



## Division of Mines and Mineral Resources — Report 1991/24

# Stability assessment, 14 Livingstone Street, South Hobart

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## Abstract

Earthworks at 14 Livingstone Street have been undertaken on a steep slope without proper engineering control. Unconsolidated fill is present. Tension cracks within the fill allow easy access for surface runoff. Build up of pore pressures in the cracks and the unconsolidated material may result in instability which could affect a track normally open to public access. Boulders dislodged during earthworks could roll or bounce onto this track.

Proper consolidation of the fill is necessary for long-term stability. Trash racks, constructed parallel to the slope above the public access track, may provide protection for users.

## INTRODUCTION

An access track across a steep slope in South Hobart has been widened by a tracked excavator. A pipeline track, normally open to public access, exists below the widened access track. There was no engineering design or control of the earthworks for the access track. A report was requested advising on the stability of the earthworks, and any remedial works necessary to guarantee the works are free from subsidence and the risk of falling boulders is eliminated.

## GEOLOGY and GEOMORPHOLOGY

The area is mapped on the Greater Hobart Area 1:25 000 scale Engineering Geology Map 1 as Jurassic age dolerite. Site inspection revealed a thin layer of dark brown to black, high plasticity clay topsoil (50 mm thick) underlain by between 0.3 and 0.6 m of medium brown to tan, high plasticity clay derived from the weathering of dolerite. Some medium to coarse-size gravel and boulders of dolerite are present in this layer. These in turn are underlain by *in situ*, variably weathered, medium-grained, jointed dolerite. Weathering in the dolerite varies from moderate to extreme. Spheroidal weathering, resulting in kernels of rock surrounded by soil-like materials, was observed in cuttings through minor drainage lines. The joint system is orthogonal with one sub-horizontal set, another approximately parallel to the major slope, and the third at approximate right angles to the major slope (although these orientations vary depending on the bearing direction of the

access track). The joints are planar to curved, with smooth to rough surfaces which varied from clean to clay lined.

The natural slope angles vary but are in the range  $32^\circ (\pm 5^\circ)$ . Oversteepening has occurred locally as a result of excavation on the property, and slopes steeper than  $40^\circ$  were observed.

## SITE WORKS

Earthworks on the property have resulted in:

- an area near the street frontage being terraced and levelled, possibly for a building site;
- the quarrying of materials, possibly for construction of the Pipeline Track;
- a narrow access track across the property, possibly constructed by hand, being widened by a tracked excavator;
- and narrow (about one metre wide) tracks, apparently constructed by hand.

The owner, Mr Young, indicated that the main track was upgraded to provide access so that the fire hazard could be reduced by removing vegetation (including trees). The initial track was about one metre wide, and the decision to use a tracked excavator has resulted in a track at least three metres wide. Mr Young indicated that the intended future use of the track was as a horse trail, and that it is intended to expand the network of narrower tracks.

The main track was constructed by cutting on the upslope side and filling on the downslope side. In places the upslope cut batter is about three metres high and reveals *in situ* dolerite rock. The soil-like materials above the rock are subject to batter erosion and instability due to oversteepening. Several areas have already failed. Within the dolerite rock the orientation of the joints with respect to the cut batters is predominantly favourable. Overall, the rock portions of the cut batters are considered to be stable.

The fill materials have been placed without any control on compaction. The only compactive effort appears to have been the relatively light pressures exerted by the excavator

used in the construction of the track. Tension cracks have appeared in the outer edge of the fill and provide easy access for any surface runoff. Settlement of the fill has occurred in places. It would appear that the fill site was not prepared by removing the existing vegetation, nor benching the slope prior to fill placement.

On the slope between the main track and the Pipeline Track there are places where, in the past, materials were quarried. Fill exists in some of these areas today. Some of this fill may be related to hand excavation of the narrow tracks below the main track constructed by the excavator. The method of emplacement is unknown. It would appear that benching of the slope and compaction of the fill did not take place.

Some of the materials moved by the excavator have "run" or flowed down the slope. In several places the cut batters along the Pipeline Track are veneered by a fresh deposit of gravelly clay, apparently originating from Mr Young's property. In addition, several boulders of dolerite (to 250 mm diameter) have been dislodged and fallen onto, and gouged moss out of, the Pipeline Track. The cut batters of the Pipeline Track in the vicinity of these boulders were examined and showed no sign that boulders had recently been displaced. It is concluded that the boulders originated on Mr Young's property.

### STABILITY ASSESSMENT

The uncontrolled emplacement of fill (i.e. the apparent lack of slope preparation and fill compaction), combined with the opening of tension cracks in the outer edge of the fill, provides concern with respect to stability of the track fill. Tension cracks provide easy access of surface runoff into the track fill. Build up of pore pressures in the cracks could initiate failure. Failure is likely to occur on a minor scale, but some failures may be sufficiently large in volume so that materials "run" or flow from Mr Young's property onto the Pipeline Track below. This is highly probable after intense storms. During prolonged rainfall the fill materials are likely to have an increased moisture content and loose shear strength. It is highly probable that minor failures of the fill will occur during these events. Similar comments apply where fill has been placed in areas of previous quarrying activities.

During any earth moving activity on Mr Young's property there exists a risk that boulders will be dislodged and roll or bounce down the slope onto the Pipeline Track. The surface roughness of the slope is moderate and some boulders will lodge against obstructions on the property. However, it cannot be guaranteed that all dislodged boulders will remain on Mr Young's property.

The stability of the cut batters in rock is assessed as high but, as has already occurred, the soil-like materials above the rock are oversteepened and will slough from the cut batter onto the main track. It is considered that there is a

very low risk that boulders dislodged by sloughing from the cut batter will roll or bounce across the track and continue down the slope onto the Pipeline Track.

### REMEDIAL MEASURES

The slope in the soil-like materials above the rock in the cut batters could be reduced to a more shallow angle. As the majority of any failures in these materials is likely to come to rest on the main track, a decision to implement this may rest with the importance of uninterrupted use of the track.

For the track to be retained as a permanent feature, the track fill needs to be re-excavated; the slope properly prepared, by removing vegetation and benching; and the fill replaced in layers, the maximum thickness of which is determined by the maximum diameter of the largest boulder. The layers should be properly compacted with a roller to achieve a satisfactory density.

If the main track has served its useful purpose it would be sensible to remove the fill materials, particularly those with tension cracks, before a failure develops.

Where fill has been placed in areas of previous quarry operations, some protection must be provided on the downslope side in the event of a failure. A trash rack inside the property boundary is probably the most effective means of restraining materials moving downslope.

There exists a possibility that boulders will be dislodged onto the Pipeline Track during any earthmoving activities on Mr Young's property. To minimise or prevent this, an intersecting slope ditch, shaped berm, trash rack or shaped ditch could be provided to capture the boulders. For a 45° slope, 10-20 m high, a shaped ditch 1.5 m deep by 3.7 m wide is indicated by Schuster and Krizek (1978). If a catch fence is used, the shaped ditch need only be 1.2 m deep. Such a provision is likely to be difficult to implement and economically unviable.

A series of trash racks parallel to the slope should retain the majority of materials which are dislodged over the slope. However, it may be less expensive to seek permission of the Hobart City Council to close access to the Pipeline Track during earthmoving activities on the property, and to ensure adequate public liability insurance cover at all times.

### REFERENCES

SCHUSTER, R. L.; KRIZEK, R. J. (eds). 1978. *Landslides. Analysis and Control*. National Academy of Sciences : Washington D.C. [Special Report Transportation Research Board, National Research Council, 176.]

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