Site 23 was constructed in 1995 and is currently the only active surface placement facility for production rock besides the tailings area.

Understanding of the design, construction, operation, hydrology and geochemistry, and closure of this facility may be found in the original permit application for the facility, Appendix 11 of the General Plan of Operations, a February 2004 report by EDE Consultants entitled "Site 23/D Hydrogeology and Geochemistry Analysis" and in annual reports associated with the sites. These reports indicate the site is stable and free draining.

Final reclamation and bonding of Sites 23 and D include the use of an engineered cover system. However, current thinking is changing with regard to Site D in that it should be excavated and returned underground at closure of the mine. Reclamation bonding should reflect this in the next permit and bond.

Site 23

KGCMC has in place a waste characterization plan to differentiate wastes by ARD potential such that the least ARD forming waste (Class 1:NNP >100 tons $CaCO_3$/1000 tons) is placed as a layer on the outside of the pile to encapsulate the potentially more ARD generating waste (Classes 2 and 3) within the fill, thereby limiting exposure of this more hazardous portion to water and oxygen at closure. The most ARD producing form of production rock is Class 4 (NNP < -300 tons $CaCO_3$/1000 tons). This rock is not brought to the surface and is kept underground as fill. All ARD rock types have the potential to leach metals at neutral pH as evidenced by elevated levels of arsenic, cadmium, copper and zinc in samples from contact waters within the fill (e.g. finger drains). Zinc in particular will leach at neutral pH. These Site 23 waters presently appear to continue to be well buffered. Annual reports indicate no significant impacts from Sites 23/D to Greens Creek.

General site management at Site 23 focuses on efforts to place and compact waste, control infiltration, drainage, run-on and run-off. Infiltration is addressed by the use of a grading plan that must be flexible in order to account for seasonal conditions and the ever-changing pile top surface. Waste is typically placed with dozers in 2-foot lifts and then compacted with 3 passes of a vibratory compactor (see Figures 11 & 12). This is done in a way to minimize the formation of permeable areas and to allow water to drain off of the surface to the mine water collection and treatment system at Pond 23. At this inspection wet conditions presented drainage and accessibility issues. During wet weather rock rapidly breaks down into "soupy slurry" on the access road and other areas receiving heavy traffic (see Figure 13). This was difficult to manage, resulting in high sediment loads in surface runoff to the lined ditch and pond containment. It

was reported the slurry was scooped up and mixed with new rock, then spread out on the pile where the excess water was able to slowly percolate down through the pile. KGCMC is clearly aware of this problem and has experimented with a ridge and swale pattern that appeared to improve drainage during the rainy season. Fine tuning of methods to improve drainage and accessibility continues.

***Figure 11: Site 23 southwest downslope. Note: drainage features***

***Figure 12: Site 23 south downslope drainage***


*Figure 13: Site 23 north upslope footprint and "soupy slurry" on access road.*

The northeast aspect of the site was being prepared to receive waste rock (see Figure 14). This was done by developing a berm of argillaceous rock with drains that are oriented to keep landfill associated water within the containment system. By keeping the boundary of the pile at this location, no water from the waste rock should run into Bruin Creek which runs adjacent to the site.


*Figure 14: Site 23 northeast footprint. Note: Prepared foundation and berm to receive waste*

Drainage of water that percolates down through the pile is facilitated through a system of 8 underlying finger drains and a curtain drain system. Following back-slope excavation and prior to production rock placement, finger drains are extended to intercept water at the base of the waste rock (see Figure 13). The finger drains are constructed concurrently with backslope excavation using 6" slotted HDPE pipe bedded in gravel/rock and added in sections progressively upslope from the active placement area. The finger and curtain drain system is designed to prevent water accumulation in the production rock pile and to intercept groundwater flow into the overlying rock material at the contact of the production rock and apparently somewhat less permeable colluvium. This also acts to produce a free-draining pile which will enhance geotechnical stability. The finger drains discharge to the lined ditch paralleling the "B"

access road at the toe of Site 23, through which the flow is conveyed to Pond 23. The curtain drain intercepts ground water from beneath Site 23 from flowing down slope into Site D, conveying those waters directly to Pond D at the lower aspect of Site D. The D-Pond water is pumped to Pond 23. At this inspection the flows from the finger drains were observed to be quite low.

