

**Red Dog Mine
Closure and Reclamation Plan**

SD F2: Evaluation of Borrow Sources

Memo

To:	File	Date:	November 28, 2005
cc:		From:	Lowell Wade
Subject:	Evaluation of Borrow Sources	Project #:	1CT006.003

1 Introduction

The final closure of Red Dog Mine is predicted to be in the year 2031. At this time it is estimated that there will be 1,300 acres of tailings and waste rock that may need to be covered.

These areas are:

- | | |
|--------------------------|-------------|
| • Tailings Pond | 520 acres |
| • Main Waste Stockpile | 380 acres |
| • Pits and Stockpile pad | 400 acres |
| Total | 1,300 acres |

To cover these areas with 3 feet of material will require approximately 6.3 million cubic yards.

1.1 Unconsolidated Sources

Unconsolidated sources are normally used for cover materials. In the vicinity of Red Dog there are two types of unconsolidated material that are being considered; sand and gravel on river flood plains and talus material. As this area did not experience glaciation, there is no glacial outwash or till material.

TCAK staff used a Digital Elevation Models and GIS software to develop the slope map shown in Figure 1. Areas with slopes of about 30-35° indicate potential talus material at angles of repose. Within two miles of Red Dog the only areas that might contain 6.3 million yards of talus material are located high on the slopes of Deadlock Mountain.

Areas of slope less than 3° identify stream flood plains. Two flood plains with potential gravel deposits were identified.

- 1) Ikalukrok Creek has potential for gravel deposits near the junction with Red Dog Creek but contains lead and zinc bearing detritus from the erosion of the Red Dog metal deposit.
- 2) Robinson Creek, five miles east of Red Dog is probably the closest location for unconsolidated sand and gravel.

Using either of these areas as a borrow source could cause significant disturbance to the streams. The development of haul roads from these sites to the mine would also create new land disturbance.

