REPORT SUMMARY:[1]
INVESTIGATION OF RECLAIMED DRILL SITES, PEBBLE PROSPECT, AUGUST 2016

Center for Science in Public Participation[2]
for
United Tribes of Bristol Bay
304 Main Street
Dillingham, AK 99576

November 3, 2016

BACKGROUND

The Pebble ore deposit was intensively explored between 2004 and 2012. Active exploration has not occurred in the past four years. The site has 1,355 drill holes ranging from shallow geotechnical holes to exploration holes (DDH) up to 6,000 feet deep, all located on State-owned land. Drilling targeted copper sulfide mineralization, and "rock flour" cuttings with copper and sulfide can create acidic soil with high copper concentrations when disposed of on the landscape. Additionally, drill holes that are not properly reclaimed could generate acid downhole and allow groundwater to carry metals to the surface.

The Pebble Limited Partnership (PLP) operates under a Miscellaneous Land Use Permit (MLUP), in part to continue reclamation work. PLP rates reclaimed drill holes as "active", "inactive", or "plugged", and within each of these rates the degree of maintenance required, from A – significant repairs necessary, to E – site is stable and fully reclaimed. The Alaska Department of Natural Resources (DNR) uses this self-reported rating system to grade these sites.

In November 2015, the United Tribes of Bristol Bay (UTBB) and others petitioned DNR to investigate the status of reclamation, including drill holes that had not been properly plugged, unsuccessful revegetation efforts, and the continuing presence and impact of drilling waste.

A Center for Science in Public Participation (CSP2) team inspected 107 wellsites in August (CSP2 sites inspected are in red, Figure 1). Of the sites visited, 34% had no issues, 41% had environmental issues, and 25% had minor issues such as open casings, frost-jacked casings, casings with plugs and valves, or no site identification. Our study determined that 71 of 107 sites inspected were not fully reclaimed. Evidence of impacts was documented through photos, pH and conductivity field meters, and laboratory analysis. Impacts observed in the field were largely dead vegetation, artesian flows, and the presence of open, apparently abandoned, drill casings

In July 2016, DNR inspected 141 sites, including 34 identified by PLP as sites that needed monitoring or repair work.[3] At 23 drill sites that CSP2 and DNR both inspected, within a week of each other, DNR identified problems at 3 and CSP2 determined that at least 8 of the 23 had problems.

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[1] The full report is: Zamzow, K and D Chambers. 2016. Investigation of Reclaimed Drill Sites, Pebble Prospect, 2016. Kendra Zamzow, Ph.D., and David M Chambers, Ph.D., P. Geop., Center for Science in Public Participation, Bozeman, MT, for the United Tribes of Bristol Bay, Dillingham, AK, October, 2016.

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[3] DNR Field summary report for APMA A20146118 and A20142788, July 26-27 2016 http://dnr.alaska.gov/mlw/mining/largemine/pebble/field-reports/A166118_20160726_TripReport_FINAL.pdf

