4. FIELD STUDIES

4.1 Initial Reconnaissance

Initial reconnaissance involved careful observation of numerous landslides, both close to, and remote from roads within the study area and the adjacent Shire of Woorayl.

The following factors were assessed:

* landslide types and processes
* geology and soils
* groundwater conditions
* the nature of the terrain
* extent of damage caused by landslides
* effectiveness of any remedial work

All landslides reported by the Narracan Shire to have caused damage to the roads were inspected. The location of these landslides is shown in Figure 3.5 and listed by the Shire in Appendix 1.2. Landslides 7, 9, 10, 13, 15, 16, 17, 20, “Klevans” and “Dingley Dell” were chosen for more detailed site investigation.

Roadside landslides recorded by the Shire, constitute the major proportion of all contemporary landslides.

4.2 Site Investigation of Selected Landslides

4.2.1 Drilling and Sampling Techniques

A Department of Minerals and Energy Gemco 210B type drilling rig equipped with continuously flighted hollow augers, was used to drill a total of 27 bores at roadside locations on selected landslides. The approximate location of each bore is shown on sketches in Appendix 4.1.

A modified core sampler was designed by the author in conjunction with Mr J L Neilson (Supervising Geologist) to obtain a relatively undisturbed continuous soil core of 6 cm diameter. Standard equipment produced a 5 cm diameter core. Drilling water is not required with either type of equipment. The modifications are described in detail by Brumley (1978). The following advantages result from the modifications:

4.2.1.1 The increase in sample diameter from 5 cm to 6 cm has achieved a reduction in sample disturbance. This is due not only to the increase in sample diameter, but also to the lower ratio of area of auger bit to sample area.

4.2.1.2 A volume increase of 44% per unit length of core has been achieved which allows selection of more representative soil samples for classification testing in highly varied lithologies.

4.2.1.3 The increased internal diameter of the auger bit allows standard 6.35 cm diameter undisturbed thin walled (6.65 cm o.d.) tube samples to be taken for triaxial, consolidation and permeability testing without the need to withdraw the augers from the borehole.

Drilling was continued at each location until further coring was prevented by hard or gravelly soils, by rock, or by cohesive drag on the augers in stiff clayey soils.

Groundwater occurrence was noted in each bore and several groundwater samples were taken for chemical analysis. The results are reported in Section 5.3

4.2.2 Field Logging

Detailed engineering geological logs were made to each of the 27 bore cores. The logs are included in Appendix 4.2. The cores represent a soil profile through the landslide material and particular attention was given to describing the stratigraphy, lithology, soil disturbance, soil consistency, relative density, plasticity, moisture content and where possible, the location of the surface of rupture. Each strata was assigned a group symbol according to the Unified Soil Classification. Consistency and relative density charts are included as Appendix 4.3, and the Unified Soil Classification chart as Appendix 4.4. Soil consistency descriptions were checked with a pocket penetrometer.

4.2.3 Observations of Selected Landslides

4.2.3.1 Landslide No. 7

Landslide No. 7 is located on the Mirboo-Yarragon Road as shown in Figure 3.5. Bores 25, 26 and 27 were drilled where the landslide crossed the roadway at the positions shown in Appendix 4.1. The landslide is a slump-earth flow, reported by local people to have occurred about 30 years ago. The slump zone is entirely above the road in the steep hillside which was cut into when the road was constructed. The slump zone has been successfully stabilised by tree planting. However, approximately 100 metres of the roadway across the earth flow zone continues to move following periods of heavy rain. The damage caused by the landslide varies from winter to winter, but a few years ago the damage was serious enough to temporarily close the road and damage a new farm dam below the road. Movement is always associated with heavy rain, but the initial road cutting would certainly have lowered the overall stability of the hillside, and impeded drainage along the roadway would have subsequently contributed to the on-going movement. The major features of the landslide are shown in Figure 4.1.

