TASMANIA

Department of Resources & Energy

DIVISION OF MINES & MINERAL RESOURCES

REPORT 1991/20

Rosetta Landslide

Geological investigation and slope risk assessment

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15 October 1991

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FIGURES

ABSTRACT

A deep-seated landslide has developed at Rosetta, a suburb to the north of Hobart. Currently some thirty-one properties are directly affected by the landslide, with five houses demolished as a result of severe structural damage associated with the movement. The landslide is occurring on a 10° slope underlain by Tertiary sediments. Movement is gradual, with an overall rate of about 1.5 mm/week. Groundwater appears to be a major driving force; a horizontal drainage pilot study has been implemented to assess the effectiveness of drainage as a possible stabilisation technique. A landslide risk assessment map has been produced delineating 'A' and 'B' landslip zones to be recommended for proclamation under the Tasmanian Local Government Act.

ACKNOWLEDGEMENTS

The author is grateful for the full support and co-operative assistance of colleagues in the Division of Mines and Mineral Resources who have contributed their comments and ideas which have assisted in the production of this report. In particular I wish to thank my colleagues in the Engineering Geology and Groundwater Section; Loyd Matthews, Barry Weldon and John Sloane; for their valuable discussions and critical review of this report.

Many of the Division's staff have been involved in this project. Barry Cox and Grant Eagling assisted with the collection of field data, and Geoff Benn carried out all survey work for the study. Drilling for the project was undertaken by Graeme Baker and Mark Whitmore. Rohan Sedgman installed and maintained the Unidata monitoring devices.

Richie Woolley carried out laboratory testing of materials. Groundwater samples were chemically analysed by Kathryn Burt and Tim Bishop. Barry Weldon produced the graphs in Appendices 2 to 5, while the other diagrams were drafted by Andrew McGuinness and Ken Bird. The Divison's word processor operators, in particular Lisa Doran, prepared several drafts of this report. Final editing and production was undertaken by Michael Dix of the Publications Section.

INTRODUCTION

The Division of Mines and Mineral Resources was initially engaged in March 1990 by an independent loss assessor, and subsequently by the Glenorchy City Council, to examine and report on the cause of the structural damage sustained by several properties in the Hone Road–Officer Street area of Rosetta (fig. 1). This resulted in an interim report by the Division in May 1990 (WELDON, B. D. 1990. Interim report on a landslide at Hone Road, Rosetta. *Rep. Div. Mines Miner. Resour. Tasm.* 1990/29) which concluded that the damage was considered to be associated with landslide movement and recommended further investigations.

A second phase of the investigation followed immediately. This study further defined the nature and characteristics of the materials and groundwater conditions within the landslide mass, and discussed remedial stabilisation options (WELDON, B. D. 1990. Investigation of a landslide, Hone Road – Officer Street, Rosetta. *Rep. Div. Mines Miner. Resour. Tasm.* 1990/20).

The major objectives of current investigation were:

- to gain a better understanding of the geology, geometry and hydrological conditions associated with the landslide for the subsequent consideration of appropriate remedial measures
- to identify the extent of similar geological conditions in the area
- to assess the potential for instability of a designated area adjacent to the landslide
- to produce a risk assessment map of that area delineating landslip 'A' and 'B' Zones to be recommended for proclamation under Section 431A of the Tasmanian Local Government Act (1962).

The investigation involved detailed geological and slope mapping, drilling, monitoring of landslide movements, collection of hydrological data, and laboratory testing and analysis.

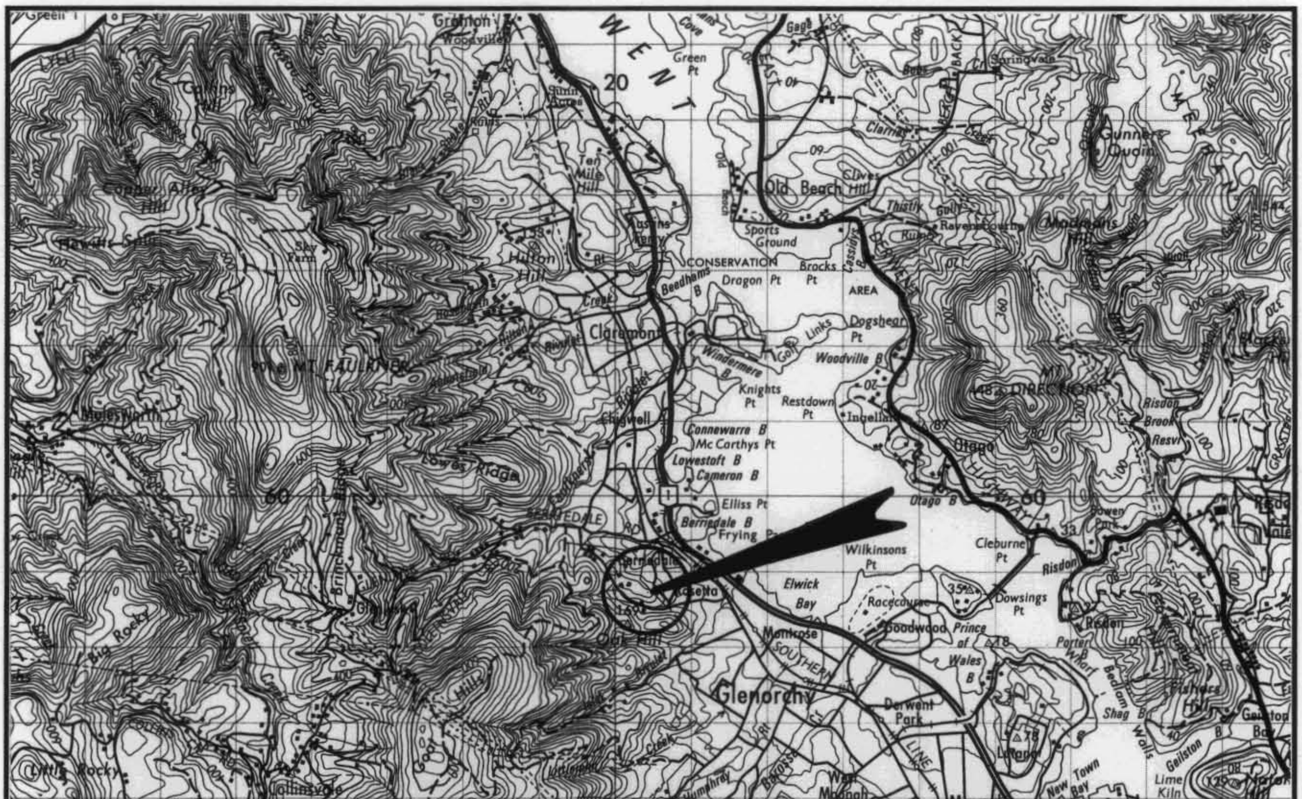

Figure 1. Location of landslide area, Rosetta

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GEOLOGICAL SETTING

The 1:50 000 geological atlas map of the Hobart area (Leaman, 1972) depicts the area under discussion at Rosetta as a complex series of faulted blocks of Jurassic dolerite, Permian and Triassic age sediments in juxtaposition against each other. While some of the boundaries and major faults remain essentially unaltered, the detailed 1:5 000 scale mapping carried out for this investigation, in conjunction with the results of the drilling programme, suggests a somewhat different geological setting for this area. The distribution of the major rock types is shown in Figure 2. No attempt has been made to differentiate between units within the Permian or Triassic sequences.

Permian Sediments

The oldest rocks in the area are Permian age sediments which occur as a fault block to the south of the landslide. They are typically grey siltstone, although pebble sandstone units were observed. They have well developed jointing and have a regional dip in this area of 30°–40° to the northeast. Leaman (1972) considered these sediments to be part of the Ferntree and Malbina Formations.

Triassic Sediments

The Triassic age sediments are exposed to the north and east of the landslide area. They typically exhibit a lithology varying from quartz-rich through to feldspathic and lithic sandstone, to carbonaceous shale beds. They are generally well bedded and have an uncharacteristic steep regional dip of between 30° and 60° to the SSE.

Jurassic Dolerite

An intrusive Jurassic age dolerite body is a prominent feature in the area. It is generally medium grained and is typically variably weathered from fresh to extremely weathered over short lateral and vertical distances. Jointing is likewise highly variable, both in attitude and spacing (from 10–20 mm to in excess of 0.5 m or so). Calcareous veining associated with hydrothermal fluids is a common feature.

Tertiary Deposits

The materials mapped as Tertiary deposits, and in which the Hone Road–Officer Street landslide has developed, are considered to have accumulated along fault scarps associated with the formation of the Derwent Graben during the early Tertiary period. These deposits consist largely of cobbles and boulders of Permian, Triassic and Jurassic age rock in a matrix of clay, silt, sand and gravel derived from the parent rock. Overall, the deposits are similar in appearance to a conglomerate. Drilling has shown these deposits to be in excess of 64 m thick, although the total thickness is unknown. Palynology has indicated an age within the Tertiary of early Eocene.

The variable nature and haphazard distribution of the materials suggests a complex erosional and depositional history. The source materials are considered to have been proximal and to have been derived from uplifted fault blocks, and accumulated in a localised, possibly closed, trough.

Material derived from Triassic age rocks is present throughout the Tertiary deposits, with Jurassic age dolerite occurring sporadically. Material derived from Permian age sediments has only been encountered within the landslide mass, and overlies materials derived dominantly from Triassic age sediments. This apparent stratigraphic anomaly has been observed both in drill core and in surface mapping. For example the large outcrop of Permian siltstone seen on the vacant lot situated at 29 Crosby Road was initially considered as probable *in situ* parent bedrock; the bedding has a northeast dip component common to the Permian sediments in the region. However the investigation has shown the outcrop to be underlain by materials derived from Triassic age sediments which crop out at about street level.

It is possible that some of the material derived from Triassic age rocks may have originated from the fault block to the south of Hone Road. As faulting continued during formation of the Derwent Graben, the Triassic rocks would have been progressively stripped off, finally exposing the Permian rocks along the fault scarp. These subsequently became the source for later deposition during the Tertiary period. This is one possible mechanism to explain the stratigraphic inversion of materials derived from the Permian overlying younger materials derived from the Triassic.

Materials to the south of Marys Hope Road are mapped as Tertiary deposits because of the similarities with those materials derived from Triassic sediments observed at the western end of Officer Street. Subsurface investigations are necessary to confirm the existence and extent of these deposits.

Faulting

Faulting in the area is possibly far more complex than indicated on the geological map (fig. 2). The major NNW-trending fault which places the Permian sequence up against the Tertiary deposits is of prime interest with respect to this investigation. The fault zone is seen exposed in the cutting along the boundary between numbers 17 and 19 Hone Road; intense shearing is apparent over a width of about 10 metres. The Permian mudstone-siltstone materials are typically highly fractured and brecciated. Borehole 18, situated off Taylor Court, intersected brecciated material considered to be associated with this fault.

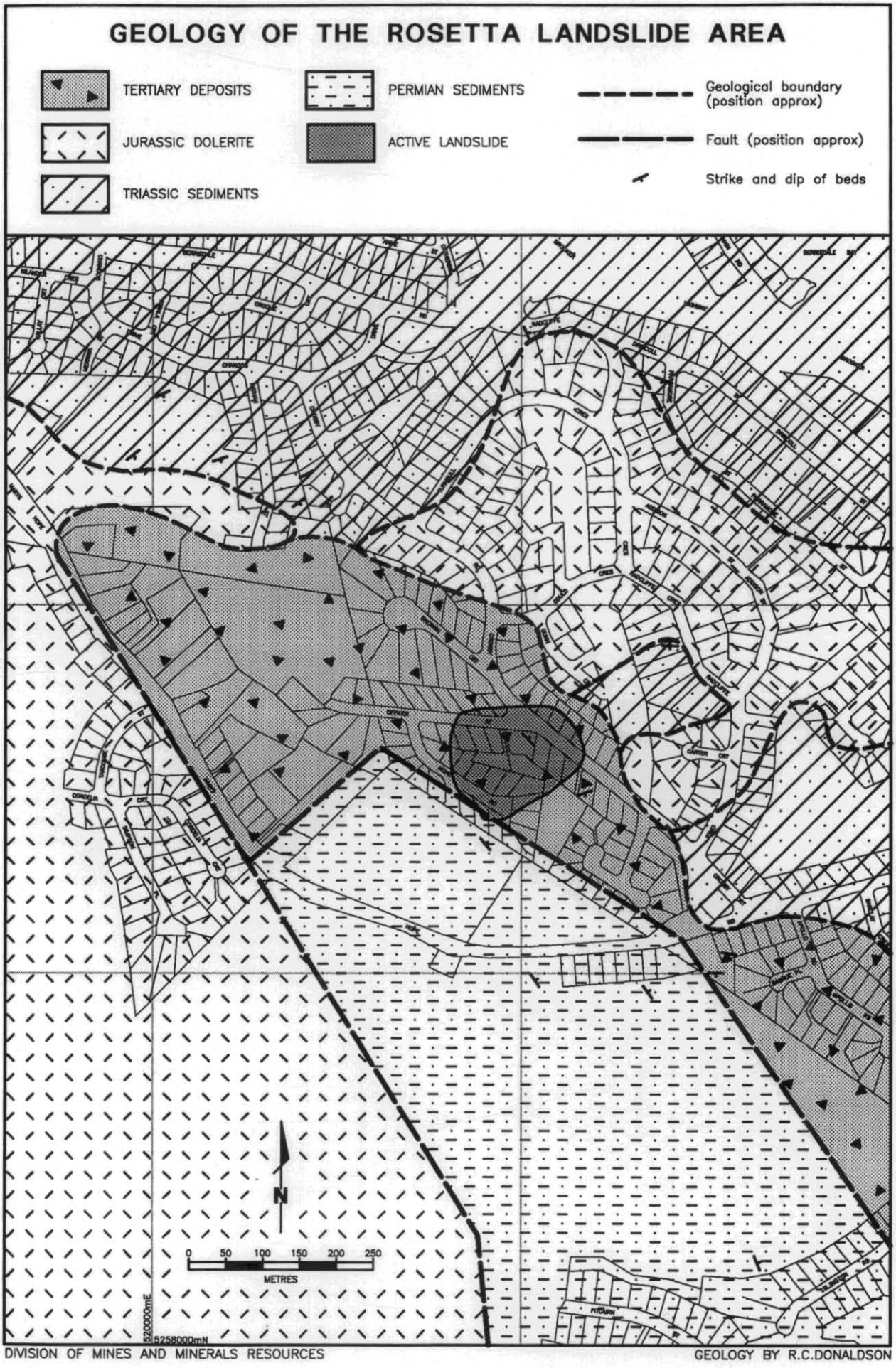
GEOLOGY OF THE ROSETTA LANDSLIDE AREA
TERTIARY DEPOSITS
JURASSIC DOLERITE
TRIASSIC SEDIMENTS
PERMIAN SEDIMENTS
ACTIVE LANDSLIDE
Geological boundary (position approx)
Fault (position approx)
Strike and dip of beds
N
0 50 100 150 200 250
METRES
5220000mE
5258000mN
DIVISION OF MINES AND MINERALS RESOURCES
GEOLOGY BY R.C.DONALDSON

Figure 2

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GEOMORPHOLOGY

The effect of erosion is to subdue original geomorphological features such as those resulting from landslides. This effect must be considered when confidently assessing the geomorphological history of an area. Subdued fossil landslide features are possibly evident in the study area.

Slope Classes

The area has been slope classed at intervals of 5° above a baseline figure of 10°; the resultant map is presented as Figure 3. The NW-trending ridge between Marys Hope Road and Crosby Road is a prominent topographic feature.

Those areas on either side of the ridge which are underlain by Tertiary deposits have moderate slopes of 10–20°, however slopes are locally steeper in the amphitheatre-shaped feature to the south of Nathan Court. The relatively flat slope segment coinciding with the active landslide area is an apparent anomaly.

The SW face of the ridge underlain by Permian age sediments is noticeably steeper, with slope segments commonly between 15–25°.

Aerial Photograph Interpretation

Several sets of aerial photographs, dating back to 1946, were examined in an attempt to identify areas of previous landslide activity. More specifically they were examined to establish if the current Hone Road–Officer Street landslide is a re-activated fossil landslide feature.

The interpretation suggests that the slopes on the SW face of the ridge, underlain by Permian sediments, do not appear to have a history of significant landslide activity. However surficial movement associated with the shallow soils developed on these Permian sediments may have occurred. The Permian sediments have a dip component to the NE which is into the slope. This accounts for the generally stable nature of this slope segment despite its steepness.

A study of the aerial photographs of the slopes on the NE face of the ridge, extending from Taylor through to Nathan Court, identified three areas with possible fossil landslide features.

A large amphitheatre-shaped feature is evident at the southern end of Nathan Court. The general arcuate form is similar to the head scarp region of a fossil landslide or debris flow. Another smaller feature occurs on the steep slope segment on the SE end of the ridge above the upper cul-de-sac off Taylor Court. It is stressed that these features may only be possible sites of fossil landslide activity and there is inconclusive evidence to make a more definite interpretation.

With respect to the current Hone Road landslide area, examination of the pre-subdivision development aerial photographs indicates features, notably in the headscarp and along the flanks and specifically the left flank, that could be associated with a fossil landslide. However, they could also be naturally occurring features associated with the drainage system developed on the slope and controlled by the underlying geology.

In summary, it is often only with the benefit of hindsight that one may be encouraged to interpret certain geomorphological features in order to comply with a perceived model.

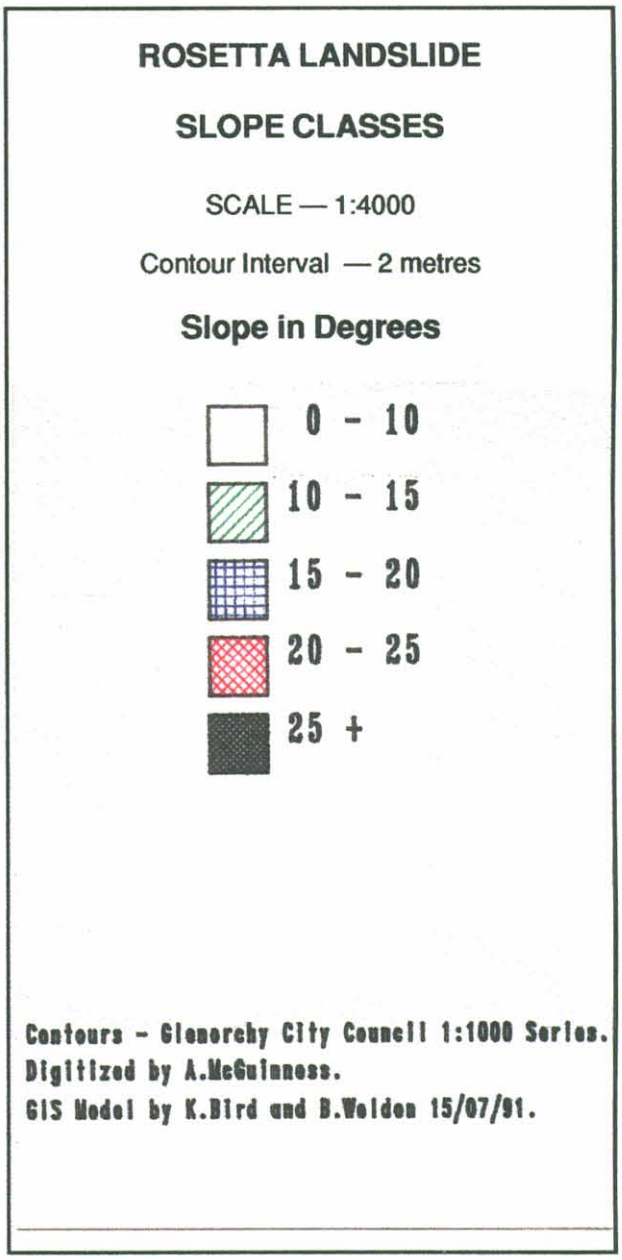

Figure 3

Slope class map, Rosetta Landslide

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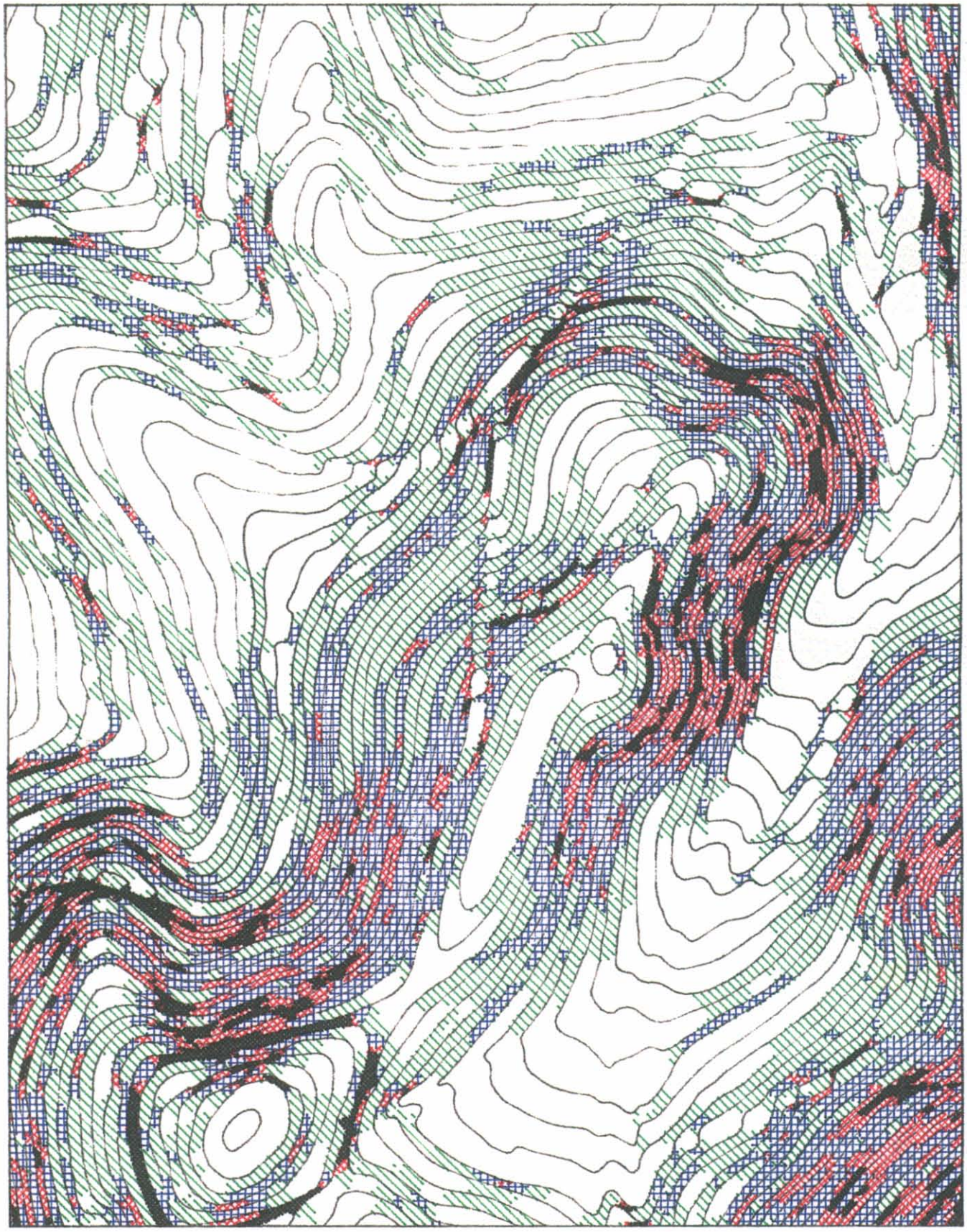

Figure 3

Slope class map, Rosetta landslide

LANDSLIDE GEOLOGY

The extensive drilling programme has confirmed the opinions expressed from previous investigations that the landslide is occurring in Tertiary deposits. Furthermore, the distribution of materials encountered in all but three of the holes (BH 8, 9 and 24) showed there to be a varying thickness (up to 28 m) of materials derived from Permian age rocks overlying materials derived from younger Triassic and Jurassic age rocks. A possible mechanism for this reversal of materials in terms of geological age has already been discussed.

An identifiable pre-Tertiary 'in-situ bedrock' sequence was not encountered during the investigation of the landslide, although boreholes were taken well below the apparent zone of failure.

MATERIAL CHARACTERISTICS

The Tertiary deposits consist of gravel to boulder-size rock fragments in a variable matrix of sand-silt-clay of medium to high plasticity. The drill core samples show clay-lined defects and slickensided surfaces. The latter were probably formed by shearing caused by differential compression and compaction during the deposition process.

The overall strength characteristics of these deposits are governed by the properties of the low-strength matrix materials supporting the boulders. Strength parameters determined by direct shear testing of matrix materials produced ϕ'_r values of 11–17° and c'_r values of 2–4 kPa. The range of values is not unexpected as the matrix strength is largely dependent on the proportions of sand, silt and clay contained in the material tested.

X-ray diffraction analyses of the clay fraction from the matrix indicated a high percentage of montmorillonite in all samples. This clay mineral has a high swelling capacity on moisture uptake, thereby softening and effectively reducing the shear strength. This consequently increases the potential for failure to occur. The results of the testing are contained in Appendix 1.

In the majority of cored boreholes it was difficult to obtain sufficient sample of suitable material for strength determinations from a single interval. However low-strength clayey matrix materials or zones of weakness, such as clay-lined or slickensided defects, do occur throughout the Tertiary deposits, and are not just confined to the landslide body.

EVIDENCE OF MOVEMENT

Evidence of movement at Hone Road has been most pronounced around the perimeter of the landslide, which is well-defined by the structural damage caused to houses and distortion to roads and pavements. Tension cracks, developed in the headscarp in the vicinity of Hone Road, are of the order of 50–75 mm wide, with similar vertical displacements. A misalignment in the kerb and guttering can be seen where the flanks of the landslide cross Officer Street and Crosby Road. The distortion and displacement of concrete blocks, clearly evident in the embankment at the junction of Crosby Road and Officer Street, defines part of the toe region. In total, the perimeter of the landslide directly cuts through nine houses, five of which have been deemed structurally unsound and subsequently demolished.

In contrast, houses situated within the body of the landslide initially exhibited only minor structural damage, often consistent with that which would be anticipated under normal circumstances. Several of these houses are now beginning to show increasing signs of stress as movement continues and the body of the landslide becomes progressively disrupted. With further movement it is likely that tension cracks will eventually develop within the body of the landslide itself.

MONITORING OF MOVEMENT

Surface evidence

A survey network was established between August 1990 and February 1991 to monitor long-term lateral and vertical movements associated with the landslide.

The survey utilises the existing road system, with survey lines generally extending well beyond the suspected area of movement (fig. 4); surveys have been conducted on a monthly basis.

The survey results (Appendix 2) have more clearly defined the area of active downslope movement. They have also indicated the average rate at which movement has been occurring over the period.

Two survey lines at Hone Road and Officer Street have recorded considerable lateral movement. The Hone Road survey line passes across the headscarp of the landslide, while the Officer Street survey line records movement in the left flank and toe region. These areas exhibit different characteristics, and will therefore be discussed separately.

Hone Road Survey Line

This survey commenced in August 1990 and results show that the overall average rate of movement between chainage 60–141 m over the period to July 1991 has been about 1.5 mm per week (75–80 mm per year). The actual amount of movement varies from month to month, as does rainfall. This is clearly illustrated in Figure 5, which is a plot of cumulative rainfall and lateral movement of several stations on the survey line.

The relationship between rainfall and landslide movement has been well documented elsewhere. With sufficient data, it is often possible to determine the rainfall conditions that are necessary for the onset of movement. However in the Rosetta situation there is abundant rainfall information but a relative paucity of landslide movement data (recorded on a monthly basis only). It is not known over what period in a particular month that movement was actually occurring, or at what rate. On the data available, there appears to be no positive correlation between rainfall events and rates of movement.

Officer Street Survey Line

Monitoring commenced in November 1990. Results have indicated that the landslide is moving downslope (northerly) between chainage 177–273 m at an average rate of about 1.2 mm/week (60–65mm/year) (fig. 6). This is slightly less than the recorded rates of lateral movement along Hone Road. The June and July survey results showed substantial increases (up to 25 mm) in downslope movement in several station readings. These movements coincide with the drilling undertaken for the horizontal drainage pilot study.

Results also indicate an apparent upslope (southerly) relative movement in the survey line; from 2–3 mm at the western end of Officer Street (Ch 00 m) to 10–12 mm outside 11 Officer Street (Ch 167 m). Monitoring is continuing to determine the significance of this apparent anomaly.

A similar effect was also observed in the short survey line established on Crosby Road at the Officer Street junction. Chainages 00–35 m (SW end of survey line) have a relative downslope movement of up to 25 mm, consistent with the movements occurring within the body of the landslide, but Ch 40–79 m (NE end) have relative upslope movements (towards Officer Street) of up to 20 mm.

Whilst there have been technical difficulties in measuring lateral movements on the Crosby Road–Sherwin Court survey line, only two or three stations in the vicinity of numbers 28 and 30 Crosby Road have shown any downhill trend since the line was established in February 1991.

Finally, results from the Gunn Court survey line indicate that within the accuracy limits of the survey there has been no movement in relation to landslide activity.

House damage

A series of linear position sensors (transducers) was installed in three dwellings in Hone Road and one in Officer Street where structural damage resulting from the landslide was clearly evident. The sensors were placed across existing cracks in the walls and slabs of the dwellings to record progressive movement. A relative, not an absolute movement, was measured. The sensors were linked up to a Unidata data logger, with readings taken at regular intervals. Both horizontal and vertical displacements were measured.

The results, presented in Appendix 3, show rates of displacement varying from virtually no change up to about 1.5 mm per week. This variation is not unexpected, and is largely dependent on the position of the sensor on the structure, and the relationship of the monitored defect to the landslide scarp movement.

Subsurface evidence

The vertical dimension (slip plane) of the landslide has also been determined at several points by observing the depth at which boreholes show signs of deformation. The results of monitoring are presented in Table 1. A simple system

Table 1. Location of Slip Surface (from borehole deformation monitoring)

Borehole	1	2	6	7	8	9
Approximate depth to slip surface (m)	15.3	13.0	13.5	15.5	8.7	5.1
Approximate RL of slip surface (m)	81.9	89.4	85.8	79.4	79.1	82.8

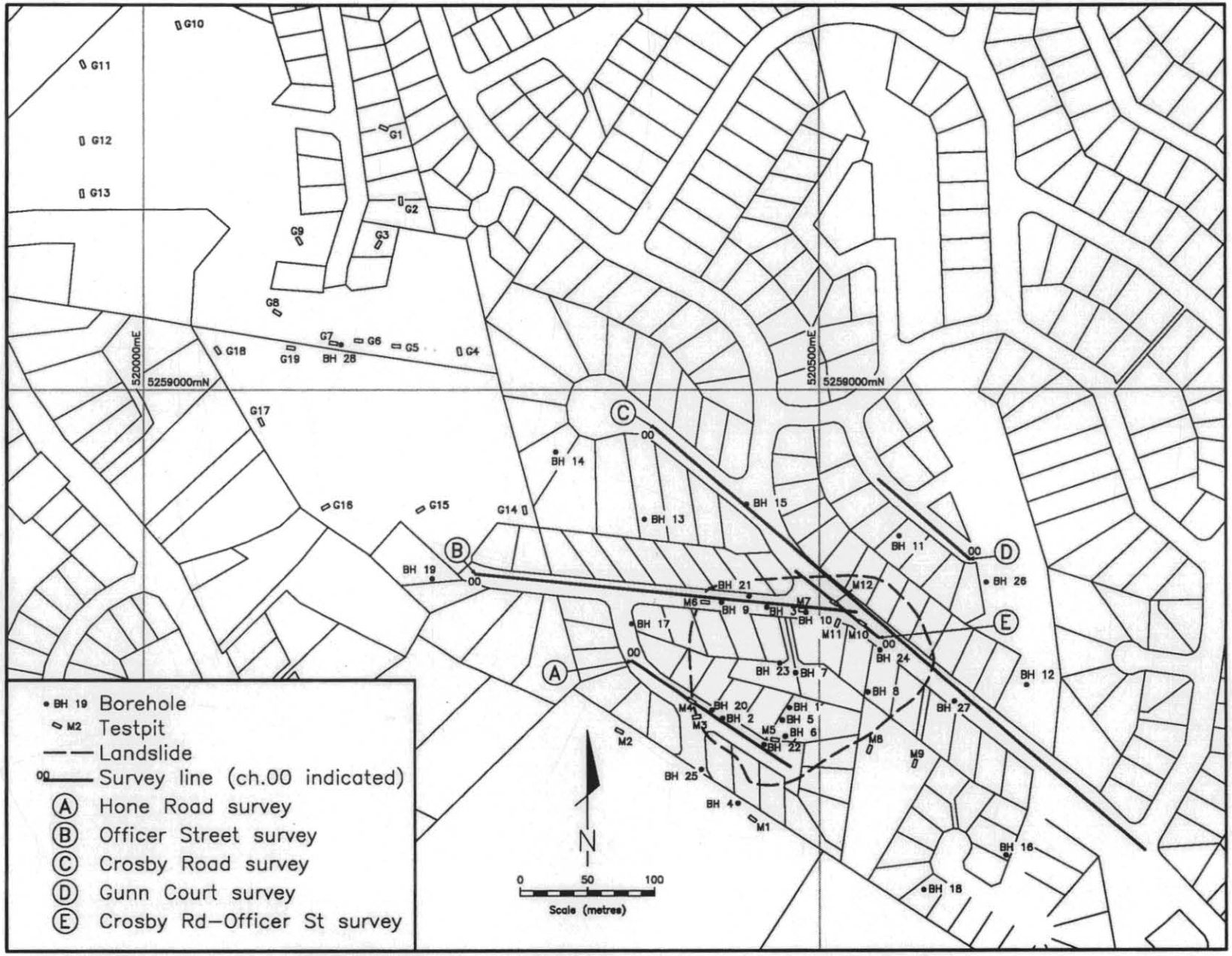

Figure 4. Survey network and locations of bore holes, Rosetta Landslide

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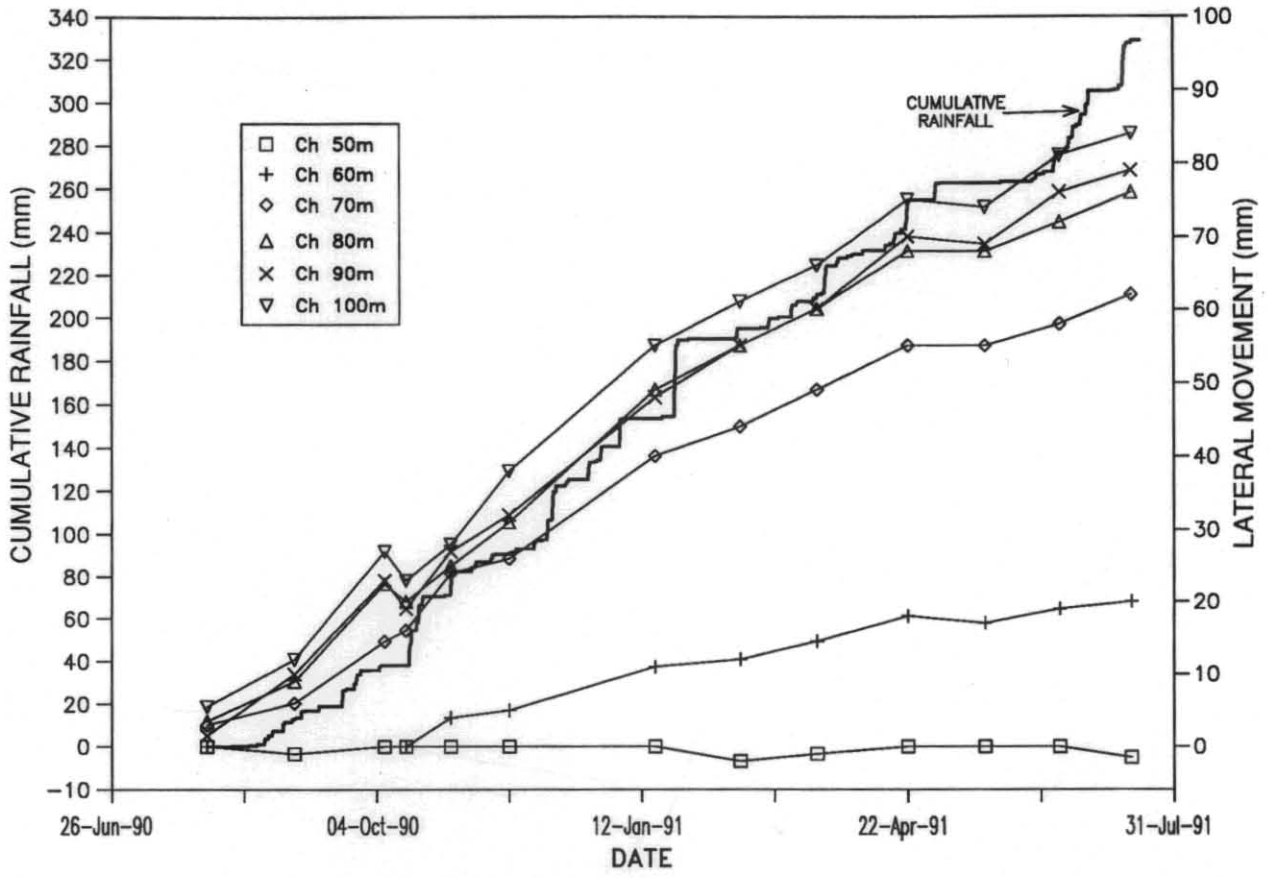

Figure 5. Cumulative rainfall and lateral movement — Hone Road survey line

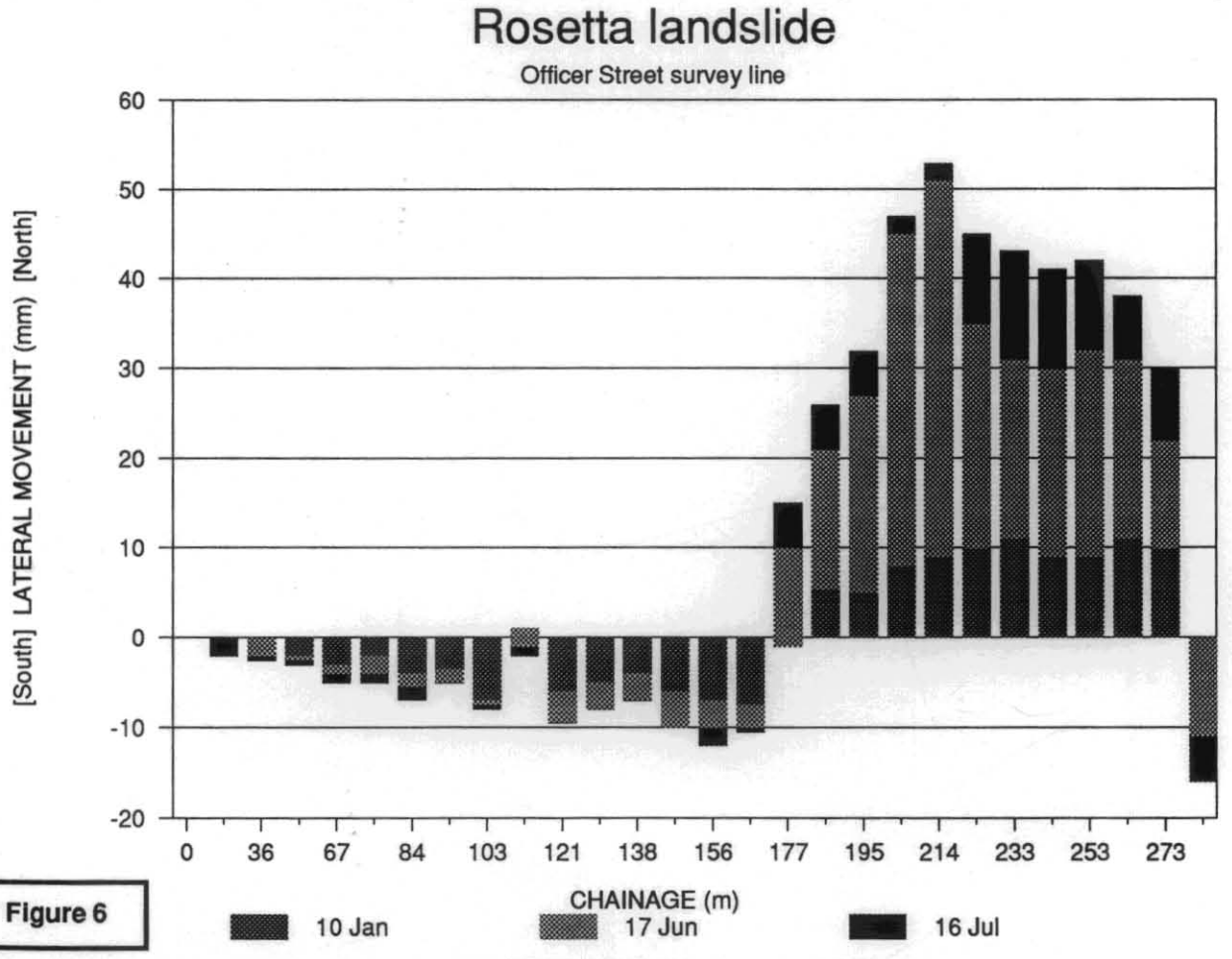

Figure 6

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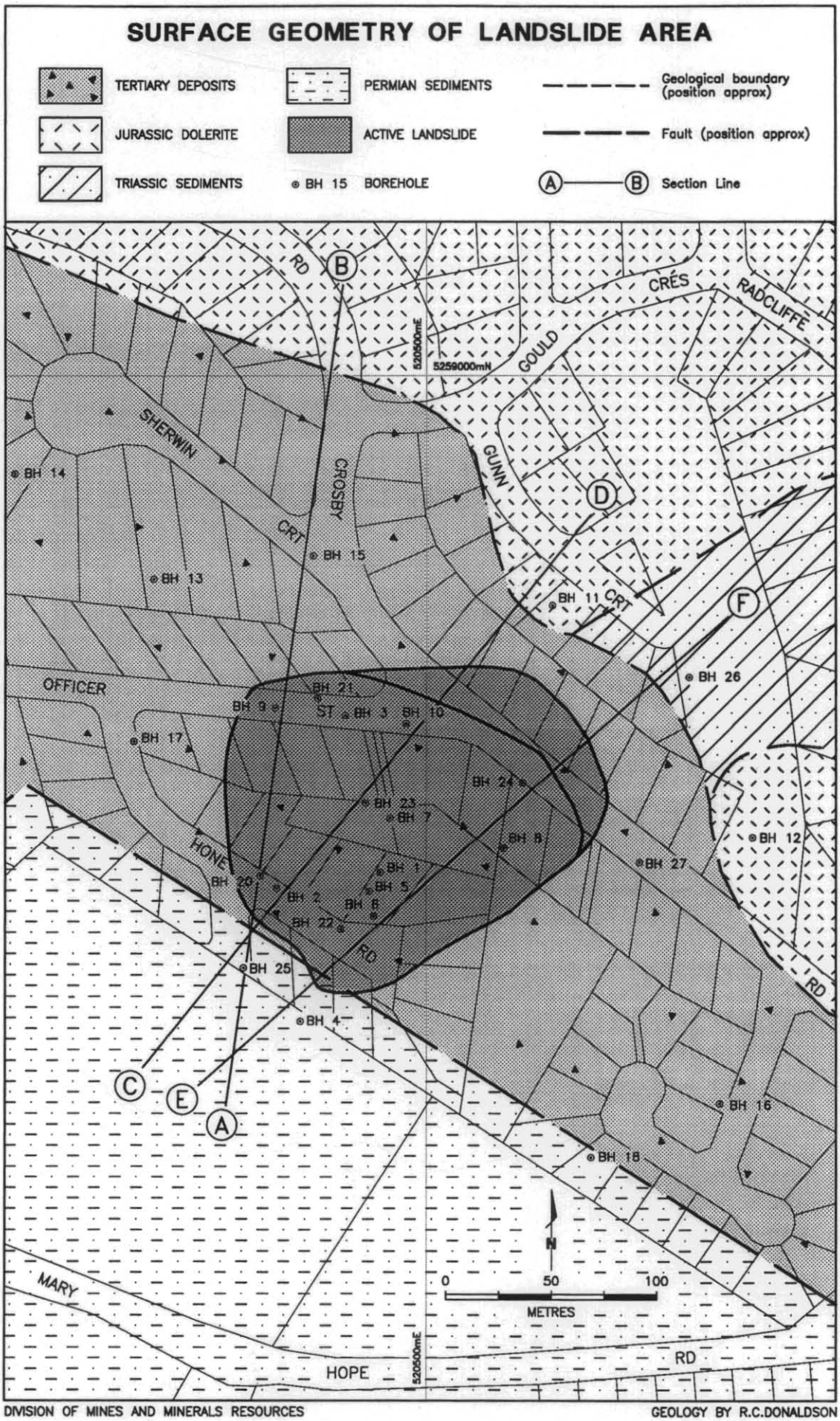

Figure 7

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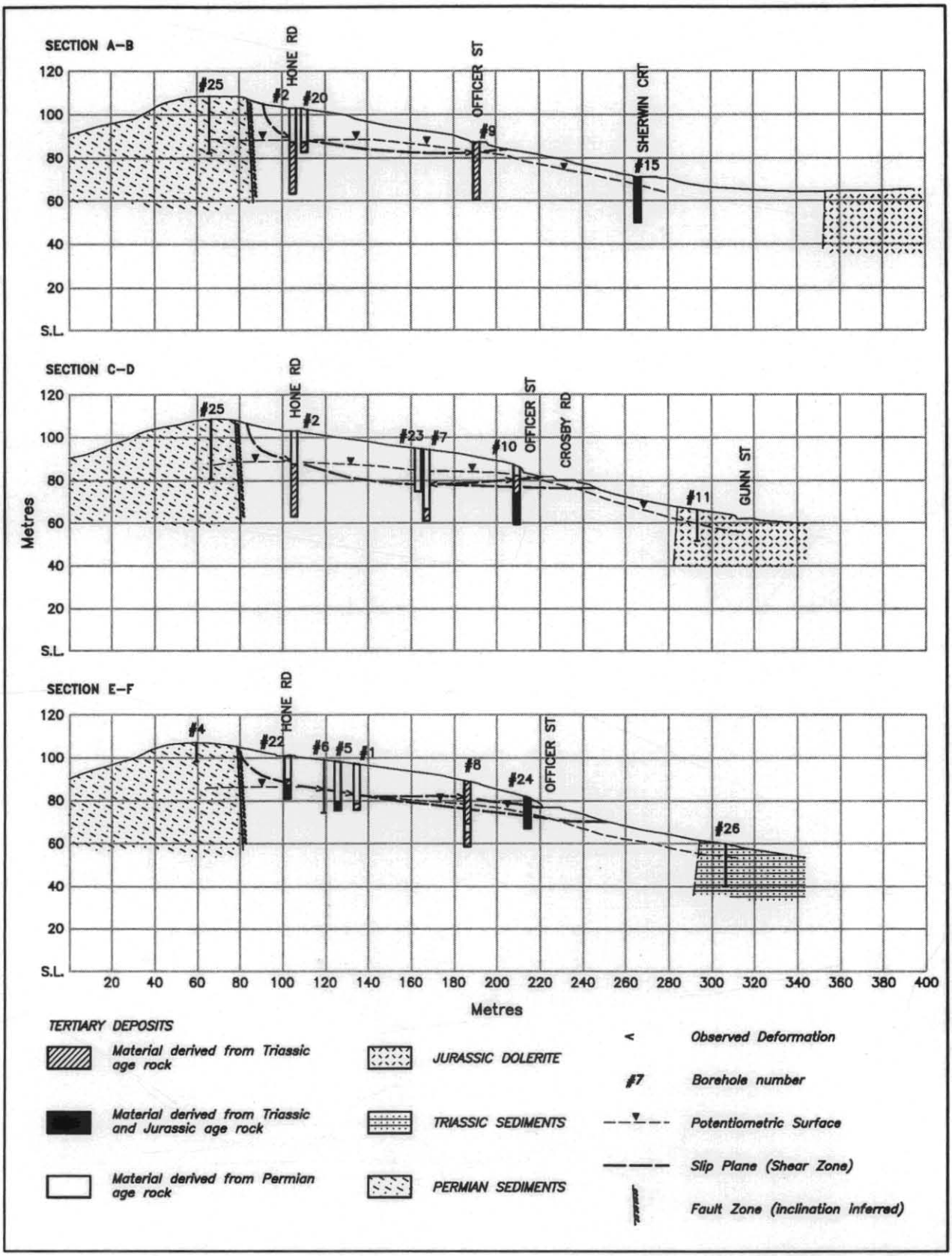

Figure 8

Landslide sections

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was used, involving a rope with a 300 mm long concrete weight marginally smaller than the diameter of the borehole. These weights were lowered down from the surface to determine the top of the deformation zone. In some holes weights were placed at the bottom on completion of drilling; these could then be raised to where they became jammed if the borehole was constricted.

