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INVESTIGATION OF A SMALL LANDSLIDE, AREA 9, YARRALUMLA VALLEY. A.C.T.

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SUMMARY

A small landslide occurred in November 1964 as a result of road-making operations in the new residential area of Lyons, Yarralumla Valley. The slide was inspected in January 1965 and was found to be due to the inability of a restricted pocket of clayey slopewash to stand as a vertical free face, 9 feet high, when saturated. There is no evidence of extensive movement away from the face and the slope as a whole is thought to be stable. It is recommended that the angle of batter be decreased and that fill material used to restore the original level be permeable and well drained. Water-logged surface conditions may be alleviated by shallow drains.

INTRODUCTION

At the request of Mr. B. Guy of Scott and Furphy, Consulting Engineers to the National Capital Development Commission, an inspection of a small landslide at Area 9, Yarralumla Valley, was made on January 7th, 1965. Mr. Guy sought geological advice on the reasons for the slide, the nature of the materials involved, drainage conditions, and the suitability of the measures proposed to prevent further movement. A detailed geological examination of the area was made on January 8th and a brief visit paid on January 11th in company with Mr. E.G. Wilson, whose suggestions have been incorporated in this report.

DESCRIPTION OF THE LANDSLIDE

The slide occurred on the uphill side of a road cul-de-sac on the eastern slopes of Oakey Hill, at an elevation of about 2050 feet. The ground surface slopes at about 10°, and the vertical face of the road cutting is about 8 feet high. A section 55 feet long and extending 18 feet uphill from the original excavation line, has collapsed onto the roadway; movement took place along curved steeply-inclined shear planes, arranged en echelon.

The slide occurred towards the end of November 1964, at a time when the ground in the area was water-logged and impassable to wheeled vehicles. Slippage does not seem to have been preceded by any unusually heavy storms. The movement was reported to have been sudden. Some of the material has been removed from the toe of the slide in preparation for the construction of a masonry retaining wall. Tension cracks parallel to the vertical face of the cutting extend for at least 60 feet northwards from the slip and for a short distance to the south, but do not occur farther uphill than about 6 feet from the edge of the excavation. The cracks are generally not wider than 1 inch; those nearest the road are the widest. There are only a few narrow cracks, generally less than ¼ inch wide, uphill from the back of the slide, and these may be due to desiccation rather than to tension. There is no evidence of earth movement higher up the slope and so far only minor fretting has occurred along the edge of the excavation elsewhere in the cul-de-sac. Although material from the slide has encroached onto the roadway, the road foundation has not moved.

TREATMENT PROPOSED BY CONSULTING ENGINEERS

It is proposed to build the masonry wall across the front of the slide, after any obstructing material is removed, and to place a gravel pack, or filter zone, between the wall and the fill to facilitate drainage of the embankment. The planned wall is trapezoidal in section, with weep-holes near the base, and is dowelled to the underlying weathered bedrock to prevent sliding. To reduce the water content of the material between the wall and the highest part of the residential blocks on the uphill side of the wall, it is proposed to construct an interceptor drain somewhat higher up the slope, in the form of a gravel-filled trench, reaching to bedrock, at the bottom of which a perforated fibrous cement pipe is to be placed.

RAINFALL

The attached table shows that rainfall in the Canberra area for the four months preceding the slide was higher than average.

TABLE 1

Monthly Rainfall and Number of Rain-days

Month	Forest Research Institute Gauge, Cotter Road		Fairbairn Aerodrome Gauge		24 Year Average	
	Rainfall (points) 1964	Raindays	Rainfall (points) 1964	Raindays	Rainfall (points)	Raindays
July	394	9	336	14	158	11
Aug.	144	6	163	13	154	12
Sept.	378	7	281	12	185	10
Oct.	398	8+	482	14	252	12
Nov.	194	6	85	9	245	10
Dec.	176	5	177	6	243	8
Totals	1684	41+	1524	68	1237	63

This would account in part for the saturated soil conditions prevailing at the site during November. In addition, the piezometric surface usually reaches its highest elevation in November or December, after rising steadily from its annual low point in July. The effect of the high groundwater level on drainage conditions in the Oakey Hill area is discussed more fully on page 3 .

