

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 *Conclusions*

This study has confirmed that the slope movements are dominantly natural geological processes that have occurred in the Strzelecki Ranges well back into geological time. More recently, slope instability has been exacerbated by man's activities in clearing the forest, building roads and changing the groundwater regime.

Comparison of the landslide distribution map (Figure 3.4) with the geology and terrain map (Figure 2.4), shows that landslides occur most frequently in areas of strongly undulating terrain. The role of the parent geological material appears to be subservient to slope – landslides common occur in each of the three major geological units in the study area. In the Tertiary Older Volcanics, landslides occur mainly in the strongly undulating terrain with steep dissected slopes, rather than in the undulating plateau volcanic terrain around Thorpdale. The Childers Formation is commonly involved in landsliding where it crops out around the margins of the Tertiary Older Volcanics. Generally, but not invariable, the more resistant rocks of the Lower Cretaceous support steeper slopes. However, landslides are still common, particularly along the Yarragon monocline where the topography consists of strongly undulating dissected terrain with slopes to 40°.

The landslides are generally of the slump-earth flow type, occurring in the clay rich residual soils that have developed on each of the major geological formations. Dominant clay minerals are halloysite and montmorillonite, which are commonly associated with landslide-prone slopes. The clays are mainly of a firm to stiff consistency, are plastic, and commonly fissured. The in-situ winter moisture content of the soils is usually greater than the Plastic Limit, suggesting that the slope movements involve at least some plastic deformation of the clay soils. The slump-earth flows range in size from a few metres to relatively large ones such as landslide no. 10 on the Trafalgar-Thorpdale Road, which starts 1 km above the road and extends for a similar distance into the valley below the road. However, most recent landslides are much smaller than the older fossil and dormant landslides upon which they usually occur.

Most landslide damage occurs during the 7 months from April to October each year, when heavy rainfall triggers movements on meta stable slopes. In nearly all cases, man has either directly or indirectly contributed to slope failure with factors such as road and rail cuttings, poorly sites dams and deforestation. The annual damage to roads and farmlands probably exceeds \$100 000. If poorly planned subdivision for hobby farms is permitted in landslide-prone areas, the potential financial losses could be immense.

7.2 *Recommendations*

Slope movements in the Strzelecki Ranges are a natural phenomenon. They have been aggravated by some of man's activities, but the hazards and inconvenience caused can also be mitigated by remedial and preventative measures. The following suggestions are made for mitigating existing and potential landslide hazards in the study area:

7.2.1 Adequate roadside drainage should be provided in landslide prone areas. Drains should be carefully maintained and regularly inspected, especially before the wet season starts in April.

7.2.2 New road alignments should be designed to minimize hillside cutting and to avoid susceptible areas if possible.

7.2.3 Reforestation of active landslide areas should be encouraged. Particularly where large areas of shallow slump-earth flow type landsliding occurs, such as at the Dingley Dell landslide complex and at landslide no. 10 which crosses the Trafalgar-Thorpdale Road near Ryans Road.

7.2.4 The local practice of enlarging small depressions on old landslides for unlined dams should be discouraged. The dams act as a direct source of excess groundwater, thus contributing to further slope movement. This phenomenon is illustrated by the 1978 landslide of the Dingley Dell complex and by Klevans landslide.

7.2.5 Detailed engineering geology studies should be carried out for proposed rural subdivisions where significant change in land use may occur. These studies would provide a detailed evaluation of slope stability upon which the feasibility of various development plans could be assessed. Development within specific landslide-prone areas could then be engineered to avoid or correct all slope stability problems found in the investigation. The investigation should consider the impact of all proposed modifications to the land – not just road construction.

7.2.6 Existing roadside landslides should be studied in detail and remedial work designed and carried out as soon as possible, before the failure becomes more serious and to avoid on-going maintenance costs.

7.2.7 The Shire should seek substantial financial aid to carry out remedial measures in existing landslide problem areas. Further funds would be required for long term preventative measures, such as the construction of new drainage systems, large scale tree planting, and research into other methods of regional stabilization, such as experimentation with the use of gypsum as a means of chemically stabilizing the Cretaceous Strzelecki Group clays.

7.2.8 Further work could also be carried out on refining the landslide distribution map. A detailed base map at a scale of, say, 1:25 000 is required in addition to further field checking of the aerial photo interpretation.

7.2.9 A more detailed knowledge of the failure mechanism of landslides in the study area could be obtained by field instrumentation of selected landslides to measure groundwater pressures and landslide movement rates. Specialized laboratory strength testing as suggested by Dr P J Hoadley in Appendix 7.1 would complement the field studies.

7.2.10 An inventory of landslide events should be established to enable correlation with rainfall, seismicity and change in land use.