There is insufficient evidence to indicate whether the basal movement is occurring on a low-angle discrete plane or within a broader zone of shearing. In conjunction with an examination of the drill core, the monitoring indicates that the slip plane or zone of deformation is of the order of 13–15 m deep at the headscarp and in the body of the slide, and 5–7 m deep in the toe region along Officer Street.

LANDSLIDE GEOMETRY

The overall three-dimensional shape of the landslide is now relatively well defined from surface evidence and monitoring. A plan showing the outline is presented as Figure 7. The two lines drawn along the toe region of the slide require explanation. The inner line, traversing Crosby Road, represents the currently measurable active region of the toe where movement has been positively identified by the regularly surveyed lines. The outer line, passing below Crosby Road, has been drawn where there are signs of stress to buildings (Nos. 28 and 34 Crosby Road) and misalignment in the kerb and guttering outside numbers 23 and 24 Crosby Road.

The Crosby Road–Sherwin Court survey line has not as yet indicated a definite long-term trend identifying movement, with the exception of two or three stations. However as discussed above, the indications are that the area is under stress and the rate of movement may be more consistent with a creep phenomenon. It is considered only a matter of time before additional movement associated with the outer line becomes evident.

Figure 8 shows three sections through the landslide, indicating the relationship of the slip surface or deformation zone to the geology and groundwater conditions. Although there is a lack of direct information in some areas, the general characteristics of this landslide appear to consist of a relatively steep headscarp, with basal movement occurring on a low-angle shear plane. The third dimension will become progressively better defined as monitoring continues.

Fortunately the movement has been relatively slow to date. However the landslide is continuing to move and therefore new stresses will develop both within and adjacent to the actively moving body. This will, in time, modify the existing shape, with the possibility that the aereal dimensions will increase; to what extent is not known.

HYDROLOGY

An understanding of the hydrology of an area is considered an important aspect of any landslide investigation. Groundwater, or more specifically pore pressure, is probably the major driving mechanism causing the continued movement of the Hone Road–Officer Street landslide. Therefore, of particular interest is the interaction between such variables as water table changes, rainfall, rates of movement and groundwater chemistry.

Rainfall

It is not precisely known at what date movement actually commenced. In the period between December 1989 and January 1990, many residents in the Hone Road–Officer Street area reported that their dwellings were showing signs of stress evident from structural damage.

An examination of the Bureau of Meteorology rainfall records from the Glenorchy Reservoir station reveals that 1989 was the driest year since 1961, with 578 mm of rainfall compared to the long-term average of 715 mm. However October 1989 was an exceptionally wet month, with 139 mm of rainfall recorded; this is well above (80%) the long-term average for October of 76 mm. Moreover, on only three other occasions over the past 15 years had the rainfall for any month exceeded the October 1989 figure.

The relationship between rainfall and slope instability is well documented in the literature. The above evidence suggests a possible correlation between the abnormally high rainfall in October 1989 and the onset of damage to several houses, which was reported some two months later. It is therefore possible that the October 1989 rains were the trigger which initiated the landslide.

Since this major rainfall event in October 1989, the records show that there has been only one month of particularly high rainfall to the end of July 1991. This occurred in July 1990 when there was 199 mm of precipitation, three times the long-term average for this month. Surveying of the landslide movement commenced a month later in August 1990. In contrast to the periods of high rainfall, May 1991 was the second driest month on record, with only 15 mm of rainfall. A rain gauge connected to a Unidata data logger was installed at the rear of 15 Hone Road. The results of monitoring are given Appendix 4.

Seepages

Seepages are a common feature in the area and have been reported by numerous residents over the period of the investigation. They appear to occur randomly and issue from both sides of the ridge from Taylor Court to beyond Sherwin Court. Some occur intermittently and are considered to be directly related to rainfall events.

A prominent seepage in the area occurs on the vacant lot situated at 29 Crosby Road. It appears to be a permanent feature, although variations in the volume of water issuing from the bank do occur. The seepage is close to the interface between the materials derived from the Permian age sediments and the underlying materials derived from the Triassic sediments. This seepage may therefore be the result of a variation in hydraulic characteristics between the materials.

Groundwater Conditions

Deep-seated failures are frequently driven primarily by a rise in pore pressure and corresponding piezometric level, often as a result of groundwater recharge following a significant rainfall event.

Regular weekly monitoring of open standpipe piezometers installed in 24 bores drilled by the Division over the period of the investigation was conducted to determine the hydrological conditions of the area. The results of the monitoring are presented in the Appendix 5.

A feature common to all but one bore (Hole 17) is the relatively static nature of the piezometric levels over the period of monitoring. Most of the bores exhibit only minor water level fluctuations of generally less than 0.5 metres. However the majority of bores appear to show a crude but direct relationship between piezometric level and rainfall (fig. 9). A direct relationship was established between water level fluctuations in Borehole 3 and barometric pressure variations, suggesting the existence of a confined aquifer.

The effect of the large water level fluctuations of up to 5 m, observed in Borehole 17, is considered to be the direct consequence of rainfall events as clearly illustrated in Figure 10. There is a rapid response time and it is considered that the area in the region of the bore is basically behaving as a local recharge mound, and may therefore be a major source for the ingress of water into the landslide mass. Whether the fluctuations are responding entirely to 'natural' infiltration of rainfall, or the bore is in part reflecting artificial recharge conditions from an additional source (runoff from surface drainage, leaking stormwater drains etc.), is unknown.

The recently completed pilot study of the horizontal drainage remedial works, supervised by the Glenorchy City Council, has demonstrated that groundwater levels can be significantly reduced within an area immediately adjacent to the installed drains. This is clearly shown by the fall in water levels in Boreholes 3 and 10 after completion of the pilot drainage study in June 1991 (fig. 11).

The potentiometric surface contour map (fig. 12) shows the conditions as at 22 July 1991, and reflects the effects of a recent rainfall period and the pilot drainage works. The most prominent feature of the contours is the flatter potentiometric gradient within the body of the landslide mass. The flattening is particularly pronounced in the western portion of the landslide. This is also the area of greatest damage to houses and services, and where the outline of the landslide body is most clearly defined on the ground.

The potential zone of influence resulting from these works is indicated by an indentation in the potentiometric contours.

Permeability

A series of falling head permeability tests carried out on several bores indicates that the hydraulic conductivity (K) of the materials varies between 10^{-3} and 10^{-6} cm/sec. These values are typically in the range expected for sand-silt-clay mixtures which characteristically behave as low permeability materials.

Groundwater Chemistry

Major changes in water chemistry commonly occur as groundwater moves along its flow paths from recharge to discharge areas. These changes often result in an increase in groundwater salinity. Therefore analyses of the groundwater obtained from the numerous bores in the area may assist in defining such areas.

Conductivity measurements of water extracted from the majority of the bores as at 18 July 1991 have been contoured and are presented in Figure 13. The results indicate a groundwater body with a wide range of conductivity values (salinity) occurring within a very localised area. The distribution and nature of materials in the area are known to be highly variable, and therefore the rates of groundwater movement and the salinities could also be expected to differ.

Consistent features appear to be the low conductivity values behind the headscarp (370 µS/cm), the slightly higher values in the head of the landslide along Hone Road (1360–1760 µS/cm), the highly variable readings within the body of the landslide (1570–10 700 µS/cm), and the consistent values along Officer Street at the toe (4150–4600 µS/cm). The relatively fresh nature of the water obtained from the bores behind the headscarp indicates that this is possibly a major local recharge area. The large variation in conductivity values from within the body of the landslide suggests a complex hydrological regime.

Outflows from the horizontal drainage pilot works at the Crosby Road–Officer Street intersection have consistently shown high salinity levels of between 8 000–10 000 µS/cm. With time, there has been a slight increase in conductivity values as the volume of groundwater issuing from the drains has decreased. The salinities associated with the horizontal drains are approximately double the values recorded in the vertical bores along Officer Street. It would therefore appear that there is a body of highly saline groundwater in the main body of the landslide to the south of Officer Street.

Tertiary sediments in southeast Tasmania are well known for their high salinities. It is possible that the high conductivity values observed in several of the vertical boreholes and in the horizontal drains represent the background threshold values, or represent areas of impeded groundwater flow. The lower conductivity values may represent recharge flow paths or conduits originating from the area to the west of the landslide.

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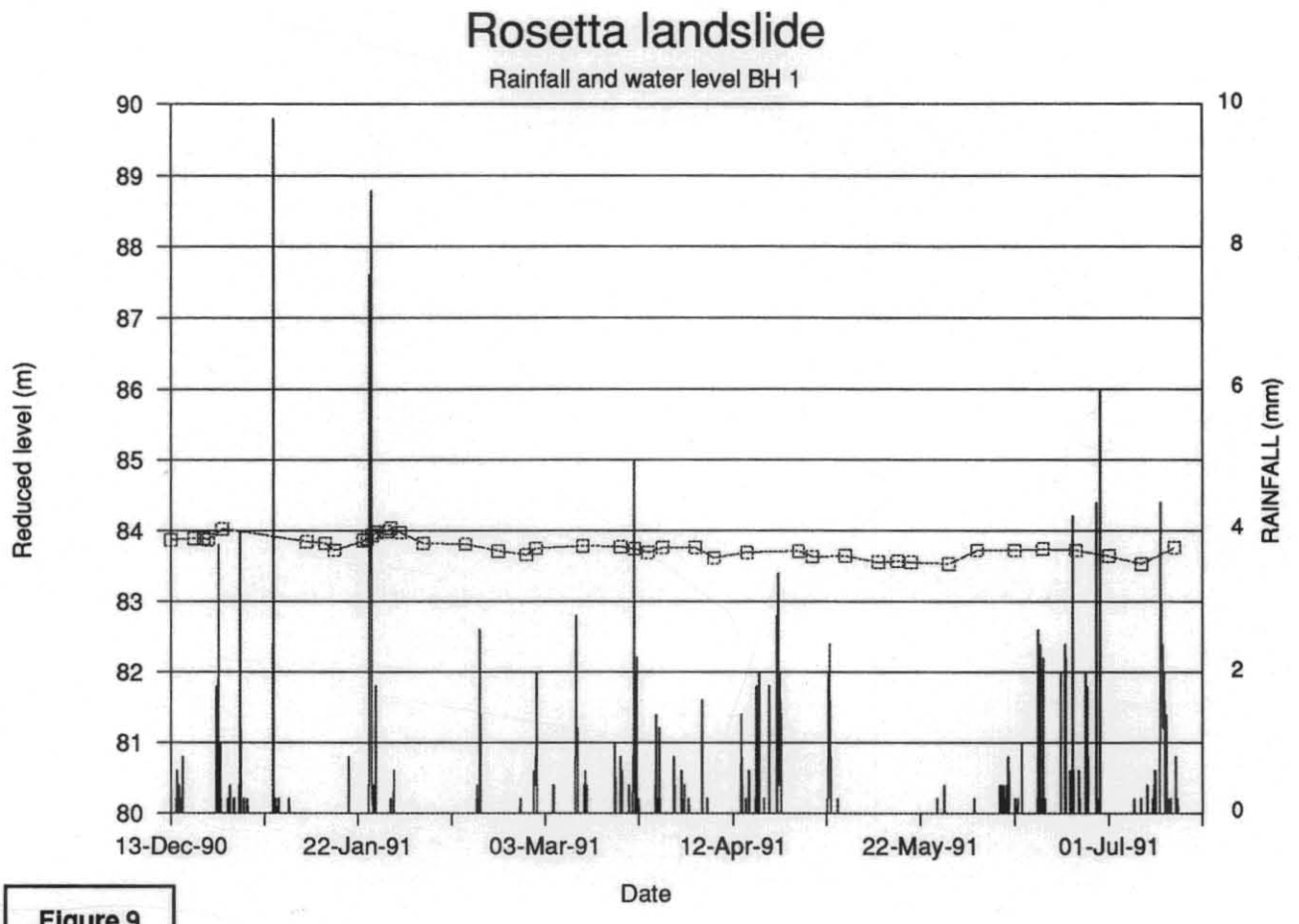

Figure 9

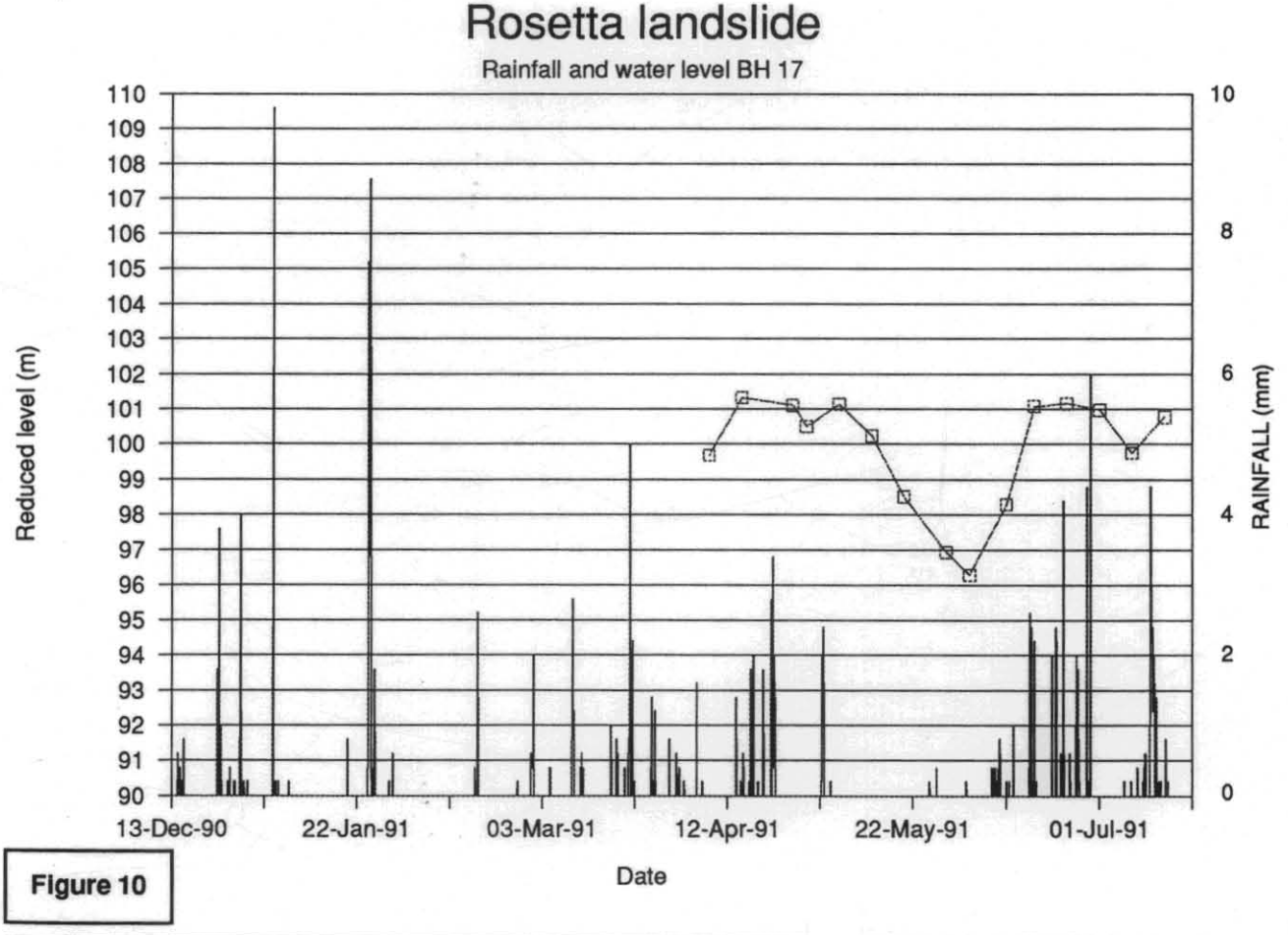

Figure 10

5 cm

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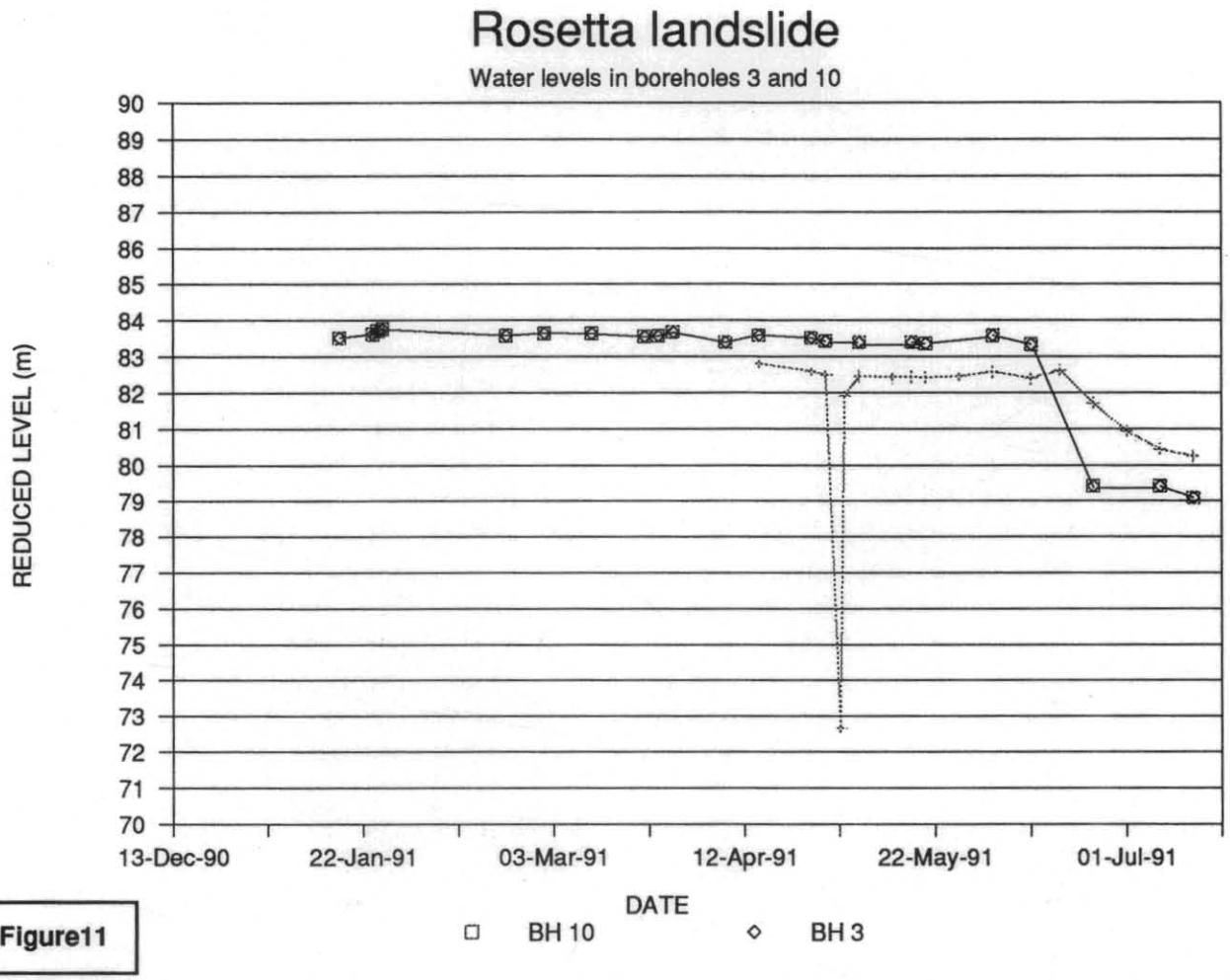

Figure11

Table 2.

Summary of pump test results

Borehole No.	Method	Drawdown		Volume (litres)		Ratio	24 hour recovery (m)
		metres	minutes	contained	extracted		
6	bailed	5.5	10	18	21	1.17	3.2
7	bailed	19.4	45	123	200	1.63	9.4
7	pumped	10.2	105	65	145	2.23	4.5
8	bailed	13.5	35	86	170	1.98	7
8	pumped	8.1	70	51	90	1.76	4
9	pumped	20	45	127	410	3.23	10
10	pumped	10	45	64	70	1.09	9.4

NOTES:

1. Contained volume is the volume of water stored within the casing, assuming that the borehole has the same volume as the internal volume of the casing.

2. The ratio of the volume of water extracted / volume of contained water provides a rough indicator of the efficiency of the bore as a water producer. A ratio of 1 indicates that the bore did not produce any additional formation water over the period of the test.

5 cm

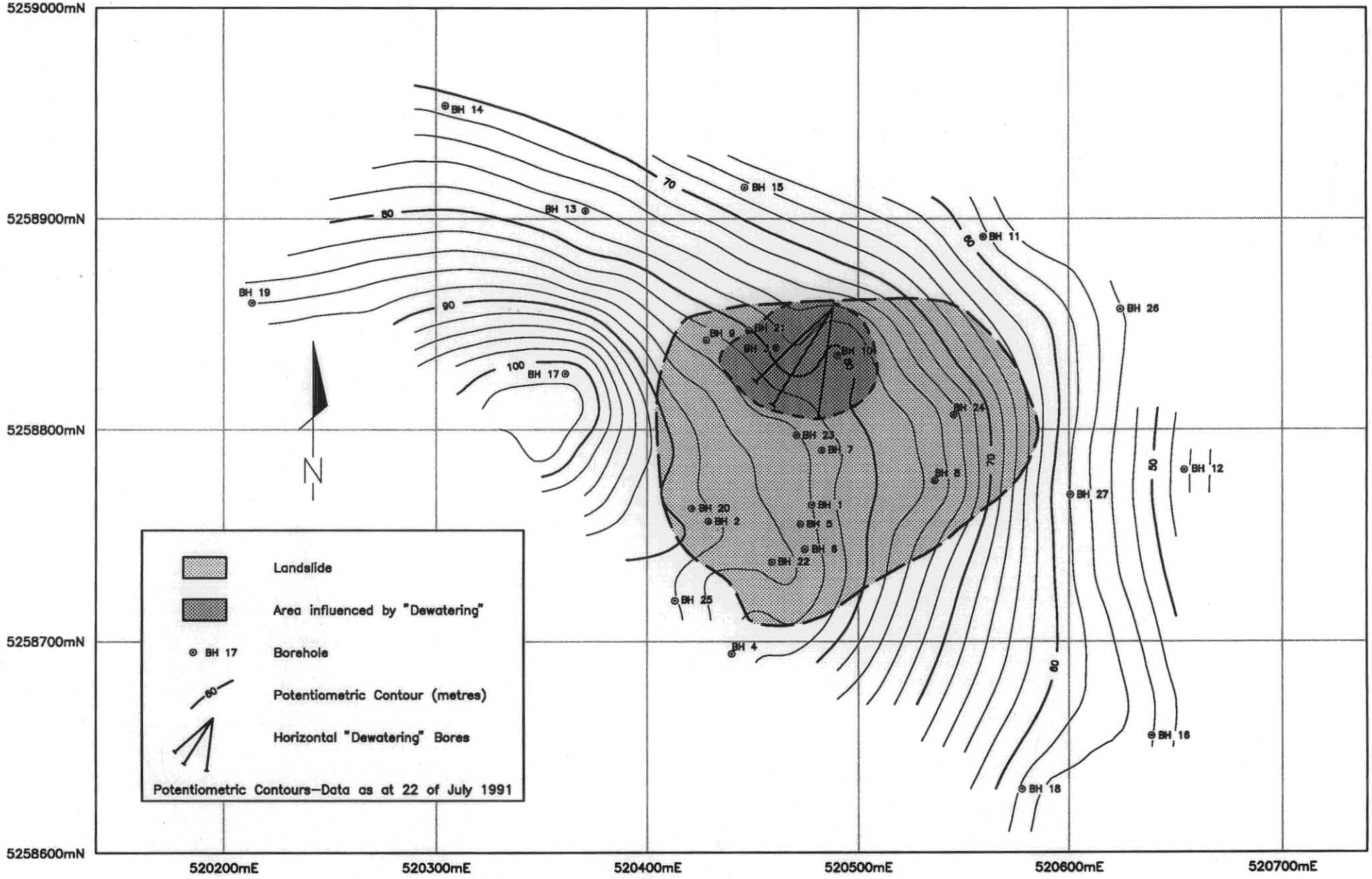

Figure 12. Potentiometric surface contour map

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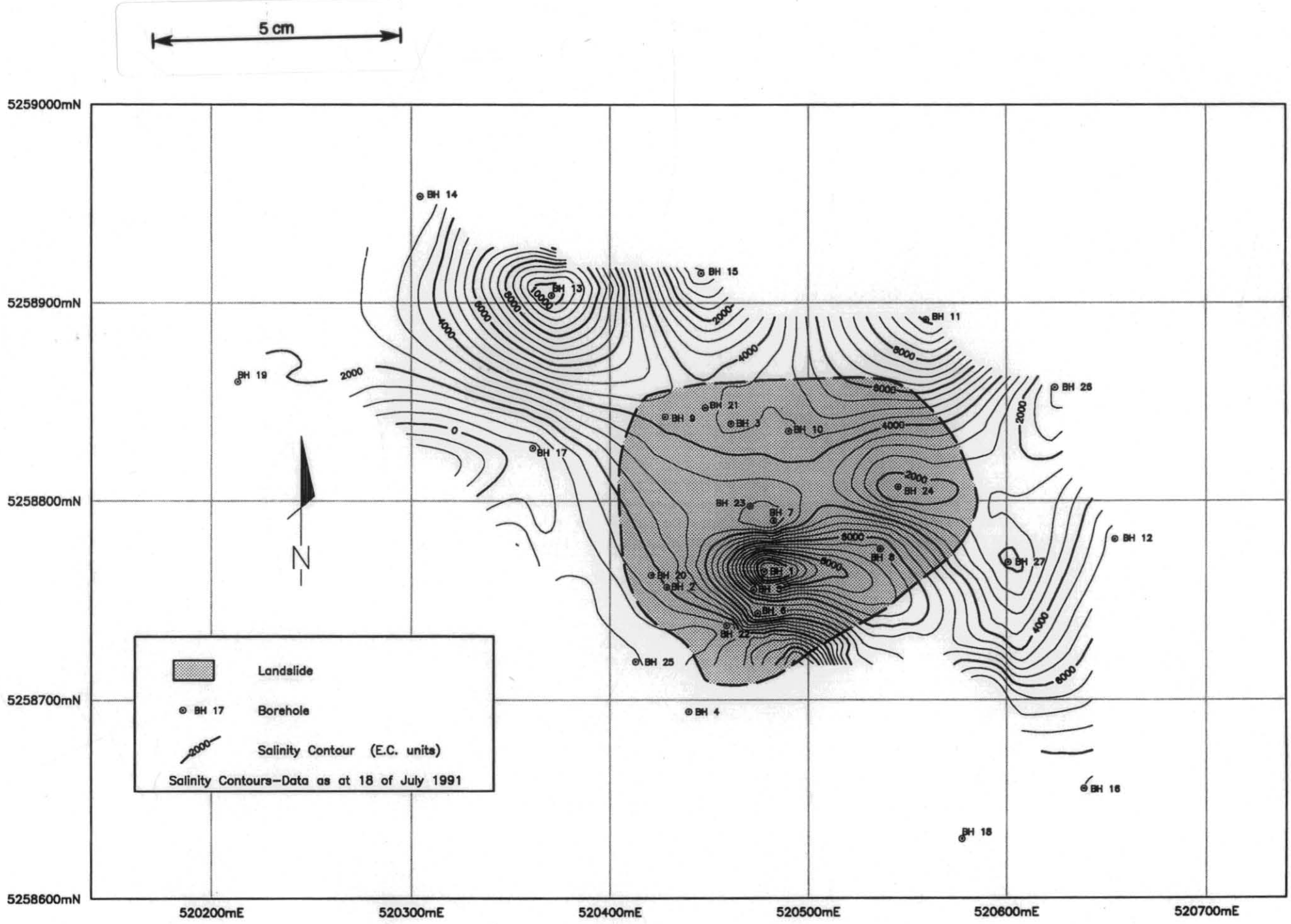


Figure 13. Conductivity (salinity) contour map

Chemical analysis of samples from pump tests shows that the groundwater is basically either a sodium chloride or sodium bicarbonate type. Fluoride values vary between 0.4 and 1.2 mg/L, whilst concentrations of nitrate in the water were <10 mg/L. Analytical results are presented in Appendix 6.

Further investigation is required to fully understand the groundwater chemistry of the area and its significance.

Pump Testing

Pump tests were carried out on five boreholes to assess the potential for dewatering the landslide as a stabilisation technique. Initially three holes were hand bailed and subsequently a venturi pump was installed in four holes, two of which had been previously bailed. Practical difficulties were encountered in installing the pumps down the hole to the required depth, because of slight distortions in the casing caused either during the installation or by landslide movement. This reduced the effectiveness of the tests as the pump was unable, with the possible exception of Borehole 9, to fully penetrate the aquifer or to be placed at a suitable depth where the water was entering the bore under pressure. Hence complete drawdown was not achievable and this may account for the relatively low volumes of water extracted. It is probable that higher yields would have resulted with deeper penetration of the aquifer.

A summary of the results is presented in Table 2. In general, the vertical hole pump tests demonstrated that this technique can extract small but useful quantities of water. Only Borehole 9 significantly penetrated the aquifer; 410 litres of water were extracted, which is an encouraging result for consideration of effective dewatering by vertical pumping.

In summary, a compilation of all the groundwater data suggests a complex hydrological regime. It is intended to continue periodic monitoring of the piezometers, particularly following periods of substantial rainfall.

KEY FACTORS ASSOCIATED WITH THE LANDSLIDE MOVEMENT

The factors which influence the development of landslides are either 'natural', such as the interaction of geology, topography and climate, or due to human intervention.

The geological conditions under which the Tertiary sediments at Rosetta were deposited have resulted in a variety of materials with different physical characteristics. It is this non-homogeneity of materials, and the occurrence of weaker zones (such as matrix materials), that make these Tertiary sediments susceptible to landsliding.

A landslide can rarely be attributed to a single factor; there is often a chain of inter-related factors, all of which may contribute to failure. The factor that finally instigates failure is referred to as the triggering mechanism but it alone cannot be regarded as the only cause, it is merely the final link in the chain of events. This is an important concept to consider when evaluating the causes of a landslide.

Probably the most commonly attributed natural trigger mechanism of landslides is rainfall, as it is influential in controlling pore pressures within a slope. The effect of rainfall can be difficult to evaluate analytically because its relationship with other factors, such as permeability, are often complex. Although the abnormally high rainfall period in October 1989 and the onset of stress to several houses some two months later are possibly coincidental, one can only speculate that this may have been the trigger that finally initiated movement.

Urban development can have a profound effect in initiating slope movements by altering the natural geological, topographical and hydrological conditions operating in an area. There is undoubtedly a host of factors at Rosetta which have collectively brought about changes in slope and groundwater conditions as a direct result of subdivision development. Some of the principal factors which may have contributed to the initiation of the landslide are listed below;

- removal of the original vegetation covering the slope;
- modification of the slope and surface drainage resulting from the substantial earthworks associated with road construction and general slope grooming;
- possible removal of support in critical areas associated with roadworks (Crosby Road–Officer Street intersection);
- further redistribution of loads across the slope as a result of the construction of substantial brick dwellings; importation of garden soils etc.;
- additional water entering the ground in the process of establishing and maintaining gardens; possible leaking services following periods of rainfall etc.

There are undoubtedly many additional significant factors which may have played a role. These either contribute to an increase in shear stress or a reduction in shear strength, which in turn alters the natural long-term stability of the slope.

The pattern of development in the area has been such that subdivision commenced on the lower slopes and progressed upslope, the last area to be developed being the Hone Road area. It is possible that the slope was at the limit of instability and this last stage of development may have been the final link in the chain.

There are numerous possible scenarios, however there is insufficient evidence to determine with confidence whether the landslide has been triggered by natural causes, development of the area, or a combination of both.

STABILITY ANALYSIS OF FAILURE

The investigation has established the basic geometry of the landslide and defined the most probable slip surface. A section through the landslide (Section CD, fig. 7) was analysed using Janbu's non-circular failure method.

There is often insufficient information about the *in situ* parameters (geometry of slip surface, piezometric level, strength parameters etc.) to enable the model to be accurately defined.

It was considered more appropriate to employ a relatively simplified method like Janbu, which allows for the actual geometry of the landslide to be modelled, than to approximate the slip surface by a circular failure for analysis by Bishop's Simplified Method or similar. The aim of the analysis was to input the information obtained from the investigation in order to gain a feel for the accuracy and reliability of the factual data.

Two slip surfaces were considered for analysis; the main difference is in the toe area as shown in Figure 8. The upper failure intersects the ground surface at the junction of Officer Street and Crosby Road. The lower failure extends downslope below Crosby Road. These slip surfaces are discussed in the **Landslide Geometry** section of this report.

The initial stability computations were based on the lowest measured strength parameters obtained from direct shear testing ($\phi'_r = 11°$, $c'_r = 2$ kPa), a density (γ) of 19 kN/m^3, and the groundwater conditions as observed from borehole information. This resulted in a Factor of Safety of 1.26 and 1.12 for the upper and lower slip surfaces respectively, as indicated in Table 3.

Analysis has shown that by considering the steep headscarp of the landslide as a tension crack and using the initial input data, the FS fell to 1.20 and 1.07 respectively. Furthermore, the effect of a 1.0 m rise in the potentiometric surface, as may be expected following a significant rainfall event for example, demonstrated a resultant FS close to unity (1.02) for the lower slip surface situation. If one assumes the long term c = O condition, analysis indicates that a FS close to unity is readily achievable, again on the lower slip surface.

The overall impression gained from the analysis is that the measured input data (strength, groundwater and slope geometry) fits the lower slip surface model reasonably well. However, because of the greater restoring forces in the toe region of the upper slip model, a reduction in the ϕ'_r value of about 2° is required to achieve failure. Alternatively, an increase in the piezometric level of several metres would be needed to achieve a similar result. This suggests either that the geometry of the upper slip surface has not been correctly defined, or the range of the strength parameters of the materials involved in the landslide have not been fully determined. The latter is possible, as it was difficult to obtain sufficient suitable material for shear testing.

Finally, stability analysis is only one of several tools which are used in the assessment process, and too great an emphasis and reliance on the resulting factor of safety can be misleading. This can especially occur when there is inherent variability and a non-homegeneity in the materials, as is the situation at Rosetta.

Table 3.

Results of Stability Analysis

Input Parameter				Factor of Safety (FS)	
ϕ'_r (°)	c'r (kPa)	TC	Water	Upper slip surface	Lower slip surface
11	2	-	-	1.26	1.12
11	2	✓	-	1.20	1.07
11	2	✓	✓	1.16	1.02
11	0	-	-	1.20	1.06
11	0	✓	-	1.15	1.01

TC = tension crack
Water = 1.0 m rise on piezometric level

FAILURE MECHANISM

The primary mechanism associated with the movement is considered to be the driving force of the water (pore pressure), which is facilitated by failure in the low-strength matrix materials.

Direct shear testing of the low-strength matrix materials has resulted in values of $\phi'_r = 11–17°$ and $c'_r = 2–4$ kPa. In addition to the low-strength matrix material, examination of the core reveals the rock mass to contain clay-lined and slickensided defects. In summary, there are therefore numerous places where shearing could occur.

Figure 8 shows the relationship between the slip plane and the piezometric level observed in several boreholes. The potentiometric surface appears to be up to 4–5 m above the slip plane in parts of the landslide. Further sliding is likely to continue while these piezometric levels are maintained.

Although there is no conclusive evidence, the most obvious movement has occurred along the headscarp and left flank. Shearing is possibly translated into the remainder of the slide by a progressive mechanism.

As discussed previously materials derived from Permian age rock are predominant only within the landslide mass. This raised the question of whether the failure mechanism could be due to these materials behaving as a single block, or as a series of discrete blocks sliding as a whole on the underlying slope deposit materials derived from the Triassic age rocks. Figure 8 clearly shows the slip plane as occurring in both lithologies. This is also apparent if a section is constructed through the bores along Officer Street. It is evident that shearing may therefore develop along any plane or zone of weakness within the Tertiary deposits.

It follows that the potential for landslide activity cannot be disregarded on adjacent slopes underlain by these Tertiary deposits where low-strength horizons are present.

In summary, the landslide is likely to progressively develop whilst hydrological conditions remain similar to those currently existing.

LANDSLIDE RISK ASSESSMENT

The recognition of areas prone to instability, or actively undergoing movement, requires an understanding of the interaction of the geological, morphological, hydrological and human processes that have operated in the area over time. The degree of confidence in correctly evaluating the stability of an area is dependent on the accuracy of the data collected from the site, and the subsequent interpretation of that data.

Ultimately, any risk assessment process involves a degree of uncertainty, because at every site there may be some unique feature which will not be apparent to the assessor.

The current study has focussed largely on the northeast-facing flank of the hillside on which the presently active landslide has developed. As a result, the risk assessment process has been restricted to this specific area. It encompasses the area adjacent to the landslide and underlain by Tertiary deposits as determined from the extensive subsurface investigation. An outline of the area assessed is shown in Figure 14.

Classification Philosophy

The Division has been involved in landslide hazard mapping for more than 20 years. Over this time, a two-tier zoning scheme has evolved and is in place in several areas throughout the State.

The lower tier is descriptive and is based on a series of classes or zones of increasing landslide risk. The zones are advisory only, intended as a guide to the public and Government Authorities, and provide an estimate of landslide risk.

The upper tier is a proscriptive system based on legislation and is brought into use when the advisory system is no longer considered appropriate. It has usually been implemented in places where landslide damage has occurred to properties in urban areas. The proscriptive zones are known as 'A' and 'B' landslip zones under Section 431A of the *Local Government Act (1962)*. It is this system which is being used in relation to the Rosetta landslide.

Landslip 'A' areas are those considered to have inherent instability. They usually include areas where actual physical movement has occurred, together with a surrounding zone. They are considered to be high risk areas and no further building is allowed in these areas apart from some minor exceptions.

Landslip 'B' areas usually surround the 'A' landslip areas. The 'B' areas generally have similar topographic and geologic conditions to those that occur in the 'A' landslip areas, but where no signs of movement have been observed. The landslide risk in 'B' areas is considered to be lower than in 'A' areas. The 'B' areas are considered safe for development provided that some commonsense precautions are taken which recognise the potential landslide hazard. These precautions are controlled by Part IV, Division 5 of the *Tasmanian Building Regulations (1978)*. In summary these regulations cover the siting and size of dwellings; the amount of earthworks permitted to construct the dwelling; drainage; and the removal of trees.

In effect the 'A' and 'B' zoning indicates to future potential purchasers the landslide hazard status of a particular property. Where buildings and structures are erected in an

'A' or 'B' landslip area after its proclamation, the building regulations previously mentioned must be adhered to. The Crown will give no compensation or other relief for any damage caused by earth movement to such buildings or structures.

CLASSIFICATION CRITERIA

Landslip 'A' Zone

The criterion developed for the determination of the 'A' landslip area at Rosetta was to put in place a 20 m wide envelope around the perimeter of the area where active movement has occurred (fig. 15).

Areas immediately adjacent to a landslide, such as that which has occurred at Rosetta, are frequently under stress as a result of the shearing forces associated with the movement. This may also result in a reduction of support to the immediate surrounding area. The physical boundary of the landslide, represented as a single discrete line, in fact could be considered as a zone of deformation possibly several metres wide or even greater.

With continued movement new stresses will develop in areas under tension (headscarp), compression (toe) and along zones of lateral shearing (flanks). As a result, there is a distinct possibility that the dimensions of the landslide will increase with time. The extent to which this could develop is not known. The current rate of movement is slow and changes should therefore be gradual. If the headscarp of the landslide progresses upslope, then it is considered likely that it could extend to the ridgeline which is currently some 20 m distant.

Based on the opinions expressed above, and the findings of the investigations, the inclusion of the 20 m buffer zone is considered to be of an appropriate magnitude for the closed residential area. It is a zone of high risk where the potential for further movement is considered to be a distinct possibility.

Landslip 'B' Zone

The purpose behind a 'B' landslip classification is to provide a grading in the level of risk in areas adjacent to an 'A' landslip area. The initial criteria selected to determine areas for consideration under the 'B' classification at Rosetta was based on a similarity in geological and topographical conditions to those occurring in the 'A' landslip area. This therefore involved those areas underlain by Tertiary deposits.

Theoretically, the steeper the slope the greater the chance that landsliding will occur. However it is often possible to determine lower (threshold) limits of slope below which landslides are unlikely to occur. This has been successfully achieved in other parts of the State; 7° for the Tertiary sediments in the Tamar Valley and 14° for the Tertiary basalt terrain on the North West Coast. The threshold values are related to the physical properties of the materials.

The incidence of landslides in the Hobart area is particularly low in comparison to the Tamar Valley and North West Coast, and hence there is limited field data to determine a threshold slope value in the area underlain by Tertiary deposits. Care must be exercised in transferring information about threshold slope values from one area to another. Because of lithological differences and physical characteristics, the relationship established between slope and landslide occurrence in the Tertiary sediments in the Launceston area is little help in selecting a threshold angle for the Tertiary deposits associated with the Rosetta landslide.

The Tertiary deposits at Rosetta are essentially gravel to boulder-size rock fragments supported in a sand-silt-clay matrix. They can be considered as a low strength, poorly sorted, weakly consolidated material. The strength characteristics of these deposits are governed by the matrix, and any preferred shearing would occur within this or along predetermined defects such as slickensided surfaces or clay-lined joints. In terms of material fabric there is little to differentiate between the Tertiary deposits at the site of the landslide and those in adjacent areas.

Based on the above discussion and the findings of the investigation, the following factors have emerged in relation to the selection of criteria for 'B' landslip areas at Rosetta.

- The presence of Tertiary deposits (i.e. similar geological conditions).
- The overall physical properties and characteristics of the materials occurring within the landslide mass are similar to those in adjacent areas.
- Distinct differences in the hydrological conditions operating within the landslide from those on the adjacent slopes; this is not unexpected.
- The overall slope of the landslide is, on average, about 10°
- The clay matrix materials have low strength values.

On the evidence available, it is considered reasonable to assume a threshold slope value of 10° for delineating the lower limit at which landslides may develop in these Tertiary deposits. Therefore, slopes of 10° or greater and underlain by Tertiary deposits have been recommended for inclusion into the Landslip 'B' zone.

