



Examination of a landslide in a private forest near Weegen a

by B. D. Weldon

Abstract

A landslide of significant dimensions has occurred in a private forest between Kimberley and Weegen a. The toe of the landslide has reached a relatively gentle sloping area adjacent to the forest access road. This area has a slight backslope in places, and may be the head region of an older landslide.

Extensive investigations will be necessary before recommendations could be made to effectively constrain the movement. Improvements to drainage above, below and within the landslide mass are considered necessary in managing the movement. Monitoring the toe region and areas below the toe should give an early indication as to whether more extensive remedial measures are required.

INTRODUCTION

Associated Pulp and Paper Mills have entered into a private forest joint venture on a property located between Kimberley and Weegen a. The area was clear felled over several years and the land apparently stood fallow for several years. Before replanting the area was ripped deeply along the contours.

A landslide of significant dimensions has occurred in the private forest [DQ556119] and an inspection was requested by APPM.

GEOMORPHOLOGY

A basalt plateau remnant occurs between Kimberley and Weegen a in the north and south respectively and between the Mersey and Rubicon Rivers in the west and east respectively. The area investigated is located on the eastern side of the Mersey River. The slope leading from the basalt plateau to the Mersey River has a complex morphology. There is a steep escarpment near the basalt plateau, with the remainder of the slope profile being stepped or terraced down to the river. Several drainage lines occur on the slope, and it is in one of these that the landslide has occurred.

The morphology of the general area suggests that landslide activity is a major element in the evolution of the landscape, particularly along the relatively steep valley slopes of the Mersey River.

GEOLOGY

The Geological Atlas 1:63 360 series Sheffield sheet shows that Quaternary age alluvium occupies the present day floodplain of the Mersey River. The floodplain below the landslide area is narrow. Quaternary age talus deposits are mapped on the lower portion of the slope on which the landslide has occurred. These colluvial materials are generally shown below the 400' (120 m) contour line. Tertiary age basalt is shown above this contour. A dyke of dolerite is mapped from the east to west side of the Mersey River, approximately below the high voltage transmission line. Permian age sediments, capped by Tertiary age basalt, occur on the western valley slope of the Mersey River.

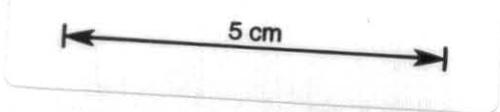
LANDSLIDE

The landslide (fig. 1) is some 200 m long, commencing as a broad arcuate-shaped head scarp about 80 m wide at its widest point and narrowing downslope into a lobe. This lobe is constricted to a width of about 30 m at a point roughly one half the length of the landslide. Downslope from the constriction, the lobe widens to between 40 and 50 metres. The body of the landslide is considerably disrupted with tension cracks. Some sections of the landslide have a back slope and ponded water. Noticeable features of this landslide are the lateral ridges on either flank. Displaced material occurring in the toe or foot of the landslide has obscured the location of the toe of the surface of rupture.