GEOLOGY

Examination of the road cutting and three pits near the landslide reveals that the slide occurred in a deep pocket or remnant of clayey slopewash about 200 feet wide. In the vicinity of the slide 1 to 2 feet of silty soil is underlain by 9 or more feet of clayey slopewash above weathered volcanic bedrock. Seventy-five feet uphill from the roadway the slopewash is only 12 to 18 inches thick and weathered bedrock lies at 3 feet. One hundred and forty feet from the roadway bedrock is encountered at a depth of 2 feet. It is apparent that the surface of the bedrock dips a good deal more steeply than the ground surface in this small area. The road cutting has exposed weathered tuff or ashstone bedrock at a depth of about 3 feet at 90 and 60 feet respectively from the northern and southern boundaries of the slide. Bedrock lies within 4 feet of the surface at most other places along the cul-de-sac.

The grey silty soil layer appears to be fairly permeable and free-draining in normal circumstances. However, the underlying clayey slopewash is almost impermeable except for desiccation cracks which extend to at least 10 feet below the surface. It is composed of quartz and feldspar granules, and fragments of very weathered to slightly weathered volcanic rock; the fragments range from $\frac{1}{4}$ to 12 inches in size in a matrix of dense tough plastic clay. Fine rootlets follow cracks to this depth. The clay is strong and hard when dry but weak and plastic when wet. The weathered volcanic bedrock is mainly composed of quartz and feldspar particles and has a gritty texture. Its permeability is probably somewhat higher than that of the slopewash but much lower than that of fresh fractured rock.

DRAINAGE CONDITIONS

Drainage difficulties at the site are due to two factors. The first is that the soil layer quickly becomes saturated and remains so for lengthy periods during high-rainfall months. This is due to the impermeability of the underlying clayey slopewash once the desiccation cracks have closed as the clay swells. The effect is greatest where the clay is thickest, but probably occurs over any part of the adjacent slopes where deposits of slopewash are to be found. Run-off from the higher,steeper slopes may contribute to water-logging of the soil after periods of heavy rain.

The second factor is saturation of the clayey slopewash by percolation of surface water through the soil and by rising ground-water from the fractured bedrock aquifer. If the piezometric surface rises to the clay layer during wet months, pore-water pressure is increased, thereby reducing the shear strength of the clay and retarding drainage of the surface soil. Under the worst conditions, with a high piezometric surface, the rising pore-water may contribute to water logging of the soil.

CONCLUSIONS

The landslide was caused by a reduction in shear strength of the clayey slopewash (owing to its saturation by downwards-percolating surface water and possibly by rising pore water from the bedrock aquifer) to a value less than the shear stress imposed on the failure surfaces by the overlying prism of material left unsupported on its downhill side by the road excavation. It is not thought that the slope as a whole will be unstable during wet periods. Apart from minor fretting of edges, it is expected that any future slides will be confined to the section, about 200 feet wide, underlain by clayey slopewash. Elsewhere along the cul-de-sac, weathered bedrock is generally within 4 feet of the ground surface and the embankment is expected to be stable.

RECOMMENDATIONS

It is recommended that the existing vertical face be cut back to a flatter angle over most or all of the section underlain by the clayey slopewash. The angle of batter chosen should be determined by a soil mechanics study of the properties of the clay and the loads imposed, and allowance should be made for a safety factor. The space behind the masonry wall should then be filled with a permeable material to restore the surface and provision made for thorough drainage. The friable weathered gritty bedrock and soil excavated elsewhere along the cul-de-sac would be a suitable filling material.

Shallow drains at a depth of about 2 feet might be effective in reducing water-logging of the soil in the area underlain by slopewash. It is doubtful whether a deeper drain uphill from the wall would be successful in reducing the water content of the slopewash because of the low permeability of the slopewash. A drain located in or below the weathered bedrock might tap water from the fractured bedrock aquifer and lower the piezometric surface; however it would need to be 10 feet or deeper, depending on its location, and is not recommended at this stage. Wherever drains are installed it is suggested that care be taken to ensure that they do in fact conduct water away from the slopewash deposit and are not of a type which might introduce water from higher up the area being drained.