Proclamation on Administrative Grounds

Landslides, their causes and their consequences, do not respect property boundaries. The areas delineated for proclamation as either 'A' or 'B' landslip zones were initially drawn on technical considerations (fig. 15). This resulted in zone boundaries cutting across properties and through houses.

In an attempt to avoid potential administrative problems associated with this aspect, the Division has amended the technical zone lines in closely built-up areas where minimum lot sizes occur to conform to property boundaries (fig. 16). The criterion used was:- if a technical zone line cut across the building envelope of a minimum size lot, then the entire lot would be incorporated into the higher risk landslip classification. On larger lots, the technical line itself has been recommended for proclamation.

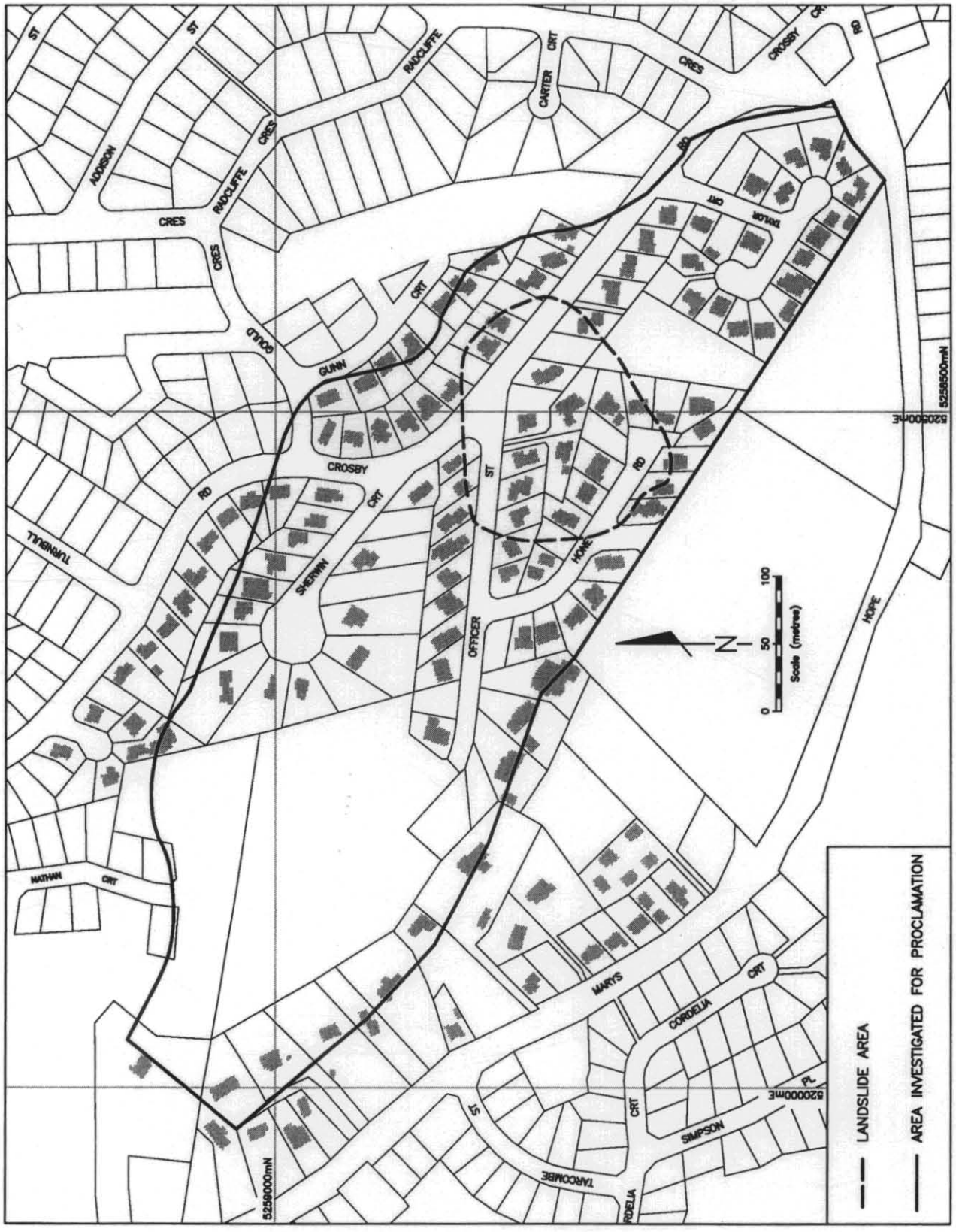
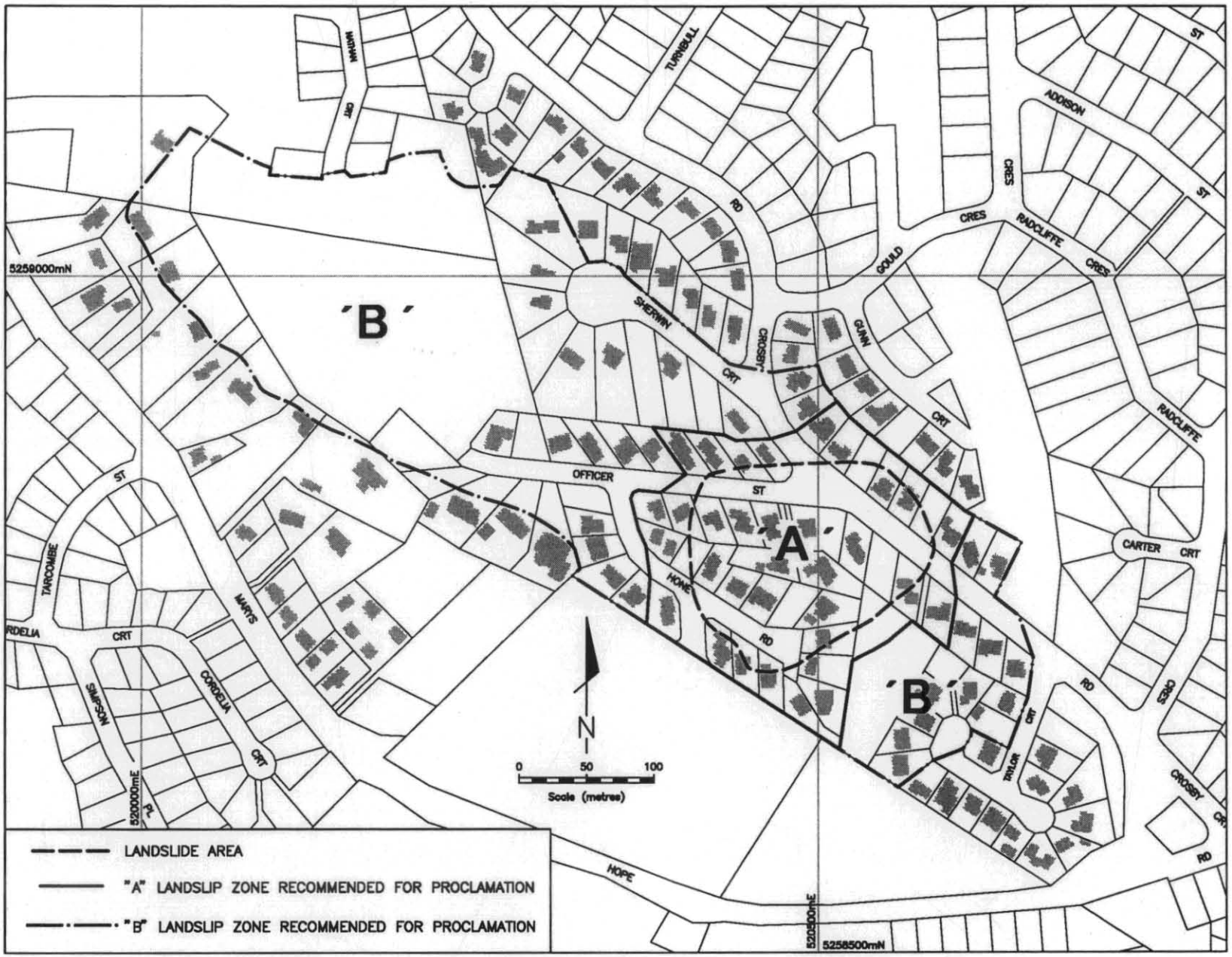


Figure 14. Area investigated for proclamation

5 cm

Figure 15. 'A' and 'B' Landslip Zones



5 cm

Figure 16. Recommended 'A' and 'B' Landslip Proclamation Zone

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APPENDIX 1

Material characteristics

Sample Number: 1

Location: Test pit M10 — at intersection of Officer Street and Crosby Road
Depth: ≈ 0.90 m
Description: Grey silty clay (CH)
Atterberg Limits: LL = 60 PL = 22 LS = 15
Emerson Number: 1
Strength parameters: ϕ_r' = 12° c_r' = 2 kPa
Particle size distribution: clay = 61% silt = 34% sand = 5%

X-ray diffraction:	Quartz	Montmorillonite	Halloysite	Goethite	Anatase	Mica
Whole sample	40	35	15	5	5	2
Clay fraction	5	60	25	10		

Sample Number: 2

Location: Test pit M10 — at intersection of Officer Street and Crosby Road
Depth: ≈ 2.0 m
Description: Carbonaceous silty clay (CH)
Atterberg Limits: LL = 67 PL = 28 LS = 17
Emerson Number: 2
Strength parameters: ϕ_r' = 15° c_r' = 3 kPa
Particle size distribution: clay = 78% silt = 20% sand = 2%

X-ray diffraction:	Quartz	Montmorillonite	Halloysite	Goethite	Anatase	Mica
Whole sample	15	75	-	2	2	5
Clay fraction	-	95	-	-	-	5

Sample Number: 3

Location: Borehole 10
Depth: 7.0 m
Description: Yellow-brown sandy clay (CH)
Atterberg Limits: LL = 104 PL = 23 LS = 18
Emerson Number: 1
Strength parameters: ϕ_r' = 17° c_r' = 4 kPa
Particle size distribution:

X-ray diffraction:	Quartz	Montmorillonite	Feld	Goethite	Chlorite	Mica
Whole sample	30	50	10	5	5	-
Clay fraction	-	85	-	5	10	-

Sample Number: 4

Location: Borehole 20
Depth: 16 m
Description: Mottled yellow-brown and grey clay (CH) — some fine sand
Atterberg Limits: LL = 69 PL = 23 LS = 18
Emerson Number: 1
Strength parameters: ϕ_r' = 11° c_r' = 2 kPa
Particle size distribution:

X-ray diffraction:	Quartz	Montmorillonite	Illite/mica	Halloys/kaolinite	Feldspar	Anatase
Whole sample	45	30	10	10	2	2
Clay fraction	-	60	20	20	-	-

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Sample Number: 5

Location: Borehole 13
Depth: 11.5–13.0 m
Description: Grey clay (CH) — some fine sand
Strength parameters: $\phi_r' = 15°$ $c_r' = 4$ kPa

Sample Number: 6

Location: Borehole 28
Depth: 6.0 m
Description: Green-grey clay (CH) — some fine sand
Strength parameters: $\phi_r' = 15°$ $c_r' = 2$ kPa

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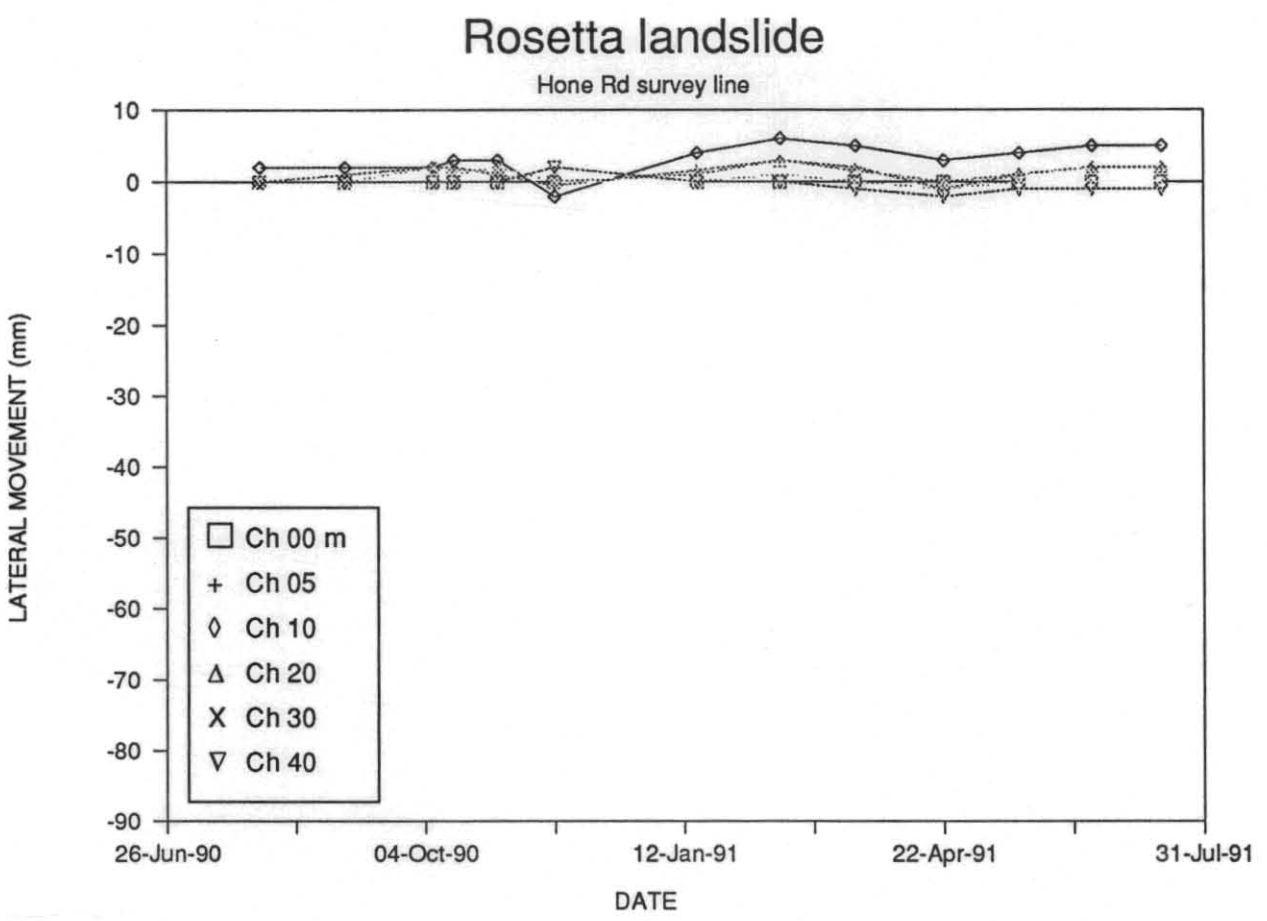
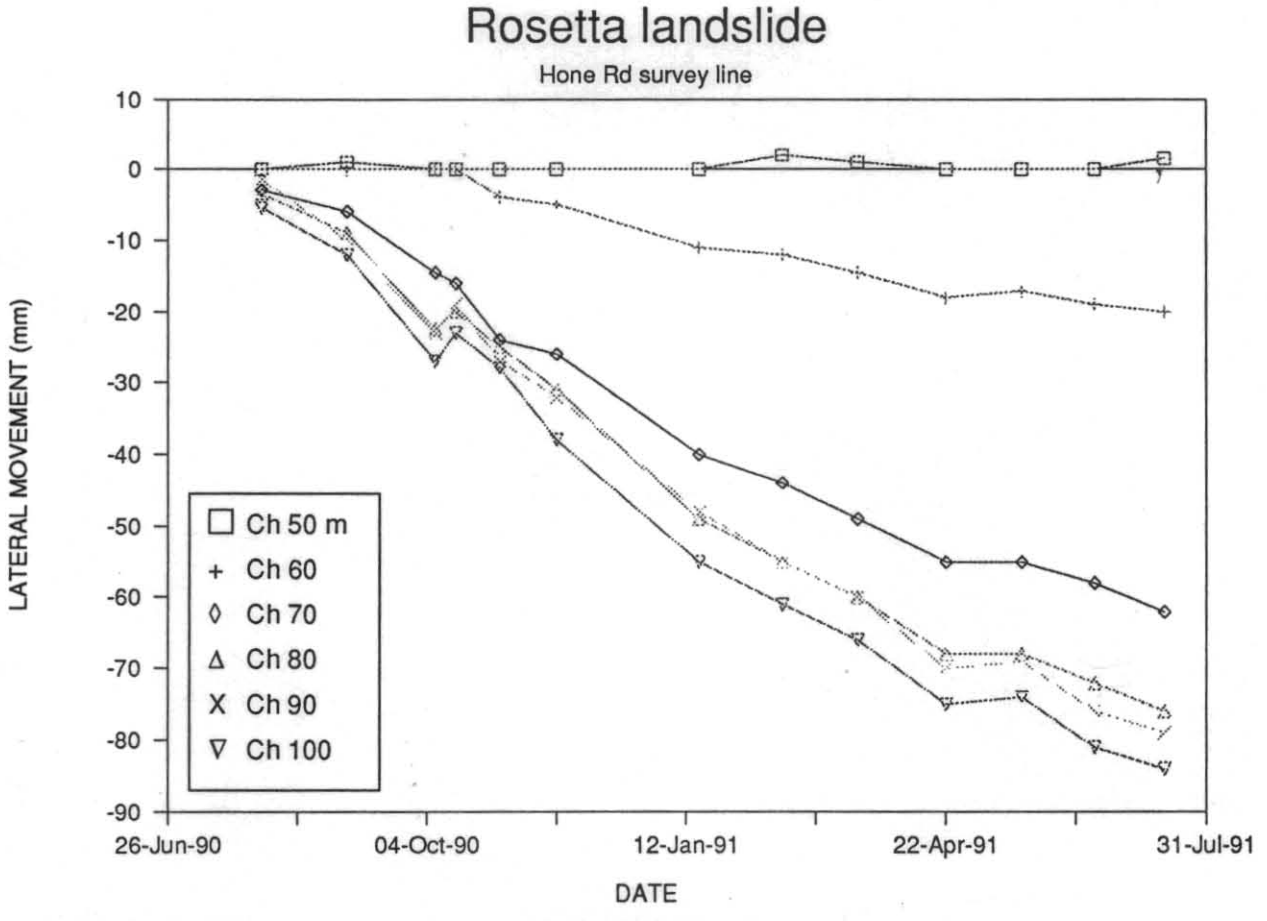
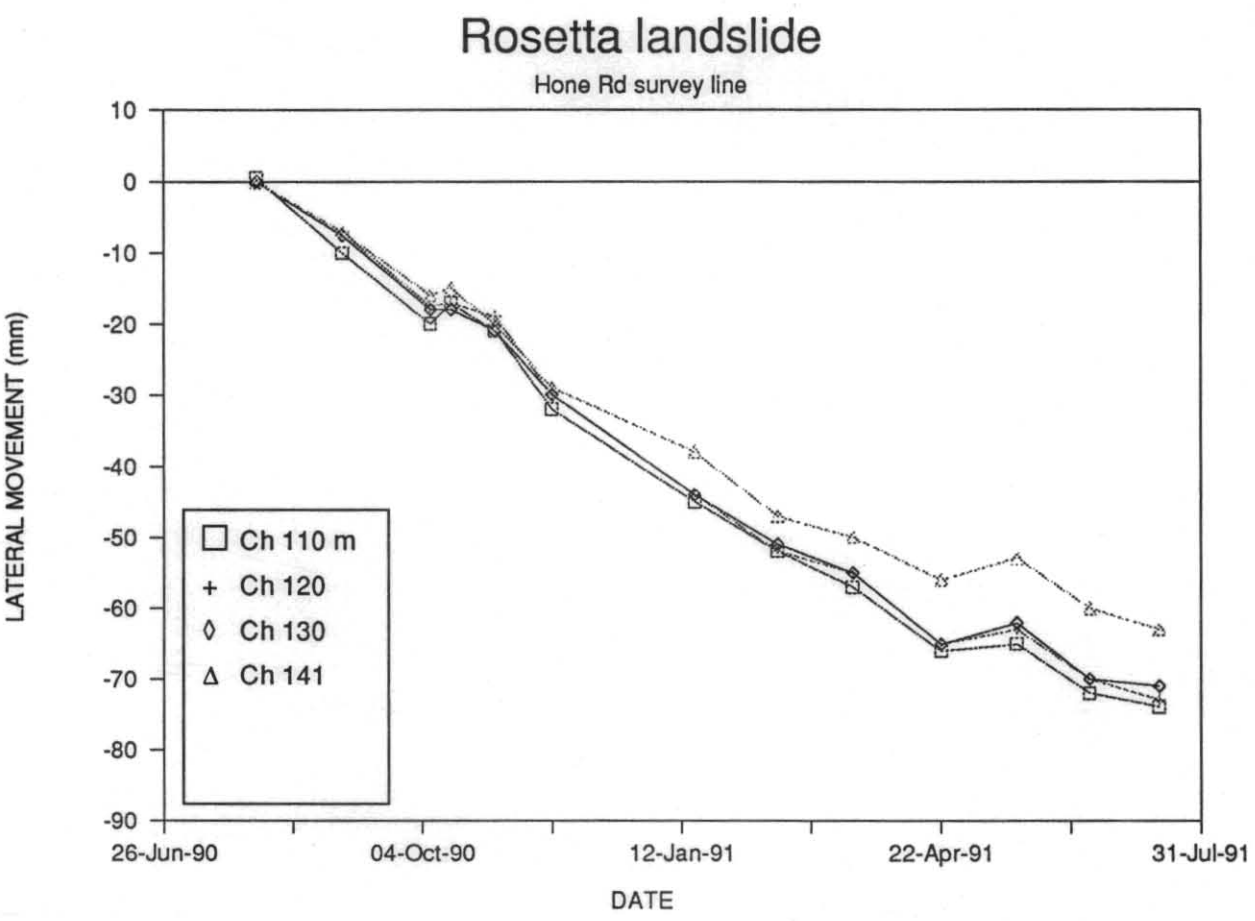
APPENDIX 2

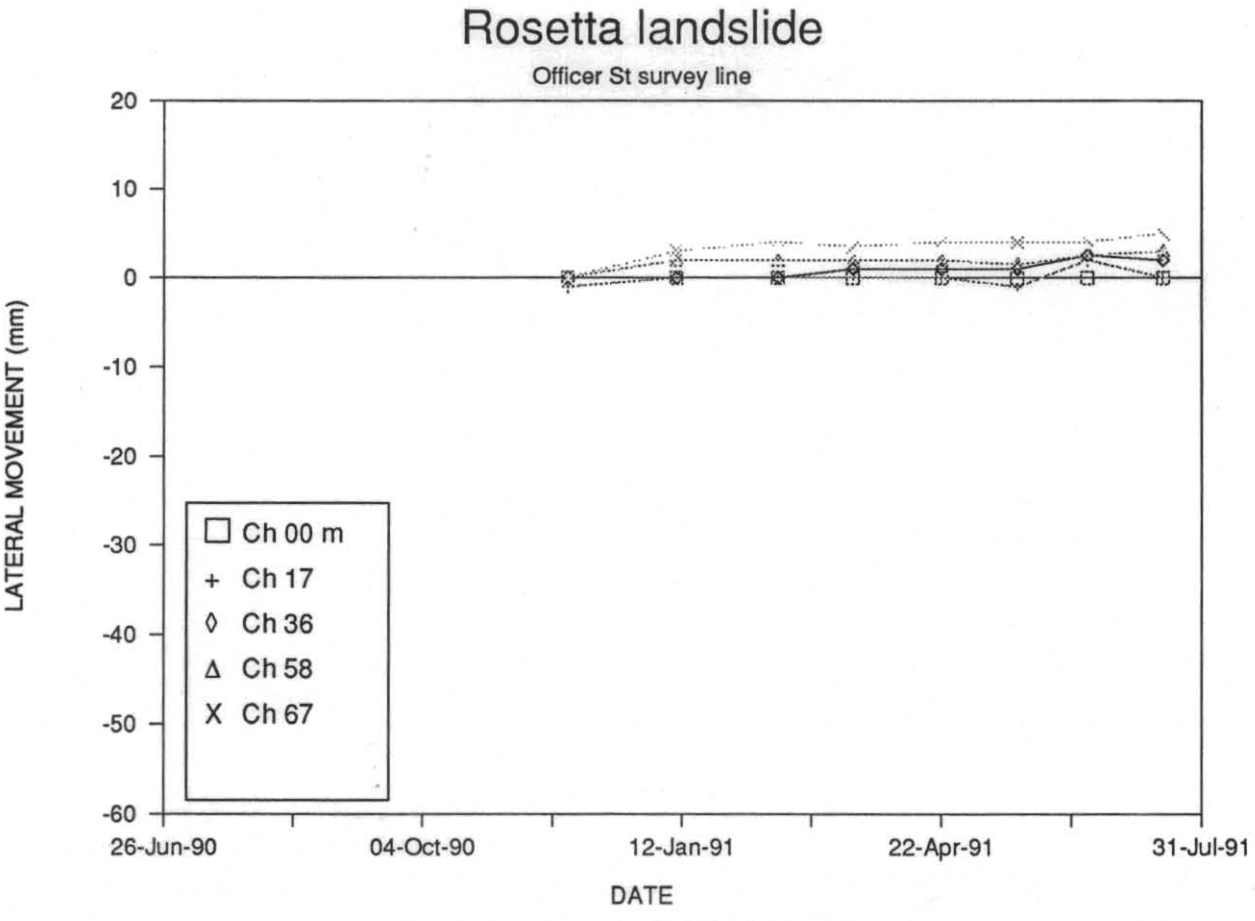
Surveyed lines — lateral landslide movements


Rosetta landslide
Hone Rd survey line
LATERAL MOVEMENT (mm)
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Ch 00 m
Ch 05
Ch 10
Ch 20
Ch 30
Ch 40
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

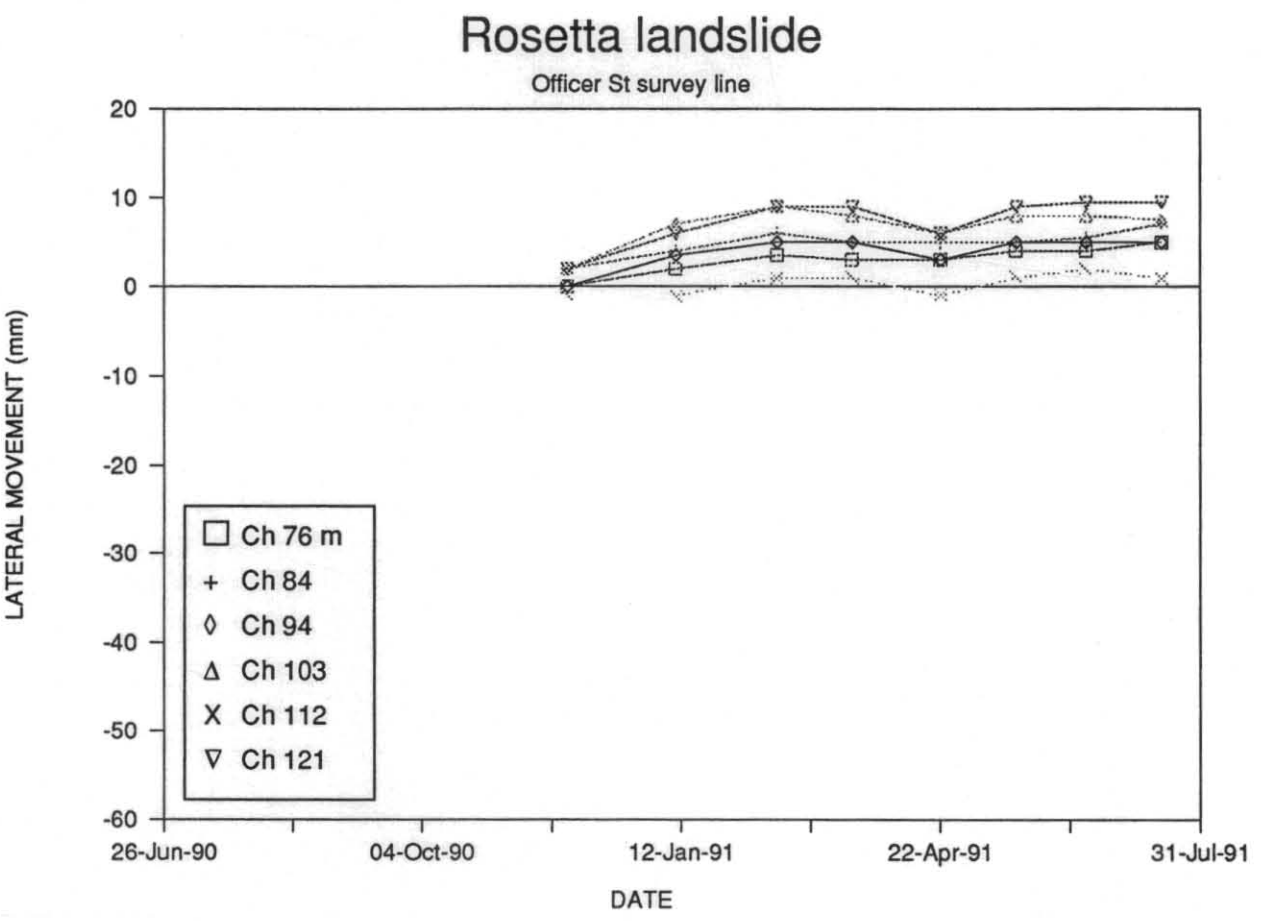

Rosetta landslide
Hone Rd survey line
LATERAL MOVEMENT (mm)
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Ch 50 m
Ch 60
Ch 70
Ch 80
Ch 90
Ch 100
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

5 cm


Rosetta landslide
Hone Rd survey line
LATERAL MOVEMENT (mm)
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Ch 110 m
Ch 120
Ch 130
Ch 141
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE


Rosetta landslide
Officer St survey line
LATERAL MOVEMENT (mm)
20
10
0
-10
-20
-30
-40
-50
-60
Ch 00 m
Ch 17
Ch 36
Ch 58
Ch 67
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

5 cm


Rosetta landslide
Officer St survey line
LATERAL MOVEMENT (mm)
20
10
0
-10
-20
-30
-40
-50
-60
Ch 76 m
Ch 84
Ch 94
Ch 103
Ch 112
Ch 121
26-Jun-90
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12-Jan-91
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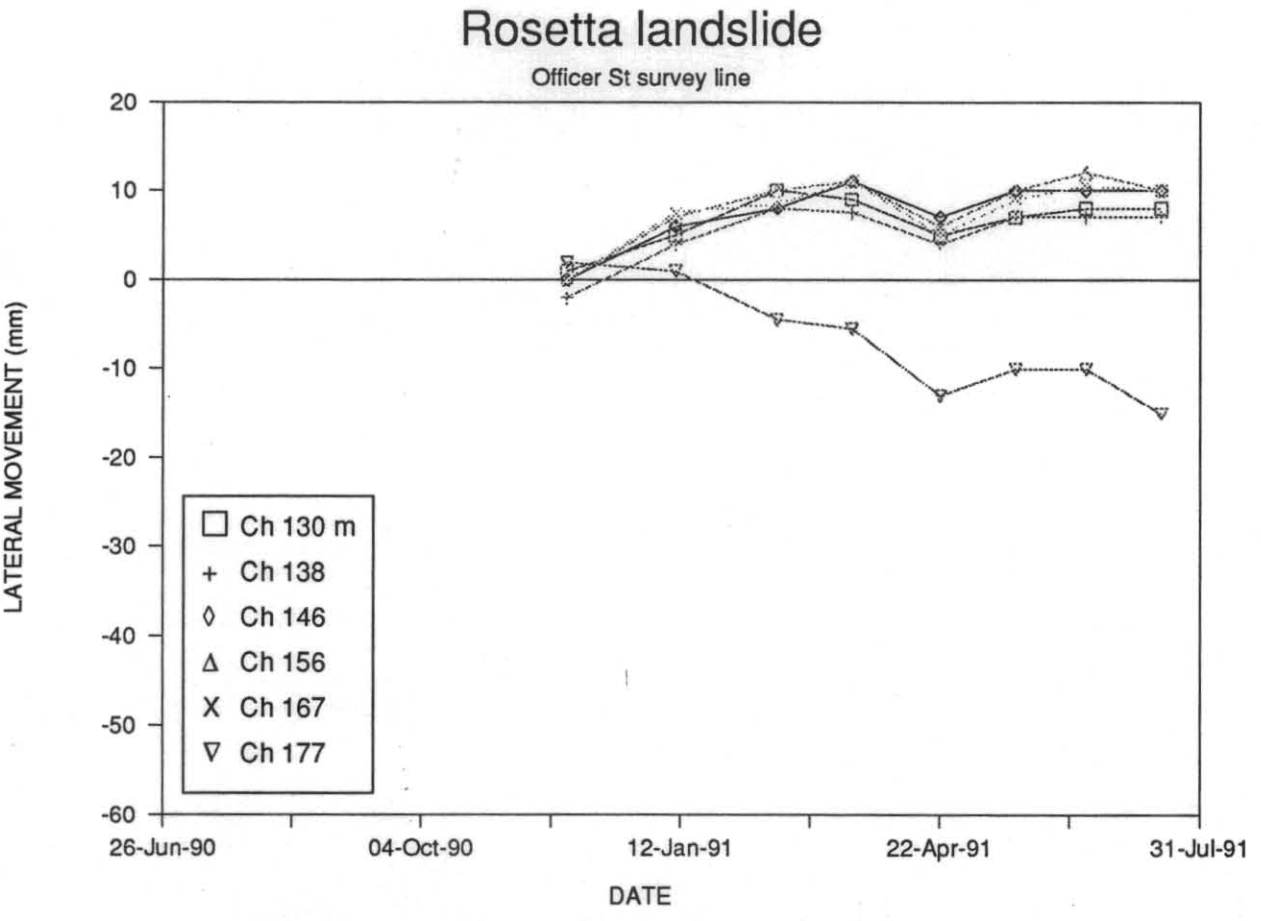
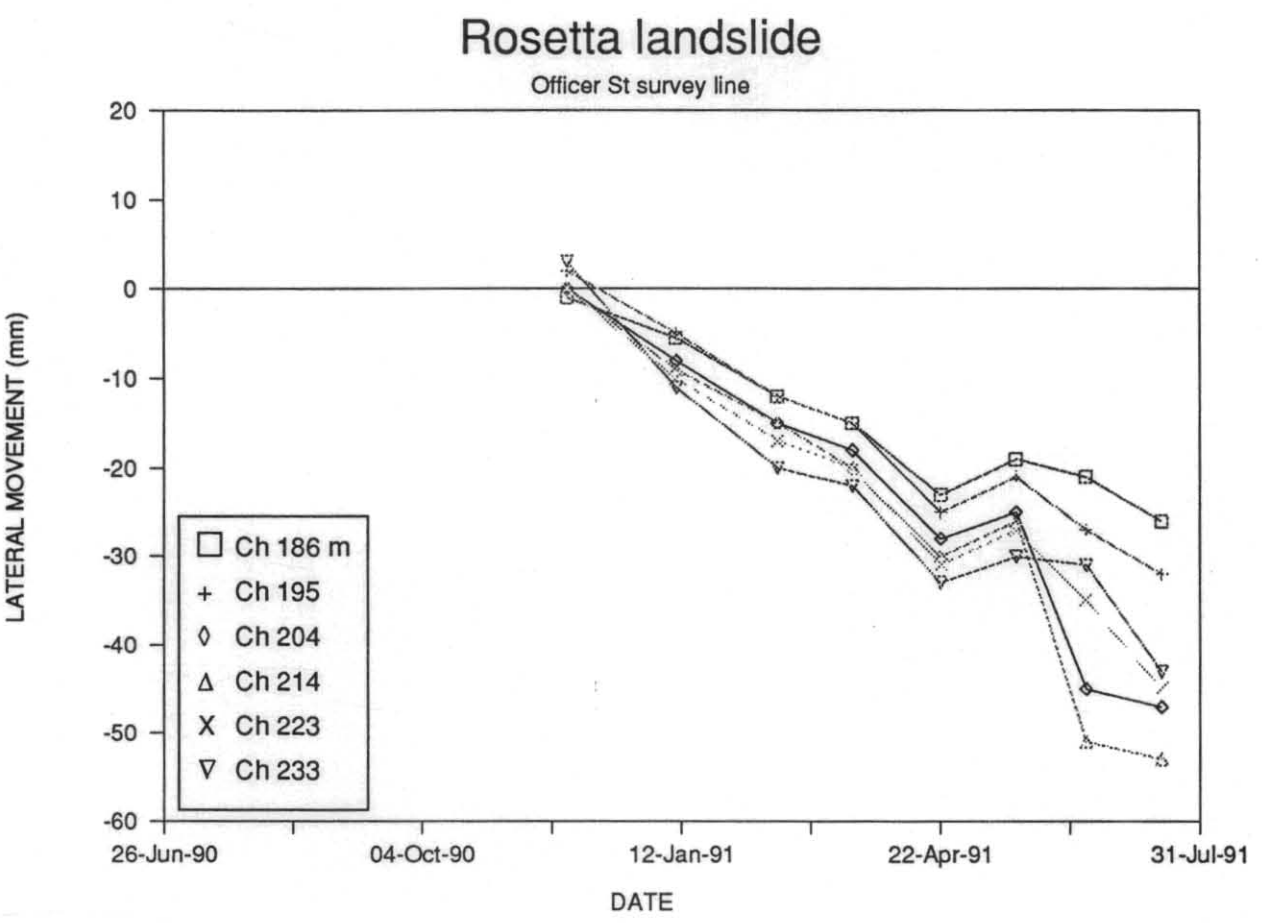
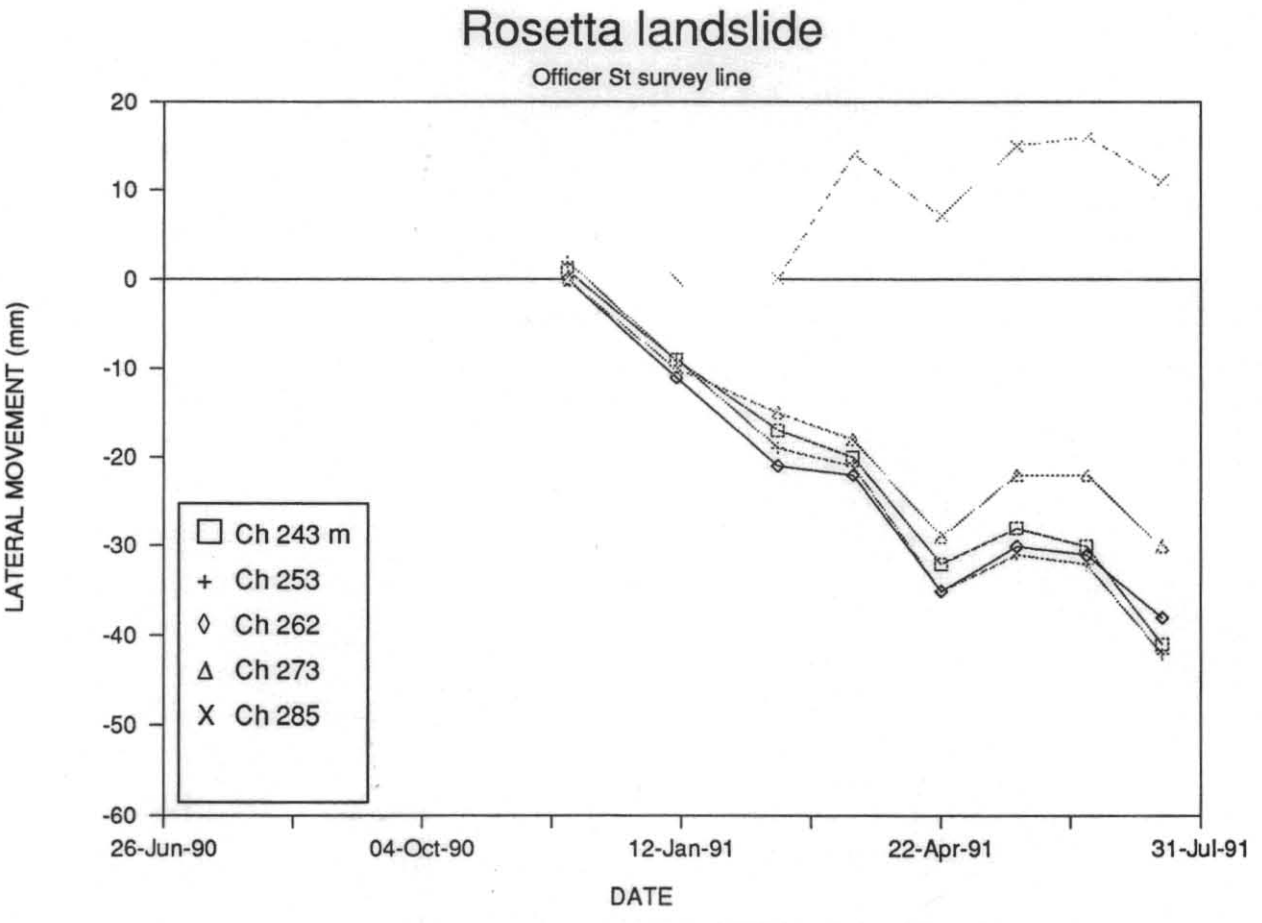
DATE

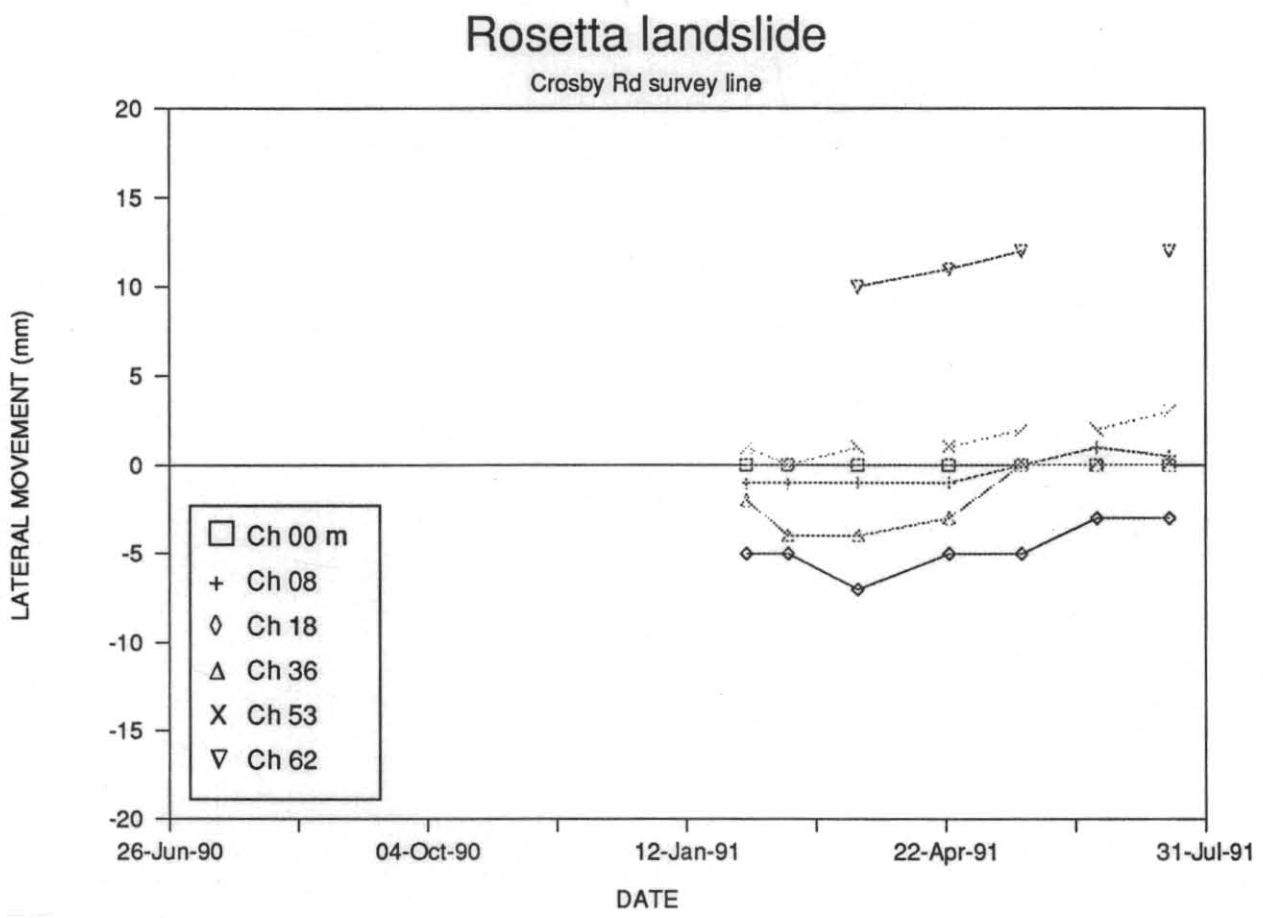

Rosetta landslide
Officer St survey line
LATERAL MOVEMENT (mm)
20
10
0
-10
-20
-30
-40
-50
-60
Ch 130 m
Ch 138
Ch 146
Ch 156
Ch 167
Ch 177
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