The landslide occurs entirely within the silty clay, silty fine sand and clayey silt of the weathered Lower Cretaceous rocks. The depth of the landslide along the road was difficult to establish, but bore 27 indicated a depth of approximately 4 metres which is consistent with the seismic refraction results obtained by the Country Roads Board (pers. com. A. Muir, 1978).

Figure 4.1 - Landslide No. 7, Mirboo-Yarragon Road looking east

4.2.3.2 Landslide No. 9

Landslide No. 9 is located 0.5 km wet of Narracan on the Narracan Connection Road as shown in Figure 3.5. Bores 7, 14 and 17 were drilled along the roadway at the positions shown in Appendix 4.1. A section of the road is affected by movement in the earth flow zone of a large slump – earth flow type landslide. Contributing factors to the movement are impeded drainage along the roadway and ongoing removal of earth from this toe zone by the creek. The creek also undercuts the toe of a similar earth flow on the opposite side of the valley. The Shire have improved the drainage along the road, but movement still occurs. The major features of the landslides and the damaged section of road are shown in Figure 4.2.

Both the Older Volcanics and the Childers Formation soils are involved in the landsliding. Drilling indicated that the landslide was 4.5 m thick where the road crossed it.

Figure 4.2 – Landslide No. 9. Narracan Connection Road, looking South.

4.2.3.3 Landslide No. 10

Landslide No. 10 is a large slump-earth flow which crosses the Trafalgar-Thorpdale Road just north of Ryans Road. The slump zone extends for approximately a kilometre above the road and the earth flow zone continues for a similar distance downhill from the road. The landslide exhibits all the classic features of slump – earth flows, including large arcuata depressions at the head of the slide, narrowing of the slide in the transition from the slump to the earth flow zone, and hummocky terrain with pools of water in the earth flow zone. These features are shown by Figures 3.8 and 4.3.

Figure 4.3 – Looking west from the road onto the hummocky earth flow zone of landslide no. 10. Trafalgar-Thorpdale Road, immediately north of Ryans Road.

The landslide causes the road to subside and to move laterally to the west following periods of heavy rain. A major contributing factor to the movement must be the very poor drainage that exists along part of the uphill side of the road. Improving the road drainage may lessen the damage, but would be unlikely to entirely eliminate movement of the earth flow across the road easement.

Bores 3 and 6 were drilled along the roadway, and bores 4, 5, 15 and 16 along a farm track off Ryans Road. The approximate positions of these bores are shown on sketches in Appendix 4.1. The bore cores indicate that the soils of both the Older Volcanics and the Childers Formation are involved in slope movement.

4.2.3.4 Landslide No. 13

Landslide No. 13 is a relatively small slump – earth flow incorporating zones of translational movement. It is located within a larger landslide complex on the Childers Settlement Road, 1.5 km west from McDonalds Track as shown in Figure 3.5. In 1978, the Shire constructed a retaining wall, improved the drainage and planted trees to prevent the earth flow from covering the road. Figure 4.4 is an oblique aerial view of the landslide and Figure 4.5 shows the retaining wall during construction. Bore 24 was drilled on the downhill side of the roadway as shown in

Appendix 4.1. The soil consists of sandy, clay silt and silty clay of the Childers Formation.

Groundwater flowed out of the bore, thus indicating that further drainage would assist the stability of the slope.

Figure 4.4 – Oblique aerial view of landslide no. 13, Childers Settlement Road. Numerous tussocks indicate wet ground.

Figure 4.5 – Landslide No. 13, looking east along the Childers Settlement Road.

Earth flow material has been cut back from the road. Steel joists are set in concrete in pre-bored holes to provide anchorage and lateral resistance for the retaining wall which was built between the columns. The ground in the vicinity of the roadway is saturated. April 1978.

Figure 4.6 - Landslide No. 15 on the Trafalgar-Narracan Road, looking south onto a large landslide complex.

A small active slump-earth flow is causing approximately 50 metres of roadway to subside.