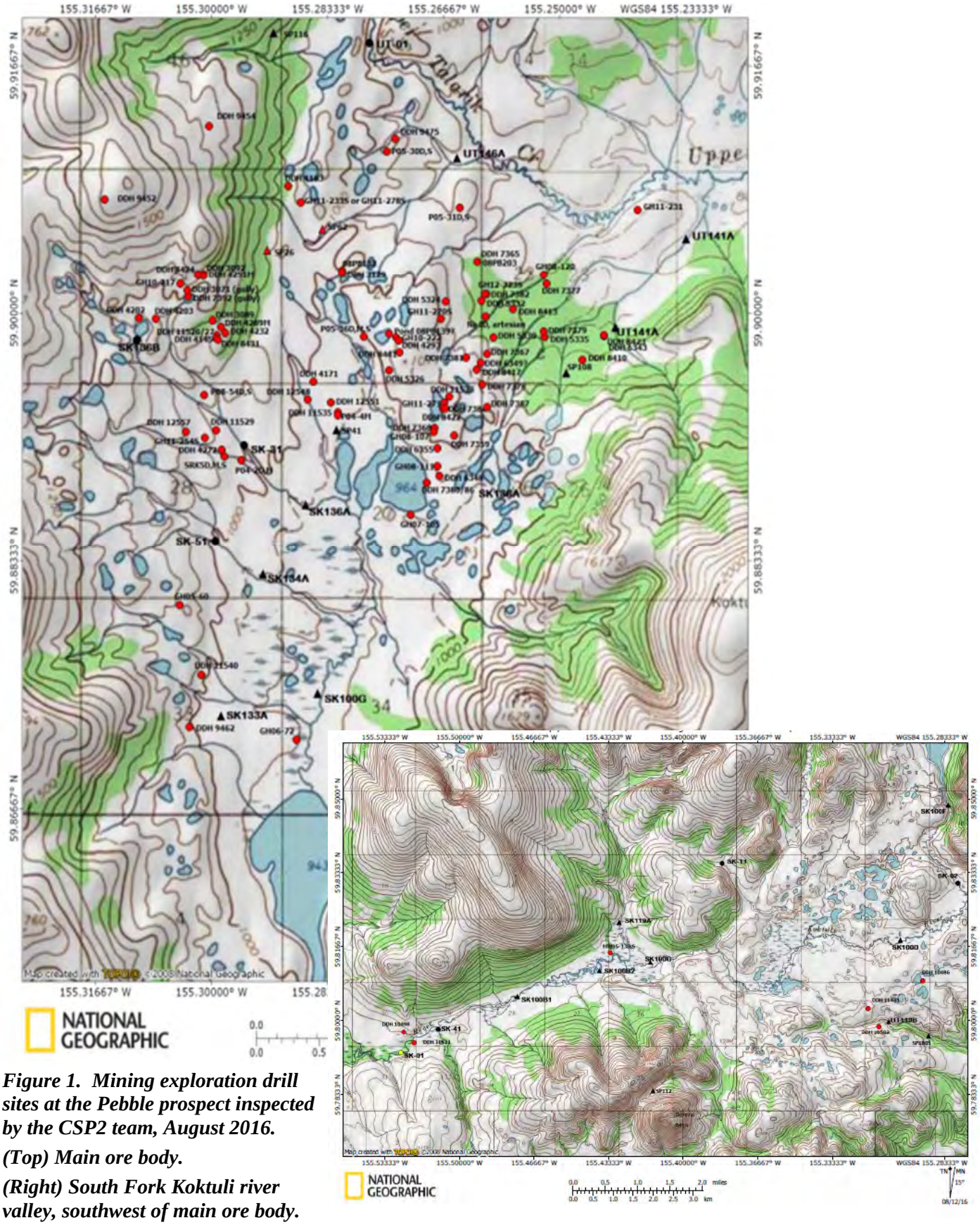

Figure 1. Mining exploration drill sites at the Pebble prospect inspected by the CSP2 team, August 2016.

(Top) Main ore body.

(Right) South Fork Koktuli river valley, southwest of main ore body.

CSP2 INSPECTION RESULTS

Drilling waste disposed of on the landscape

Remnants of direct discharge from drilling are still evident on the landscape as oxidized or grey fine-grained material accompanied by dead brush and tundra (Figure 2). Exploration drilling targeted sulfide ore with copper, gold, and molybdenum, and sampling by CSP2 determined sites with remaining drill waste discharge to be very high in copper and molybdenum. Some samples were acidic, and may be continuing to impact vegetation. Five areas with discharge were located. The nearest sites to these discharges were drilled in 2004, 2006, 2007, and 2012, indicating that the waste may have been impacting vegetation and soil for anywhere from 4 to 12 years.

Figure 2: Dead vegetation and acidic drill cuttings (light-colored material in foreground) remain years after the hole was drilled. Soil was over 100 times higher in copper and molybdenum than background. The nearest hole (DDH 6355) was drilled in 2006.

Figure 3: Dead vegetation on reclaimed drill waste sump DDH 11540, drilled in 2011.