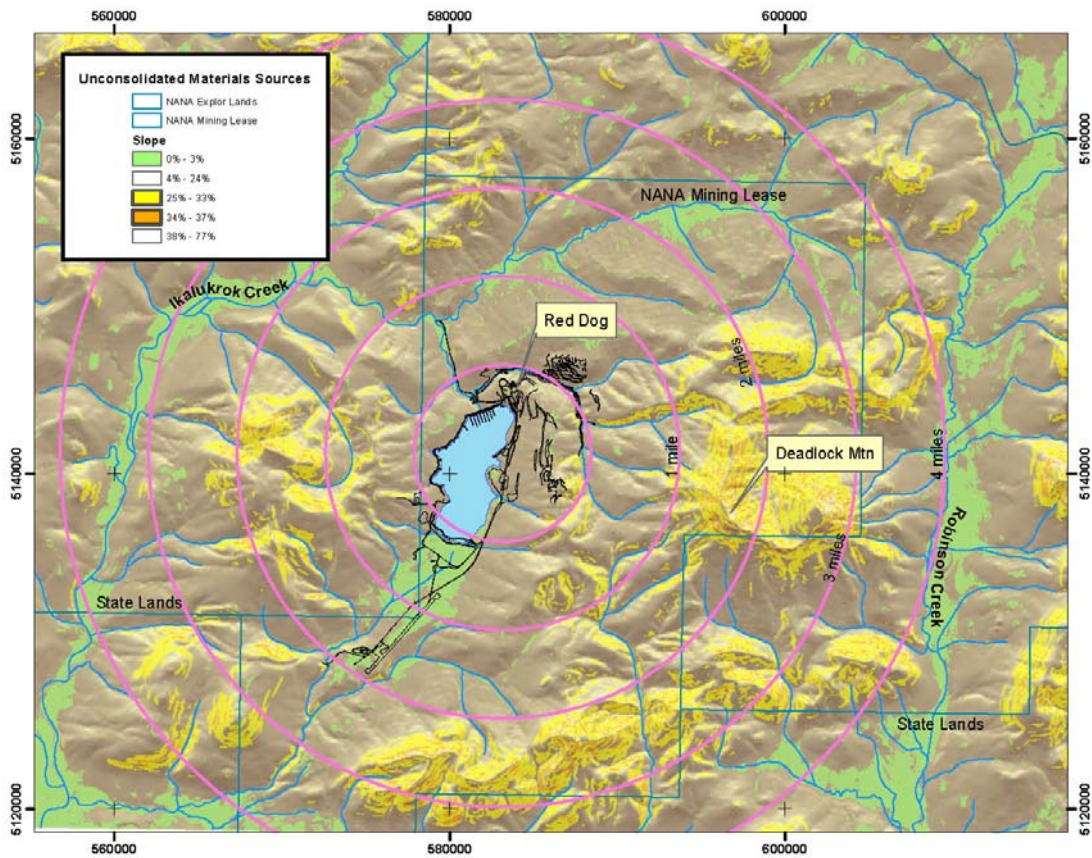


Figure 1: DEM and GIS slope map

1.2 Existing Coarse Rock Quarry

Two existing quarry sites at the Red Dog mine could provide the 6.3 million yd³ of cover material. They are labeled MS-14 at the south end of the airport and DD-2 on the west side of the tailings impoundment (Figure. 2). The Airport site is on NANA land. DD-2 lies on both NANA and State land. Both potential borrow sources are in the Middle Siksikpuk Formation. The Middle Siksikpuk is siliceous shale and contains only a trace of iron sulfide and minor iron carbonate. It is not acid generating and it has low acid neutralization potential. Blasting yields size fractions that might be usable as coarse cover material without crushing.