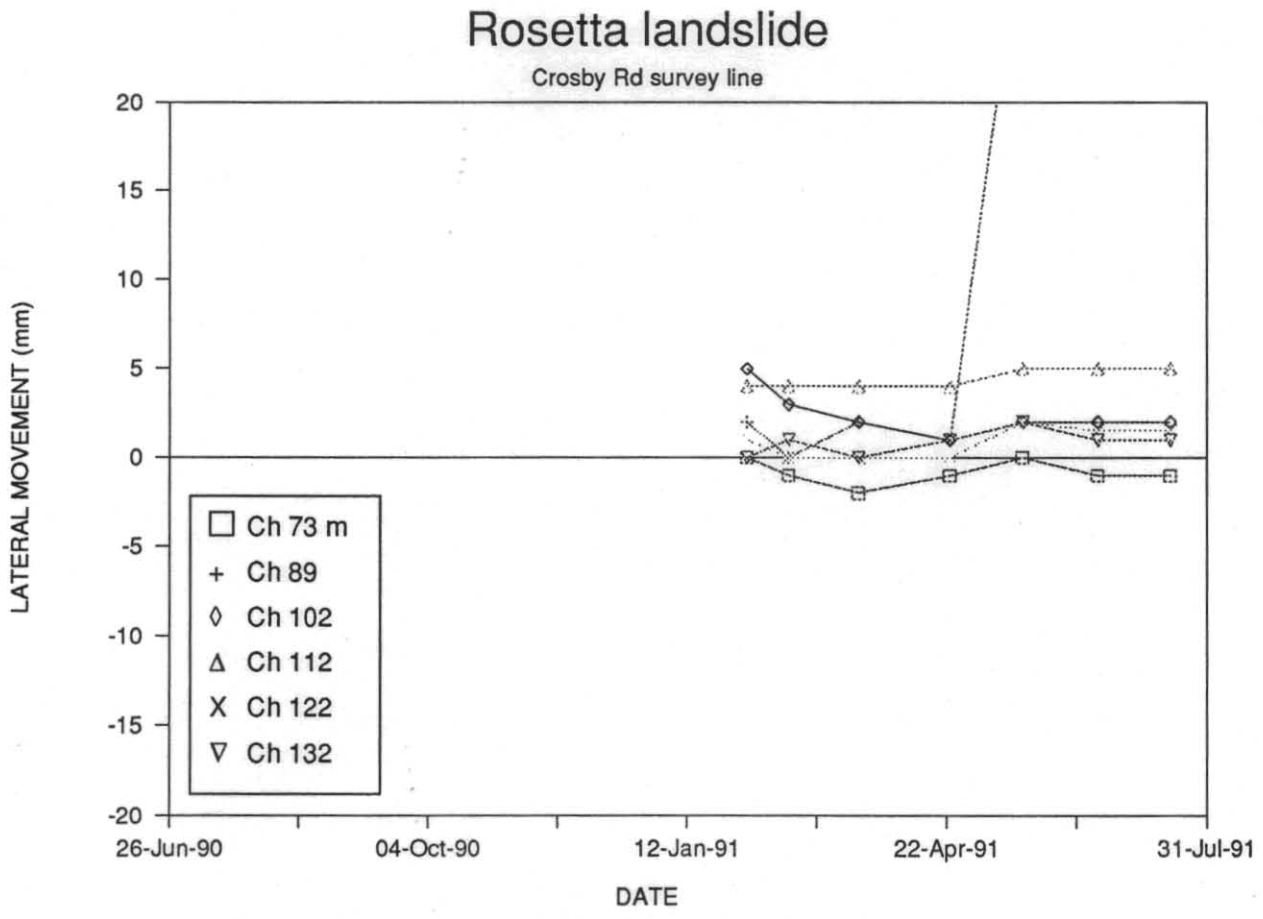
5 cm


Rosetta landslide
Officer St survey line
LATERAL MOVEMENT (mm)
20
10
0
-10
-20
-30
-40
-50
-60
Ch 186 m
Ch 195
Ch 204
Ch 214
Ch 223
Ch 233
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

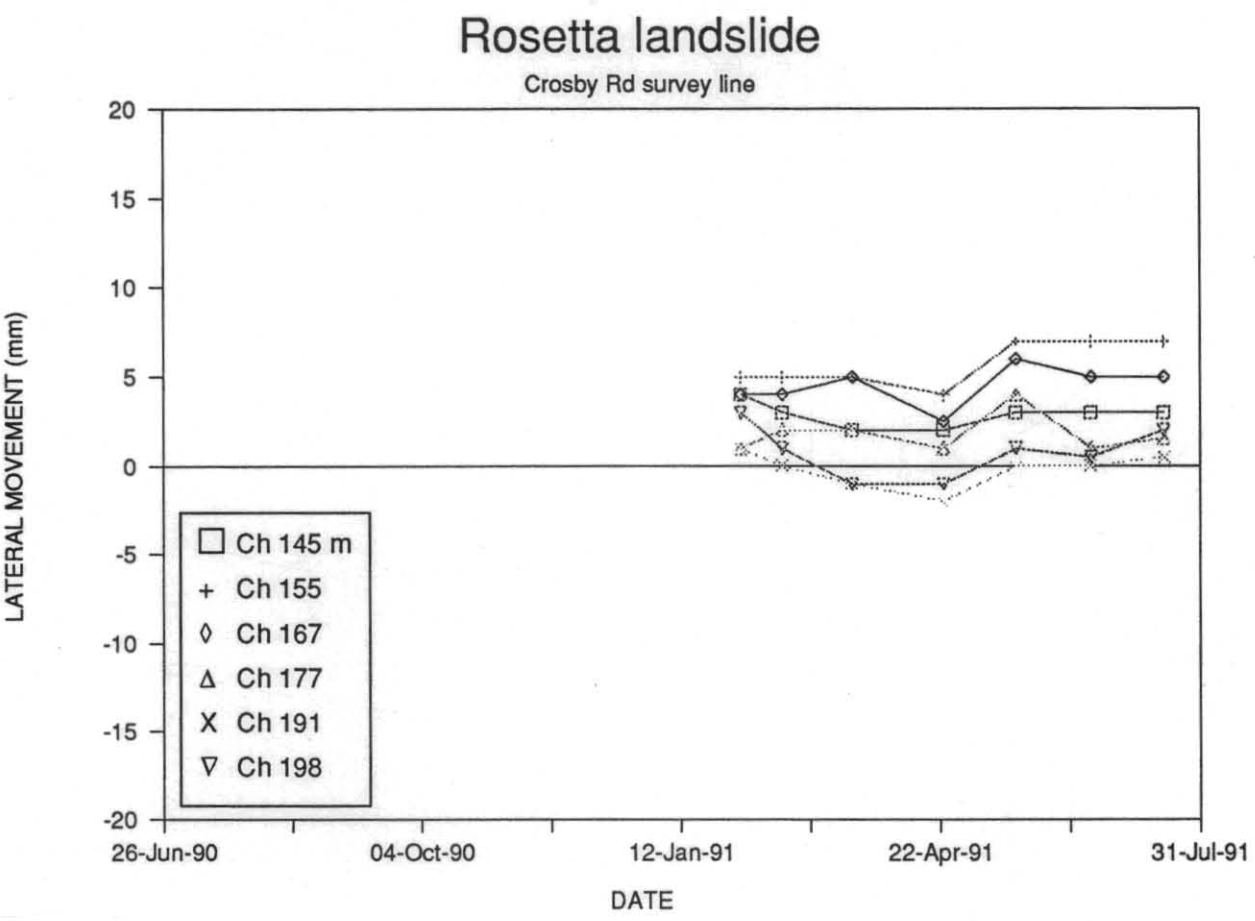

Rosetta landslide
Officer St survey line
LATERAL MOVEMENT (mm)
20
10
0
-10
-20
-30
-40
-50
-60
Ch 243 m
Ch 253
Ch 262
Ch 273
Ch 285
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

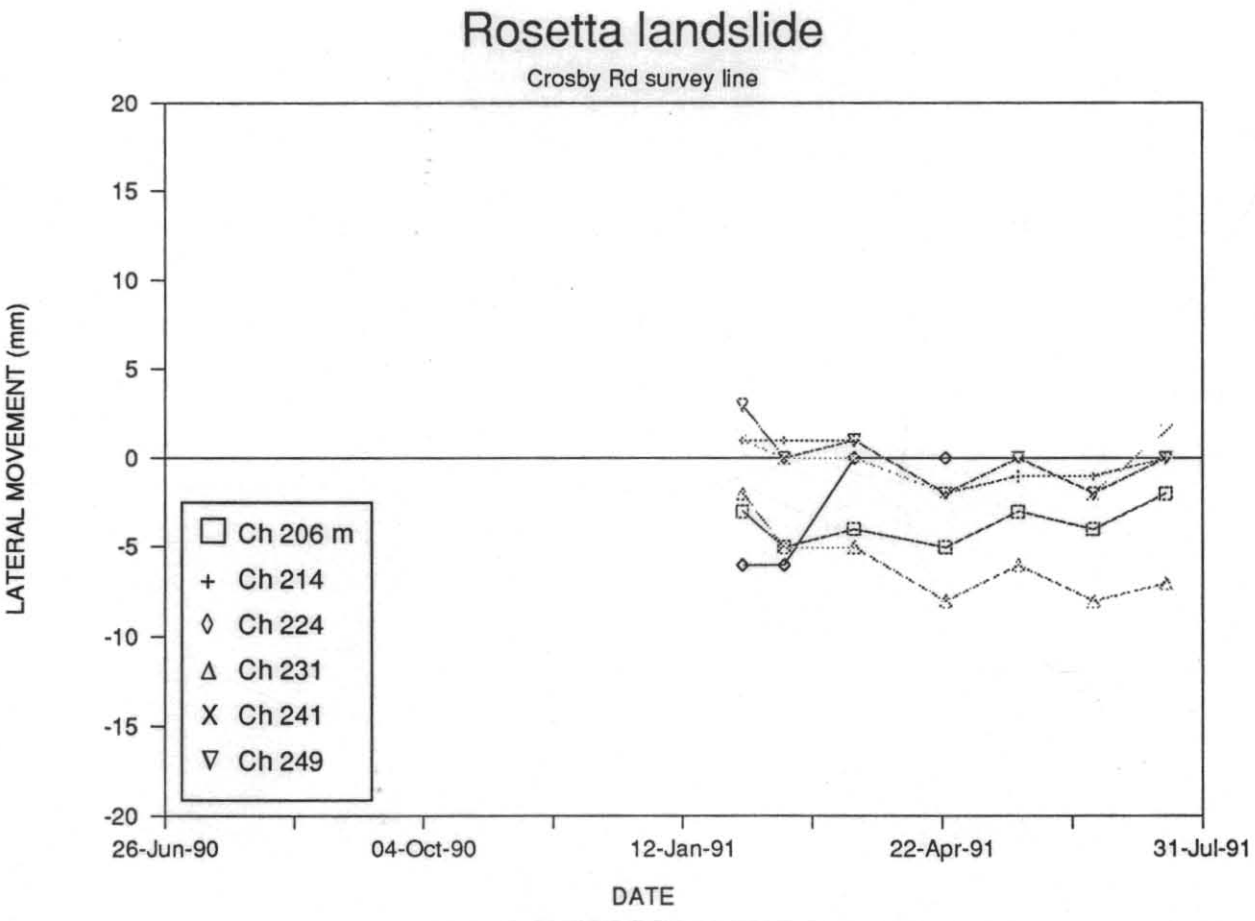
5 cm


Rosetta landslide
Crosby Rd survey line
LATERAL MOVEMENT (mm)
20
15
10
5
0
-5
-10
-15
-20
Ch 00 m
Ch 08
Ch 18
Ch 36
Ch 53
Ch 62
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

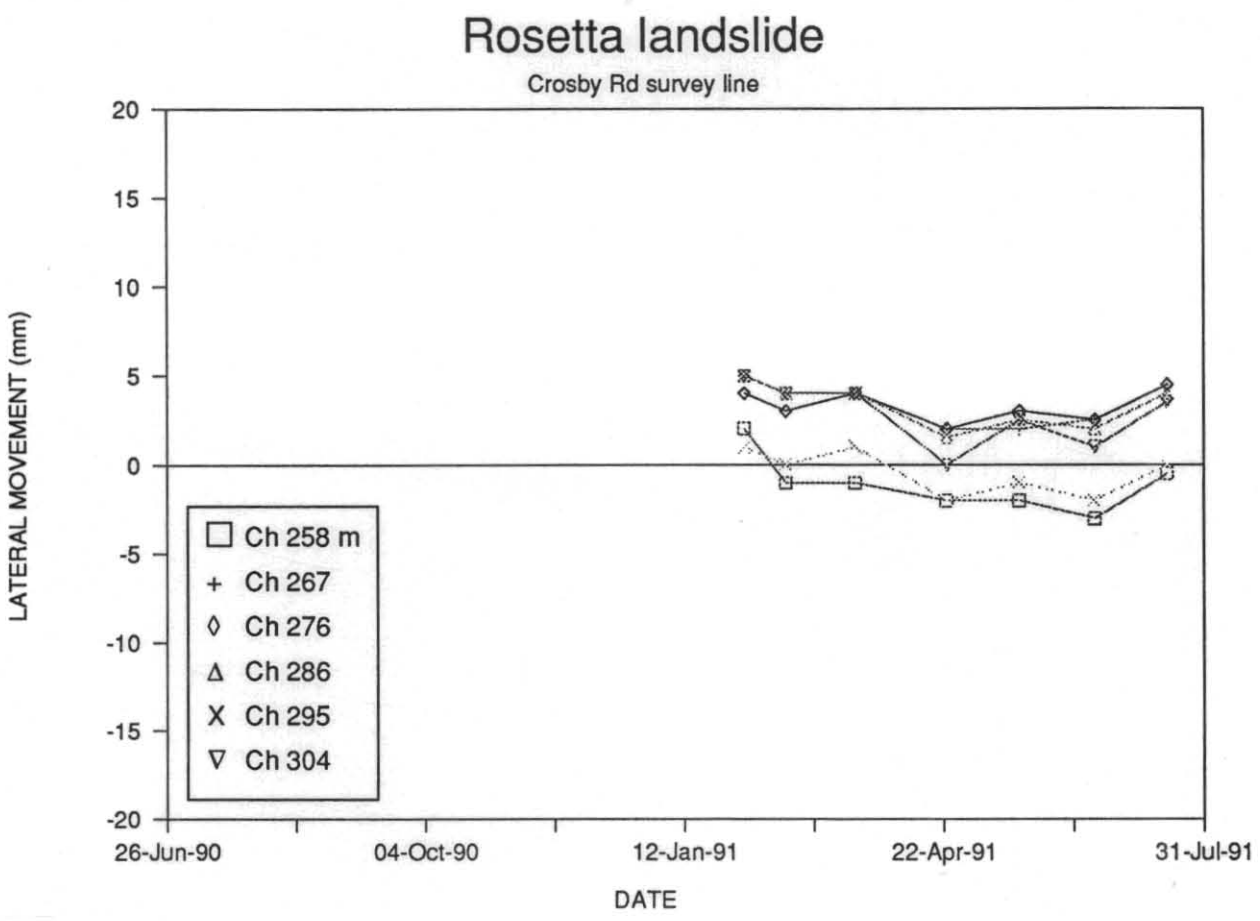

Rosetta landslide
Crosby Rd survey line
LATERAL MOVEMENT (mm)
20
15
10
5
0
-5
-10
-15
-20
Ch 73 m
Ch 89
Ch 102
Ch 112
Ch 122
Ch 132
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

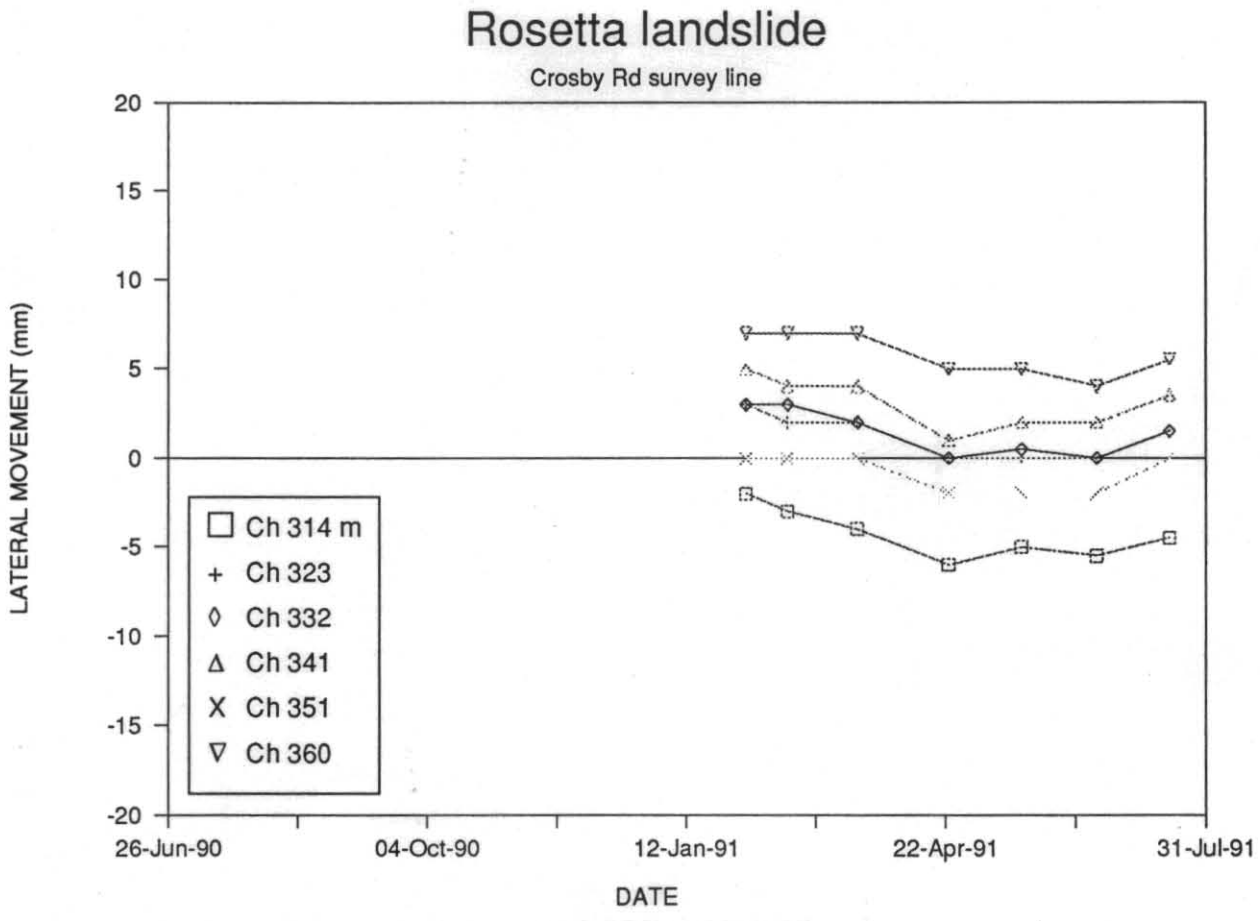
5 cm


Rosetta landslide
Crosby Rd survey line
LATERAL MOVEMENT (mm)
20
15
10
5
0
-5
-10
-15
-20
Ch 145 m
Ch 155
Ch 167
Ch 177
Ch 191
Ch 198
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

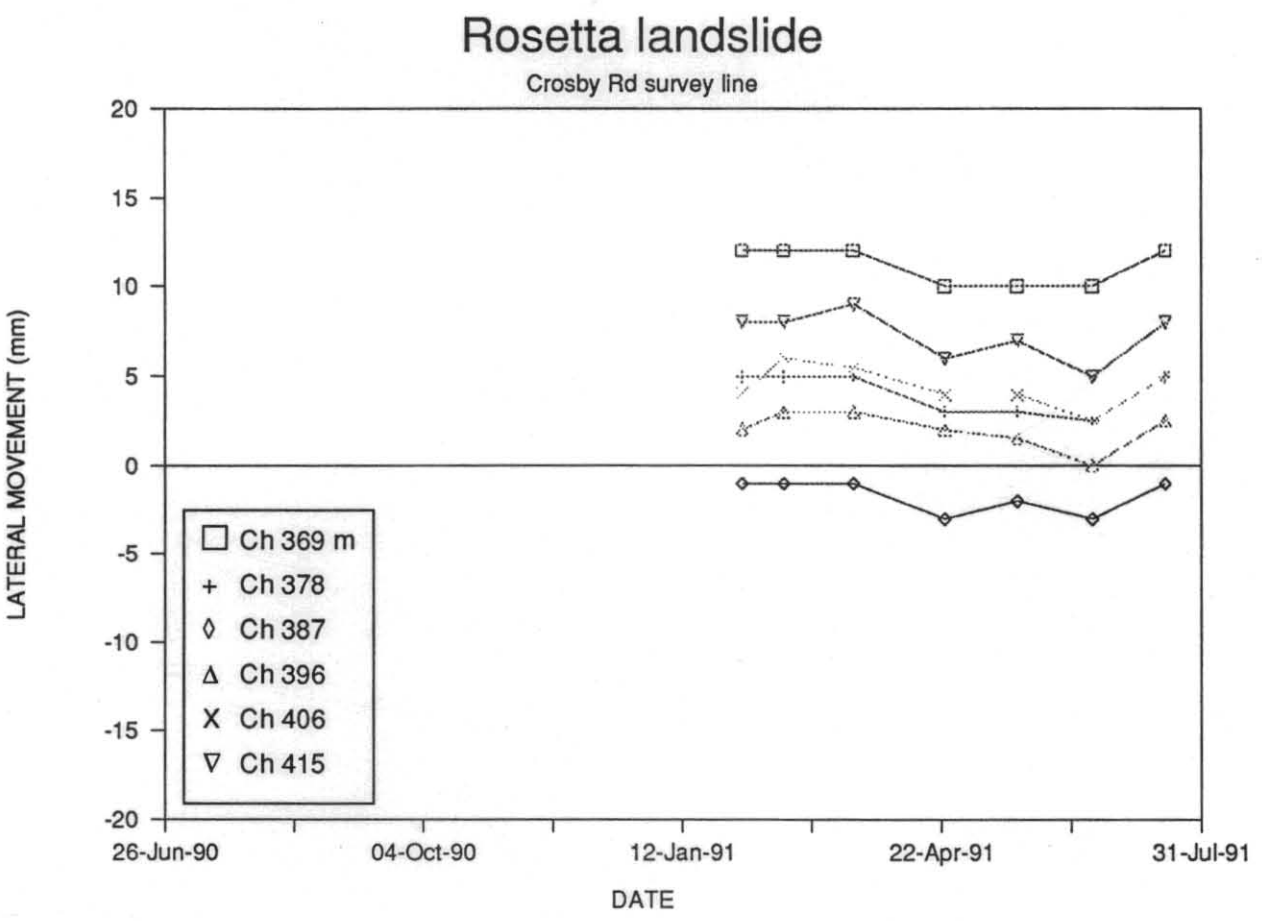

Rosetta landslide
Crosby Rd survey line
LATERAL MOVEMENT (mm)
20
15
10
5
0
-5
-10
-15
-20
Ch 206 m
Ch 214
Ch 224
Ch 231
Ch 241
Ch 249
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

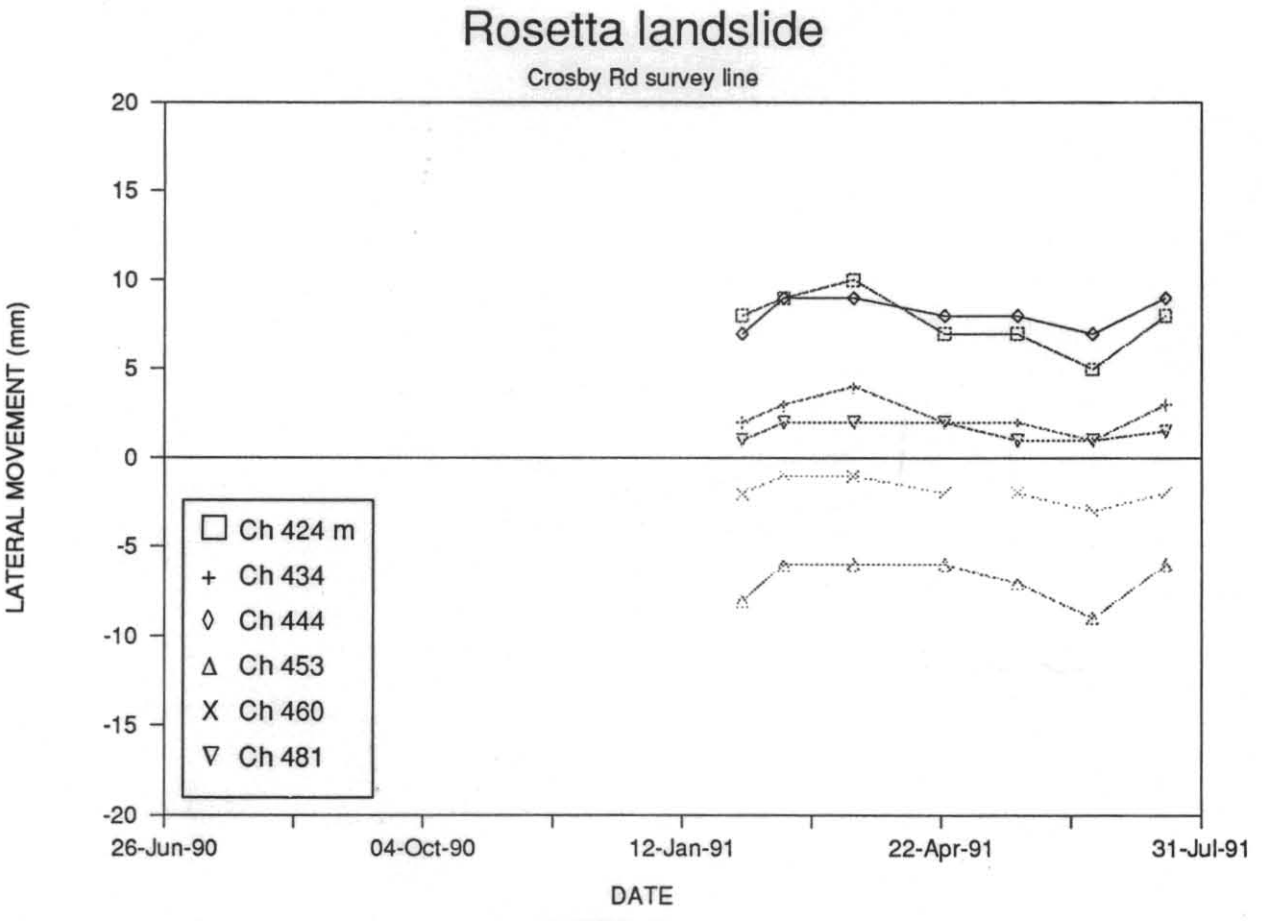
5 cm


Rosetta landslide
Crosby Rd survey line
LATERAL MOVEMENT (mm)
20
15
10
5
0
-5
-10
-15
-20
Ch 258 m
Ch 267
Ch 276
Ch 286
Ch 295
Ch 304
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

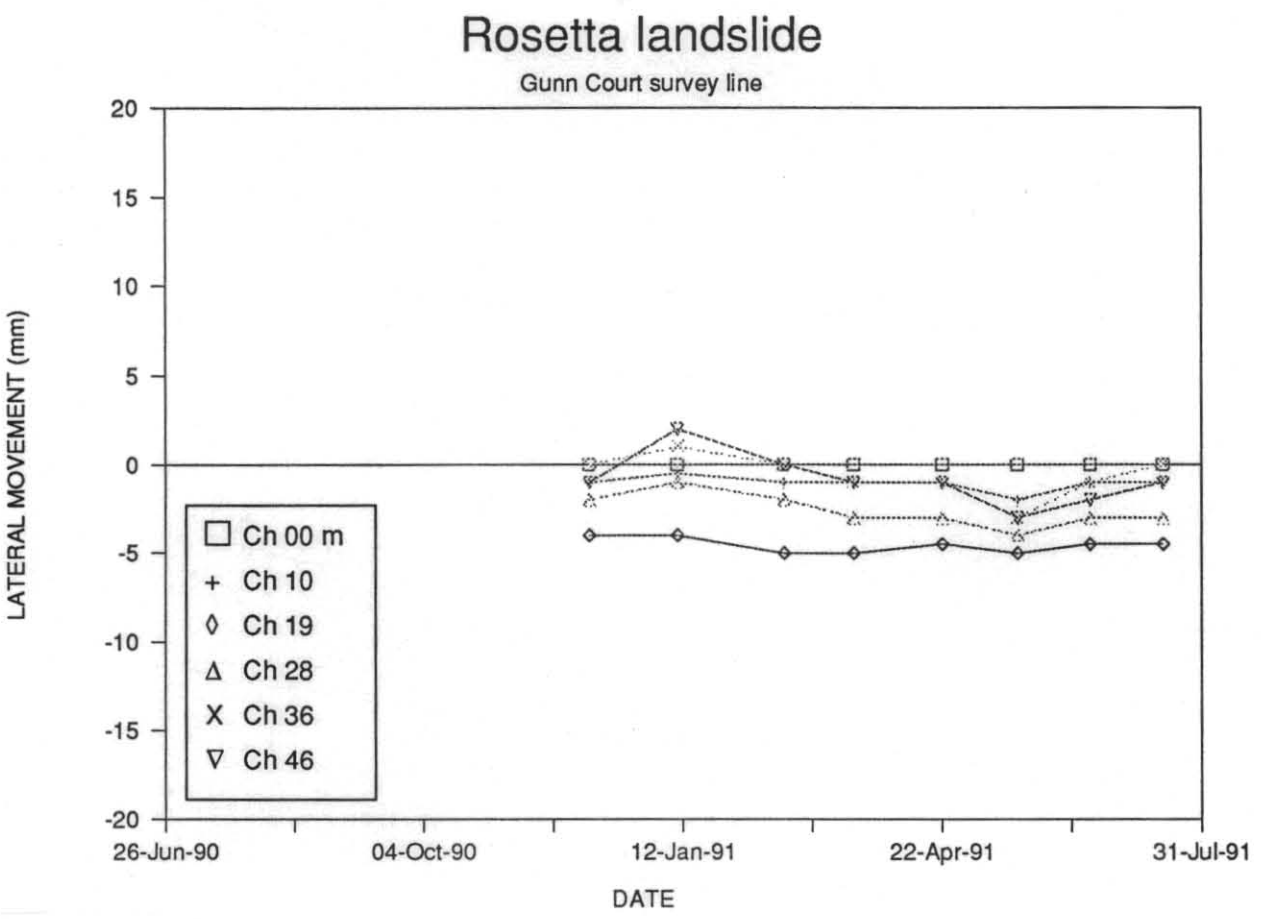

Rosetta landslide
Crosby Rd survey line
LATERAL MOVEMENT (mm)
20
15
10
5
0
-5
-10
-15
-20
Ch 314 m
Ch 323
Ch 332
Ch 341
Ch 351
Ch 360
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

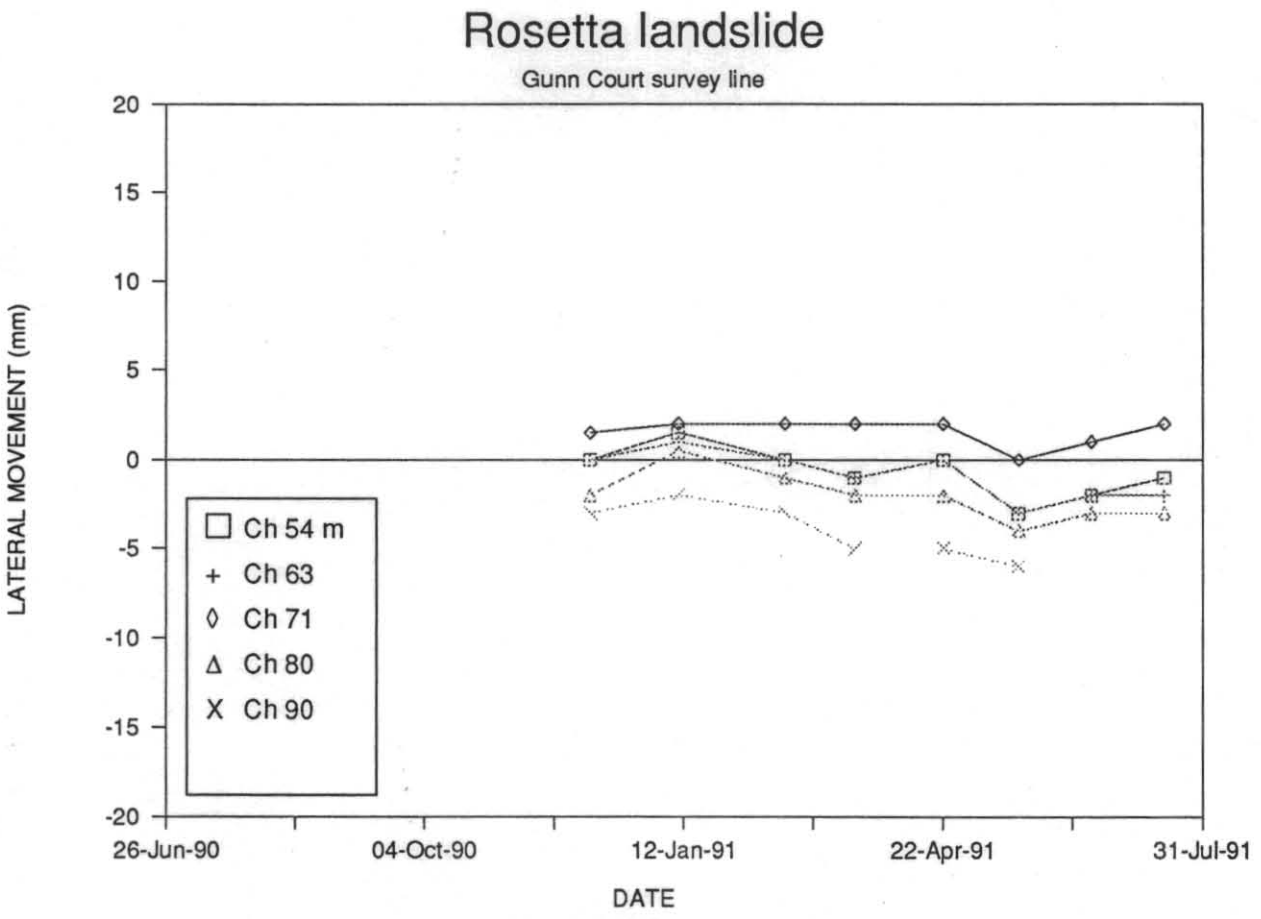
5 cm


Rosetta landslide
Crosby Rd survey line
LATERAL MOVEMENT (mm)
20
15
10
5
0
-5
-10
-15
-20
Ch 369 m
Ch 378
Ch 387
Ch 396
Ch 406
Ch 415
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE


Rosetta landslide
Crosby Rd survey line
LATERAL MOVEMENT (mm)
20
15
10
5
0
-5
-10
-15
-20
Ch 424 m
Ch 434
Ch 444
Ch 453
Ch 460
Ch 481
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

5 cm


Rosetta landslide
Gunn Court survey line
LATERAL MOVEMENT (mm)
20
15
10
5
0
-5
-10
-15
-20
Ch 00 m
Ch 10
Ch 19
Ch 28
Ch 36
Ch 46
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE


Rosetta landslide
Gunn Court survey line
LATERAL MOVEMENT (mm)
20
15
10
5
0
-5
-10
-15
-20
Ch 54 m
Ch 63
Ch 71
Ch 80
Ch 90
26-Jun-90
04-Oct-90
12-Jan-91
22-Apr-91
31-Jul-91
DATE

5 cm

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APPENDIX 3

House deformation monitoring

DISPLACEMENT TRANSDUCER INSTALLATIONS

2 Officer Street

Two displacement gauges were mounted on the brickwork at the base of the NE-facing brick wall. The X (horizontal) and Y (vertical) movement transducers were mounted across the cracked section of brickwork on this external wall of the house. Both transducers measured the change in size of the gap between the mortar joints.

13 Hone Road

Two displacement gauges were mounted on the slab floor inside the carport/patio area of 13 Hone Road. The gauges measured the movement of the support wall relative to the concrete slab in an X (north-easterly) and Y (south-westerly) direction.

15 Hone Road

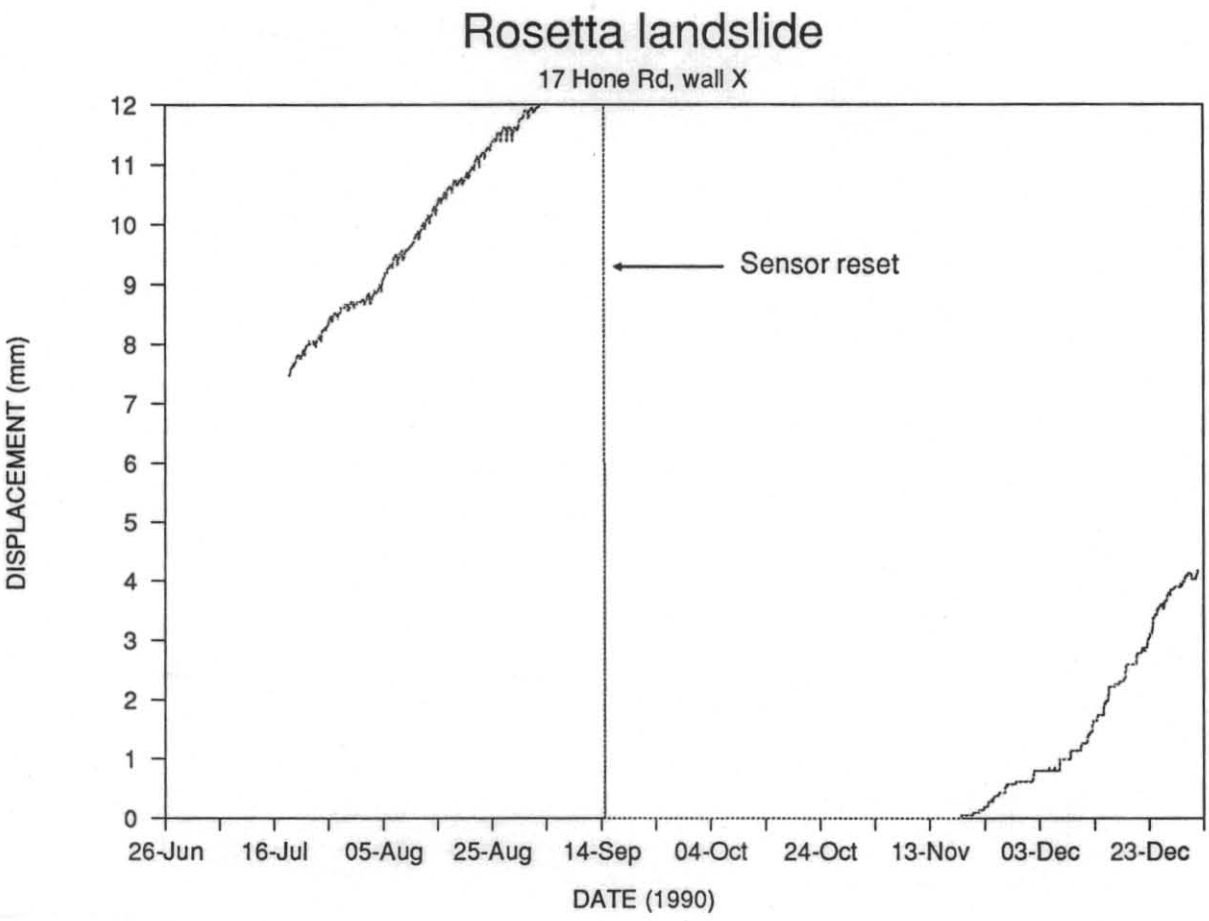
Four displacement gauges were located on the east-facing wall to monitor varying degrees of movement. X and Y movement transducers were mounted across a cracked section of brickwork inside the east wall of the garage. Both transducers measured the change in size of the gap between the mortar joints. The pillar movement transducer was mounted on a support pillar inside the garage and measured the distance between the east wall and the pillar itself. The slab movement transducer was mounted on the slab floor and measured the distance between the slab floor and the east wall.

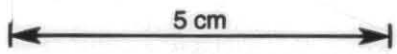
17 Hone Road

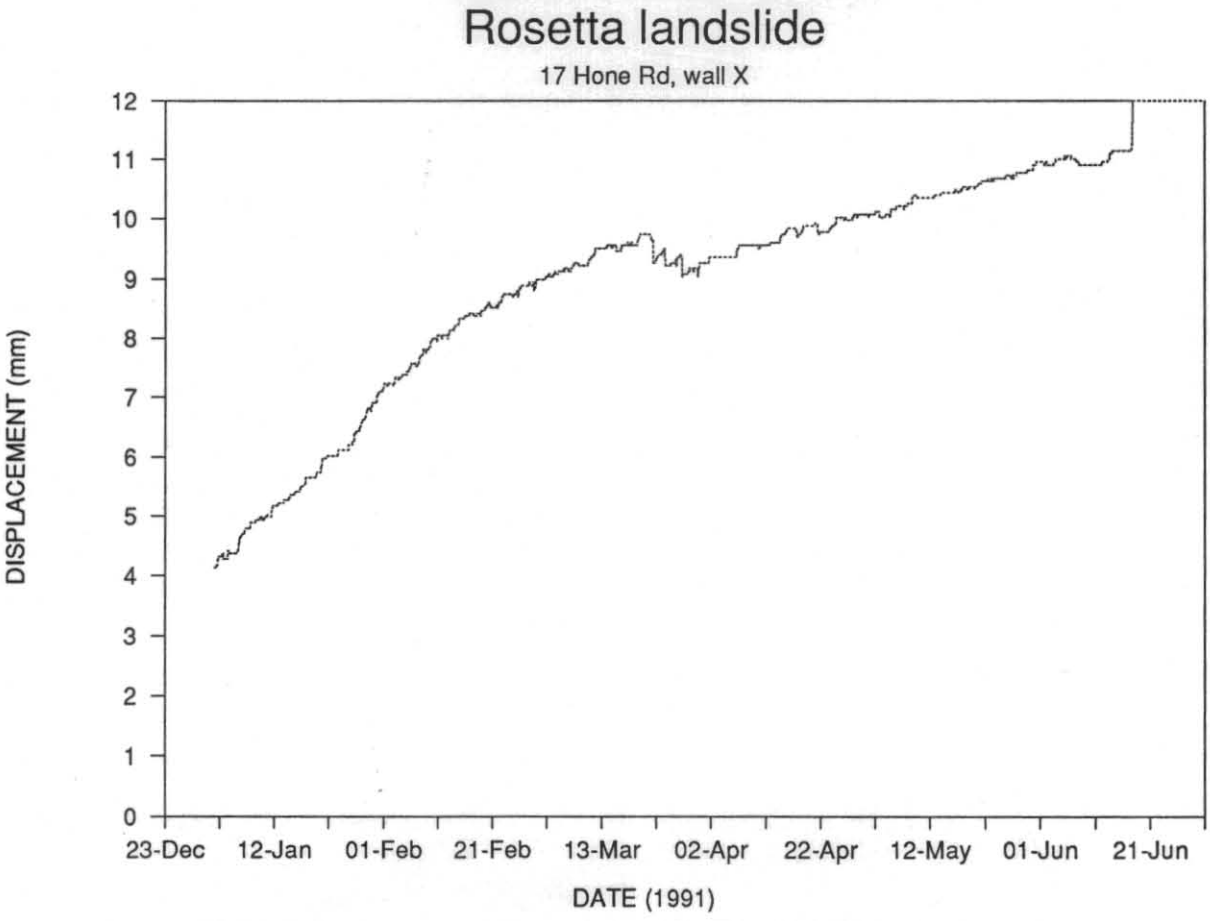
Two displacement gauges monitoring X and Y movement were mounted on a cracked section of brickwork on the western wall of 17 Hone Road. Both transducers measured the change in size of the gap between the mortar joints.

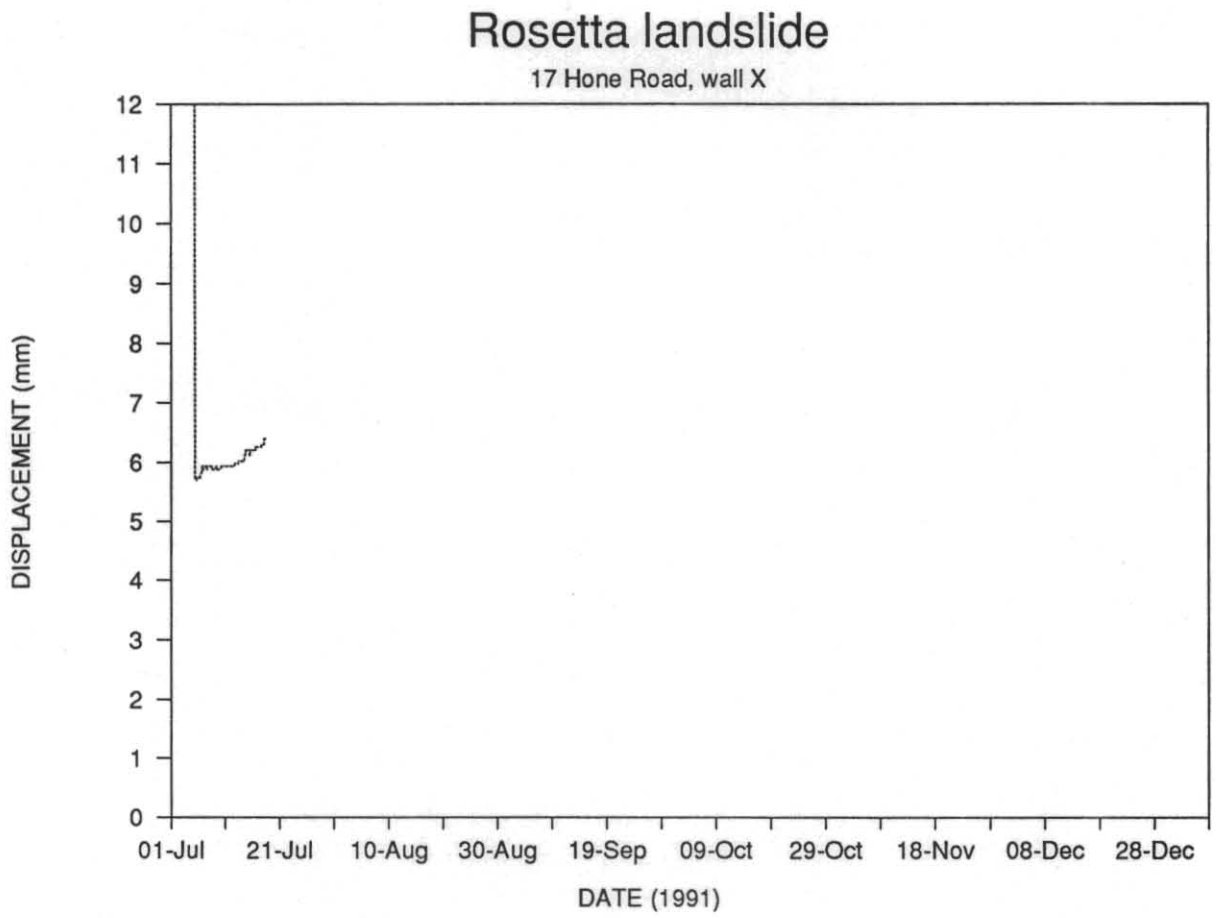
REFERENCE

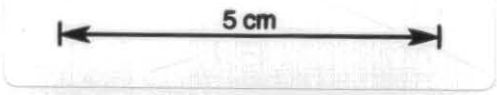
SEDGMAN, R. J. 1990. Unidata installations at Hone Road and Officer Street, Rosetta (Stage 1). *Rep. Div. Mines Miner. Resour. Tasm.* 1990/23.