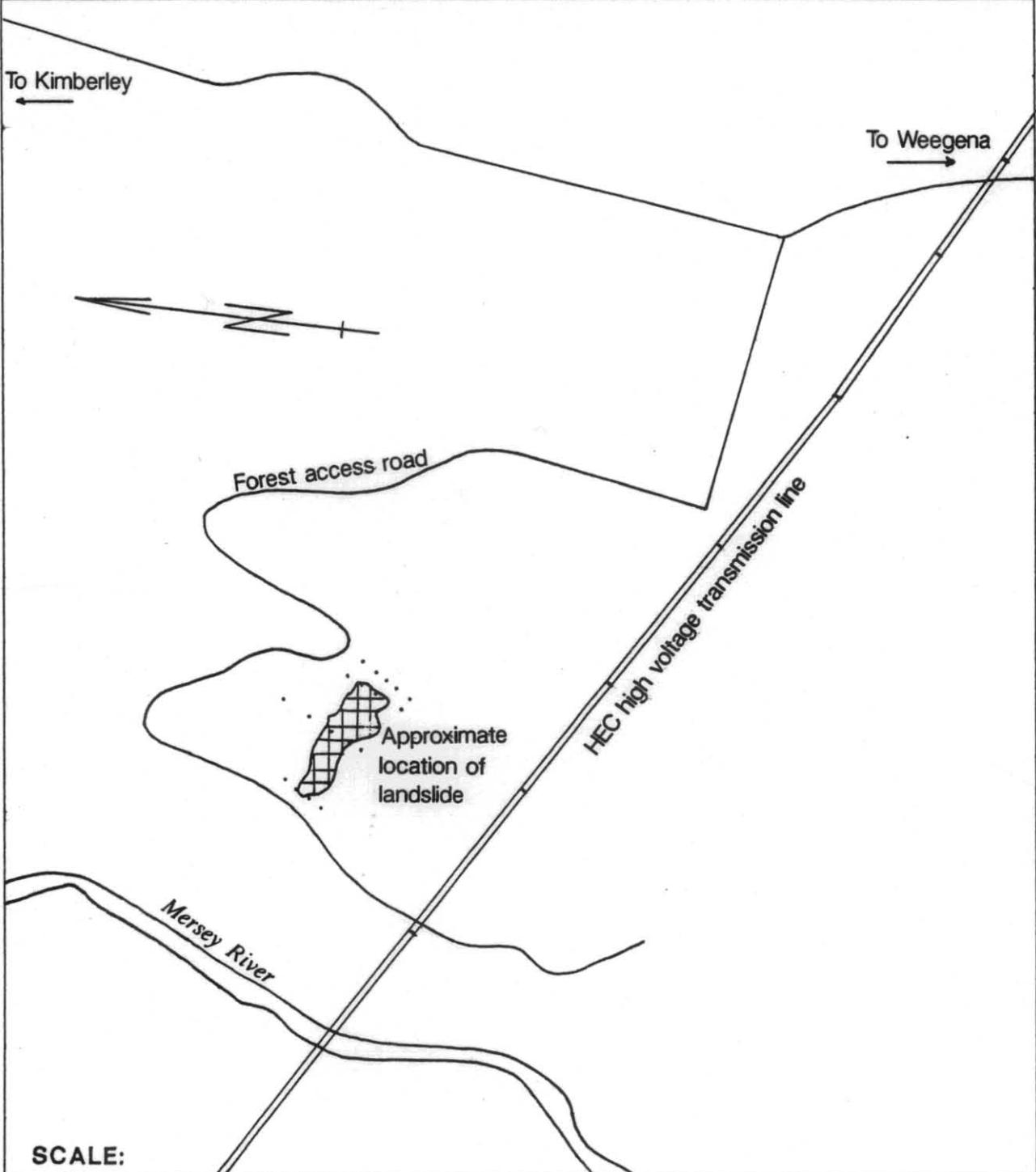
The overall impression is that the landslide is probably less than 10 m in depth. The lag in time between harvesting the original forest and the occurrence of the landslide was about 4 years. This is a relatively short period of time with respect to time scales usually associated with root decay. This suggests that the surface of rupture is probably below the depth of significant root penetration. In the head region the landslide appears to be of rotational type but further downslope becomes translational. The landslide is thus complex. The landslide has probably occurred because of significant changes in the hydrological conditions accentuated by the delay between harvesting the original forest and establishing regrowth.

An APPM survey has more accurately defined the shape of the landslide and was used to install several lines of star pickets across the landslide. These are monitored regularly for displacement of individual pickets. Where a picket has moved, a flagged and dated stake is placed at the original

TASMANIA DEPARTMENT OF MINES
SITE PLAN



OWNER: *M. FIELDS* STREET/ROAD: GEOLOGIST: *B.D.W.*
 SUBURB: TOWN/CITY: *WEEGENA* DATE: *18-3-92*



SCALE:

- | | | | |
|--|--|--|----------------------------------|
| | Convex break of slope
(profile form: | | Suitable area for building |
| | Concave break in slope
(profile form: | | Suitable area for septic outfall |
| | Ridge crest | | Slope angle and direction |
| | Gully | | |

Figure 1.

location of that picket. In this way a record of movement of the landslide has been documented.

