Case Study: Concave slope on outer batter of TSF C at Wiluna Gold Mine

Summary

Landloch was commissioned to advise on material selection and slope profile design for Tailings Storage Facility (TSF) C at the Normandy (later Newmont) Wiluna Gold Mine. Laboratory investigations and computer simulations of runoff and erosion were used to design slope profile that included a concave slope below a berm.

To the best of our knowledge, this is the first concave slope constructed for landform rehabilitation in Australia. Observations indicate that the slope is currently showing excellent stability.

Background

The original TSF at the Wiluna Gold Mine (WA) was decommissioned in the 1940's. The storage was not rehabilitated and, as a consequence, extensive erosion of tailings occurred. More recently, during the period when the mine was managed by Barrack, Asarco then Wiluna Mines, the tailings were collected, re-processed, and placed in Tailings Storage Facility C. Re-processing had been completed before Normandy Mining Ltd took over management of the mine. TSF C was constructed with an outer wall of tailings 35 m high.

Figure 1: *Aerial view of old Wiluna TSF and eroded tailings prior to placement in TSF C*

As a condition of closure, the physical stability of the storage for a lifetime of 200 to 500 years had to be demonstrated. Rehabilitation of the tailings storage was therefore necessary. A planned pit expansion in 2001 provided an opportunity to rehabilitate TSF C using some of the waste rock likely to be trucked past the facility.

Landloch was engaged to assess the erodibility of the various spoil types available, and to undertake computer simulations of erosion to determine the most effective slope design to ensure long-term landform stability.

Work Programme

Three waste rock types were identified in the pit: oxidised, transitional and fresh. Samples of each rock type were taken and laboratory flume and rainfall simulator studies were carried out to derive erodibility parameters for input into the Water Erosion Prediction Program (WEPP) runoff/erosion model. This model was then used to derive parameters for the SIBERIA landform evolution model.

Simulations using WEPP indicated a range of slope options that could be applied. A design was developed using a 10 metre high 1:3 batter slope drained by a berm, with a 25 metre high concave slope below the berm.

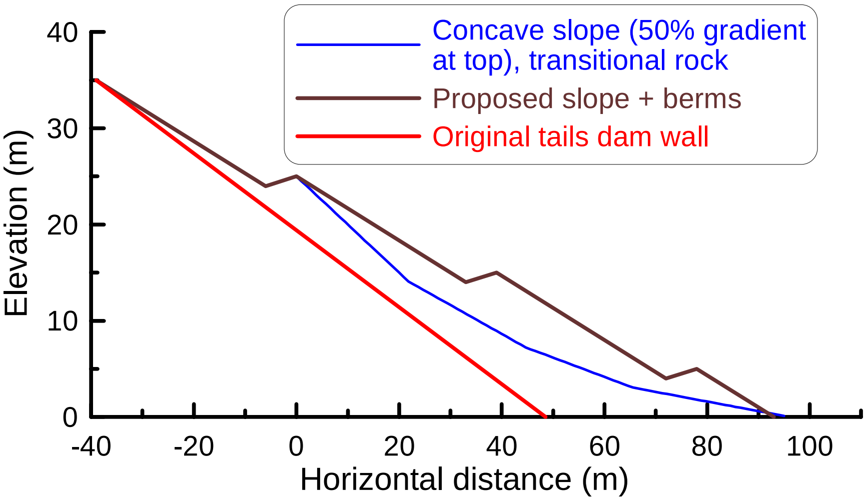

Figure 2: *Comparison of concave slope, original tailings dam wall, and use of berms and batters for the entire slope, Wiluna. (For convenience, horizontal distance was set at zero at the outer edge of the first berm.)*

As the material most suitable for construction of the slope was the transitional rock (most plentiful, and most suitable for plant growth), simulations used that rock type. These simulations indicated that erosion rates could be expected to be <3.5 t/ha/year, with maximum erosion rates at points on the slope <6.7 t/ha/year.

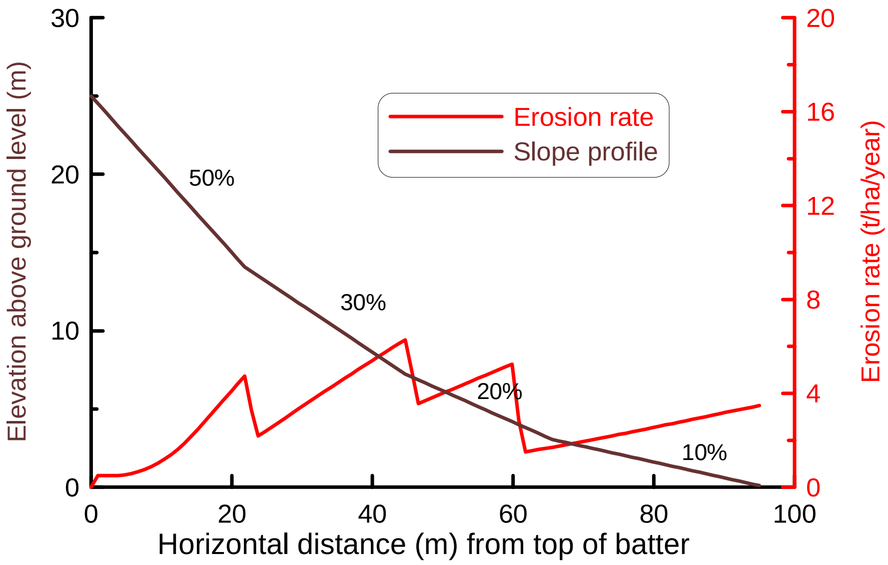

Figure 3: *Slope profile and predicted erosion rates along it, for transitional rock at Wiluna. Gradients of each slope segment shown.*

SIBERIA landform evolution simulations for up to 1000 years showed that the facility would have considerable long-term stability, provided runoff on the top of the dam was prevented from discharging onto the dam wall slopes, and provided the berm did not overtop.

Slope Construction

The outer batter consists, effectively, of a short (10m) linear section draining to a berm, and then a concave section (25m) stretching from the berm to ground level.

The linear section of slope draining to the berm was almost entirely constructed of coarse, fresh, waste rock and not transitional rock as originally intended. Because of the coarseness of the rock, runoff and erosion from that section of slope will be close to zero for a considerable period. The berm was constructed as an inward-sloping structure with high storage capacity. An average depth of erosion of 0.35 m over the batter slope draining to the berm would be required to exceed its capacity. That depth of erosion of the fresh waste rock on the upper slope is extremely unlikely, even over extremely long periods.

The concave section was constructed of transitional waste rock.

Figure 4: *Reconstructed Tailings Storage C .*

Performance to date

Dr R. Loch inspected the batter slope in July 2002, 7 months after its completion.

There was no visual evidence of any runoff having been generated on the linear slope constructed of coarse waste rock.

Compared to long-term average rainfall, the first 6 months of the slope's existence saw it exposed to more "large" rain days than would normally be encountered in two years. There appeared to have been little runoff on most of the concave slope, and no erosion.

A small area of noticeably less rocky spoil on the concave slope showed minor erosion. Importantly, the erosion was discontinuous, starting slightly more than halfway down the slope and ending well before the end of the slope. The discontinuous nature of the erosion was encouraging evidence that the concave slope was functioning as designed, with the gradual decrease in gradient causing rilling to become ineffective.

Benefits of the design

Amounts of waste rock required to construct the slope were significantly reduced (see Figure 2).

The risk of overtopping and/or failure generally associated with berms was greatly reduced.

The structure has a slope profile consistent with landscapes in the area.

The designs were based on measured properties of the materials to be used in the construction of the outer batter slopes.