A spring was encountered during the fall/winter of 2005 when the backslope was excavated in preparation for vertical expansion of Site 23. It is reported this flow could be as much as 200gpm during high precipitation events. This water is collected and piped off-site to the east by HDPE pipe. Doing so alleviated the need to treat water during operation if it were allowed to enter the finger drain system. Springs have not been encountered in excavating the backslope since 2005.

Site D

Site D was constructed with waste rock, some of which may produce acid rock drainage and metals leaching conditions. The retention pond at Site D collects stormwater from Sites 23/D and landfill associated water from a curtain drain at the toe of site 23. Pond D is located less than 50-feet from Greens Creek. Site D was constructed prior to current regulations (Title 18, Chapter 60 of the Alaska Administrative Code (18 AAC 60.225(b)(2) that require the landfill prevent from contributing to siltation or flooding problems in nearby surface water bodies, construct and maintain a control system capable of containing and controlling the run-off from a 24-hour, 25-year storm". Pond D was reported to overflow into Greens Creek for 7 days during a 5-day storm event in November of 2005. According to U.S. Weather Service data none of the days during the November 2005 storm event reached a 25 year event. KGCMC should show compliance with the above requirement at Pond D. If this demonstration cannot be made then a plan and schedule should be provided.

The containment berm is constructed with pyritic rock, is not lined and allows some landfill associated water to pass through the berm. The berm at Pond D should be reconstructed without material that could produce ARD or metals leaching and in such a way that water does not pass. A plan and schedule to do this work should be provided.

Also, any planned excavation of the waste from Site D in preparation for closure would need to be carefully planned to prevent stability problems with Site 23. A plan for the closure and treatment of landfill associated water from Site 23 at closure is needed.

## Site E

A temporary geosynthetic cover had been placed over the majority of Site E in preparation of moving this waste to the tailings facility. The cover will enable material that is at field saturation to drain without additional water infiltrating into the pile, and will minimize water quality impacts from Site E. The latest plan is to begin moving the waste to the tailings disposal facility in the spring of 2008. A report that details the geochemical impact of Site E waste rock on the tailings facility is pending from co-disposal tests currently underway at KGCMC.

## Tailings Facility.

The focus of tailings disposal during the winter of 2007-2008 will be in the northwest expansion area. Construction and installation of the liner system in the NW expansion area was under way and appeared to be conducted according to approved plans submitted by KGCMC dated March 8, 2007. A geosynthetic liner had been placed over approximately two-thirds of the proposed expansion area. This included a northeast stormwater retention pond that is configured to maximize the tailings placement footprint in this area. A new, gravity-drain system was added from this pond to the west in order to enhance water collection and transport from this area of the fill. With the exception of the Pit 5 aspect of the NW Expansion area, the installation of the liner system was nearing completion. The liner was also placed over a bedrock exposure previously covered by the original tailings pile, which was excavated in conjunction with the expansion effort in the NW corner of the pile. This could possibly address a potential source of anomalous sulfate concentrations in the wells to the north and west of the tailings area. A compacted sand service layer had been placed over much of the lined area according to a "construction quality assurance" plan. The results of the plan should be submitted prior to tailings disposal in this area.

As noted above, the tailings material from the existing tailings pile, in the southwestern aspect of the NW expansion, were excavated to allow the liner to cover the full extent of the bedrock in this area, and tie into the natural till layer that acts as an aquatard below the site (see Figures 15, 16, and 17). A plastic tarp was placed over the open tailings face in order to minimize the phreatic water surface level in this area. According to KGCMC the phreatic water surface level was lower than expected as noted after excavation in this area of tailings. This may be cause for recalculating stability figures and the factor of safety for the tailings both of which will be enhanced with the confirmed lower saturation level in the pile.

The Pit 5 treatment plant will be removed and the area's underlying bedrock reconfigured in preparation for lining when the new water treatment plant at Pond 7 is complete. The new water treatment plant is expected to be finished in the 2$^{nd}$ quarter of 2008. At the time of this inspection construction of the new plant was well under way, with tanks having been constructed on the concrete foundations. At about the time the new treatment plant is commissioned, Pond 6 water will be rerouted to Pond 7 in preparation for the permitted expansion of the tailings pile to the south. The new plant will increase water treatment capacity about 3 times current capacity such that KGCMC will be able to fully utilize the permitted discharge capacity of the NPDES permit and the outfall to Hawk Inlet.