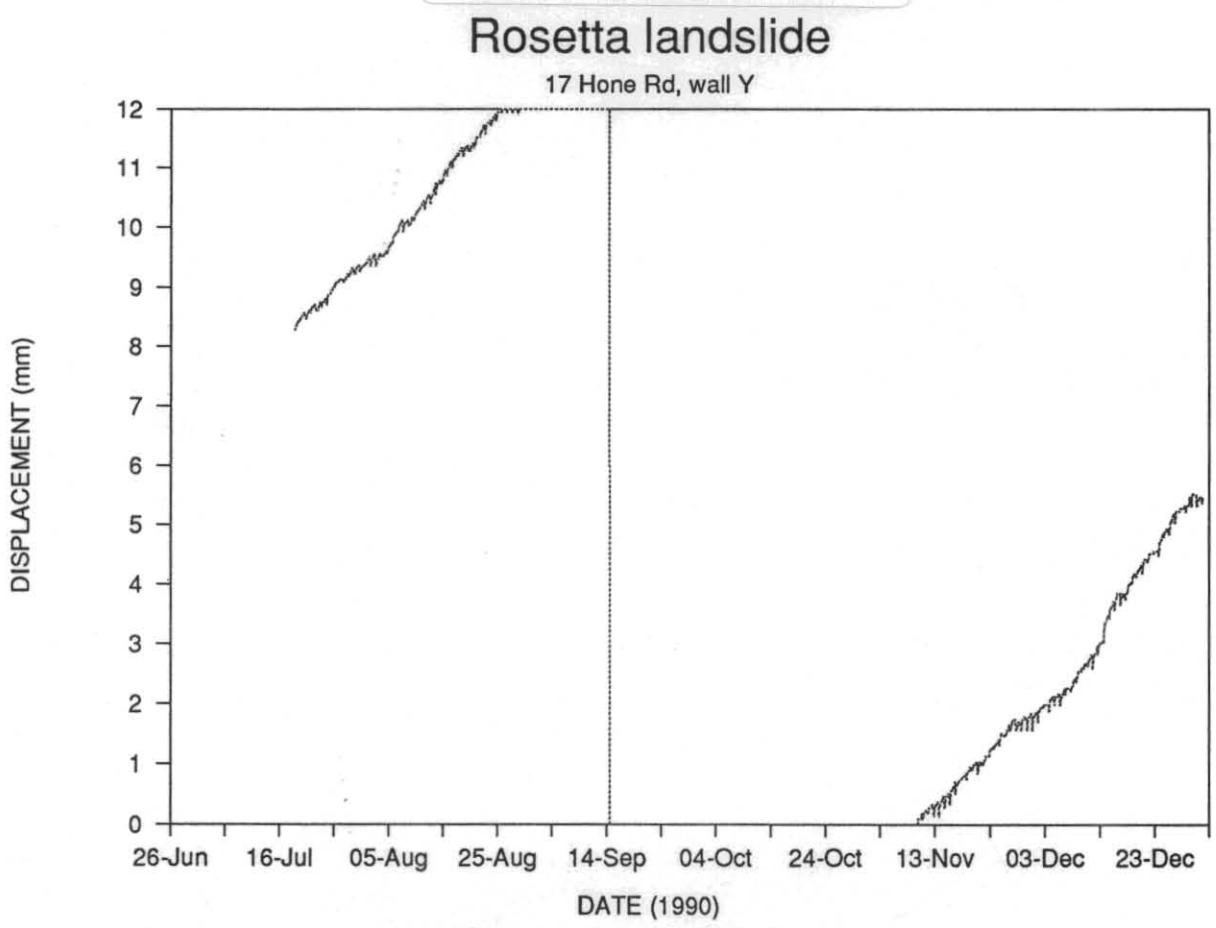

Rosetta landslide
17 Hone Rd, wall X
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
Sensor reset
26-Jun
16-Jul
05-Aug
25-Aug
14-Sep
04-Oct
24-Oct
13-Nov
03-Dec
23-Dec
DATE (1990)

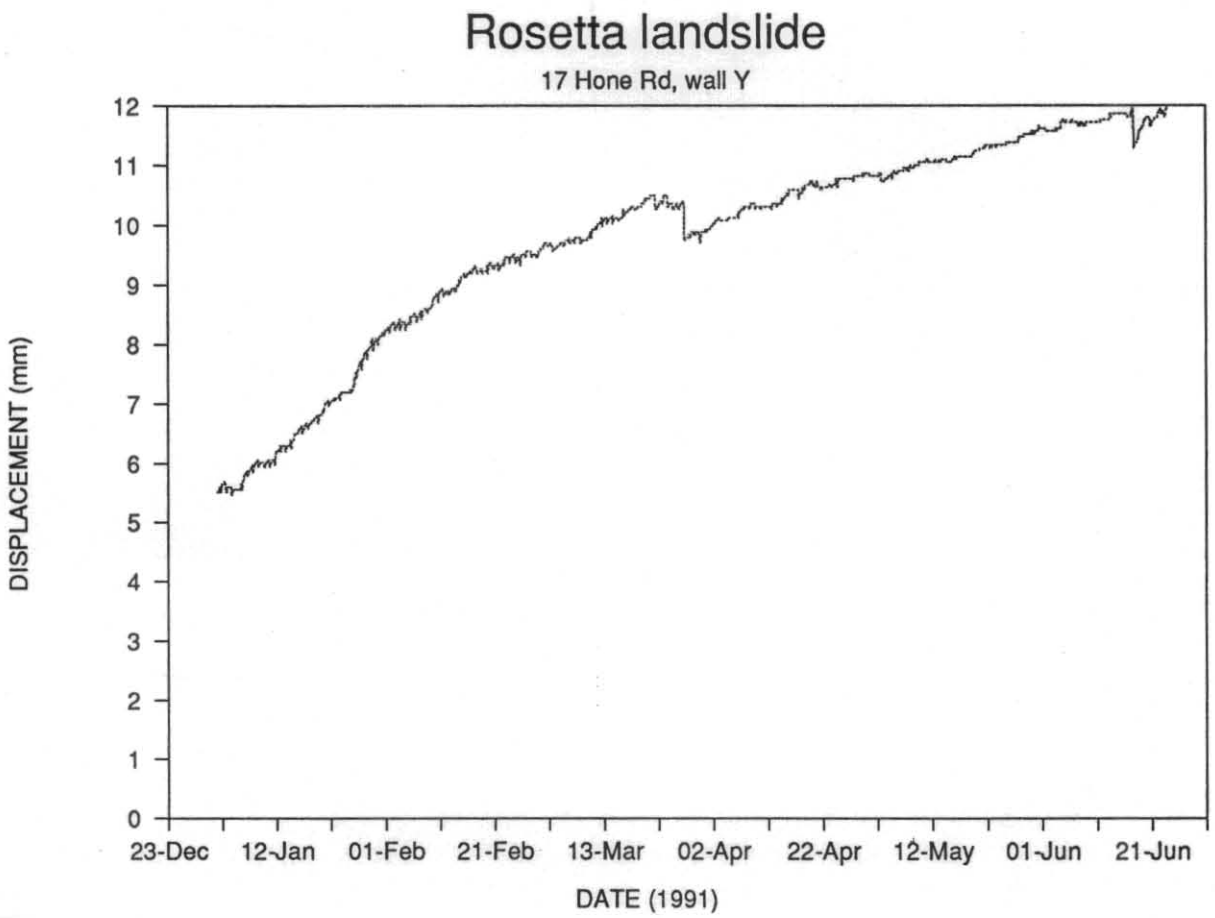

5 cm

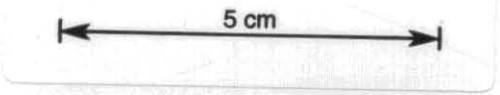

Rosetta landslide
17 Hone Rd, wall X
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
23-Dec
12-Jan
01-Feb
21-Feb
13-Mar
02-Apr
22-Apr
12-May
01-Jun
21-Jun
DATE (1991)

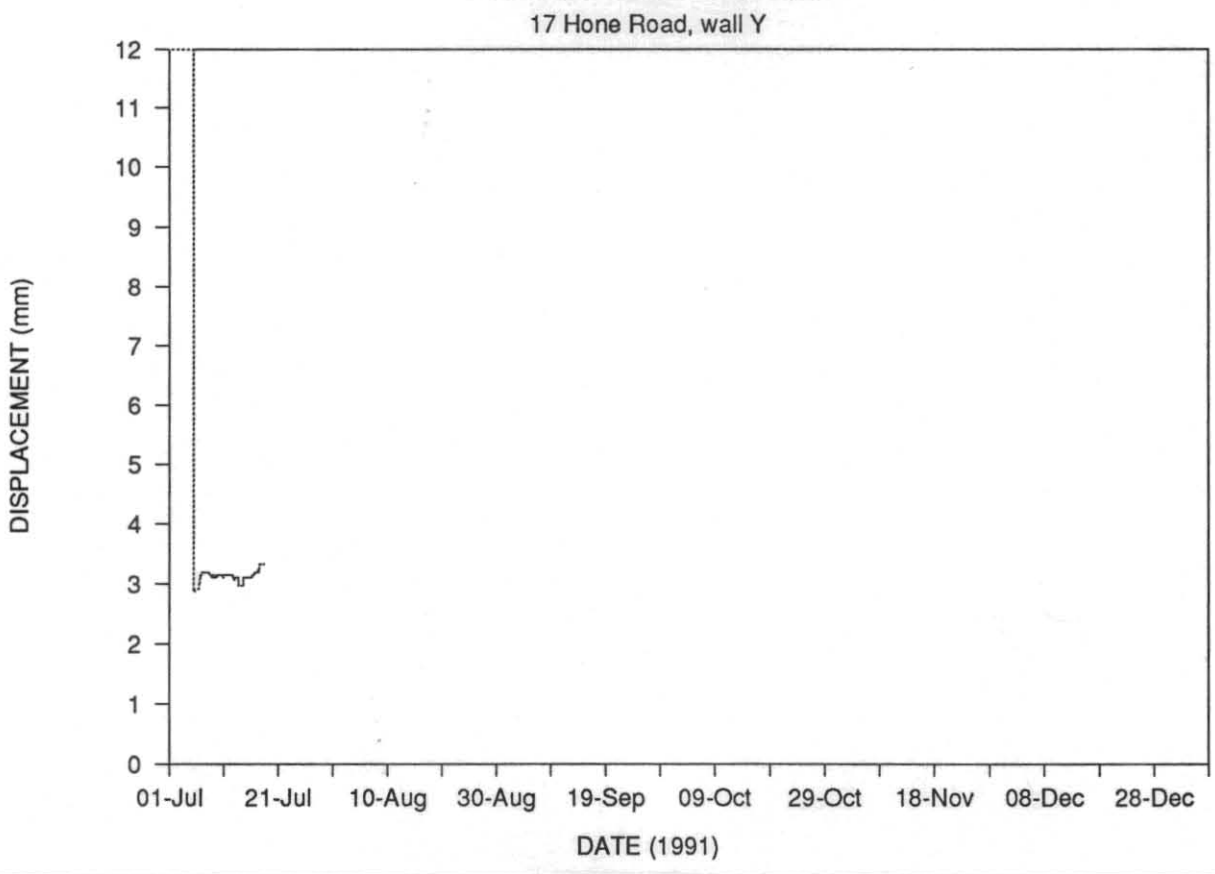

Rosetta landslide
17 Hone Road, wall X
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
01-Jul
21-Jul
10-Aug
30-Aug
19-Sep
09-Oct
29-Oct
18-Nov
08-Dec
28-Dec
DATE (1991)

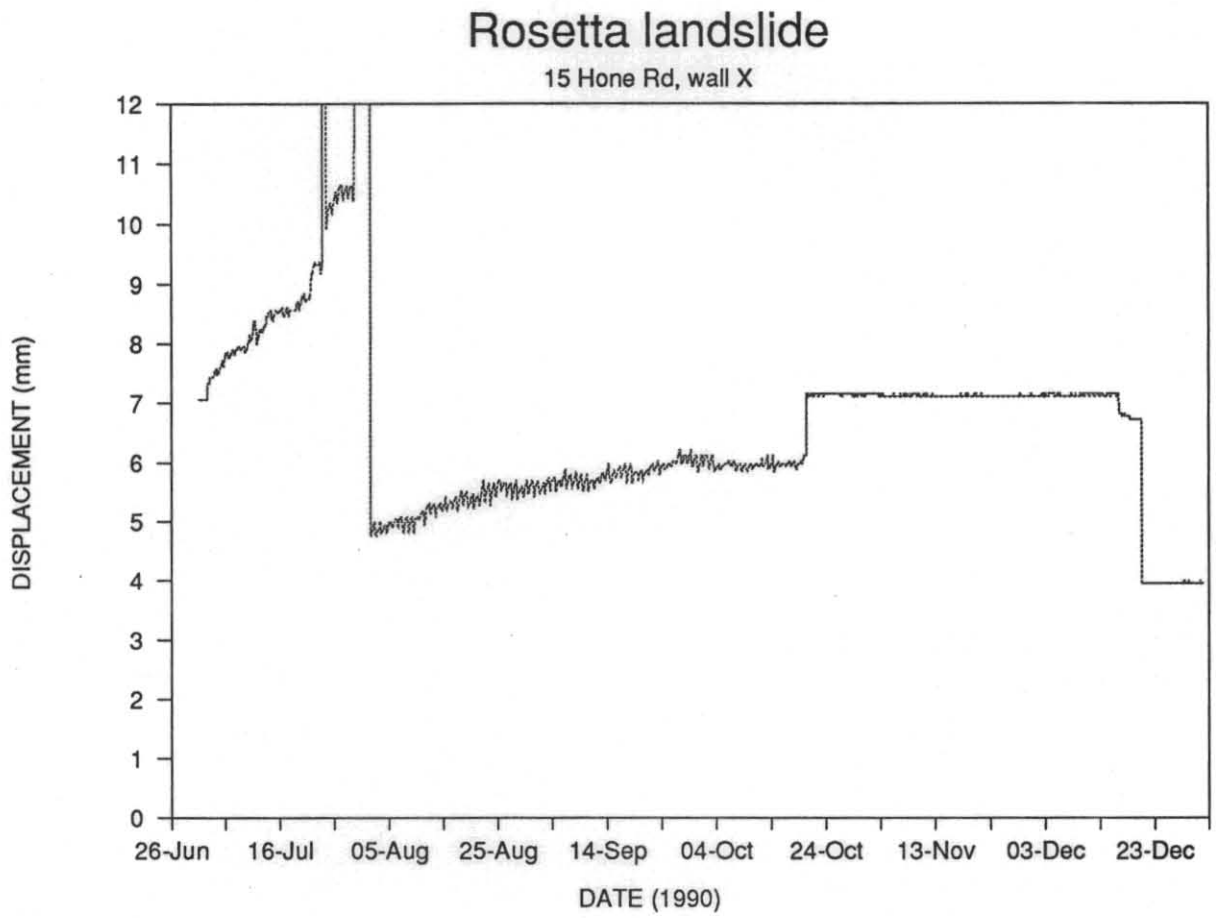

5 cm


Rosetta landslide
17 Hone Rd, wall Y
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
26-Jun
16-Jul
05-Aug
25-Aug
14-Sep
04-Oct
24-Oct
13-Nov
03-Dec
23-Dec
DATE (1990)

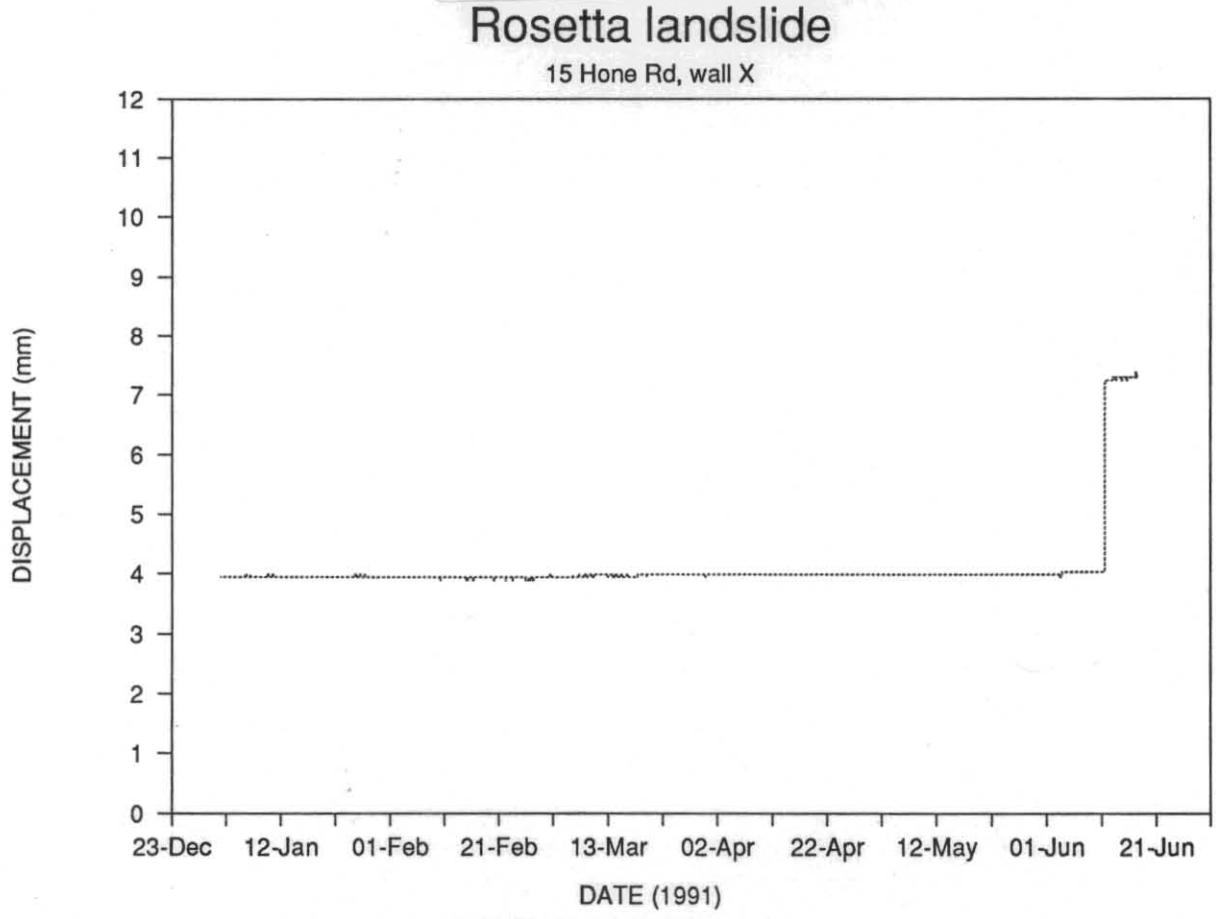

Rosetta landslide
17 Hone Rd, wall Y
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
23-Dec
12-Jan
01-Feb
21-Feb
13-Mar
02-Apr
22-Apr
12-May
01-Jun
21-Jun
DATE (1991)

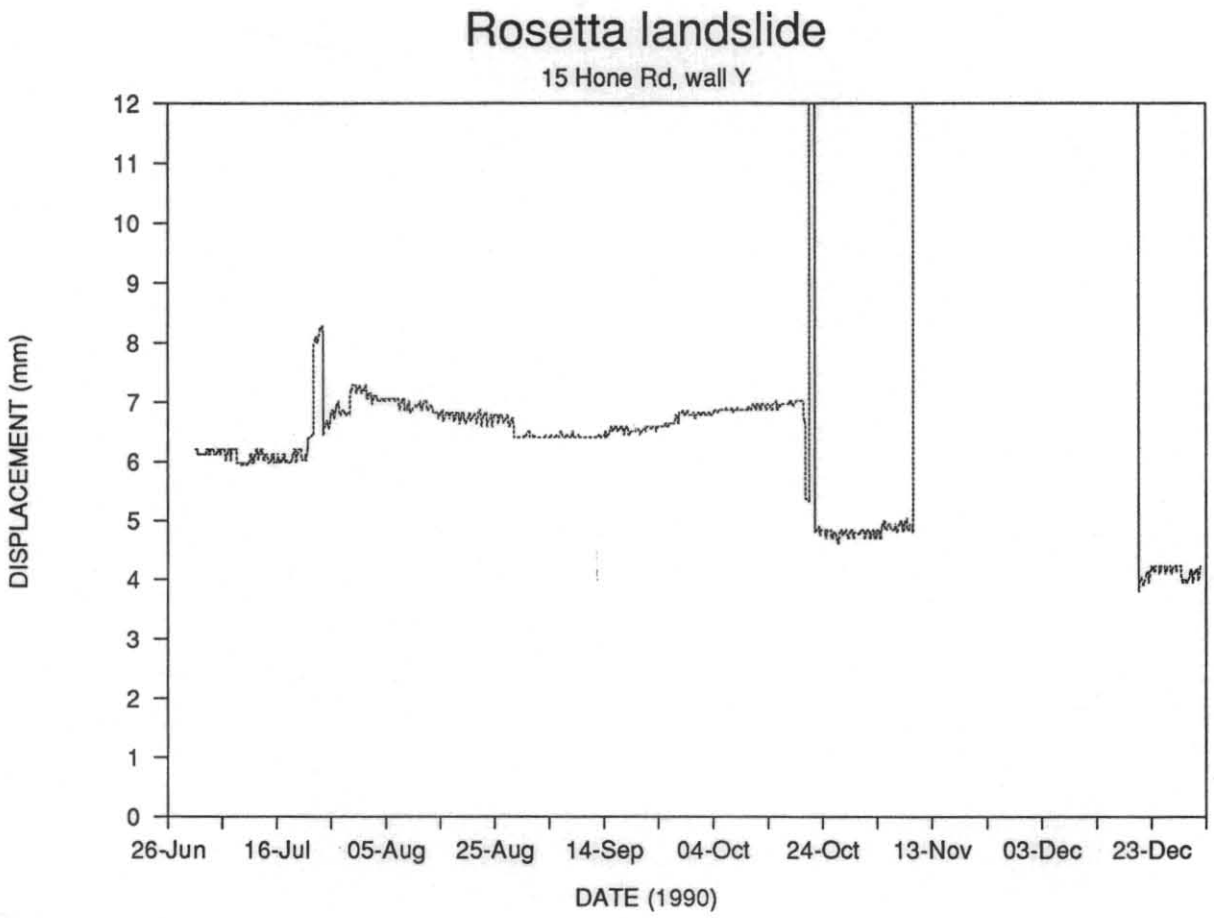

5 cm


Rosetta landslide
17 Hone Road, wall Y
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
01-Jul
21-Jul
10-Aug
30-Aug
19-Sep
09-Oct
29-Oct
18-Nov
08-Dec
28-Dec
DATE (1991)

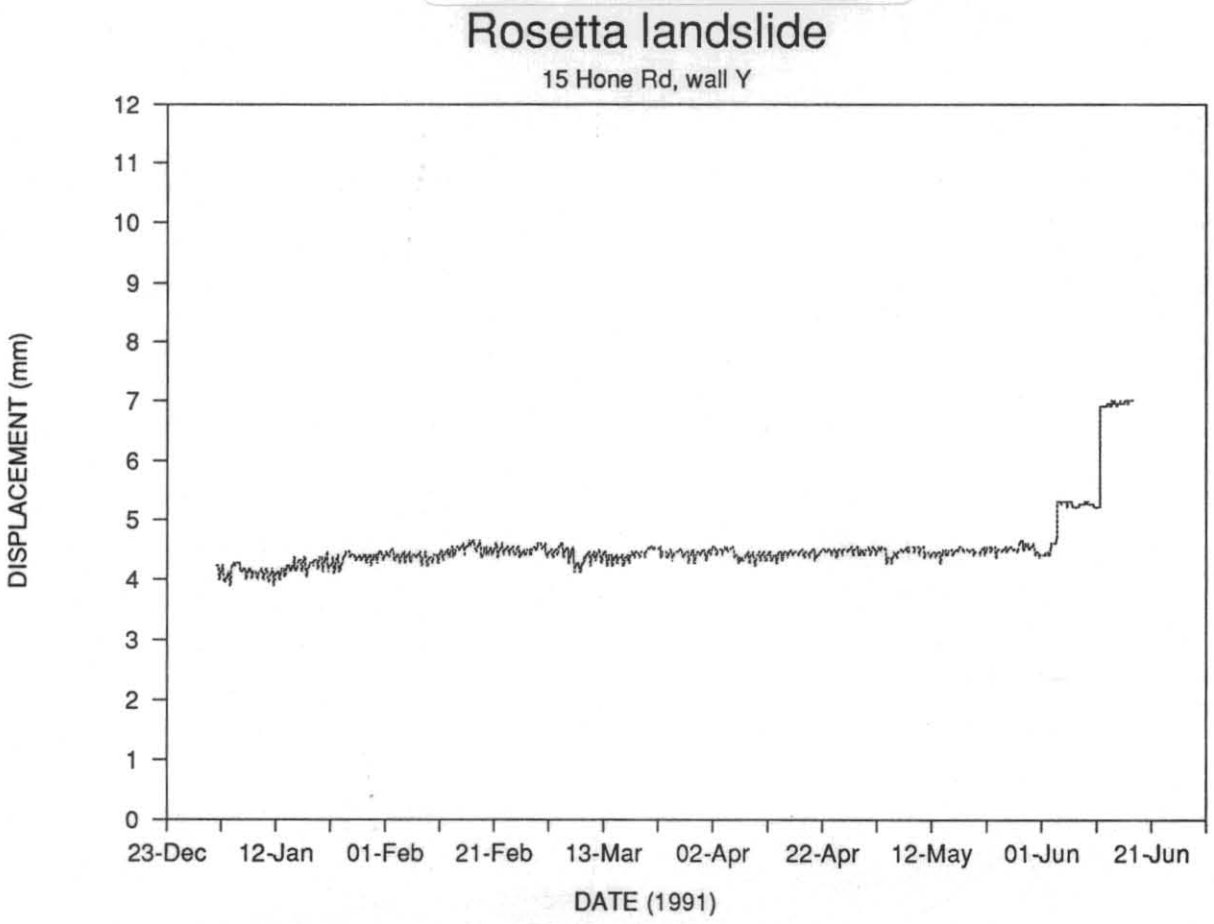

Rosetta landslide
15 Hone Rd, wall X
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
26-Jun
16-Jul
05-Aug
25-Aug
14-Sep
04-Oct
24-Oct
13-Nov
03-Dec
23-Dec
DATE (1990)

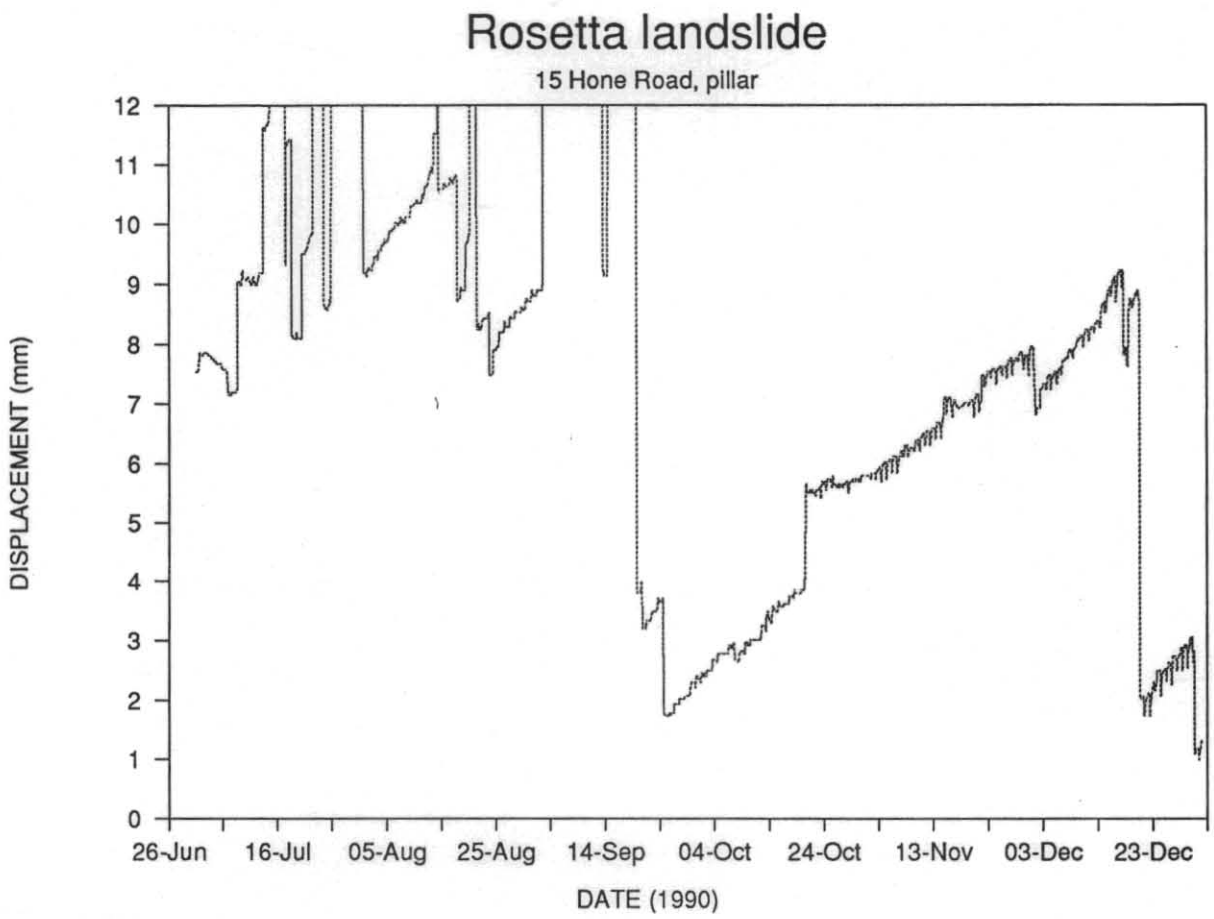
5 cm

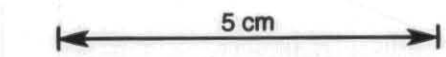

Rosetta landslide
15 Hone Rd, wall X
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
23-Dec
12-Jan
01-Feb
21-Feb
13-Mar
02-Apr
22-Apr
12-May
01-Jun
21-Jun
DATE (1991)

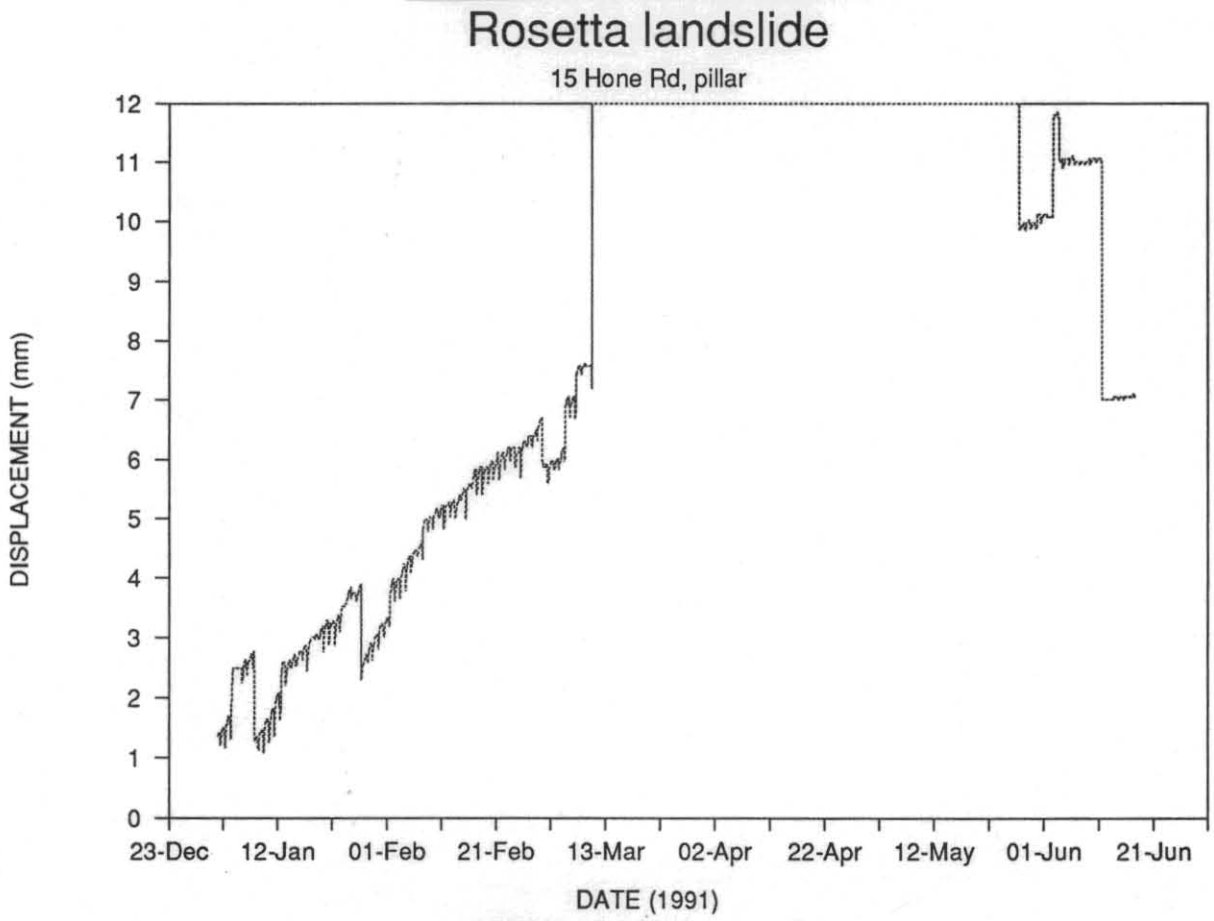

Rosetta landslide
15 Hone Rd, wall Y
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
26-Jun
16-Jul
05-Aug
25-Aug
14-Sep
04-Oct
24-Oct
13-Nov
03-Dec
23-Dec
DATE (1990)


5 cm


Rosetta landslide
15 Hone Rd, wall Y
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
23-Dec
12-Jan
01-Feb
21-Feb
13-Mar
02-Apr
22-Apr
12-May
01-Jun
21-Jun
DATE (1991)


Rosetta landslide
15 Hone Road, pillar
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
26-Jun
16-Jul
05-Aug
25-Aug
14-Sep
04-Oct
24-Oct
13-Nov
03-Dec
23-Dec
DATE (1990)


5 cm


Rosetta landslide
15 Hone Rd, pillar
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
23-Dec
12-Jan
01-Feb
21-Feb
13-Mar
02-Apr
22-Apr
12-May
01-Jun
21-Jun
DATE (1991)

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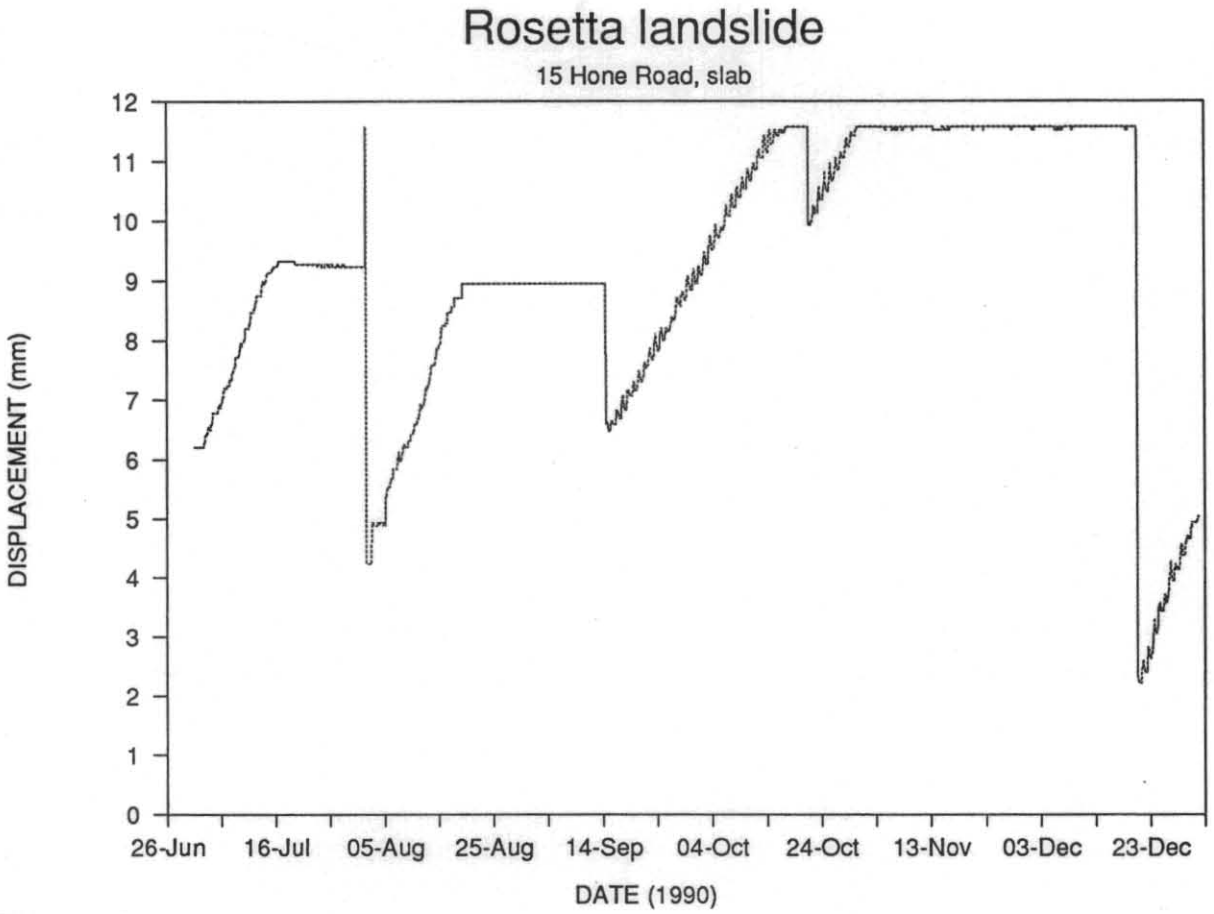
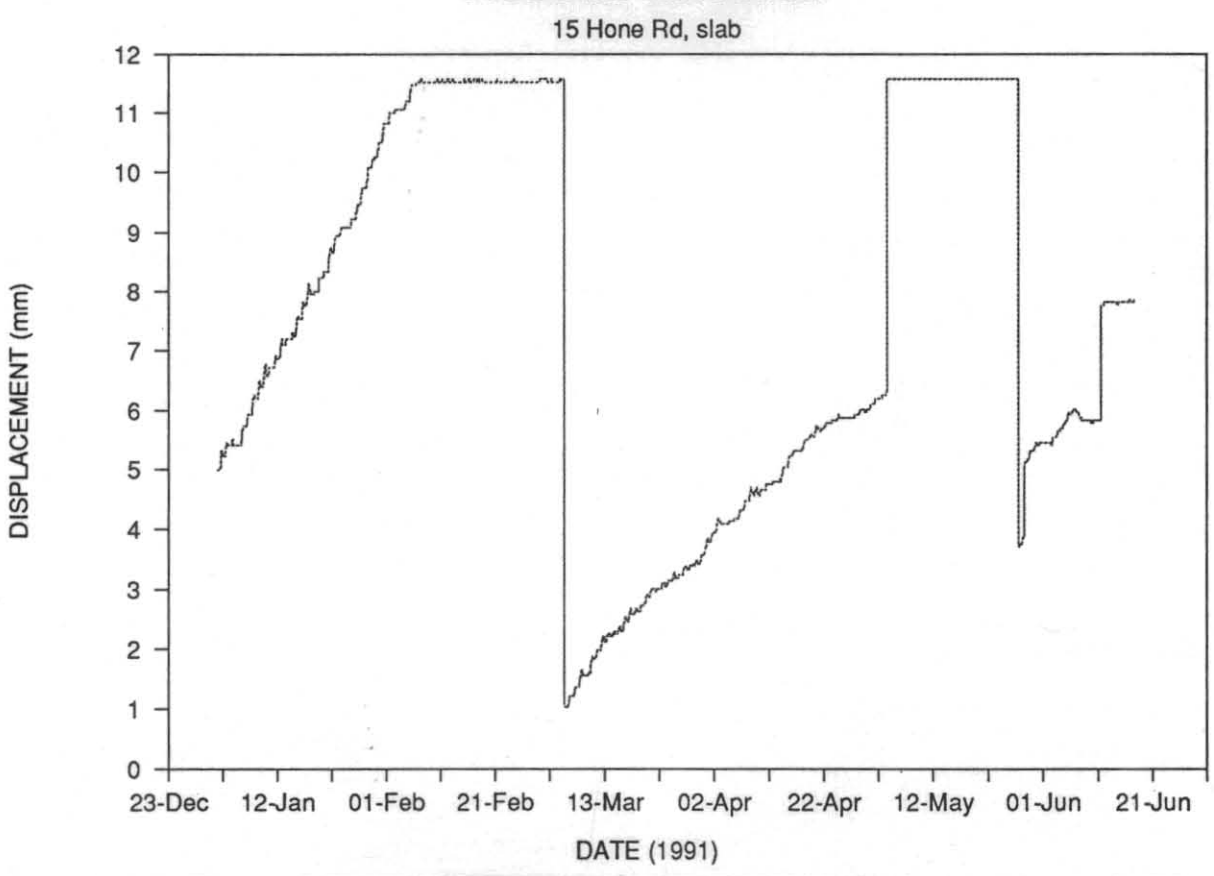
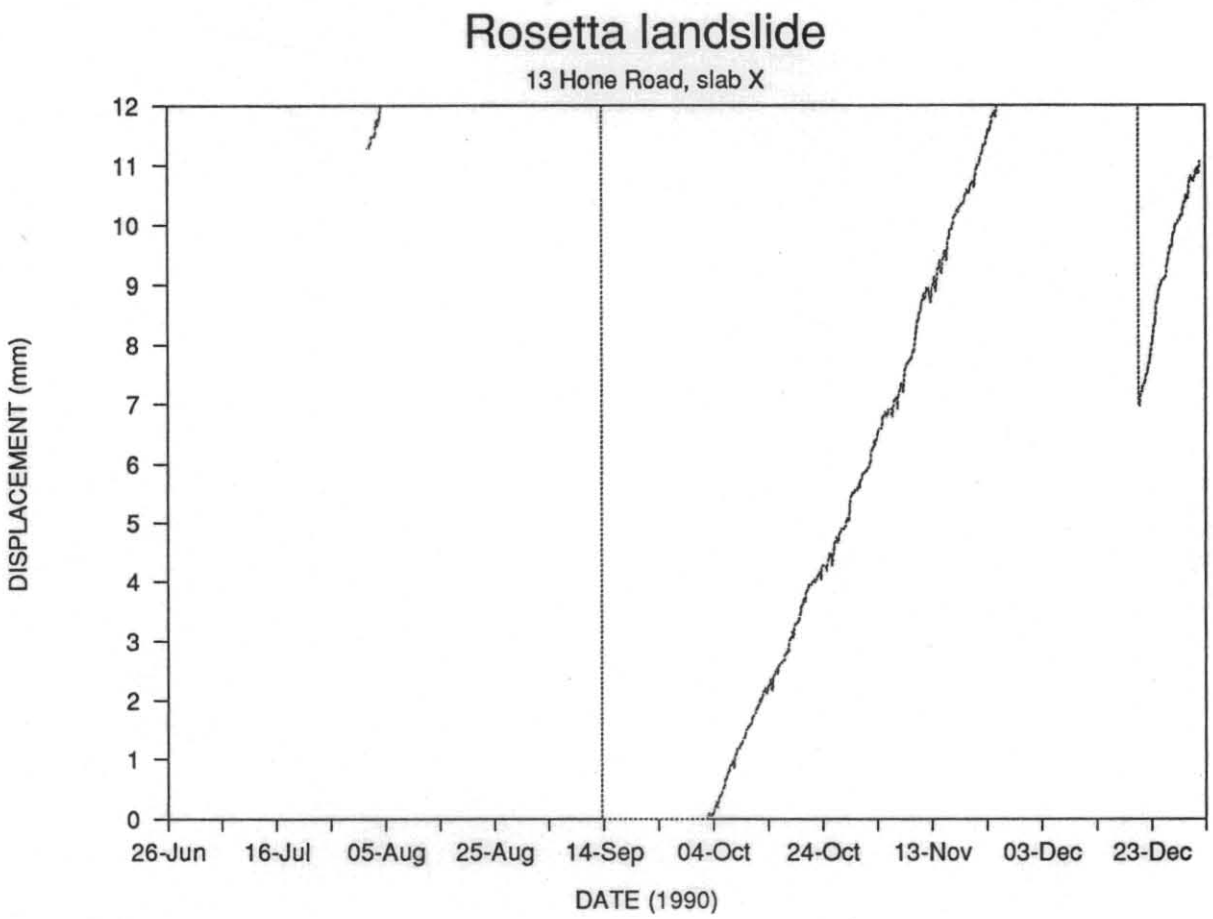
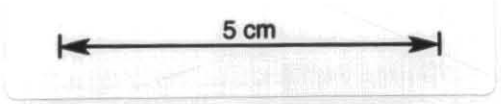
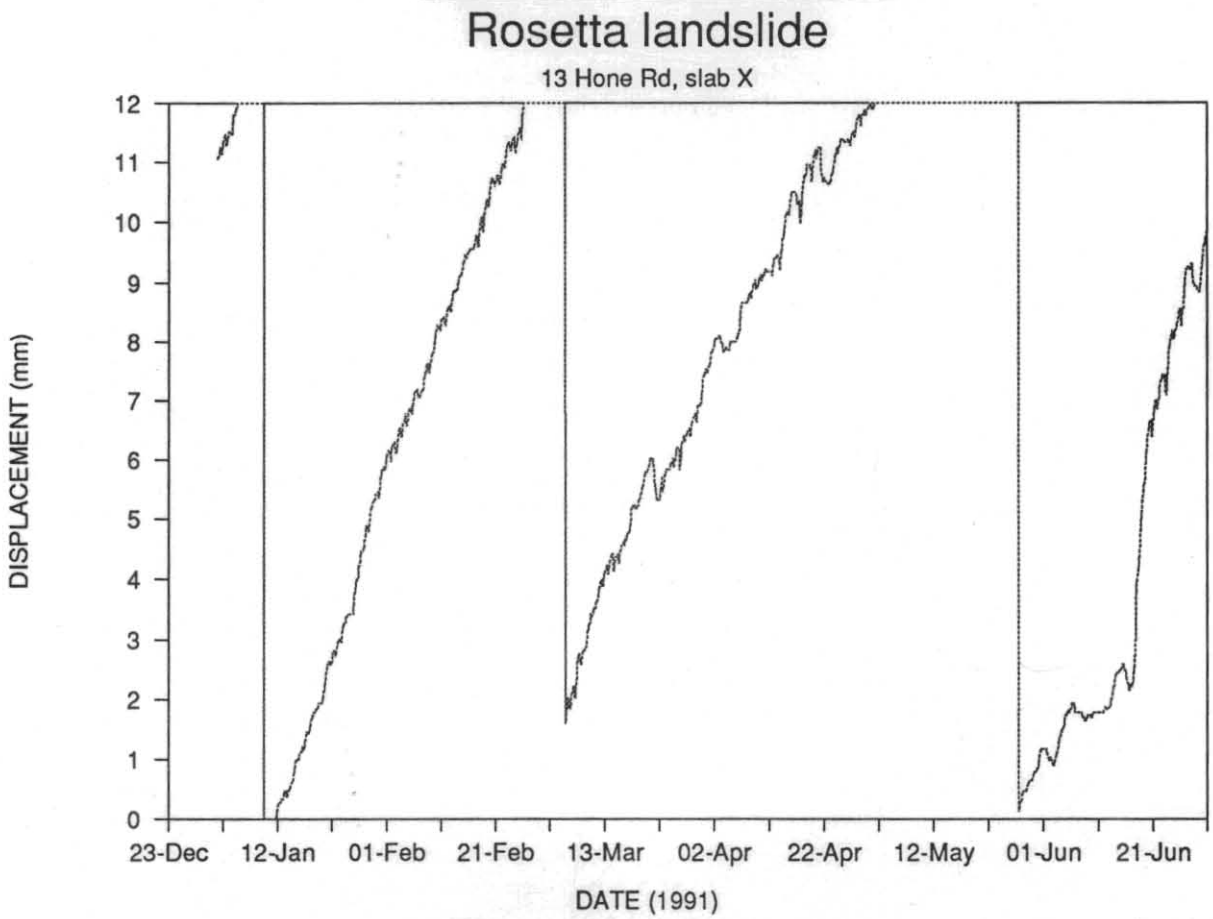