Drill Waste Sumps

During exploration drilling some drilling waste was contained in small pits, or "sumps", which were then covered over with the material that came from the original hole. Determining whether sumps are leaching contaminants, and the potential impact on groundwater, is difficult without baseline water data. One site (DDH 11540) was observed with sumps in use but overflowing in 2011. A nearby groundwater spring was not contaminated with metals, based on samples taken. In 2016, the spring was sampled by CSP2 and the concentrations of copper, iron, manganese, arsenic, and aluminum were much higher than in 2011, suggesting the sump contents could be leaching into groundwater. However, a more detailed investigation of groundwater is needed to verify whether contamination exists.

Vegetation fails to grow on some of the drill sumps established to contain drill waste (Figure 3). After drilling is complete, drill sumps are covered with soil removed from the sump, and tundra mats or other vegetation placed on top. CSP2 sampling determined that the soil on top of the sump is not toxic. Therefore, vegetation should grow on sump covers if tundra and other vegetation are handled correctly.

Artesian drill holes

Artesian sites are producing water, neutral in pH, but elevated in metals. Artesian flow is occurring whether the drill casing is present or not. DNR listed six artesian sites for PLP to address but did not collect samples to determine what type of water was being discharged. CSP2 sampled one of the six artesian sites DNR visited and found it to be discharging aluminum, manganese, sulfate, sodium, calcium, and magnesium in high concentrations but was low in copper (DDH 9475, Figure 4). Of five artesian sites CSP2 had tested, two were very high in copper, iron, and at least six other metals, with copper being well into the range of being toxic to aquatic life.[4]

Drill cuttings have also flushed from open drill casings frequently cut off just above the ground surface. These were all acidic, and high in copper and molybdenum. If these are continuing to flush periodically, either the holes were not cemented, or the cement has failed. As wells age, it will be important to know if the problem is observed at more sites.

Figure 4: Artesian flow at DDH 9475, drilled in 2009.

Artesian conditions may vary daily and are not always dramatic. For example, one site that was flushing material up around a casing and into a wetland – and testing found petroleum elevated in the wetland sediment – was not noted as artesian when DNR visited (DDH 7382). A site DNR described as artesian was not flowing when CSP2 visited a week later (DDH 5332).

Some sites that clearly have been artesian have temporary fixes. It is not clear why temporary fixes have been applied instead of removing the drill casing, as required by DNR. At least two of these sites, repaired in 2015, were visited by DNR and approved as "good condition", with aerial photographs provided. Photographs on the ground (CSP2) indicate that sites are not permanently stable.

The 2016 DNR inspection report states:

> *No violations of stipulations within MLUP A6118 were identified during the inspection. In addition, no violations of any other State or Federal Agency authorizations or permits were identified during the inspection.*

and;

> *Overall, the Pebble Limited Partnership operation is in good condition and is consistent with industry standards... ADNR concurs with the structure and effectiveness of the internal borehole rating system developed and utilized by PLP.*

However, CSP2 visited several sites with an "E" rating (stable and fully reclaimed) that had active uncontained artesian flow (DDH 7379 and DDH 7380/7386, drill hole with no ID) or drill holes flushing acidic cuttings (DDH 5324, DDH 6355, DDH 7392M, GH08-111 area). Most of these had the 3E rating, indicating they were plugged and fully reclaimed.

[4] Sites DDH 7382 and DDH 7380/7386 had copper of 76 or 215 µg/L and iron of 8 or 178 mg/L; Alaska water quality standards for the protection of aquatic life are less than 3 µg/L for copper and 1 mg/L for iron.

Incomplete Reclamation

Approximately 25% of the sites visited had steel drill casings extending above the surface. These drill casings can pose a risk to snow machine operators when fully or partially covered with snow. The Multiple Land Use Permit that DNR issued to allow Pebble mine exploration on State land requires specific reclamation actions, including cutting abandoned drill casings off below ground surface, filling drill holes with a minimum of 10 feet of cement, removing equipment and buildings, and submitting an annual reclamation statement.