**Figure 15: Tailings NW Expansion Area: Note area to the left that ties in to the natural till layer (aquatard)**

In order to prevent rainwater and snow intermixing with tails before they are spread and compacted, a portable, covered tailings dry storage structure will be erected within the tailings containment near the truck wash building. This will alleviate an associated rise in moisture content that adversely affects compaction to no less than 90% standard proctor density when current placement must occur during heavy precipitation events. At this inspection this structure's construction had not begun.


**Figure 16: Northeast Retention Pond**


**Figure 17: Southern aspect of the NW Expansion. Note tailings excavated to natural till layer to allow the liner to tie in to the natural till layer**

## Hawk Inlet Facilities

Cyanide is stored in a dry form in a locked container at the Hawk Inlet facilities. When needed it is transported to the mill, put into solution in the reagent mixing area, and stored in a tank.

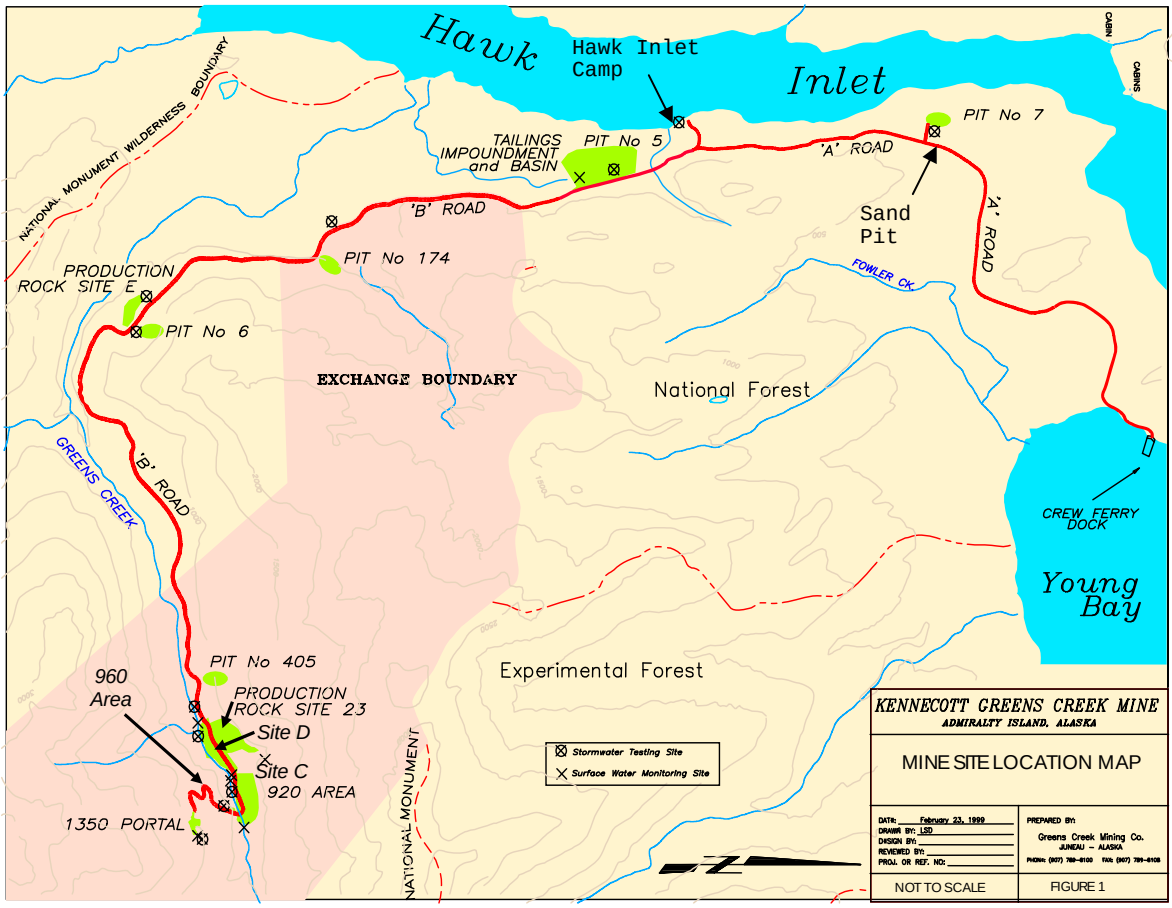


***Figure 6: Map of KGCMC Sites of Interest***

## Action Items

1. Elevated lead concentration has been noted in drainages at Pit 7. Presently storm water is monitored within the constructed wetlands. EPA and Greens Creek are in the process of relocating the storm water compliance point to the outlet of the constructed wetland, just prior to the discharge entering the stream. Compliance with EPA stormwater benchmark values will be a point of interest in future evaluations.
2. ADEC will continue to track the effectiveness of the following in reducing sediment from roads:
    a. rock check dams;
    b. burrito wrap check dams;
    c. installation of more culverts;
    d. revegetation of ditches;
    e. sediment removal from road catchment features, and;
    f. use of chipseal along certain high sediment areas
3. KGCMC should provide a schedule for moving Site E, Site D, Site C, and other inactive sites?
4. ADEC will continue to track the removal of approximately 60,000 tons of production rock at Site 1350.
5. ADEC will continue to track the effectiveness of the pumpback system, use of glacial till material in the downstream face at Site C pond, and improvements to the stormwater ditch that sheds water from the B-road between the 920 and Site C in reducing sporadic fluctuations in lead concentrations in Greens Creek below Site C.
6. Because of the close proximity to Greens Creek, underground disposal of the more hazardous portions of production rock with disposal of less hazardous portions at Site 23 in the final reclamation of Site C should be considered. Currently, the plan and bond includes placement of an engineered cover over this site.
7. ADEC will continue to monitor the surface drainage improvements at Site 23 as fine tuning of methods to improve drainage and accessibility continues. KGCMC should focus efforts on how to control high sediment loads in surface runoff especially in wet conditions in areas of heavy traffic where drainage and accessibility present the greatest challenges.
8. A plan for the closure and treatment of landfill associated water from Site 23 at closure is needed.