Rosetta landslide
15 Hone Road, slab
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
26-Jun
16-Jul
05-Aug
25-Aug
14-Sep
04-Oct
24-Oct
13-Nov
03-Dec
23-Dec
DATE (1990)

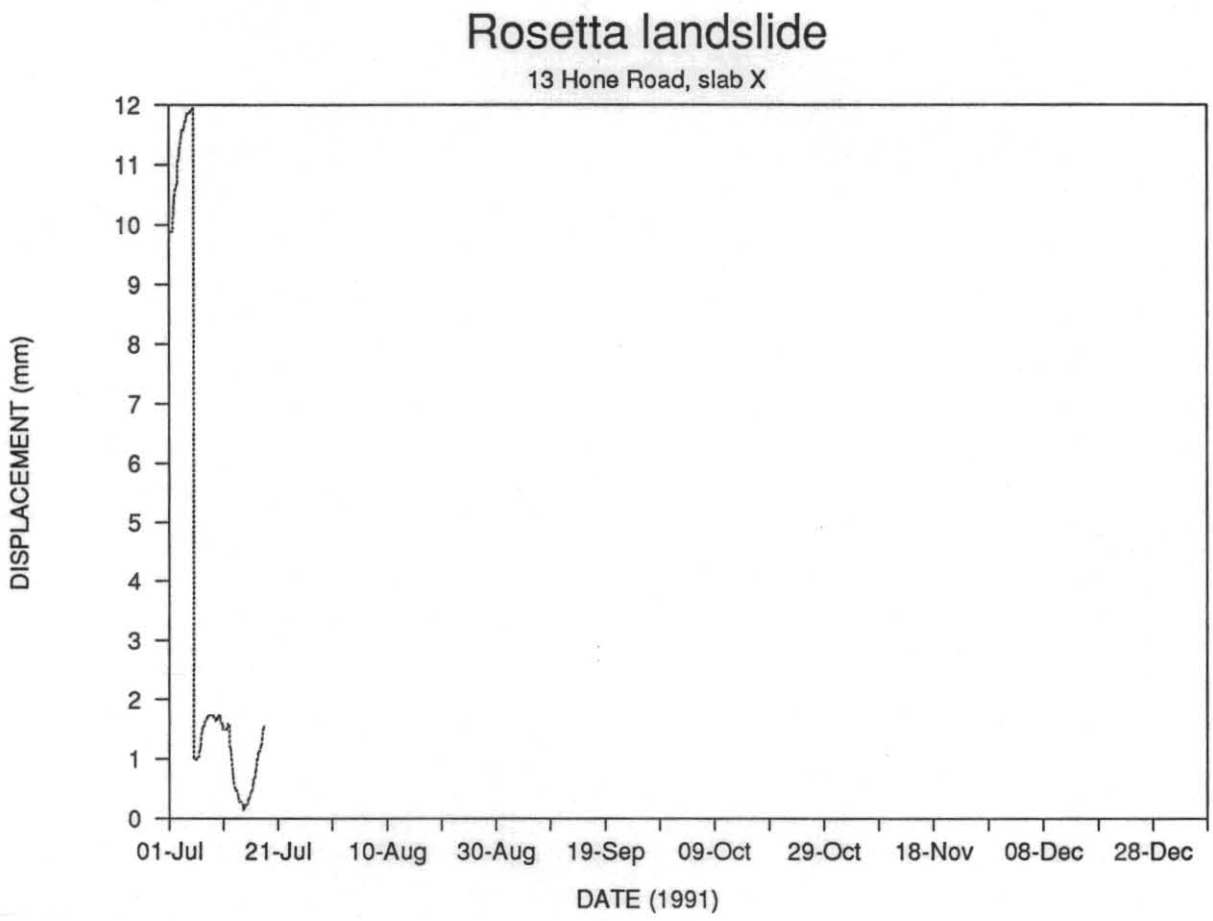
5 cm


Rosetta landslide
15 Hone Rd, slab
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
23-Dec
12-Jan
01-Feb
21-Feb
13-Mar
02-Apr
22-Apr
12-May
01-Jun
21-Jun
DATE (1991)

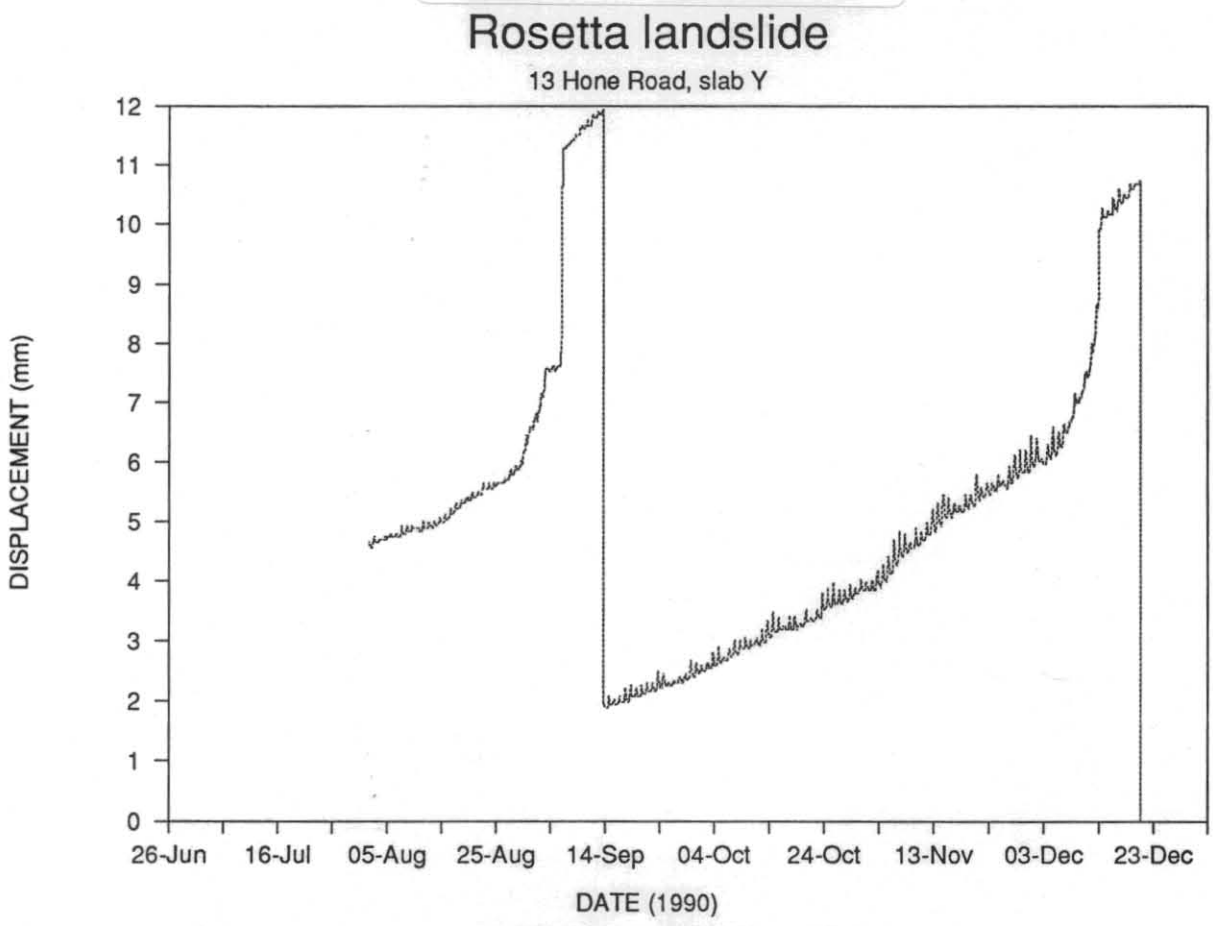

Rosetta landslide
13 Hone Road, slab X
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
26-Jun
16-Jul
05-Aug
25-Aug
14-Sep
04-Oct
24-Oct
13-Nov
03-Dec
23-Dec
DATE (1990)


5 cm


Rosetta landslide
13 Hone Rd, slab X
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
23-Dec
12-Jan
01-Feb
21-Feb
13-Mar
02-Apr
22-Apr
12-May
01-Jun
21-Jun
DATE (1991)


Rosetta landslide
13 Hone Road, slab X
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
01-Jul
21-Jul
10-Aug
30-Aug
19-Sep
09-Oct
29-Oct
18-Nov
08-Dec
28-Dec
DATE (1991)

5 cm


Rosetta landslide
13 Hone Road, slab Y
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
26-Jun
16-Jul
05-Aug
25-Aug
14-Sep
04-Oct
24-Oct
13-Nov
03-Dec
23-Dec
DATE (1990)

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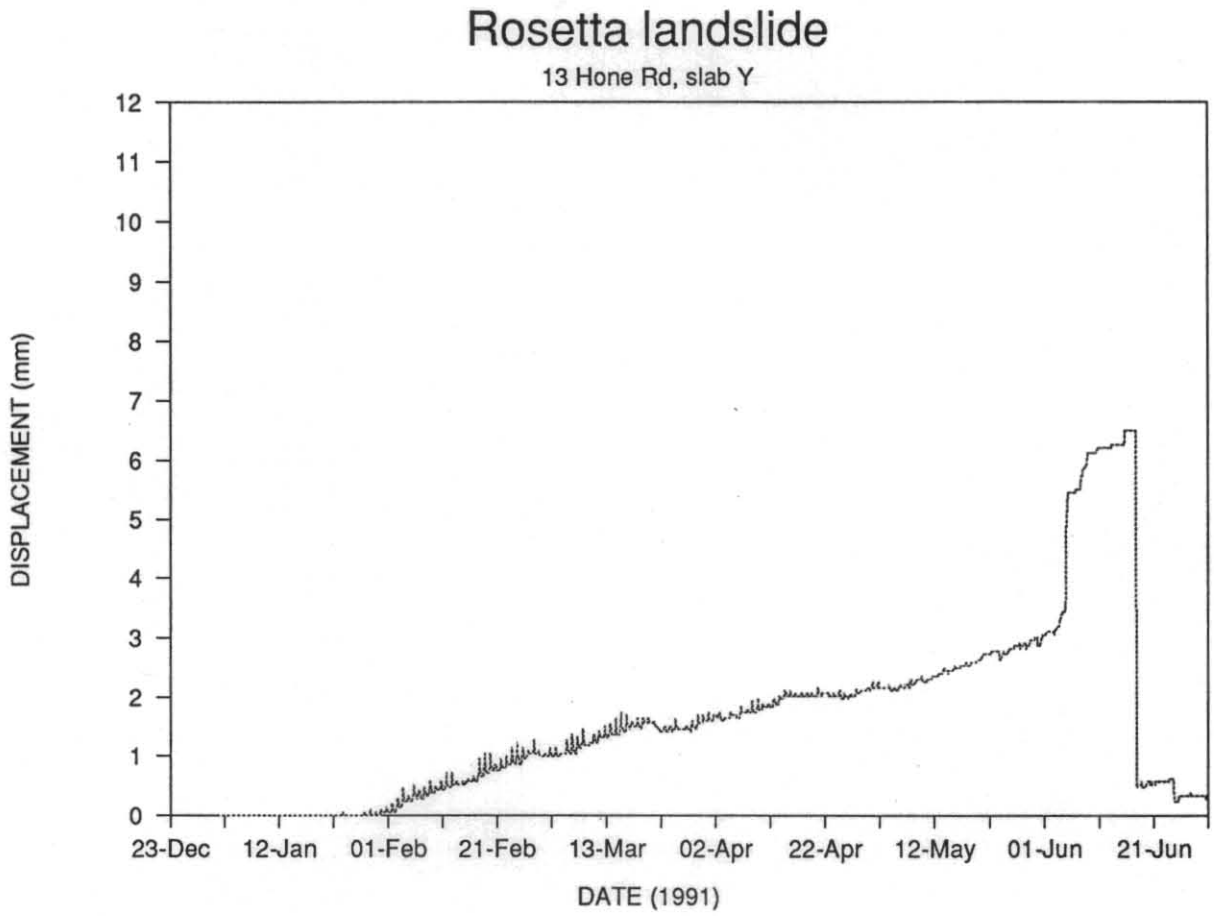
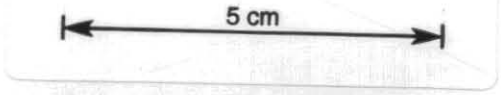
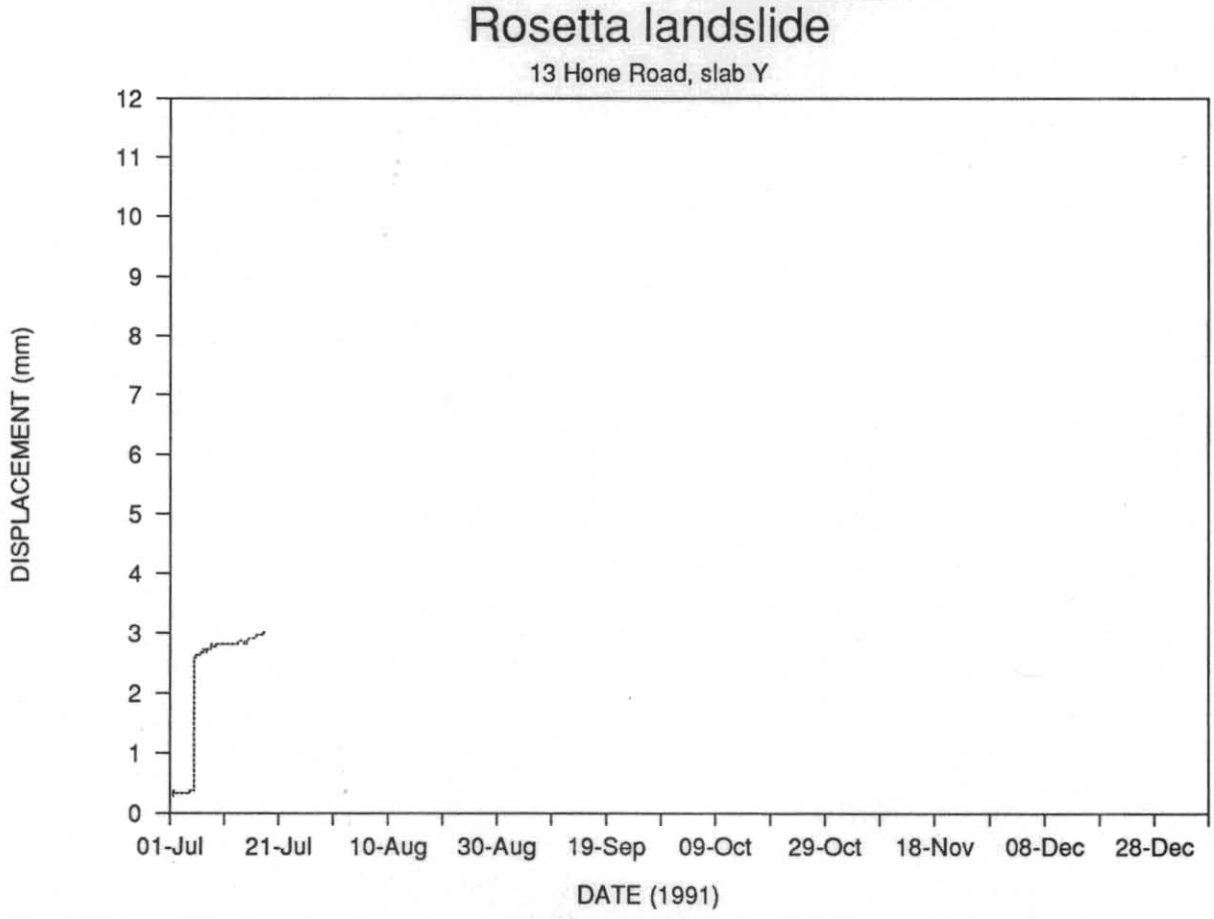

Rosetta landslide
13 Hone Rd, slab Y
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
23-Dec
12-Jan
01-Feb
21-Feb
13-Mar
02-Apr
22-Apr
12-May
01-Jun
21-Jun
DATE (1991)


5 cm


Rosetta landslide
13 Hone Road, slab Y
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
01-Jul
21-Jul
10-Aug
30-Aug
19-Sep
09-Oct
29-Oct
18-Nov
08-Dec
28-Dec
DATE (1991)

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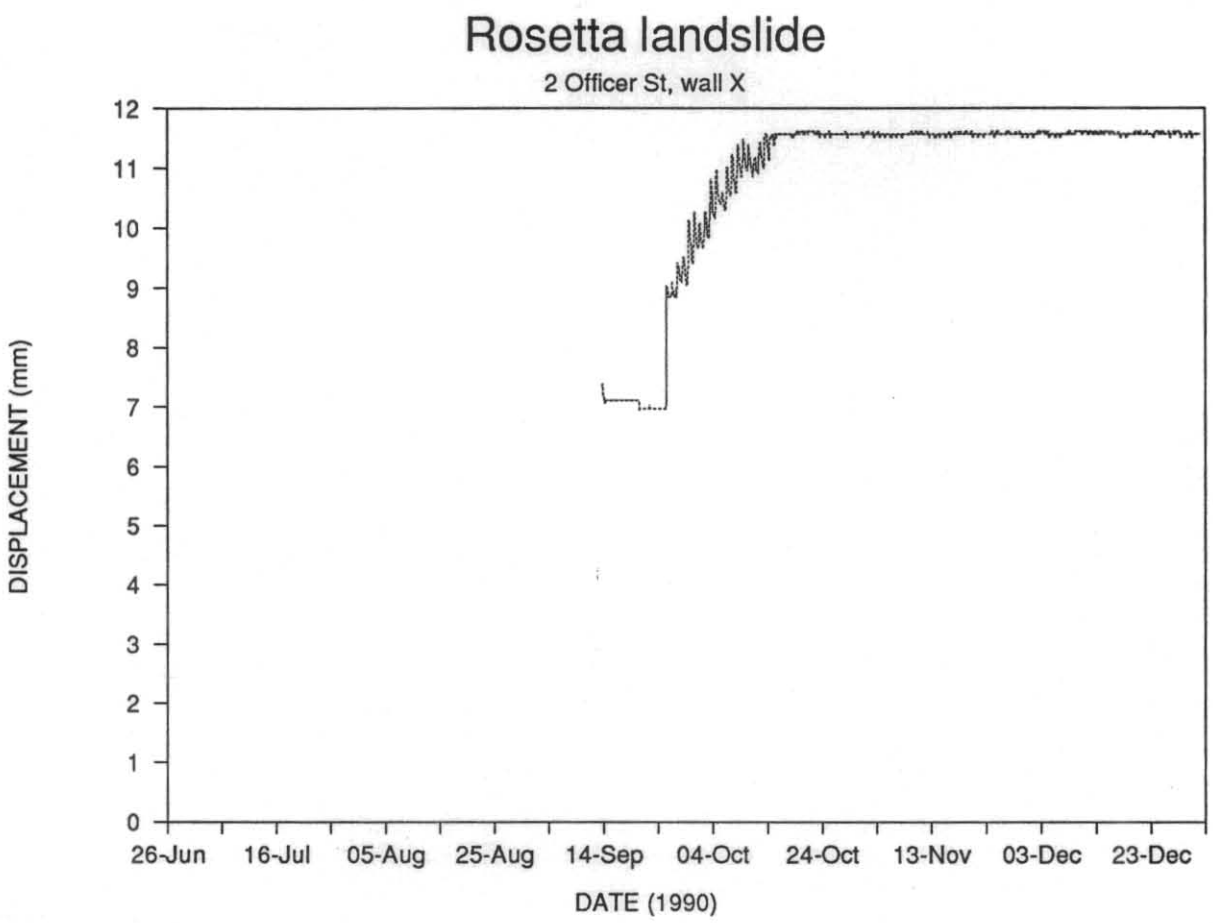
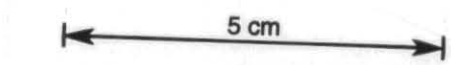
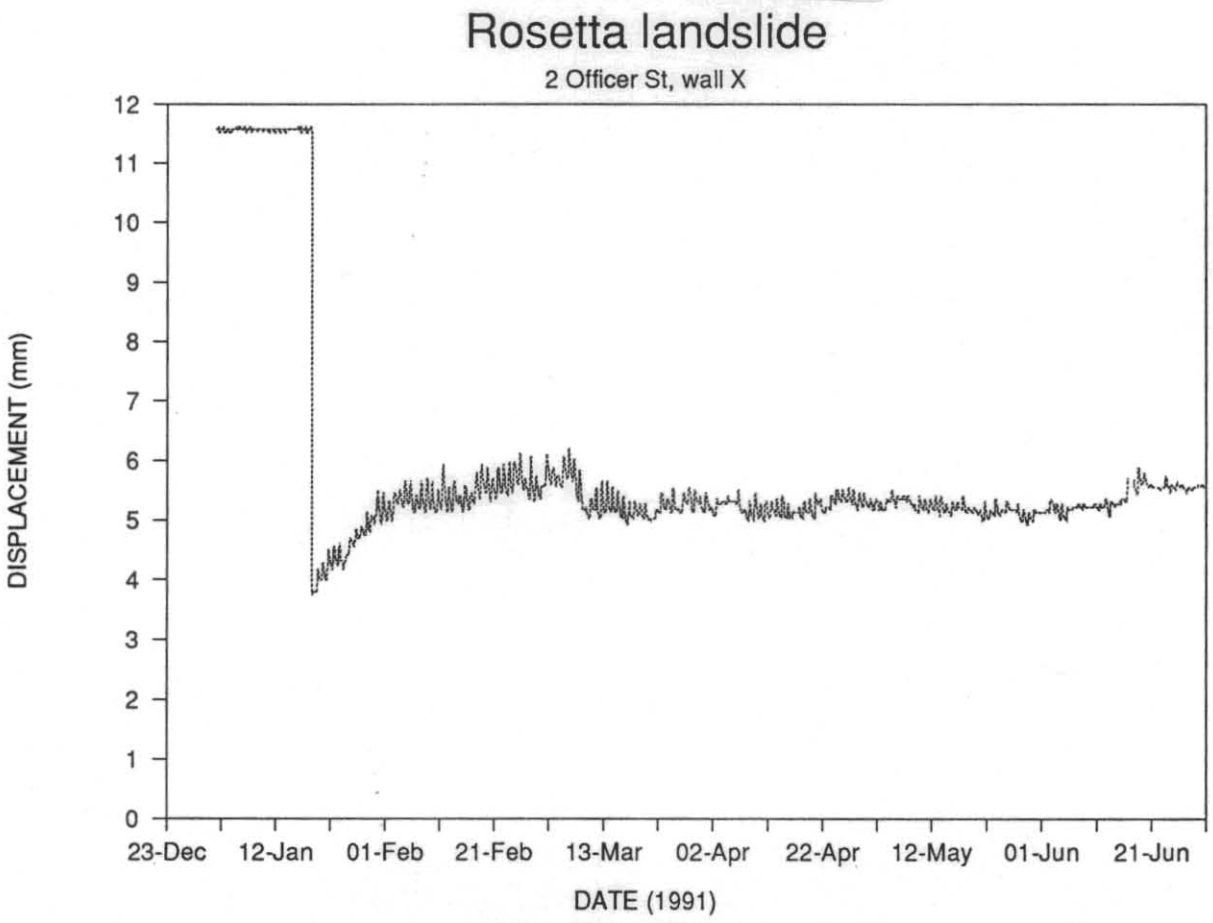

Rosetta landslide
2 Officer St, wall X
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
26-Jun
16-Jul
05-Aug
25-Aug
14-Sep
04-Oct
24-Oct
13-Nov
03-Dec
23-Dec
DATE (1990)


5 cm


Rosetta landslide
2 Officer St, wall X
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
23-Dec
12-Jan
01-Feb
21-Feb
13-Mar
02-Apr
22-Apr
12-May
01-Jun
21-Jun
DATE (1991)

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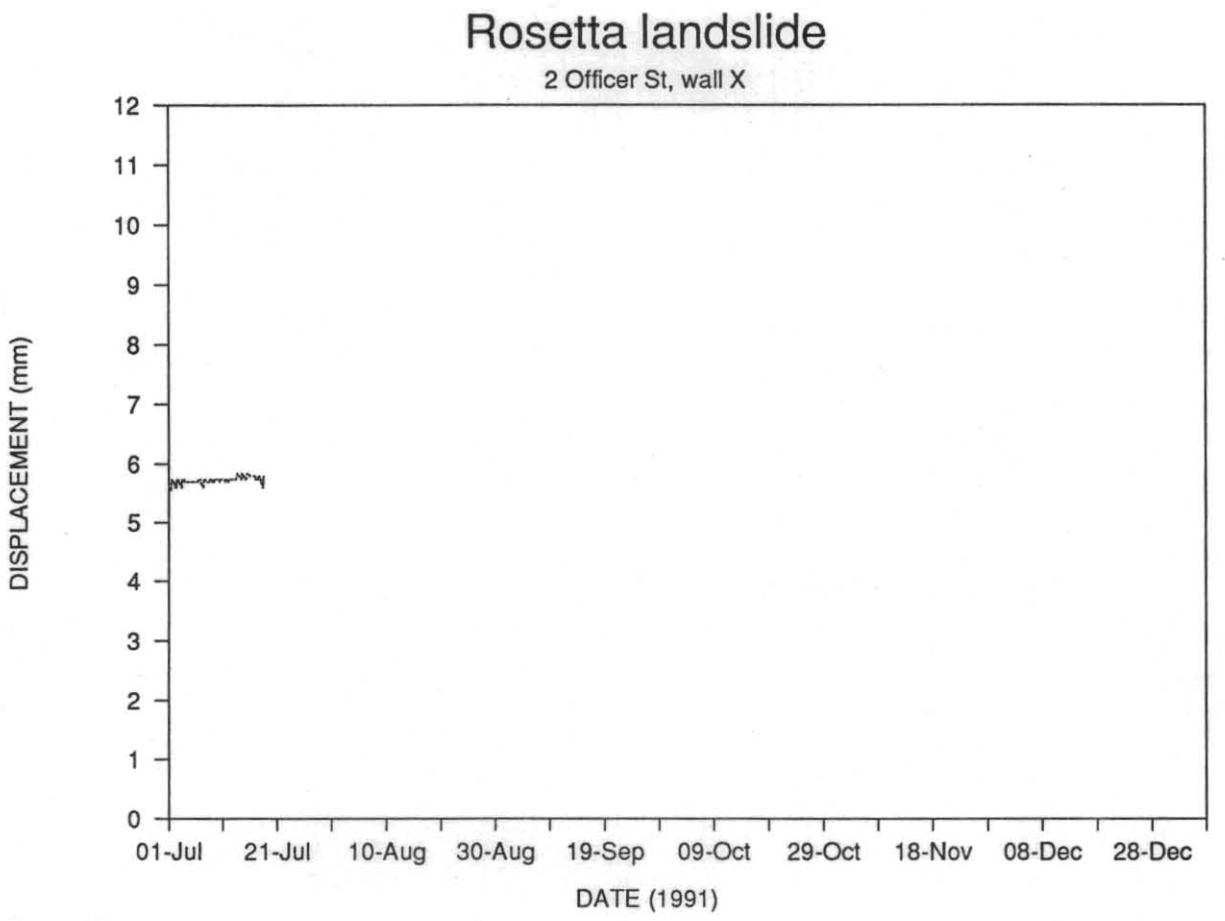
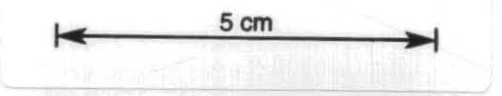
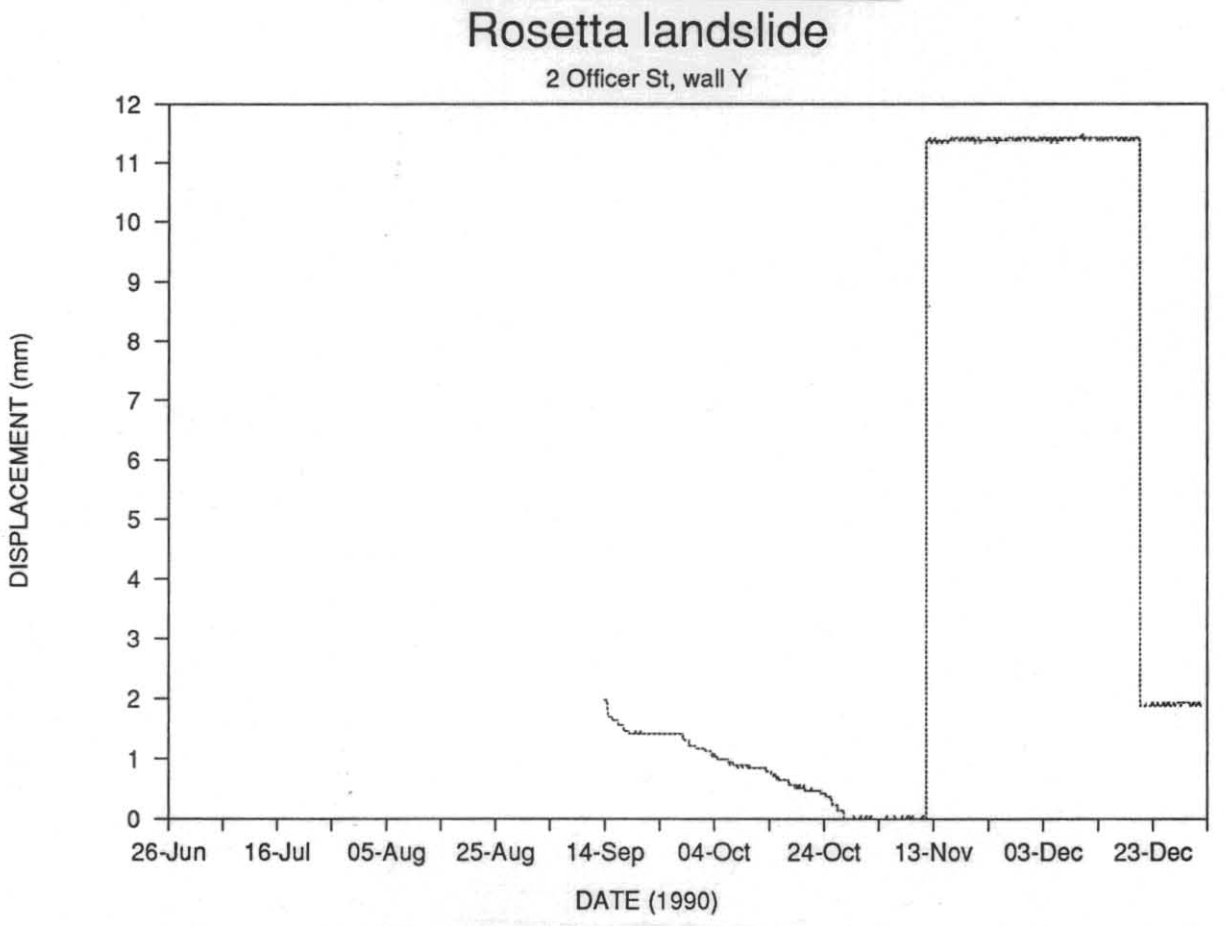

Rosetta landslide
2 Officer St, wall X
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
01-Jul
21-Jul
10-Aug
30-Aug
19-Sep
09-Oct
29-Oct
18-Nov
08-Dec
28-Dec
DATE (1991)


5 cm


Rosetta landslide
2 Officer St, wall Y
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
26-Jun
16-Jul
05-Aug
25-Aug
14-Sep
04-Oct
24-Oct
13-Nov
03-Dec
23-Dec
DATE (1990)

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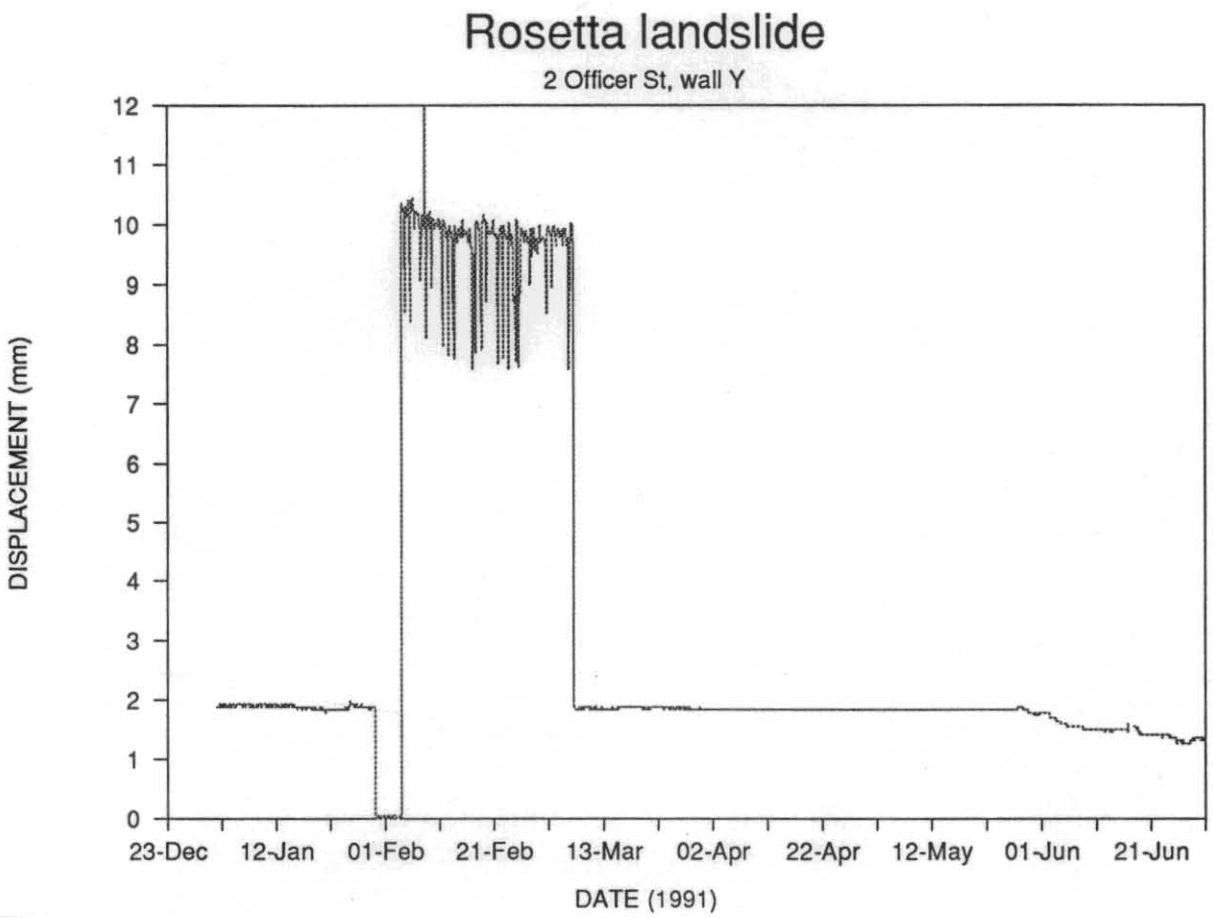
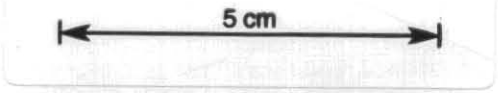
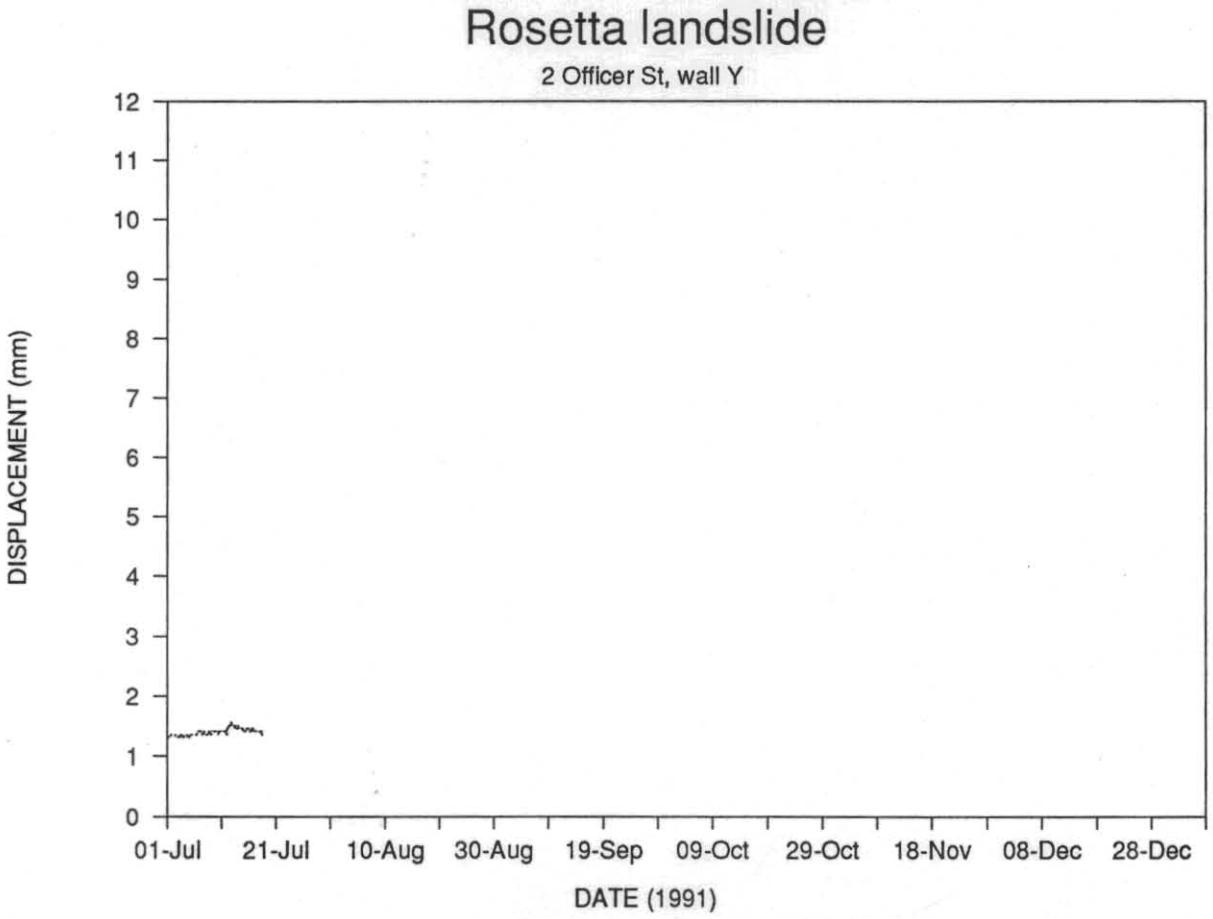

Rosetta landslide
2 Officer St, wall Y
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
23-Dec
12-Jan
01-Feb
21-Feb
13-Mar
02-Apr
22-Apr
12-May
01-Jun
21-Jun
DATE (1991)


5 cm


Rosetta landslide
2 Officer St, wall Y
DISPLACEMENT (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
01-Jul
21-Jul
10-Aug
30-Aug
19-Sep
09-Oct
29-Oct
18-Nov
08-Dec
28-Dec
DATE (1991)