SURFACE MATERIALS

The surface materials vary from scree (i.e. boulder deposits with little or no fines matrix) through talus (gravelly clay with boulders) to clay. The materials at the surface (whether scree, talus or structured clay soils) appear to have a relatively high permeability. This is significant in relation to remedial measures dealing with surface drainage. Surface intercept drains are unlikely to be very effective unless they are excavated into a substratum which is impermeable. Any such drains should be located so as to intersect surface waters above the head scarp area of the landslide and divert this away from the landslide mass into alternative drainage lines.

HYDROLOGICAL CONDITIONS

A review of water bore logs drilled on the basalt plateau between Kimberley and Weeena suggests that several major basalt flows occurred during Tertiary times and that these flows are separated by clayey sediments. The sediments may act as a barrier to downward migration of water. Water falling on the surface may infiltrate into the subsurface and may move through the basalt until the sediment barrier is reached. It may then migrate laterally until it intersects the surface as a seepage or spring.

Drainage from any such seepages or springs should be intersected by french and/or surface drains and diverted away from the landslide mass via lined flumes into alternative drainage lines.

Ponded water occurs at several locations within the landslide mass. These areas appear to be receiving water from either surface drainage or sub-surface seepages. They usually, but not exclusively, have an outlet through which water was observed to be flowing. It is considered that the drainage system within the body of the landslide could be improved to remove these areas of water storage. French and/or surface drains from the head region to the toe area, connecting up with the ponded areas, are considered necessary. The base of the drains should be excavated into an impermeable layer where practicable and coarse stone used as backfill.

TOE AREA

The toe of the landslide, that is the front of the area where the displaced materials are accumulating, has reached a relatively gentle sloping area which in places has a slight backslope. This could be the head region of an older landslide. The displaced material is expected to move laterally over this area. The plantation access road is currently about 15–20 m downslope of the active toe of the landslide. A relatively flat area, again with a slight back slope probably indicating older landslide activity, occurs below the road. The roadside drainage is directed via culverts towards the northern flank of this area where there is an existing drainage line. Some drainage improvements have already been made along this drainage line, but if french and surface drains are installed into the body of the landslide above the road, the drains should be continued into and beyond this region below the access road. Lined

flumes should be used to prevent water ingress into areas not already on existing drainage lines.

The roadway may become threatened by forward movement of the active toe. The roadway may also be affected if the mass of the displaced materials from the existing landslide overloads a pre-existing failure plane. This may subsequently become re-activated. If this occurs, land movement downslope from the plantation access road may eventually end up in the Mersey River. It was indicated by the APPM representatives on site during the inspection that this would be unacceptable.

REMEDIAL MEASURES

The landslide is of significant dimensions. The movement may be arrested by drainage improvements, revegetation and/or toe restraining structures. Subsurface drainage by sub-horizontal bores or drains is likely to be the most effective. An extensive (and expensive) series of investigation bores would be necessary to determine piezometric levels within the landslide and adjacent areas to delineate target areas for subsequent subsurface drainage. Similarly, investigation bores would be needed for a toe retaining structure to determine the depth of the landslide, to determine whether the area has been subject to previous landslide activity, and to determine whether piles could be driven to sufficient depth to resist the moving mass.

In either case an extensive (and relatively expensive) investigation programme would be necessary with no guarantee that movement will be arrested. Therefore this is not advised at this stage.

It is usual not to remove mass from the toe of a landslide. This mass contributes to restraining forces which prevent movement. However, it is common to remove some of the mass from the toe and replace it, often with an additional load to act as a buttress, against which the landslide must push. This load usually consists of large boulders placed in a trench (with a properly designed drainage outlet) dug across the toe of the moving mass. Naturally such operations must be well co-ordinated, as unsupported trenches should not be left open in the toe area of a landslide for any period of time.