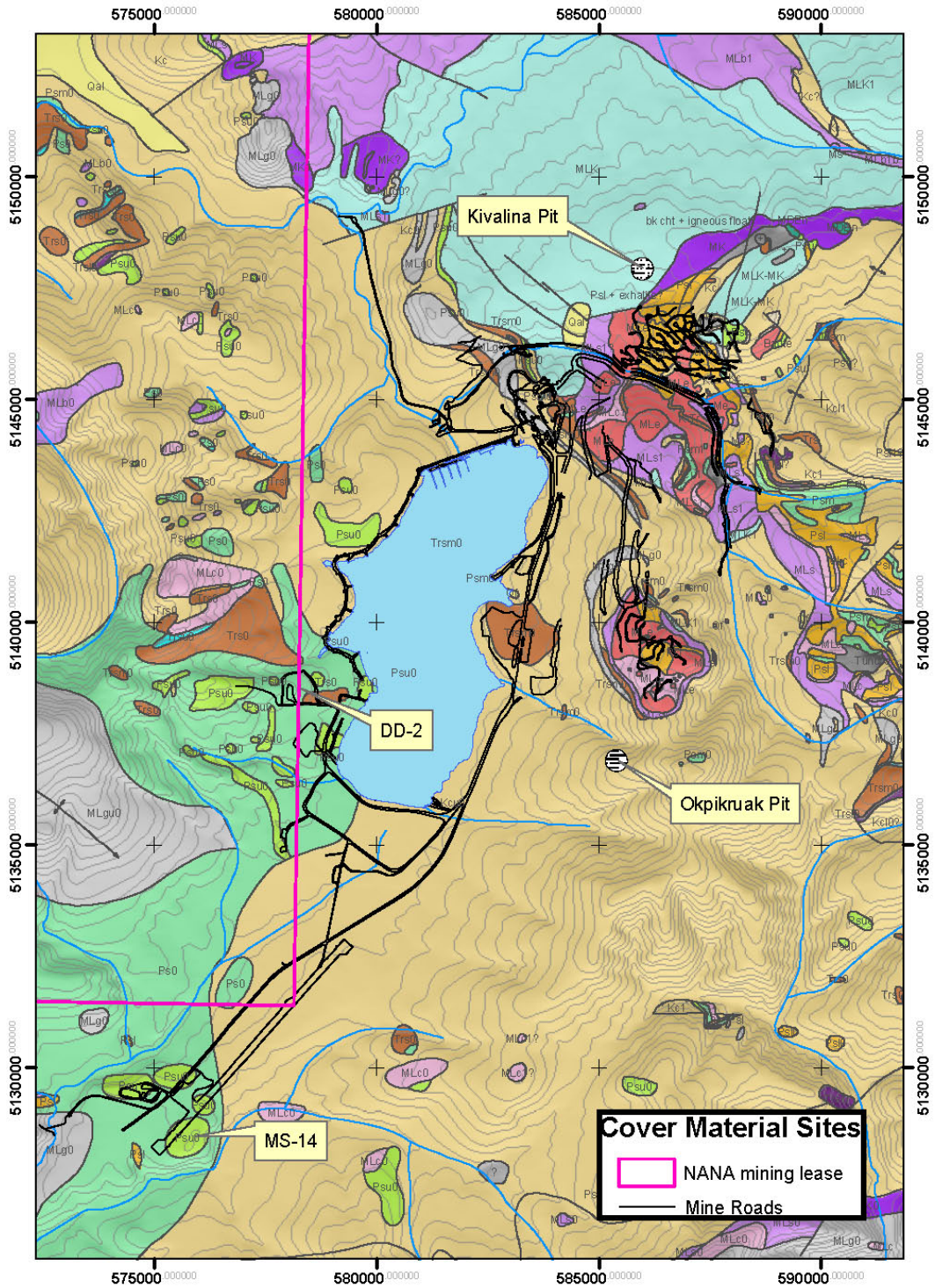


Figure 2: Coarse Rock Quarry Sites

1.3 Sources of Unmineralized Shale

1.3.1 New Quarries

There are two geologic formations in the Red Dog area that could yield rock that will weather to relatively fine grained soil:

- 1) The Kivalina Formation is calcareous shale with acid neutralization potential. It is highly sheared and does not require crushing for coarse cover purposes. The Kivalina shale does contain traces of orange sphalerite and may have a slight potential for metal leaching.
- 2) The Okpikruak Formation is shale which does not contain base metals, but has only traces of pyrite and is neutral in acid generating/consuming potential. This shale should also quarry without crushing and weathers quickly to finer sizes.

Just north of the Future Aqqaluk Pit, at the head of Sulfur Creek, is an area which could provide in excess of 6.3 million yd³s of material from the Kivalina Formation. This is labeled Kivalina Pit on Figure 2. This potential borrow source is on NANA land. Just south of the Future Qanaiyaq Pit is a potential borrow source for Okpikruak materials which is labelled as the Okpikruak Pit on Figure 2. This potential borrow source is also on NANA land.

O’Kane Consultants Inc. (OKC) preformed a particle size distribution (PSD) analysis of Okpikruak shale and compared its physical properties to those of the Kivalina material (OKC, 2005). It was determined that the PSD of the Okpikruak shale falls within the coarse and fine limits of the Kivalina Shale. The median particle size of the two different materials is approximately 7 mm (0.28 in). The Okpikruak shale shows slightly more uniform and is generally coarser in grain size below the 1 mm (0.04 in) particle size compared to the Kivalina shale. The Okpikruak shale may have a slightly higher saturated hydraulic conductivity and slightly less moisture retention under negative pore pressure compared to Kivalina shale.

1.3.2 Waste Rock from Future Mining

Figure 3 shows the estimated production of Okpikruak and Kivalina Shale waste rock, between the years 2006 and 2031. Also shown are the requirements for construction of the tailings dam and the required amount for covers in 2031. Requirements for dam construction are shown from the earliest possible construction date, starting in 2010, to the latest possible construction date, starting in 2018. Raising of the Main Dam could occur at any time between these two dates.