9. Final reclamation and bonding of Site D includes the use of an engineered cover system. However, current KGCMC thinking is changing with regard to Site D in that it should be excavated and returned underground at closure of the mine. Reclamation bonding should reflect this in the next permit and bond. Any planned removal of production rock from Site D in preparation for closure should prevent geotechnical stability issues with Site 23.
10. KGCMC should show how it complies with the requirements of Title 18, Chapter 60 of the Alaska Administrative Code (18 AAC 60.225(b)(2) at Pond D. If this demonstration cannot be made then a plan and schedule should be provided.
    The berm at Pond D should be reconstructed without material that could produce ARD or metals leaching and in such a way that water does not pass. A plan and schedule should be provided.

Also, any planned excavation of the waste from Site D in preparation for closure would need to be carefully planned to prevent stability problems with Site 23. A plan for the closure and treatment of landfill associated water from Site 23 at closure is needed.

11. Section 2.4.8 of the Waste Management Permit says, "Within 2 years from the issuance date of this permit, conduct a qualitative and quantitative study performed by a qualified plant or soil scientist that addresses long-term issues related to tree blow-down on the final cover system. Incorporate findings into reclamation plan as appropriate. The study shall provide reliable information on whether or not tree blow-down may cause deterioration of the integrity of the final cover system over time or change any of the design assumptions." The permit was issued October 7, 2003; the report on tree blow-down was due October 7, 2005. KGCMC initiated this assessment as a component of the Oregon State University study of the cap and native forest floor hydro-geologic conditions. ADEC understands the results of this study are ongoing. KGCMC should request an extension to this requirement in the WMP and provide justification for the request for ADEC approval.
12. KGCMC should submit reports that specifically deal with the geotechnical and geochemical affects of having waste rock from Site E at the tailings disposal facility. We would like to know the ARD and metals leaching characteristics of the waste that are proposed to be disposed (i.e. quantity of Class IV rock) and what effect this will have. KGCMC has mentioned that work has been done regarding the geotechnical issues but await results of the ongoing co-disposal study to produce a report on the geochemical characteristics.
13. KGCMC should submit an operational plan for ADEC approval that shows specific details of Site E waste rock placement at the tailings disposal facility.
14. The results of a Construction Quality Assurance (CQA) plan conducted for the Northwest Corner Expansion area of the tailings disposal facility is needed. A similar CQA program should also be conducted when the geosynthetic liner is placed in the Pit 5 area of the Northwest expansion area. Results should be submitted prior to tailings placement.
15. A tailings dry storage structure is needed to be constructed at the tailings facility as outlined in the 2007 Construction Summary.

## **Final Note**

The Alaska Department of Environmental Conservation appreciates the continuing cooperation of the Kennecott Greens Creek Mining Company with the ADEC Solid Waste and Wastewater Programs.

** * * End of Report * * **