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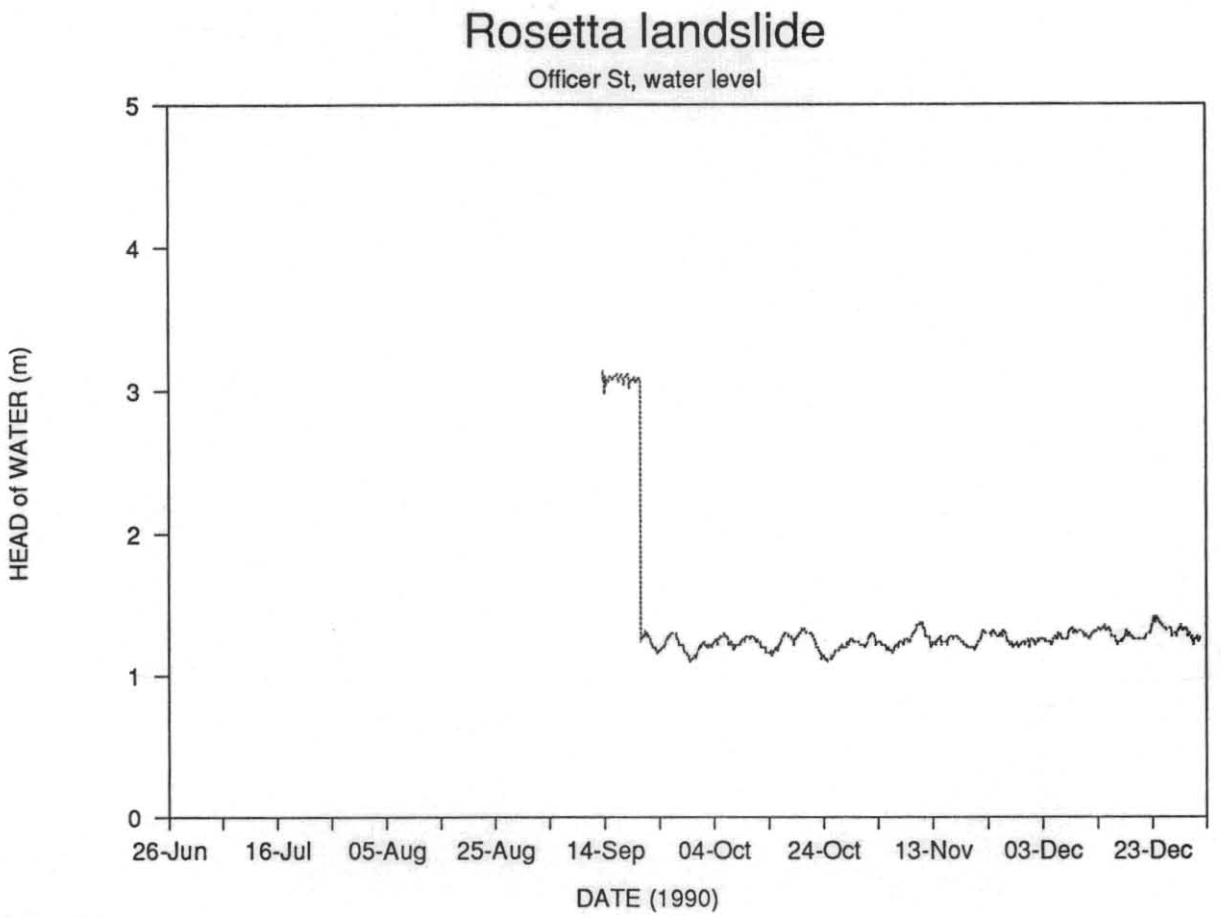
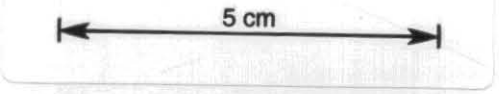
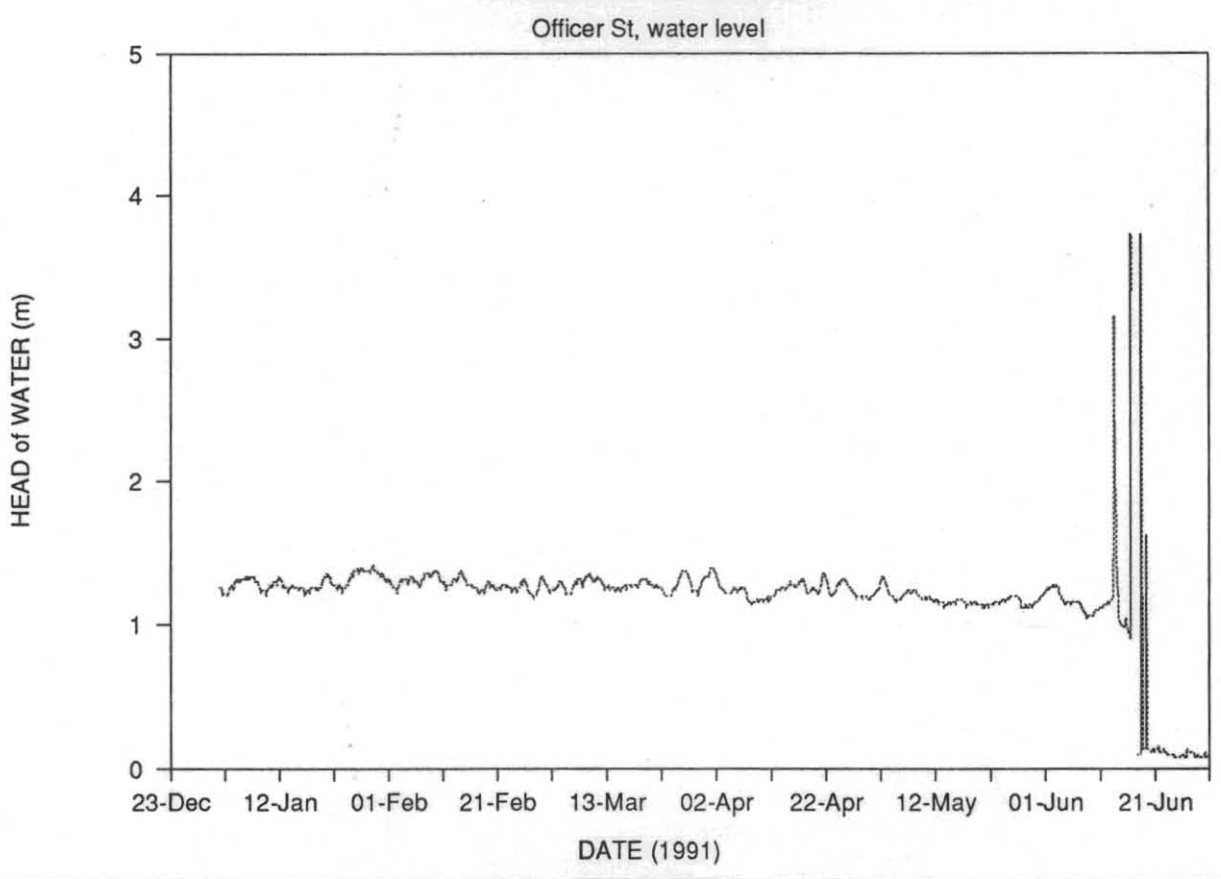

Rosetta landslide
Officer St, water level
HEAD of WATER (m)
0
1
2
3
4
5
26-Jun
16-Jul
05-Aug
25-Aug
14-Sep
04-Oct
24-Oct
13-Nov
03-Dec
23-Dec
DATE (1990)


5 cm


Rosetta landslide
Officer St, water level
HEAD of WATER (m)
0
1
2
3
4
5
23-Dec
12-Jan
01-Feb
21-Feb
13-Mar
02-Apr
22-Apr
12-May
01-Jun
21-Jun
DATE (1991)

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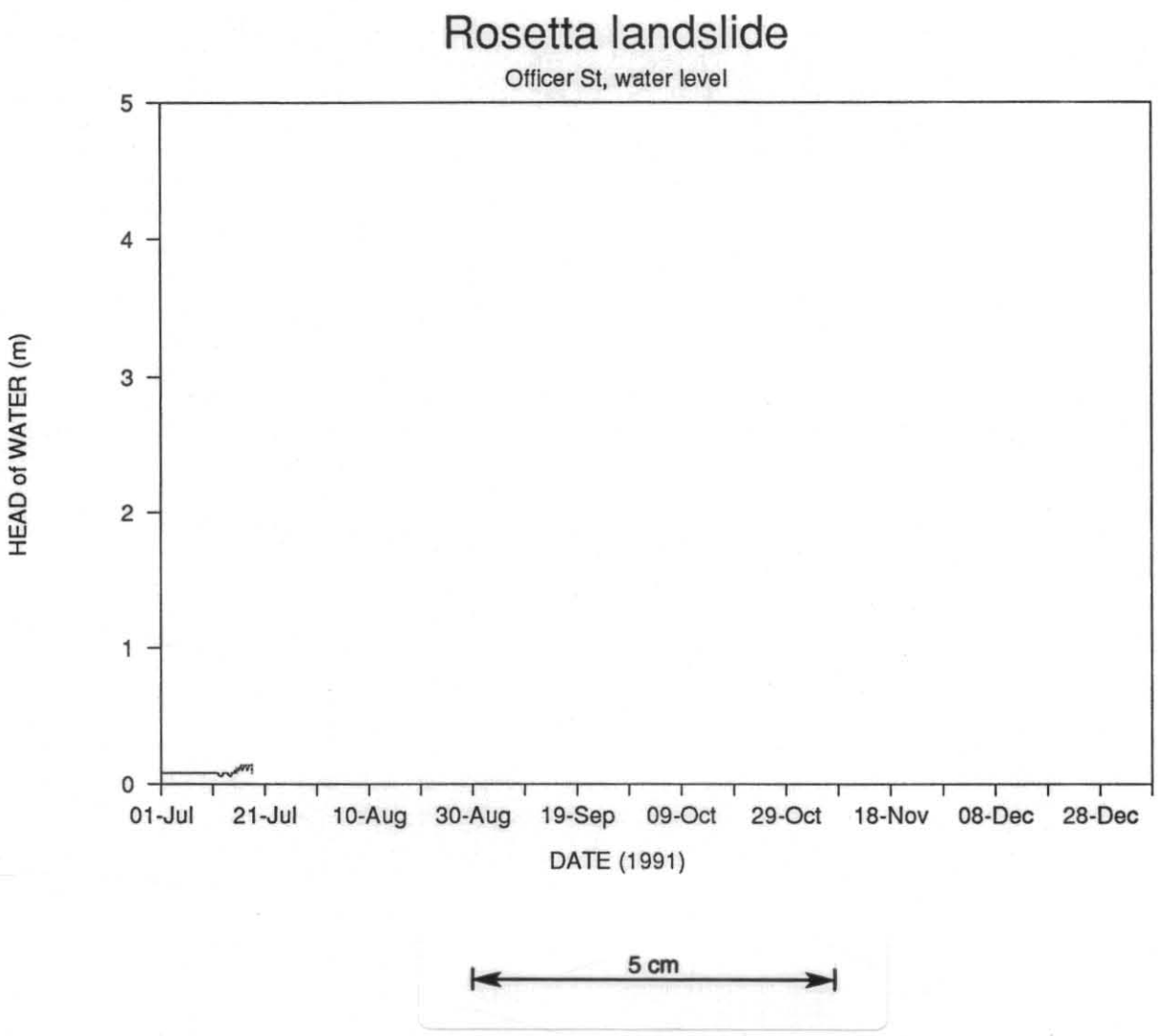
Rosetta landslide
Officer St, water level
HEAD of WATER (m)
5
4
3
2
1
0
01-Jul
21-Jul
10-Aug
30-Aug
19-Sep
09-Oct
29-Oct
18-Nov
08-Dec
28-Dec
DATE (1991)
5 cm

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APPENDIX 4

Rainfall data, 15 Hone Road

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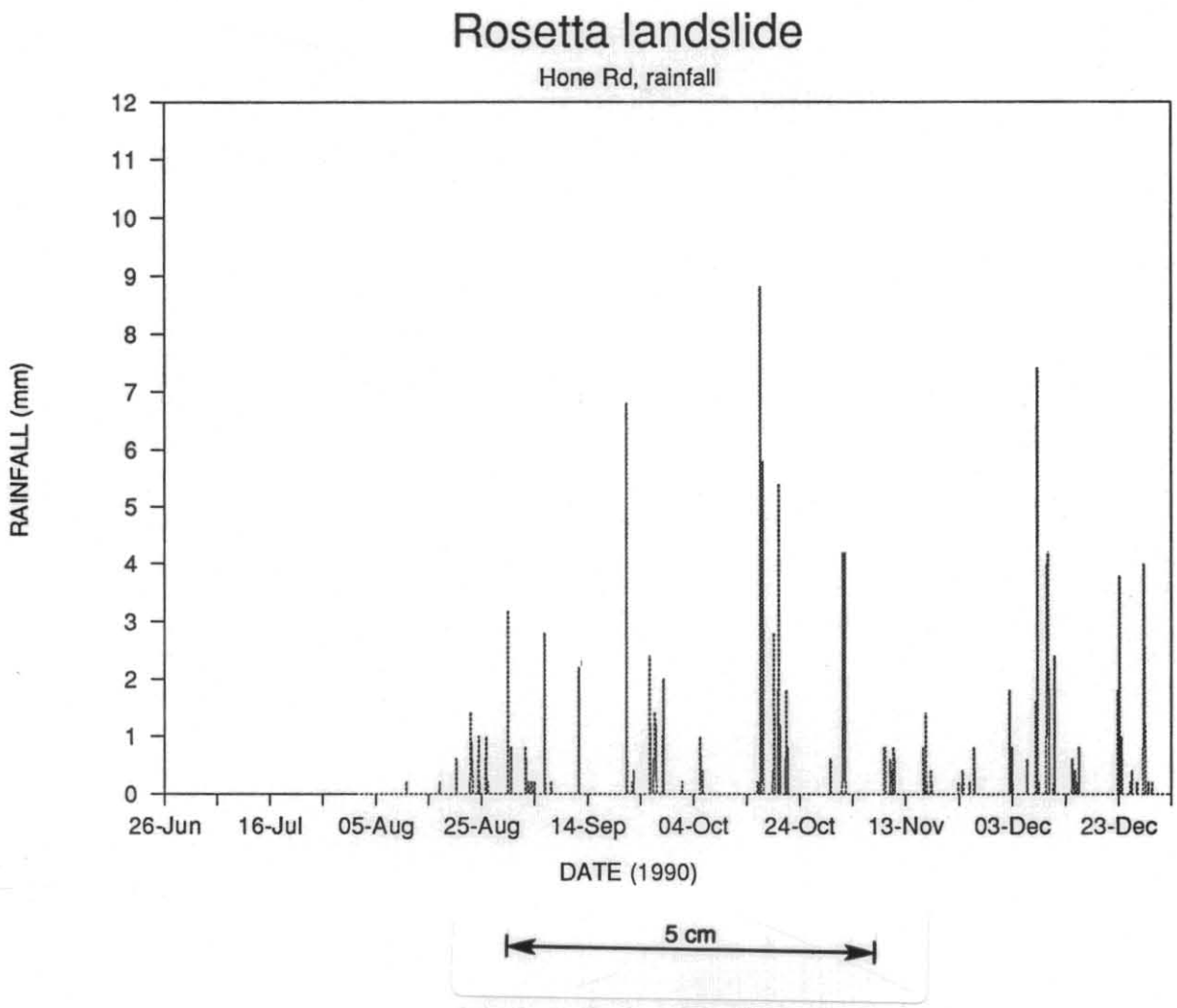
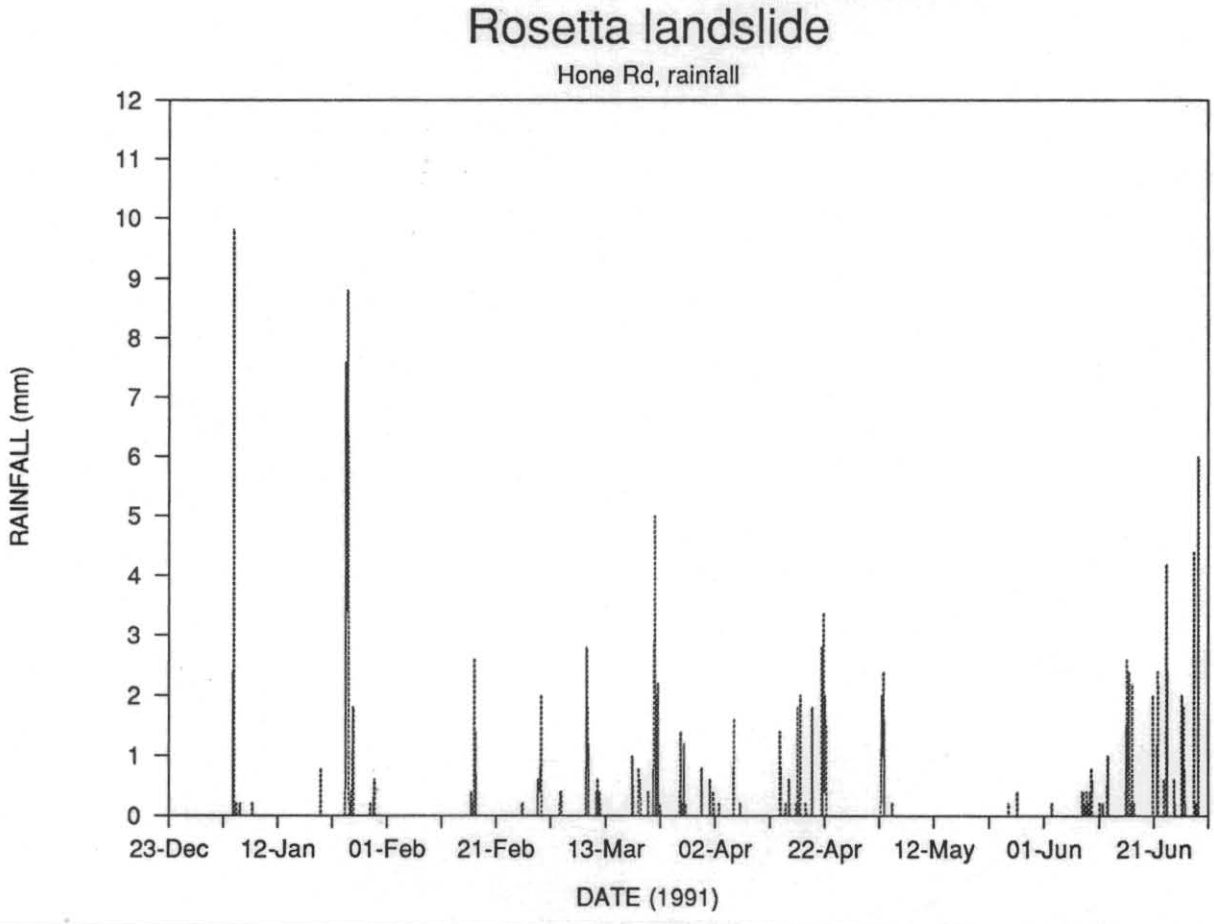
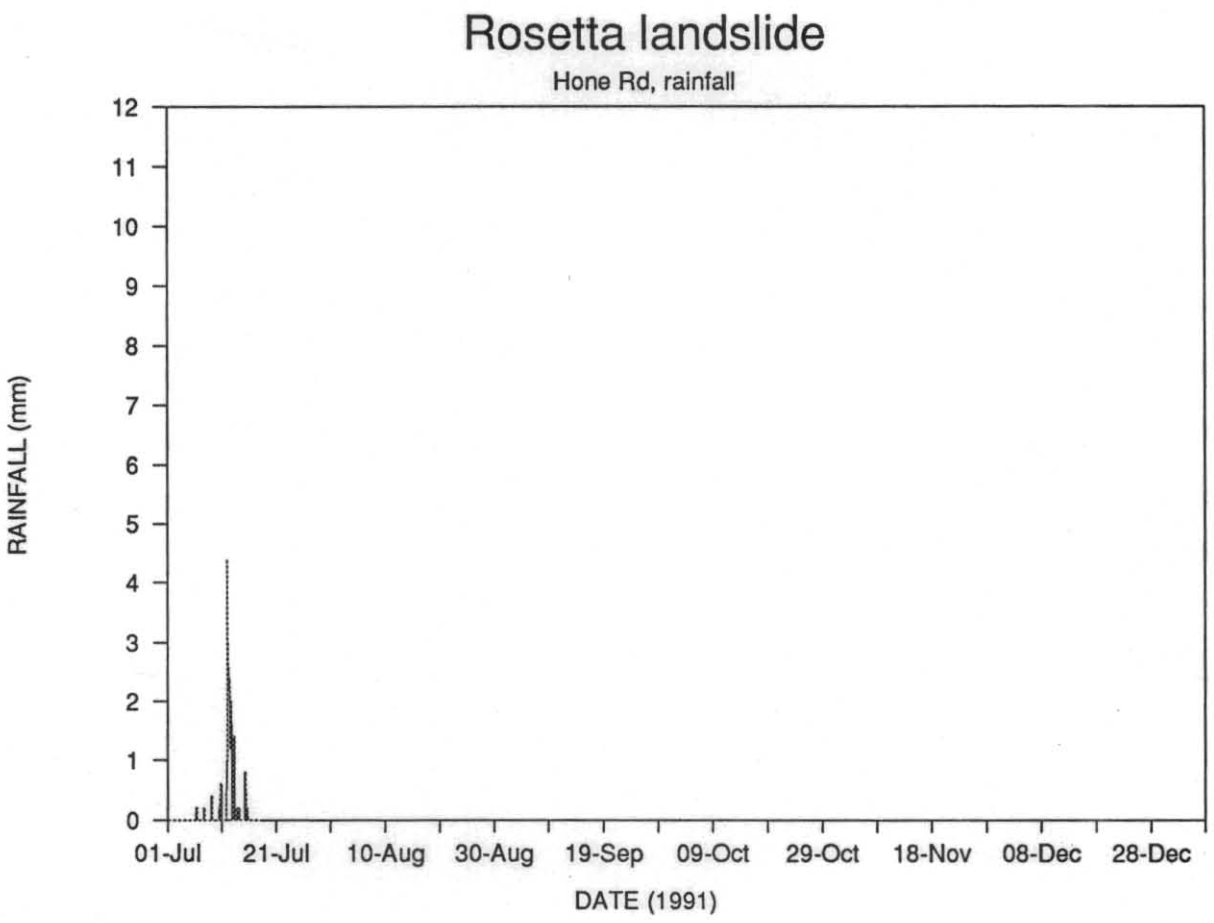
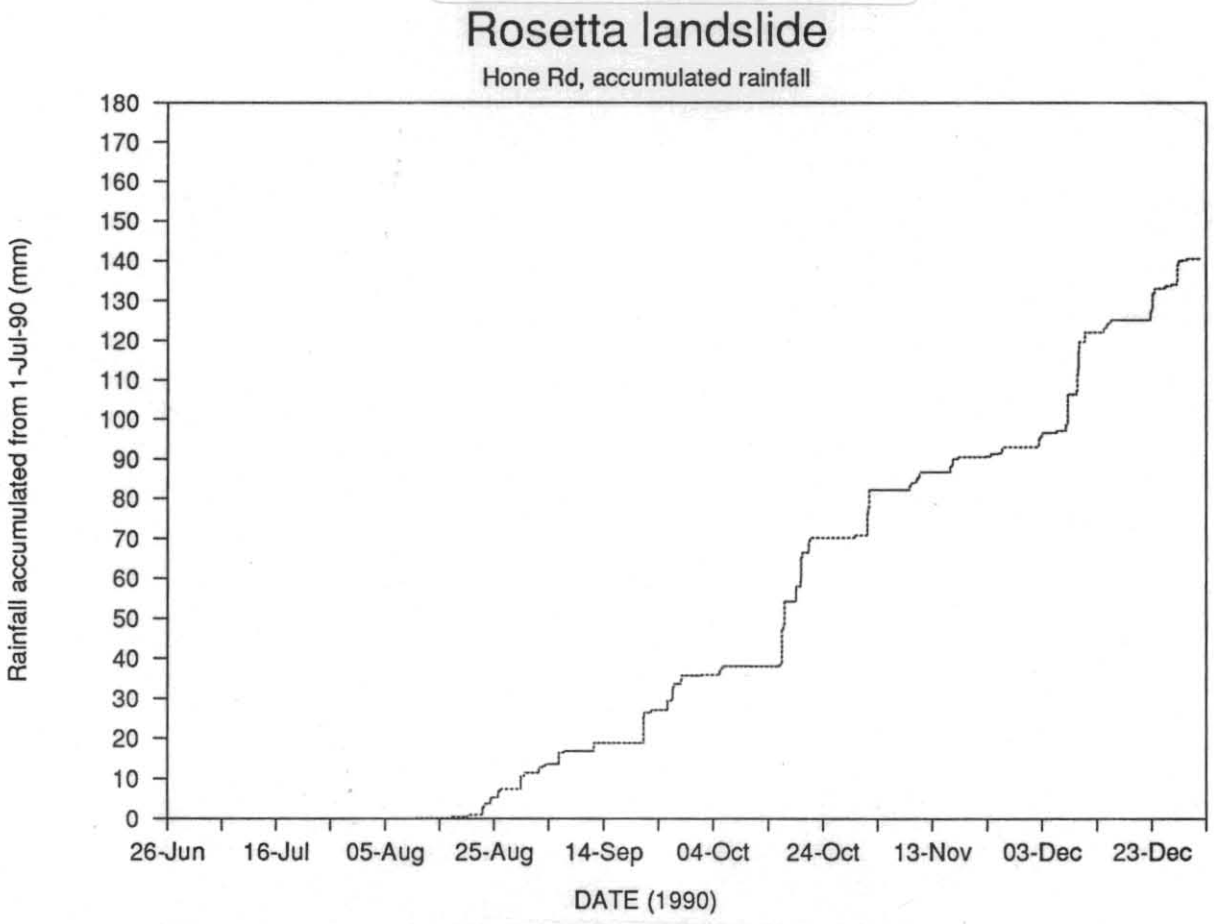

Rosetta landslide
Hone Rd, rainfall
RAINFALL (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
26-Jun
16-Jul
05-Aug
25-Aug
14-Sep
04-Oct
24-Oct
13-Nov
03-Dec
23-Dec
DATE (1990)

5 cm


Rosetta landslide
Hone Rd, rainfall
RAINFALL (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
23-Dec
12-Jan
01-Feb
21-Feb
13-Mar
02-Apr
22-Apr
12-May
01-Jun
21-Jun
DATE (1991)


Rosetta landslide
Hone Rd, rainfall
RAINFALL (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
01-Jul
21-Jul
10-Aug
30-Aug
19-Sep
09-Oct
29-Oct
18-Nov
08-Dec
28-Dec
DATE (1991)

5 cm


Rosetta landslide
Hone Rd, accumulated rainfall
Rainfall accumulated from 1-Jul-90 (mm)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
26-Jun
16-Jul
05-Aug
25-Aug
14-Sep
04-Oct
24-Oct
13-Nov
03-Dec
23-Dec
DATE (1990)

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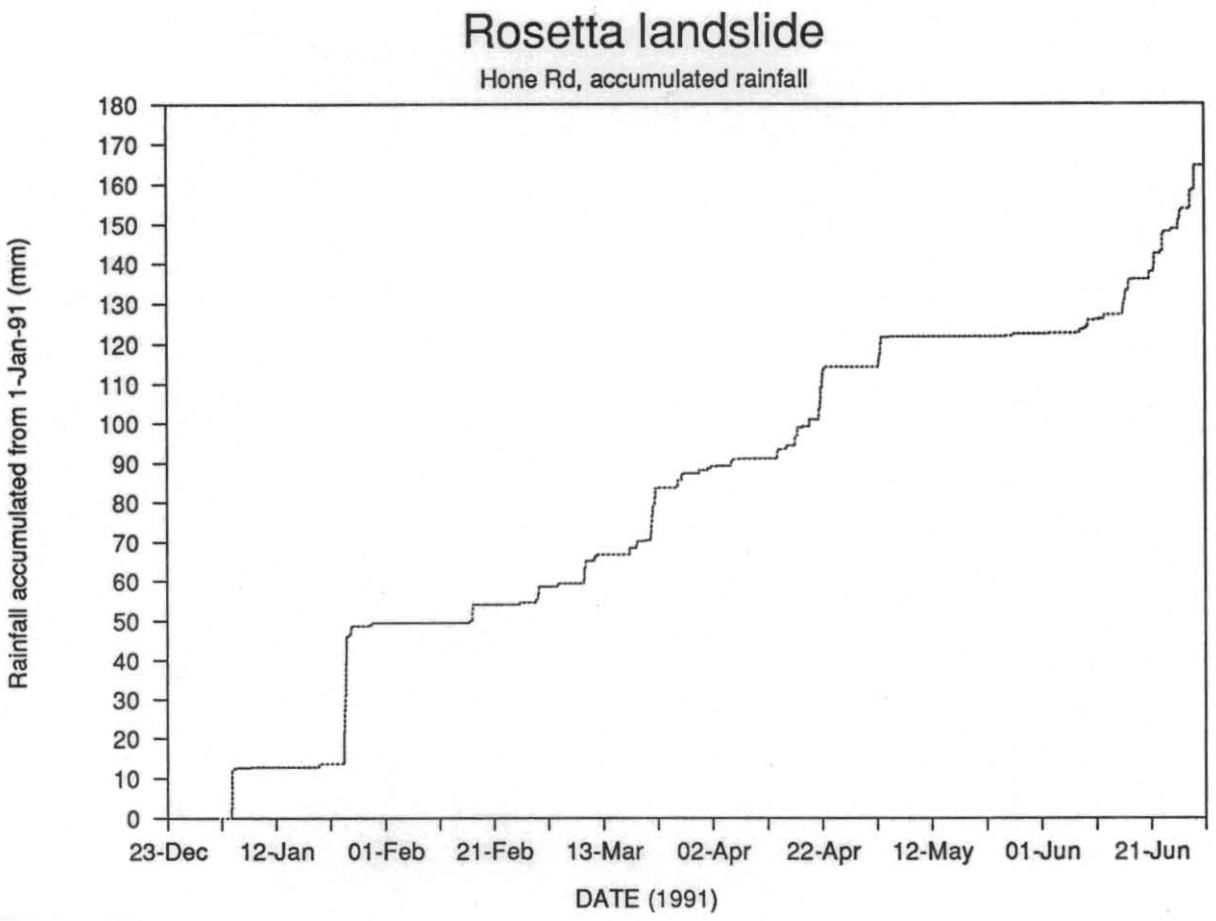
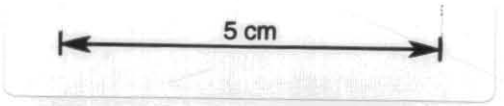
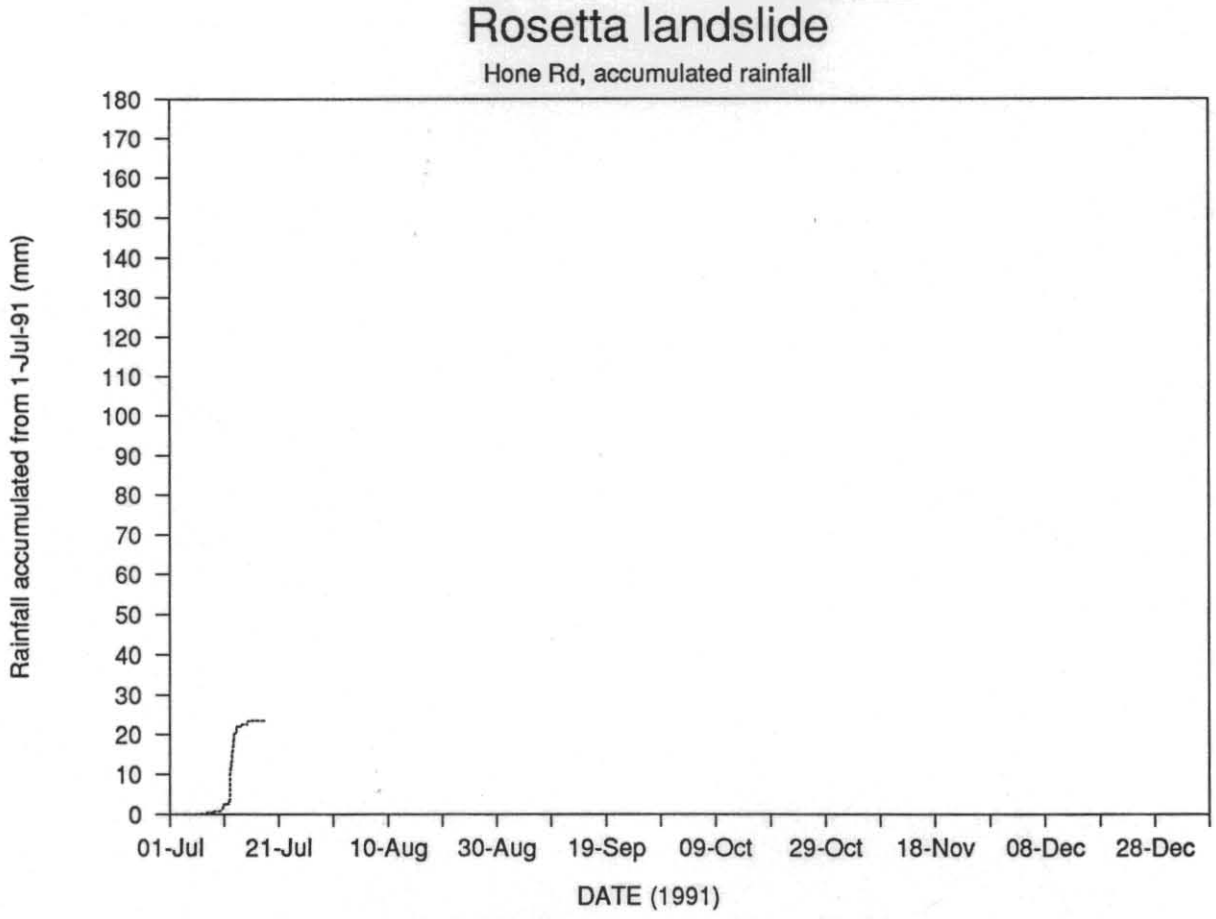

Rosetta landslide
Hone Rd, accumulated rainfall
Rainfall accumulated from 1-Jan-91 (mm)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
23-Dec
12-Jan
01-Feb
21-Feb
13-Mar
02-Apr
22-Apr
12-May
01-Jun
21-Jun
DATE (1991)


5 cm


Rosetta landslide
Hone Rd, accumulated rainfall
Rainfall accumulated from 1-Jul-91 (mm)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
01-Jul
21-Jul
10-Aug
30-Aug
19-Sep
09-Oct
29-Oct
18-Nov
08-Dec
28-Dec
DATE (1991)

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APPENDIX 5

Borehole water level data

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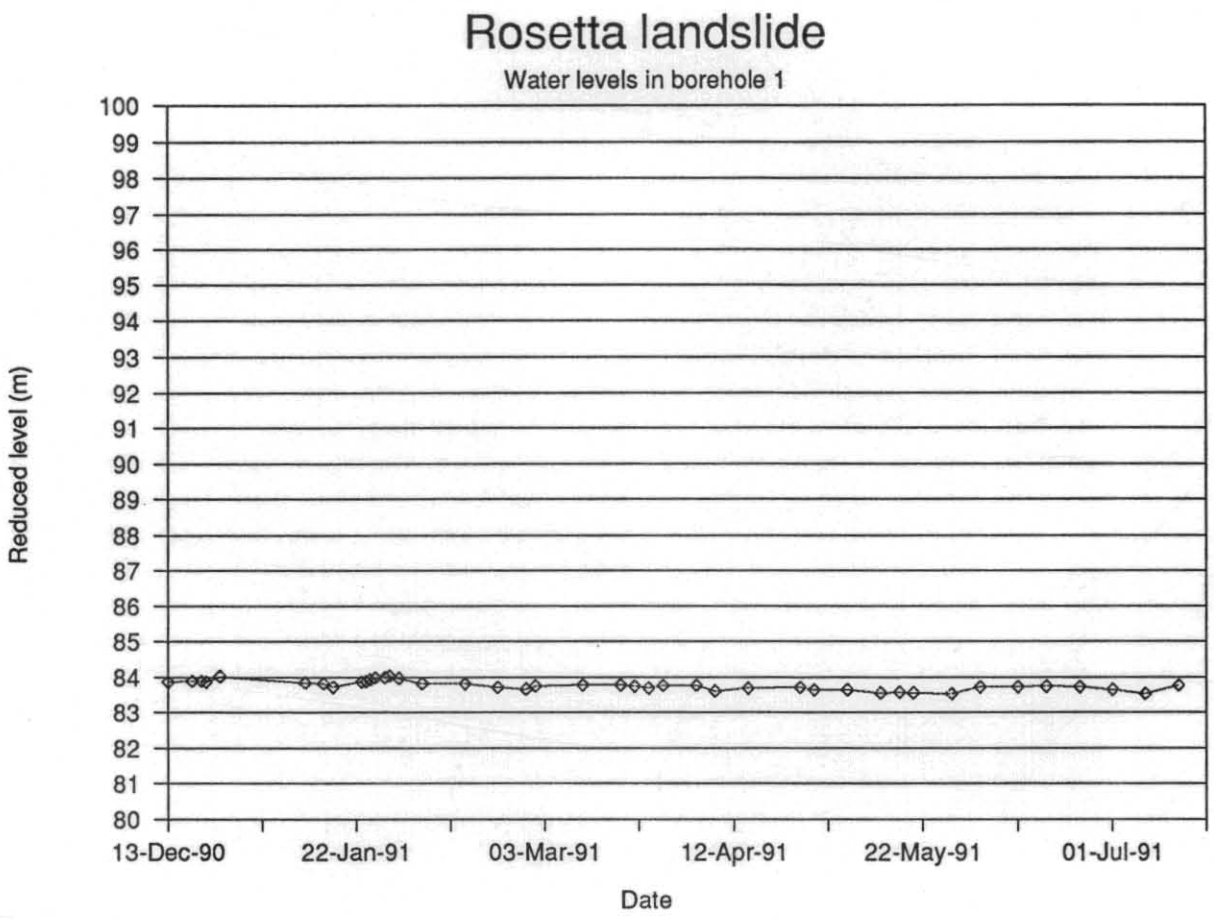
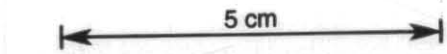
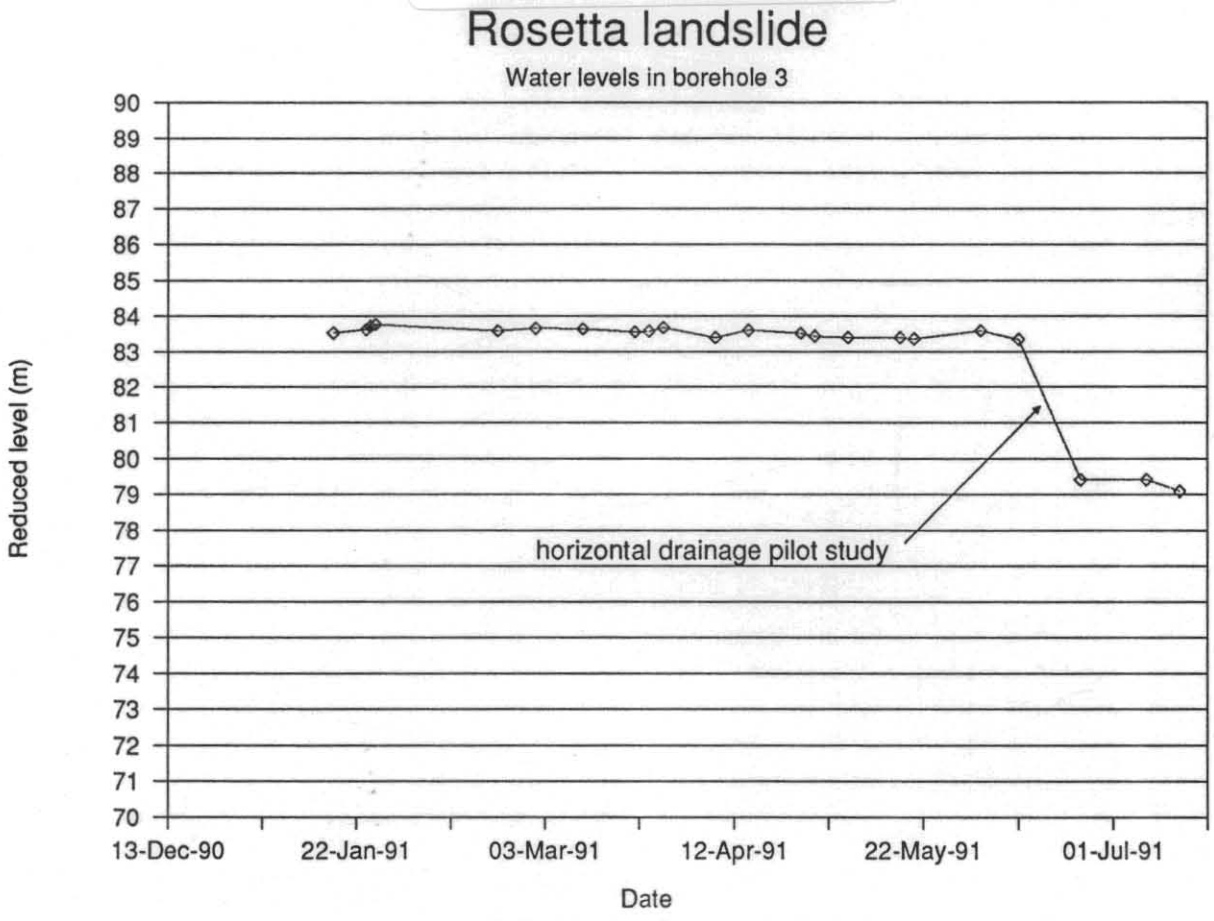
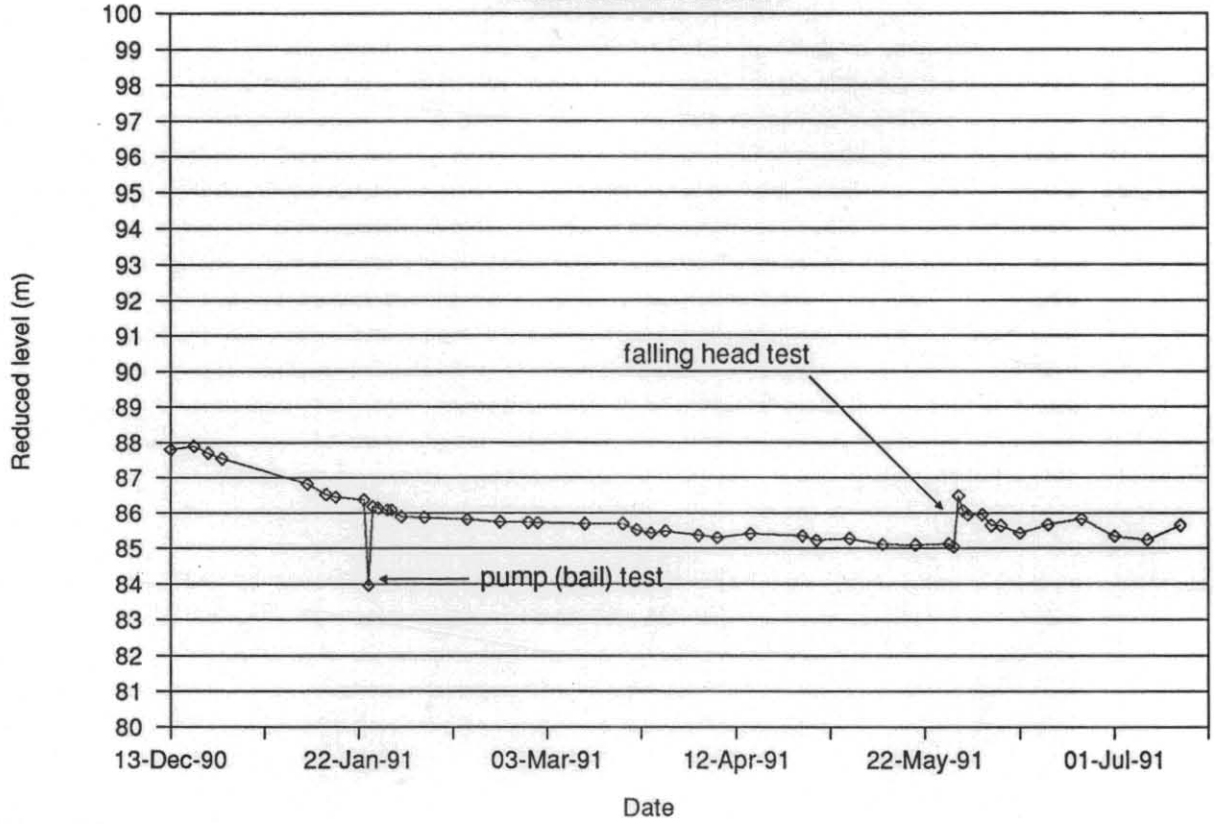

Rosetta landslide
Water levels in borehole 1
Reduced level (m)
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
83
82
81
80
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date

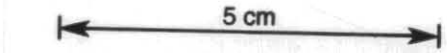

5 cm


Rosetta landslide
Water levels in borehole 3
Reduced level (m)
90
89
88
87
86
85
84
83
82
81
80
79
78
77
76
75
74
73
72
71
70
horizontal drainage pilot study
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date