As previously discussed, the toe of the landslide could be loading an area underlain by pre-existing failure planes. For this reason it is not a recommended option to provide any significant additional toe load in the absence of investigations to determine whether pre-existing failure plane(s) underly the area which would be loaded.

Removal of the mass at the toe reduces restoring forces and simply encourages further movement of the materials already disturbed by the landslide. It would be an on-going operation with no impact on stabilising the landslide. It would, however, remove load from an area which, if underlain by pre-existing failure planes, has the potential to become unstable because of that load.

RECOMMENDATIONS

- Any seepages and surface drainage above the head of the landslide should be intersected by french and/or surface drains and preferably diverted into alternative drainage lines. Lined flumes should be considered when designing the drainage diversions over areas which are not on natural drainage lines.
- The drainage within the landslide itself should be improved by using french and surface drains from the head to the toe, with spurs, if necessary, to drain areas of ponded water. A herringbone pattern of drains feeding into a central collector drain may provide a satisfactory solution.
- Drainage improvements should be made in the toe area to ensure that water ponding does not occur. In this way the supply of lubricant to any potential failure planes underlying the toe area would be minimised.
- Effective disposal of roadside drainage must be ensured at all times, particularly in the vicinity of the toe of the active landslide. The use of lined flumes from the culvert outlet should be considered.
- Drainage improvements should be made in the area of springs and seepages below the roadway. This area receives the roadside drainage from a culvert. Surface and french drains, augmented by lined flumes where necessary, should be provided to improve the drainage, preventing upslope culvert water from entering an area considered to be underlain by pre-existing landslide failure planes. A suitably graded outlet should be provided from any works to ensure effective drainage.
- The species and density of plantings on and adjacent to the active landslide should be reviewed. The primary aim would be to use the vegetation cover to remove as much moisture as possible from the subsurface and to increase the binding effect afforded by root systems. A similar review is recommended where seepages and springs occur above the head of the active landslide, and below the road.
- The toe area, the roadway, and the area below the roadway should be regularly inspected for any signs of instability caused by the toe stressing any pre-existing failure planes which may underlie these areas. If the area was found to be stressed, and bearing in mind the proximity of the Mersey River, it would be prudent to immediately undertake investigations to relieve the stress.
- Landslide movement rates should be carefully monitored by survey. If movement rates become

unacceptable, other remedial measures may have to be considered.

HINDSIGHT

Active landslides are known to the Department of Mines on the slopes of the basalt plateau remnant which occurs in this general area.

The morphology of the area in which the landslide has occurred shows evidence of previous landslide activity. This indicates that there is a potentially higher than usual risk of forestry operations contributing to slope instability. Had this risk been identified early in the planning stages then it would have been possible to design a forestry operation to minimise those risks. Conditions such as:-

- selective, rather than clear-fell operations;
- reserves along the drainage lines, even though these may have been poorly defined;
- shorter time scale between the commencement of forestry operations and the reforestation of the area;

would have minimised the potential hazard.

Undoubtedly there will be debate as to whether deep contour ripping contributed to this landslide. The permeability of the surface materials suggests that, for the majority of the joint venture area, it may only be a minor factor but perhaps becoming more significant on or near drainage lines.