The waste rock production quantities shown on Figure 3 are totals. However, it could be difficult to segregate some of the “clean” shales from other rock units during mining. In practice, perhaps only half of the total volume will be available for “clean” uses.

The schedule of production for the Okpikruak shale appears to be favorable for use in concurrent reclamation. The large Okpikruak units in the lower levels of Main Pit could possibly be placed on final raises of the Main Waste stockpile. Large units slightly mineralized Kivalina Shale will be produced from the third and fourth phases of the Aqqaluk Pit, which would also allow use on the Main Waste stockpile and possibly on completed lifts of Main Pit stockpile.

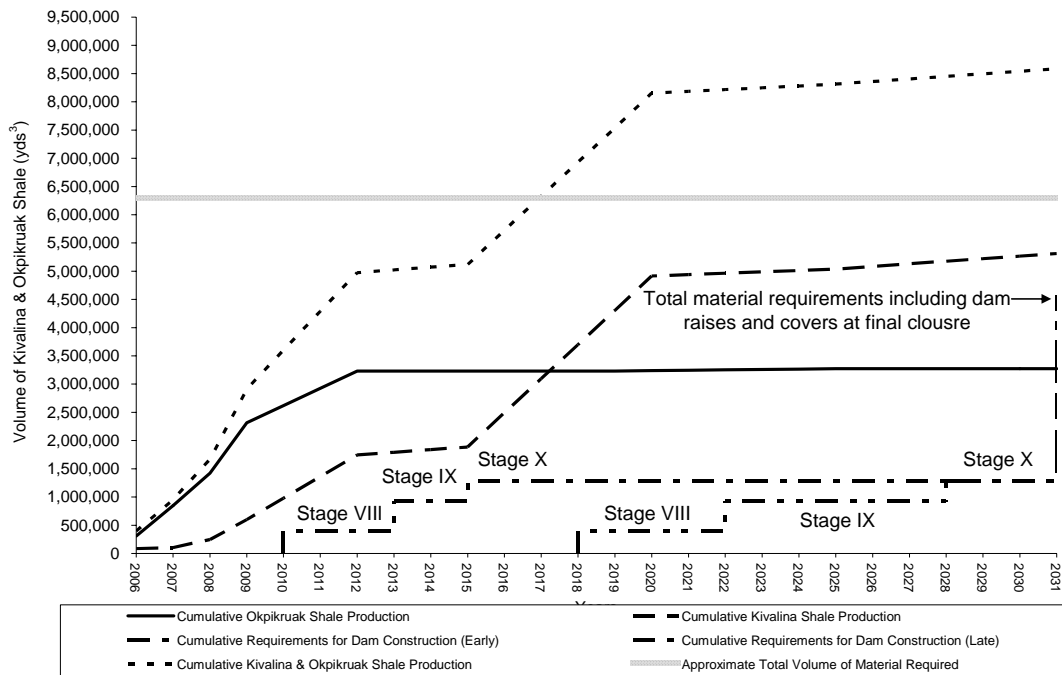


Figure 3. Production rates for Kivalina & Okpikruak Shales as well as Dam construction requirements.

1.3.3 Overburden Stockpile

The current Overburden Stockpile, located at the south end of the tailings impoundment, will be integrated into the Back Dam. Depending on the final design of the Back Dam up to half of the 6.6 million cubic yards may be available for other uses. Kivalina shale is the dominant material, but it is known that other more mineralized materials are also present. Material from this stockpile is therefore likely to be somewhat contaminated. Runoff from the stockpile area currently carries about 2,700 mg/L zinc.

2 References

OCK 2005. “Red Dog Waste Rock Cover Design Project – Comparison of Particle Size Distribution of the Kivalina and Okpikruak Shale Formation Materials”. Memorandum to Red Dog Operations, Teck Cominco Alaska Inc., AK, USA. February 10, 2005.

TCAK 2002. “Red Dog Mine Site Current Conditions – Waste Management Permitting Program Tasks B-04, C-02 and D-02”. December 5, 2002