There were sites that had open drill casings (Figure 5), and sites where drill casings had been removed but artesian water appeared to flow from the old drill hole.

Mobilizing equipment to properly remove these drill casings and close the drill holes will be very expensive due to the remoteness of the location.

Figure 5: Steel drill casing at reclaimed drill site DDH 11540, drilled in 2011.

CONCLUSIONS

Key categories of problems that were identified during the inspection include: artesian drill holes that are flushing water, and sometimes drill cuttings; drill cutting that were placed unrestrained on the surface and in ponds, and have since turned acidic; drill waste sumps that may be leaching contaminants into groundwater, and which are covered with vegetation that is still dead; drill casings that have no cap, or the cap is open, and, steel drill casings that stick up above ground level and pose a safety risk to snow machines.

Allowing drill waste to be placed directly on the tundra, where it is exposed to oxygen and water, has led to acid generation in the waste. This is not only a demonstrated source of contamination at Pebble, but it should be obvious that allowing this practice to continue at any mineralized drilling site could result in similar contamination. DNR should not allow drill waste to be placed on the ground surface.

The impacts of placing drill waste into kettle ponds, and unlined waste pits covered with overburden, is less clear. It appears that drill waste in the waste pits is turning acid, but to see if this is impacting groundwater would require additional monitoring. Drill waste has been observed in kettle ponds, but these ponds flush annually, and additional water quality and sediment monitoring would be required to determine if there are impacts to aquatic organisms.

It is evident that these are significant ongoing reclamation and maintenance issues. Sites that have not been in use for years continue to have artesian flows or possibly flush drill cuttings; many sites require revegetation. Until all the drill holes are fully reclaimed they pose a financial risk to the State if the mining operator were to go bankrupt.

DNR has the discretion to subject each permit to "*any provisions the department determines necessary*" to assure compliance with the MLUP regulations, and "*to minimize environmental impacts*." Currently DNR depends on PLP to self-rate the level of reclamation still needed at drill sites, but these ratings are

not always accurate. Random inspections, such as conducted in 2016 by DNR, in addition to inspections of self-reported problem sites should continue. However, DNR decided that none of the 134 drill sites they inspected in 2016 posed an environmental or compliance risk. CSP2 identified several areas where drill holes may be having current and continuing impacts in the area, and where there were impacts from discharge during drilling that have not recovered yet.

DNR currently requires no reclamation plan, and can waive the reclamation bond, as it has for the most recent land use permit. To fully understand and address the extent of all environmental impacts a detailed inspection, detailed reclamation plans with funding, and follow up monitoring is needed. It is clear that with the existing issues, and Pebble's unstable financial state, the full environmental impacts cannot be understood nor addressed, and the full financial risks to the State will not be known until a more detailed inspection has been done.

CSP2 recommends that the following tasks be included in the process of additional reclamation inspections at Pebble:

- Collect water quality data at springs located in proximity to drill waste pits in to determine whether high concentrations of metals are present and whether water quality changes with time;
- Collect water quality from existing monitoring wells, including sites listed as "converted to active" wells, in proximity to exploration holes to determine if groundwater is being impacted;
- Where springs are not present, collect groundwater from new shallow wells upgradient and downgradient of drill waste pits to assess potential impacts on groundwater;
- Collect additional sediment data in kettle ponds that were used for drill waste disposal, and around wells where drill waste is still in evidence;
- Collecting water quality at artesian wells, including sites that are "daylighting" or "upwelling" to determine the type of environmental impact occurring;
- Collect water quality where ponded water with iron staining is observed around a casing; if water is elevated in copper, it may indicate the ponded water is from artesian conditions;
- Collect groundwater from new shallow wells both upgradient and downgradient from selected drill waste pits to assess potential impacts on groundwater.
- Remove drill waste that is leaching metals and/or acid, or is not revegetating;
- Identify all wells with remaining drill casings, and cut off all well casings at wells that are not being actively used. Properly mark remaining drill casings so they can be avoided by snowmachines in the winter; and,
- Re-plug wells with free-flowing artesian water and from which drill cuttings have flushed out onto the landscape.

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