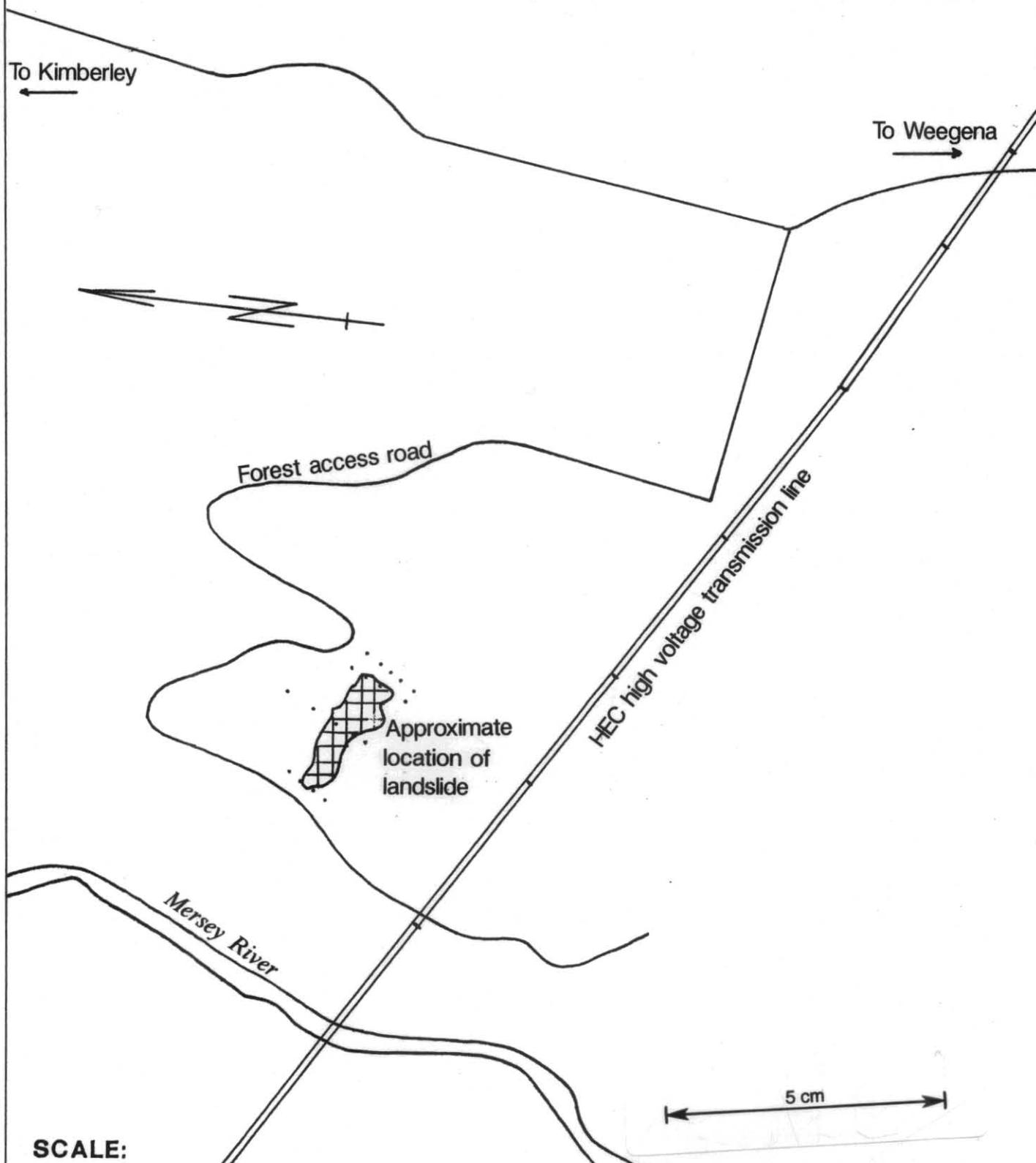
The presence of gleyed clays in exposures made by the landslide movement indicates that high groundwater conditions were present for a considerable period prior to the current landslide movement. Gleyed clays on slopes in forested areas are increasingly being recognised as associated with landslide-susceptible areas.

The forestry practices adopted for this joint venture area were not in keeping with the potential landslide hazards of the area. An office-based assessment during the initial planning of operations would have indicated a potential geological hazard. If inspected prior to harvesting the presence of old landslides in an area of geological configuration known to be potentially unstable would certainly have been recognised. This potential landslide hazard recognition would then have had an influence on forest harvesting plans. However, even if this had been recognised, the landslide may still have occurred.

[17 March 1992]

TASMANIA DEPARTMENT OF MINES SITE PLAN

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