4.2.3.6 Landslide No. 16

Landslide No. 16 is a recent small slump-earth flow which is encroached on the Trafalgar-Coalville Road as shown in Figures 3.5 and 4.7. It is located within a larger slump-earth flow complex. The soil consists of coarse sands and gravels of the Childers Formation, and in this respect it differs from the other landslides studied. Bores 10 and 11 were drilled at the locations shown in Appendix 4.1. The major cause of failure is attributed to the steep road cutting which crosses the slope at this location. The road has been re-established through the earth flow. Willow trees have been planted and the drainage improved to minimize the risk of further landslide movement.

Figure 4.7 – Landslide No. 16, Trafalgar-Coalville Road

4.2.3.7 Landslide No. 17

Landslide No. 17 is moving slowly across the junction of the Trafalgar-Coalville Road with the Moe-Thorpdale Road. It is essentially a translational earth flow with some minor rotational shear displacement. It occurs within a larger old slump-earth flow complex and involves soils of the Older Volcanics and the underlying Childers Formation as shown in bores 7, 14 and 17 which were drilled at the locations shown in Appendix 4.1. The location and features of the landslide are shown in Figures 3.5 and 4.8 respectively. The damage consists of earth flowing onto the Trafalgar-Coalville Road and subsidence of the Moe-Thorpdale Road. The drainage has been improved along the Moe-Thorpdale Road in an attempt to lessen the damage. The relatively new house shown in Figure 4.8 is located just to the north of the active landslide zone.

Figure 4.8 – Landslide No. 17, crossing the junction of the Trafalgar-Coalville Road with the Moe-Thorpdale Road.

4.2.3.8 Landslide No. 20

Three bores were drilled where landslide no. 20 crosses the Allambee-Thorpdale Road as shown in figure 3.5 and Appendix 4.1. The landslide is not clearly defined, though it consists essentially of a slump-earth flow in the Childers Formation clay and silty clay. The Shire records show that the road is subsiding and has to be periodically filled. It is important to keep this road open, now that the Dingley Dell Road is closed by landsliding.

4.2.3.9 "Klevans" Landslide

The head of the "Klevans" landslide is high above the Leongatha-Yarragon Road at the location shown in Figure 3.5. The slump zone grades into a debris flow zone which crosses the road and continues for some distance down the valley as shown in Figures 4.8 and 4.9. Bores 19 and 20 were drilled on the roadway at the locations shown in Appendix 4.1. The head of the recent landslide is shown by the solid red line, while a dashed line delineates the head of an older passive slump-debris flow. A dam (marked by arrow) is located in the slump zone of the old landslide immediately above the head of the recent landslide. The landslide material above the head of the recent landslide. The landslide material consists of silty clays and clayey silts mixed with weathered rock fragments of the Lower Cretaceous Strzelecki Group.

The landslide has evidently passed through active phases, probably dating back to when the forest was cleared. The most recent movement may be attributed, in part, to the presences of a small dam in the old slump zone above the recent landslide, combined with the effects of heavy rain.

Figure 4.9 – Oblique aerial view of the Klevans landslide looking NE

Figure 4.10 - Down slope view of Klevans landslide showing small farm dam located in old slump above the recent landslide.

4.2.3.10Dingley Dell Landslide Complex

This extensive complex of sump-earth flow type landslides has been described in Section 3.3.4 and is illustrated in Figure 3.10. It is located across the Dingley Dell Road as shown in Figure 3.5. Slope movement involves soils from the Older Volcanics, the Childers Formation and the Strzelecki Group rocks. The site has been investigated by the Country Roads Board of Victoria and recommendations for stabilization are given by Fielding (1975). No drilling was carried out in the present investigation, but several bulk samples of soil were taken for classification testing. The road is presently closed by the two landslides shown in Figures 4.11 and 4.12. The causes of slope movement are complex, with the very large landslides most probably occurring prior to clearing the forest. Subsequent, smaller movement, are probably due to a combination of factors involving clearing, road construction, location of dams, slope, geology, soils and periods of intense rainfall.

Figure 4.11 – Active slump-earth flow across Dingley Dell Road.

Figure 4.12 – Active slump-earth flow which has removed a section of the Dingley Dell Road. A large tree in the slump zone remains approximately vertical.