Rosetta landslide

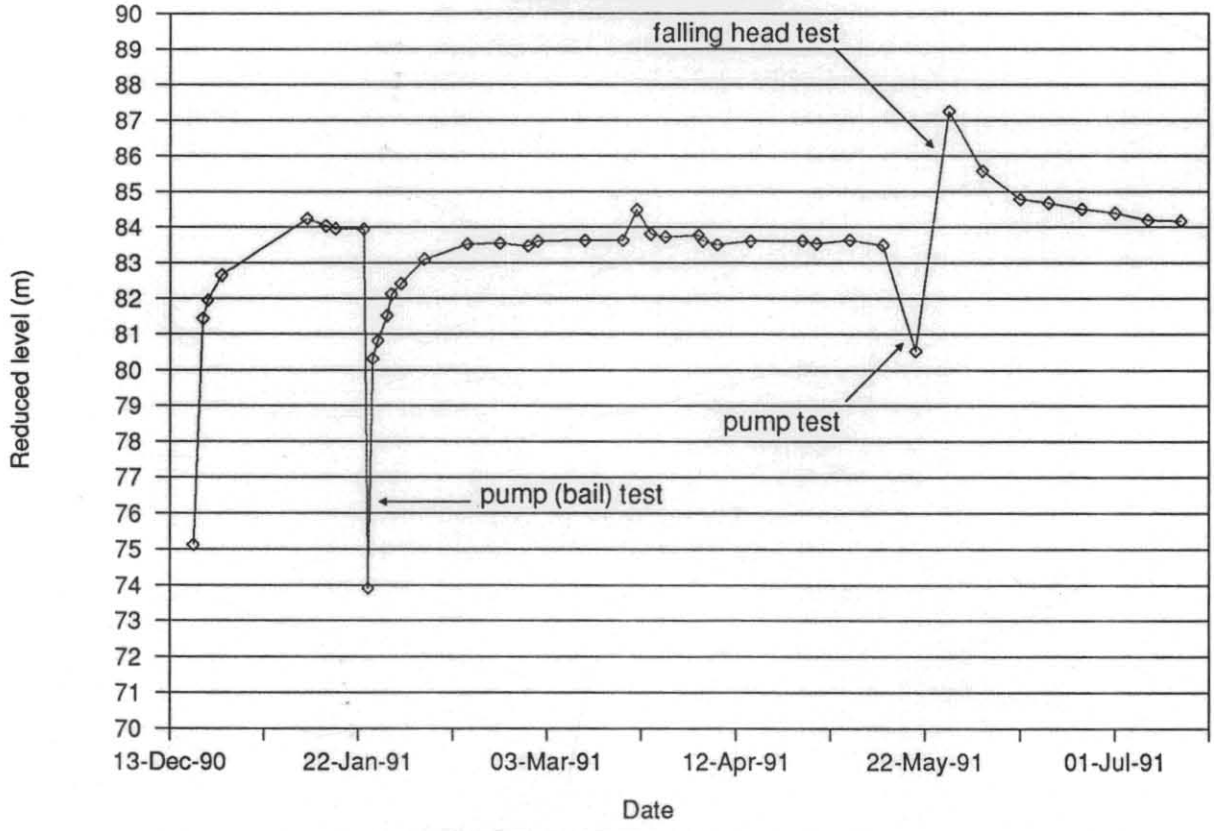
Water levels in borehole 6





Rosetta landslide

Water levels in borehole 7



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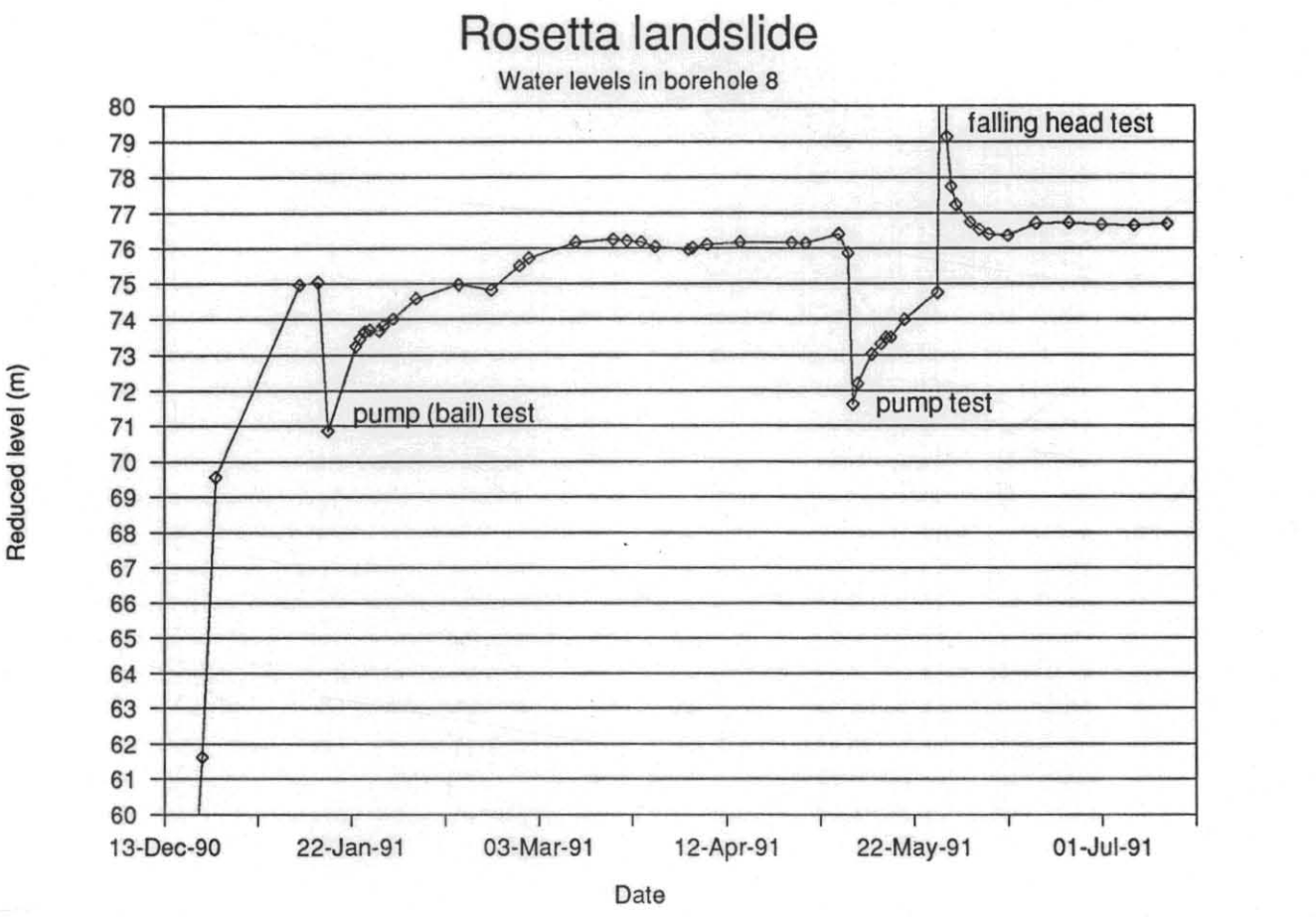
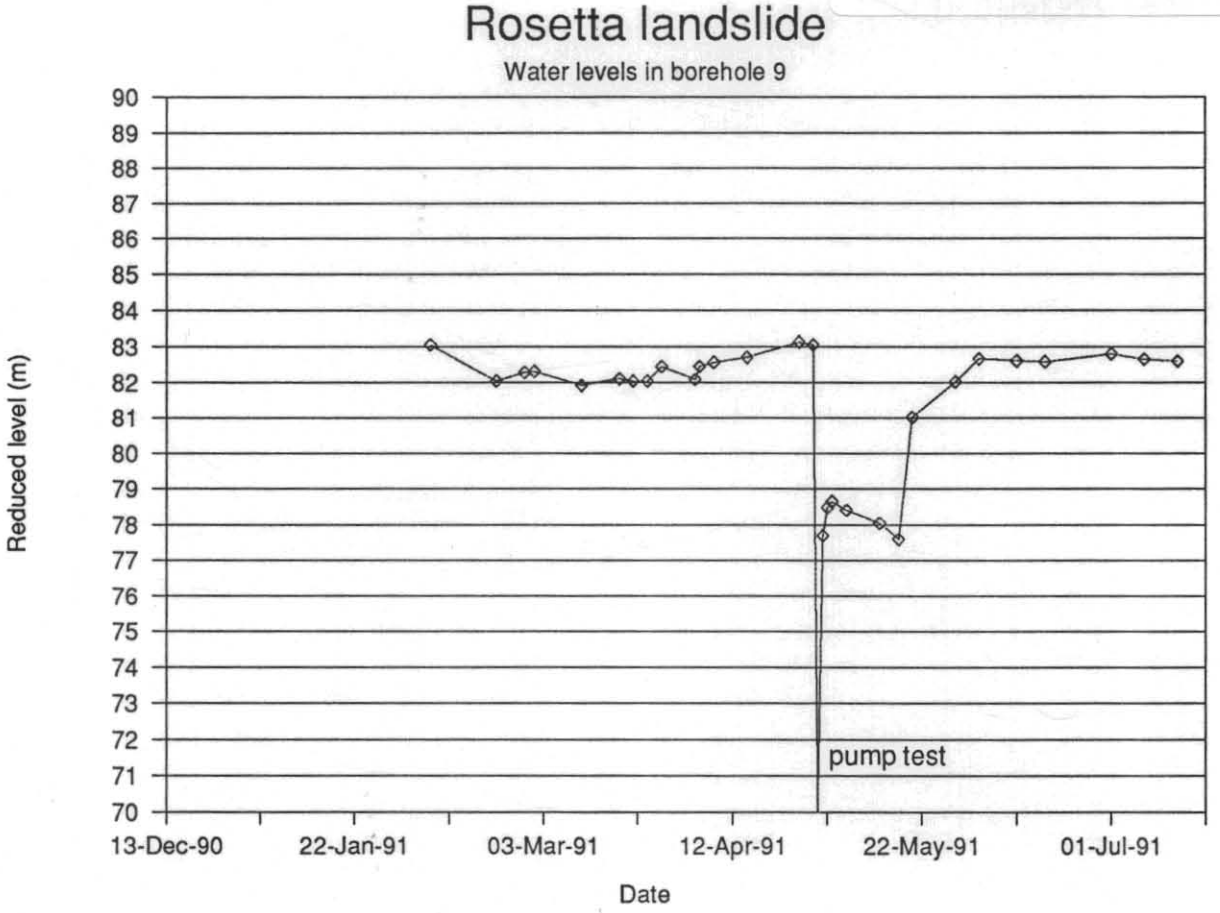
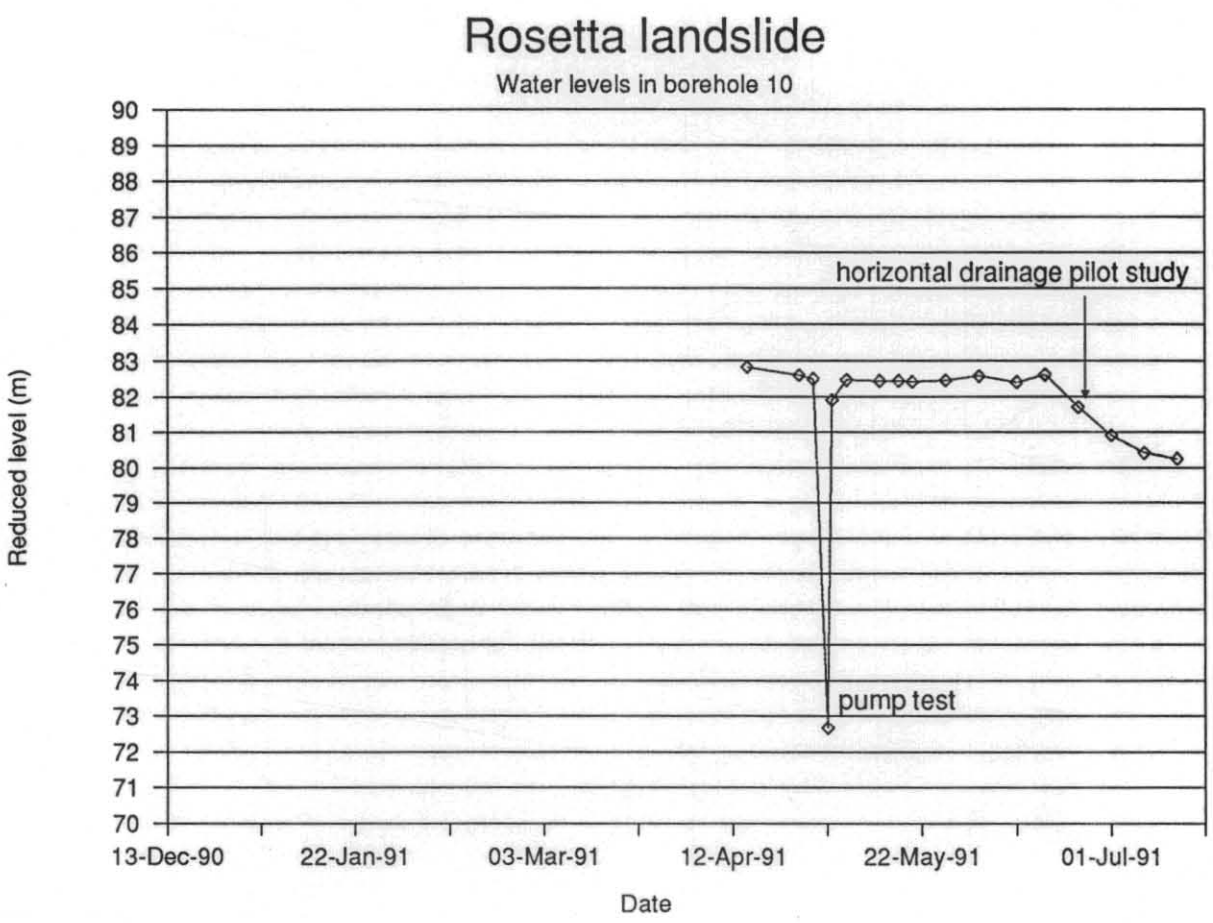
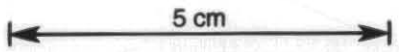
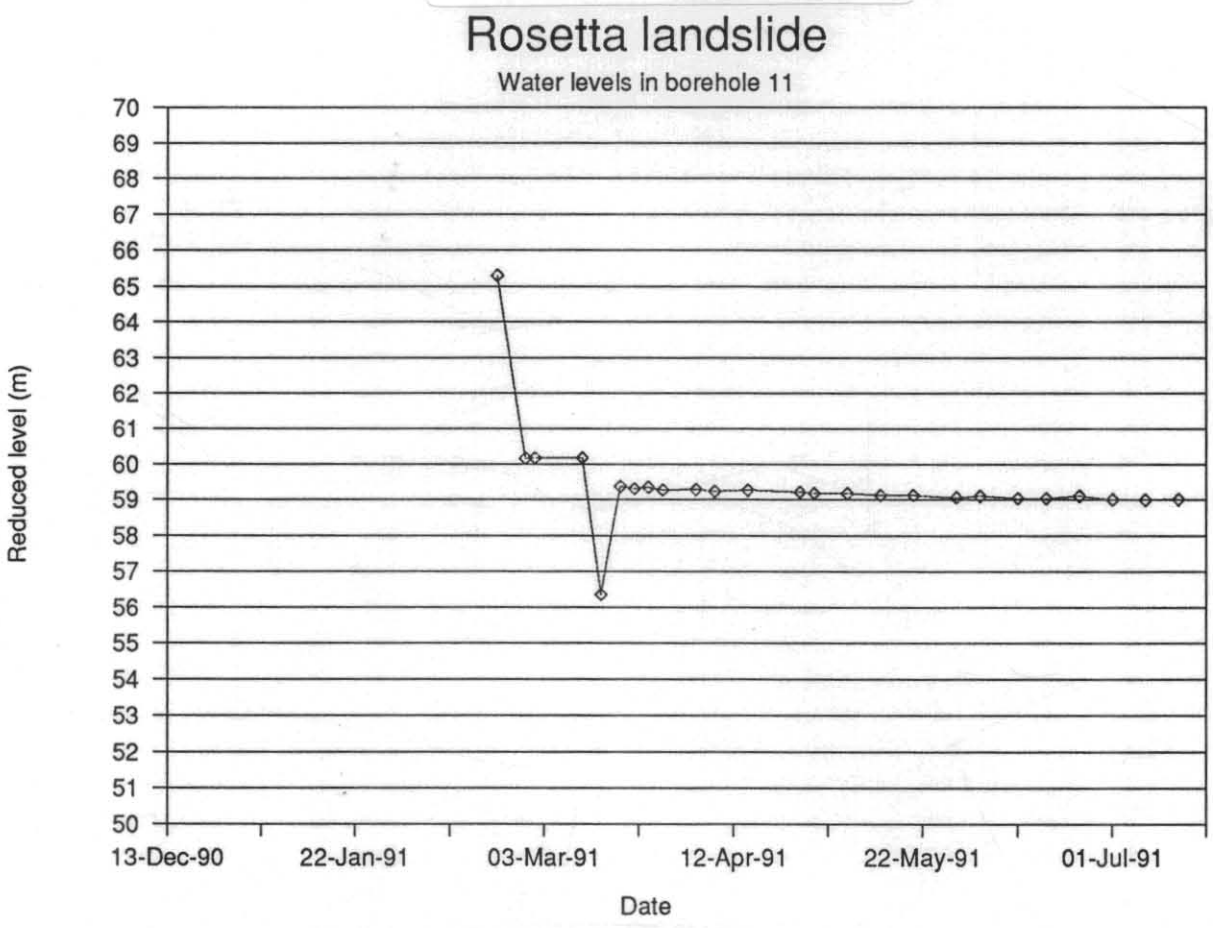

Rosetta landslide
Water levels in borehole 8
Reduced level (m)
80
79
78
77
76
75
74
73
72
71
70
69
68
67
66
65
64
63
62
61
60
falling head test
pump (bail) test
pump test
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date
5 cm


Rosetta landslide
Water levels in borehole 9
Reduced level (m)
90
89
88
87
86
85
84
83
82
81
80
79
78
77
76
75
74
73
72
71
70
pump test
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date


Rosetta landslide
Water levels in borehole 10
Reduced level (m)
90
89
88
87
86
85
84
83
82
81
80
79
78
77
76
75
74
73
72
71
70
horizontal drainage pilot study
pump test
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date


5 cm


Rosetta landslide
Water levels in borehole 11
Reduced level (m)
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date

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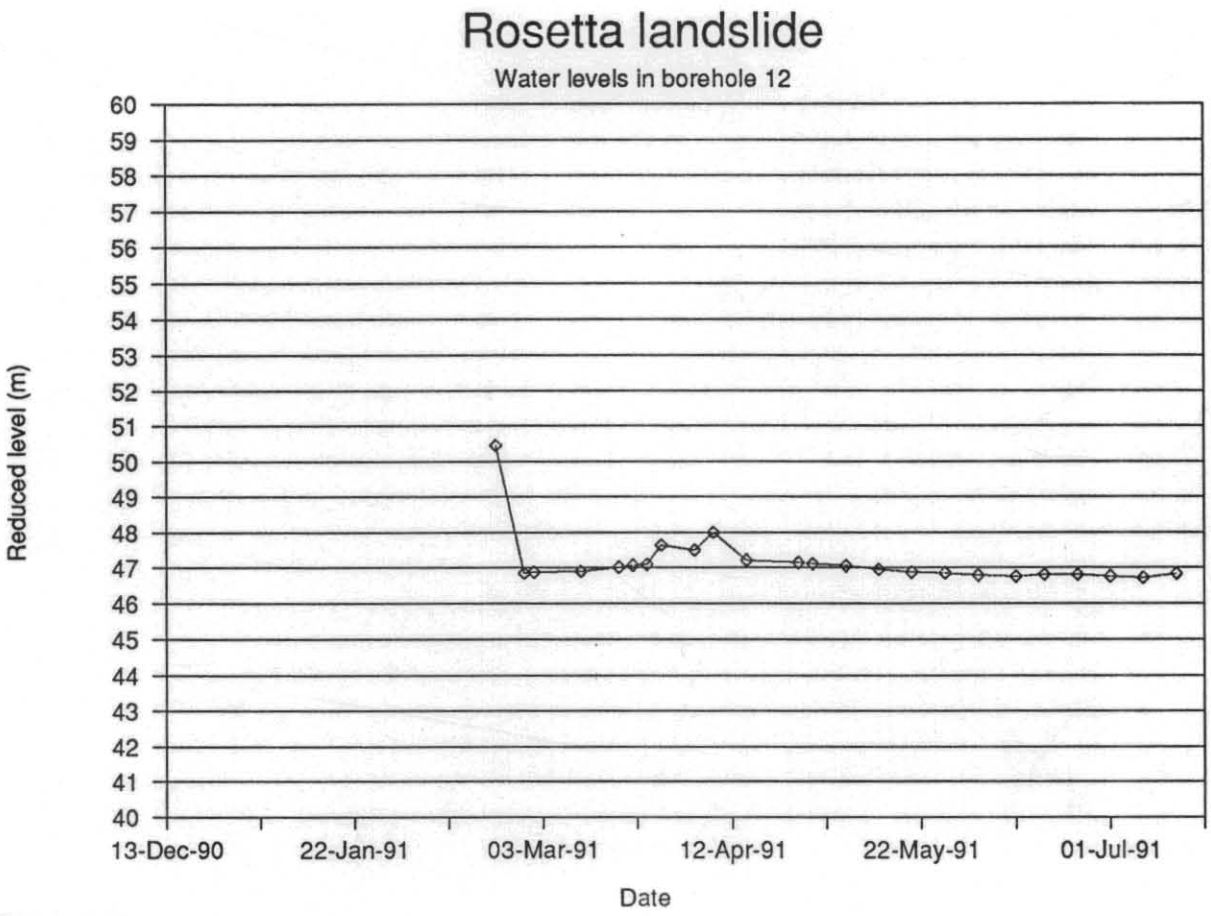
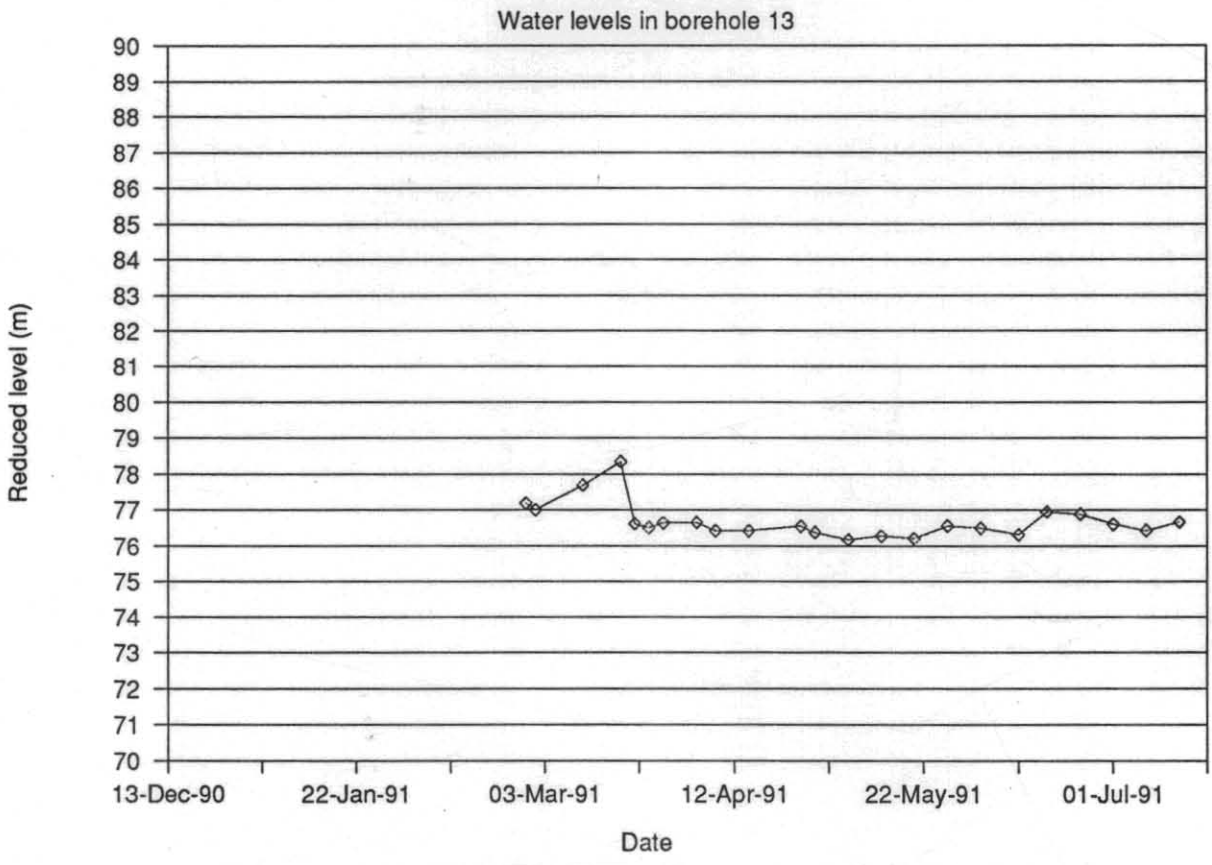

Rosetta landslide
Water levels in borehole 12
Reduced level (m)
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
40
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date


5 cm


Rosetta landslide
Water levels in borehole 13
Reduced level (m)
90
89
88
87
86
85
84
83
82
81
80
79
78
77
76
75
74
73
72
71
70
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date

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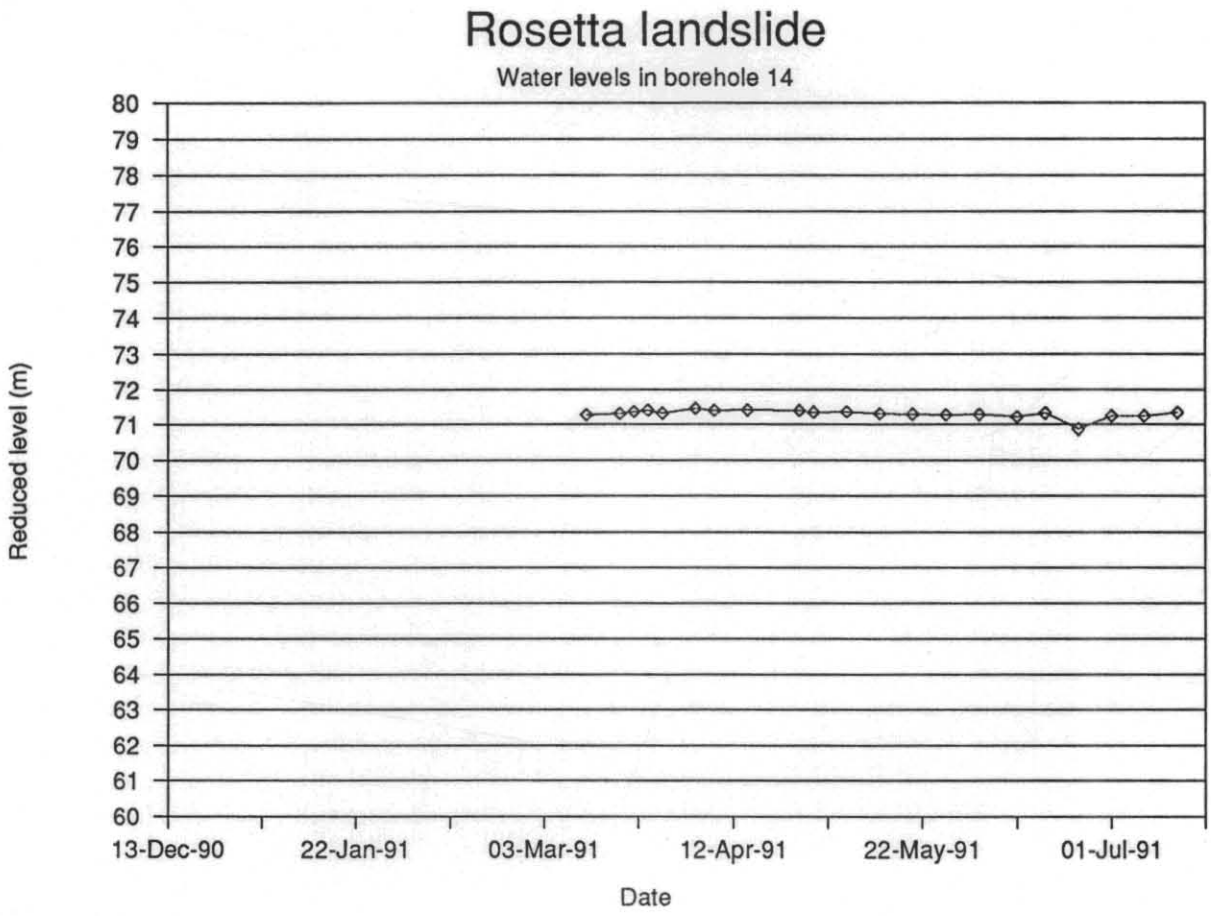
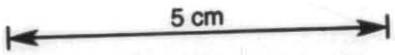
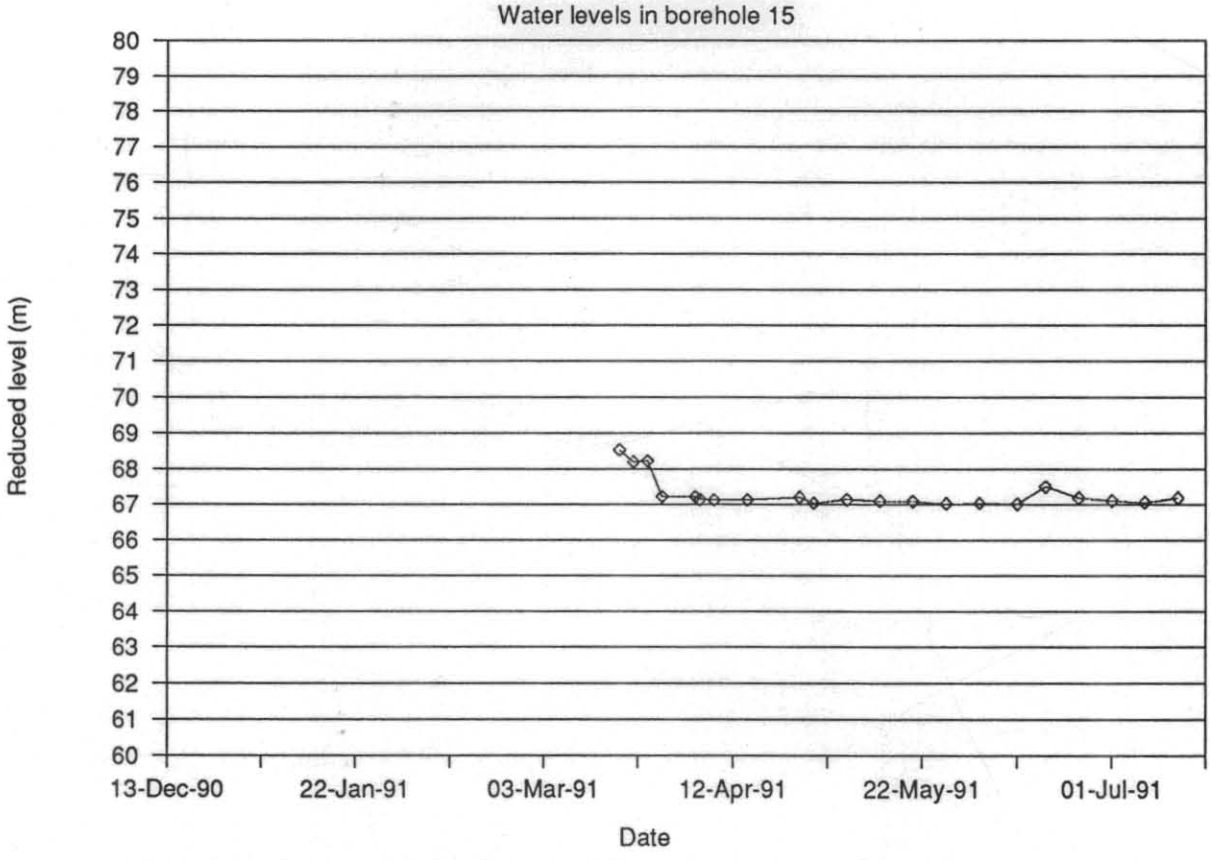
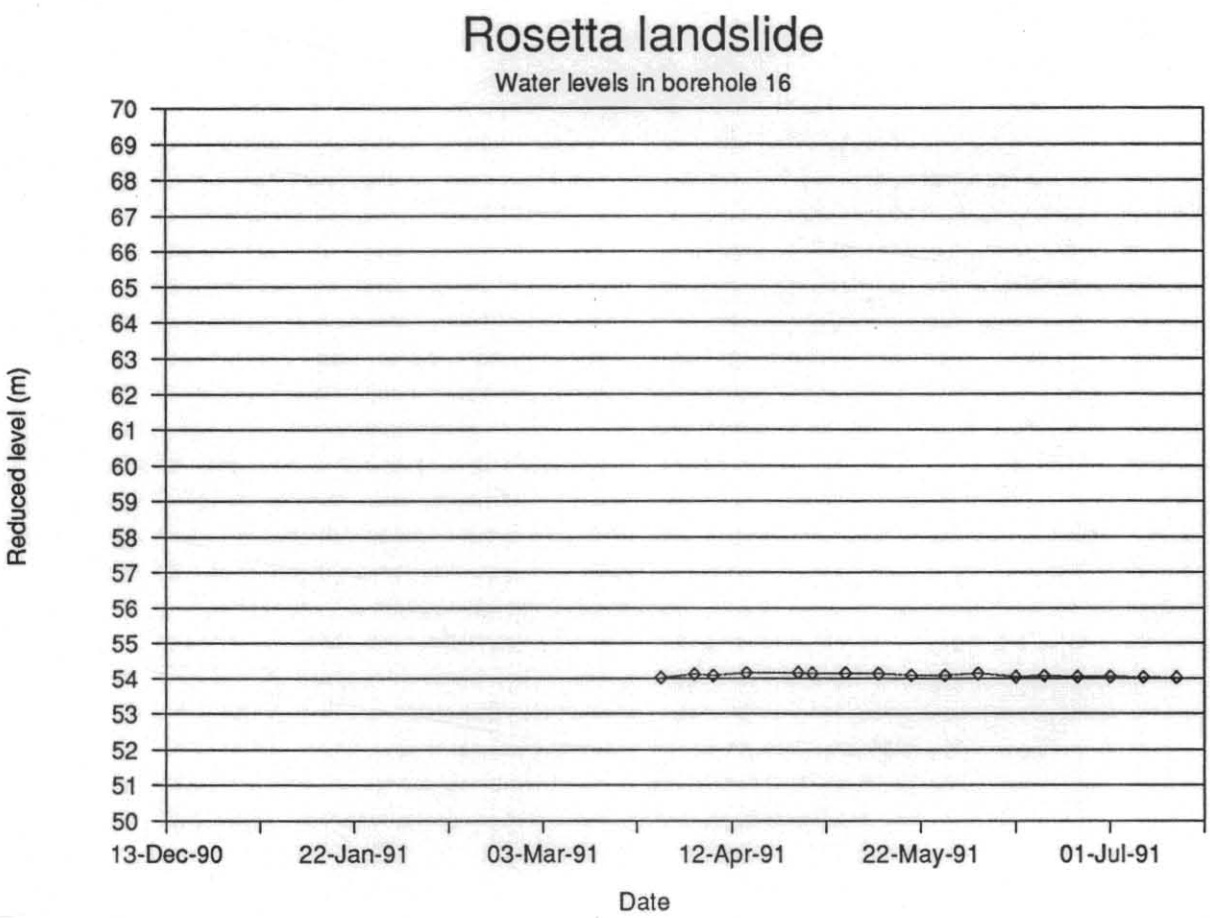
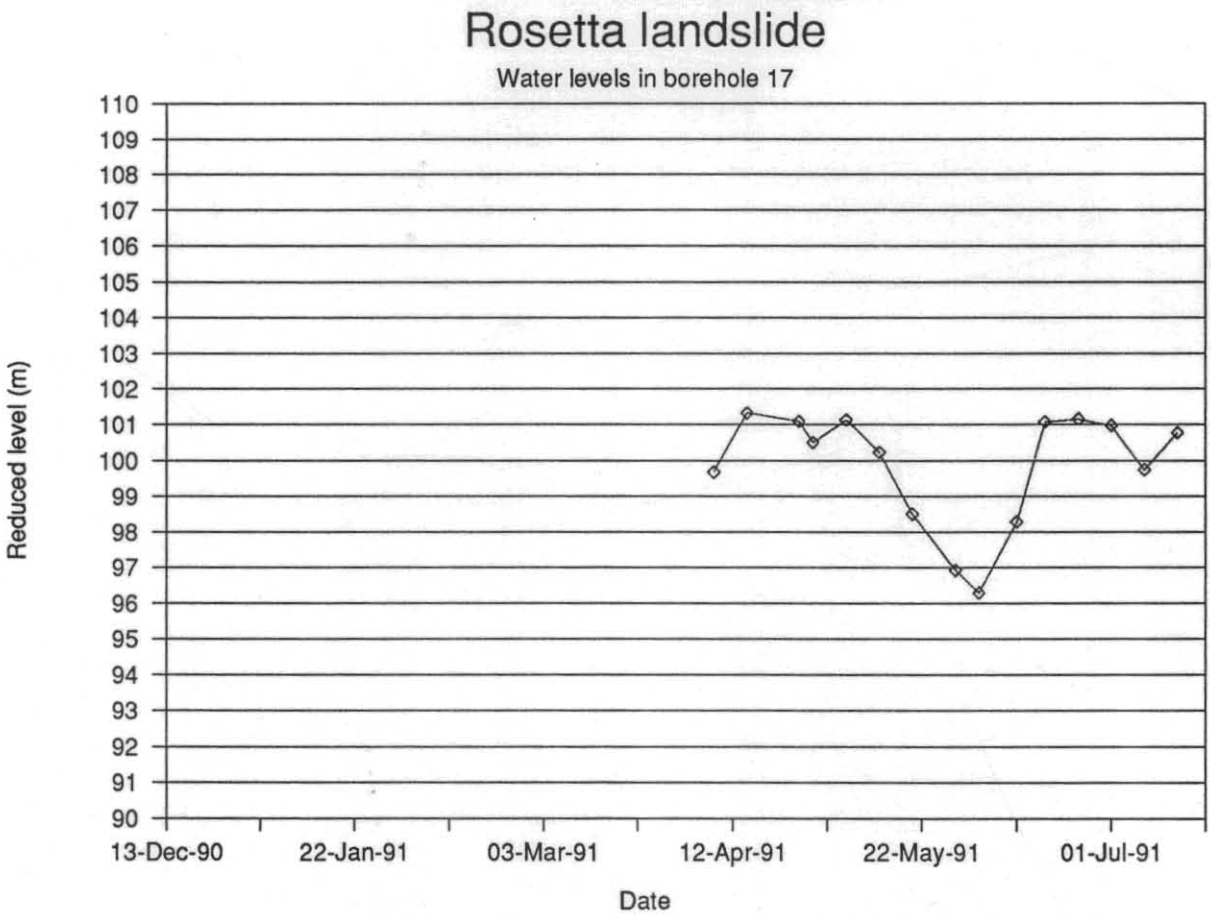

Rosetta landslide
Water levels in borehole 14
Reduced level (m)
80
79
78
77
76
75
74
73
72
71
70
69
68
67
66
65
64
63
62
61
60
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date

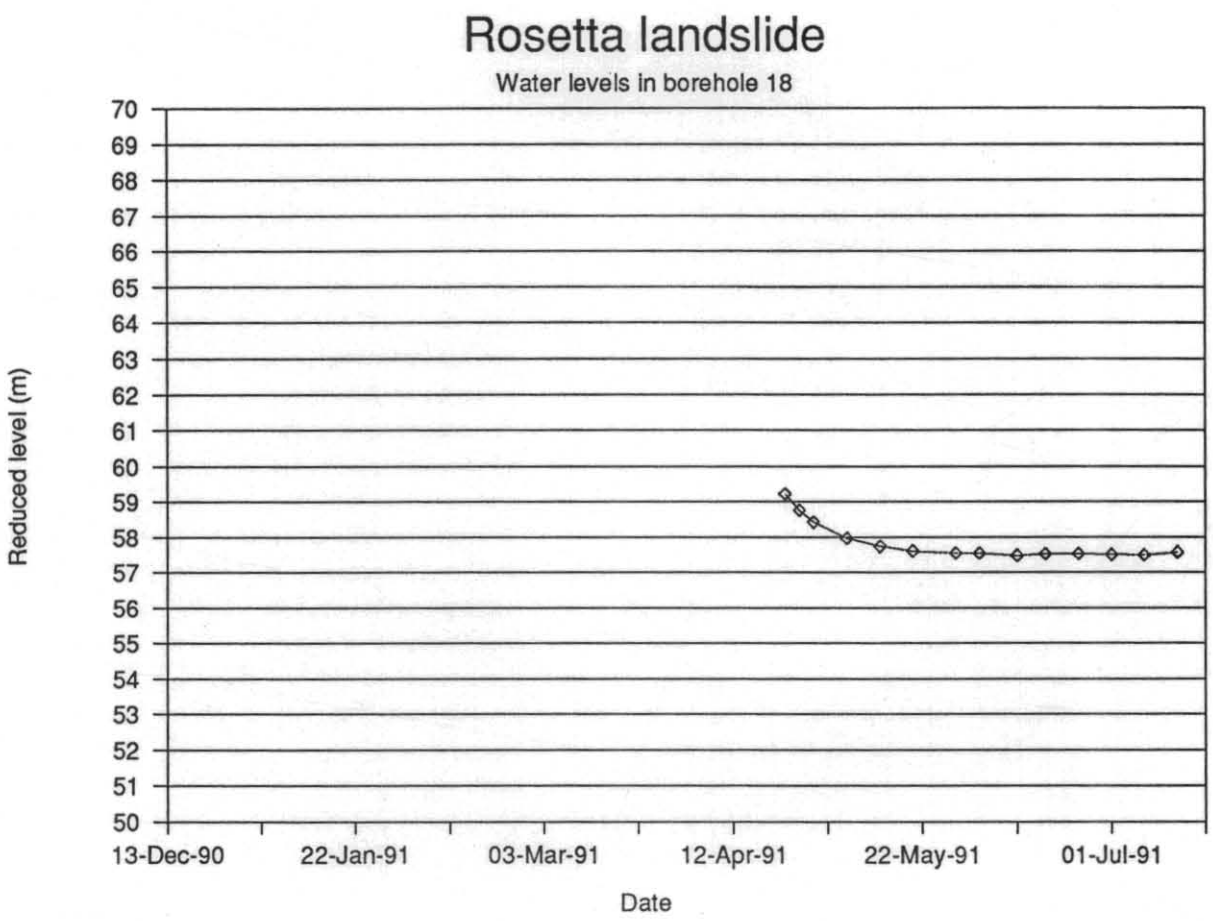

5 cm

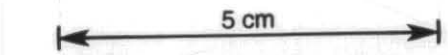

Rosetta landslide
Water levels in borehole 15
Reduced level (m)
80
79
78
77
76
75
74
73
72
71
70
69
68
67
66
65
64
63
62
61
60
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date

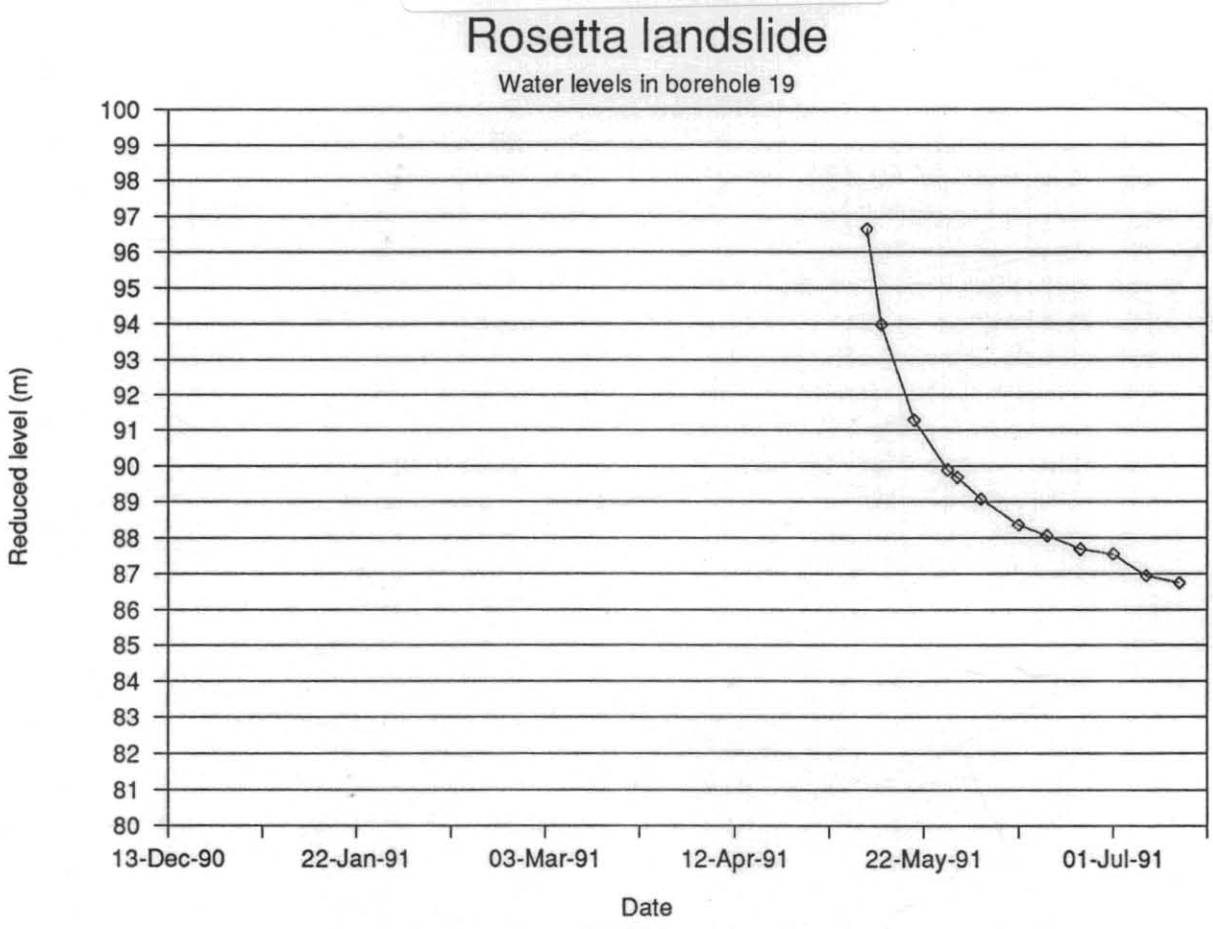

Rosetta landslide
Water levels in borehole 16
Reduced level (m)
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date


5 cm


Rosetta landslide
Water levels in borehole 17
Reduced level (m)
110
109
108
107
106
105
104
103
102
101
100
99
98
97
96
95
94
93
92
91
90
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date


Rosetta landslide
Water levels in borehole 18
Reduced level (m)
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date


5 cm


Rosetta landslide
Water levels in borehole 19
Reduced level (m)
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
83
82
81
80
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date

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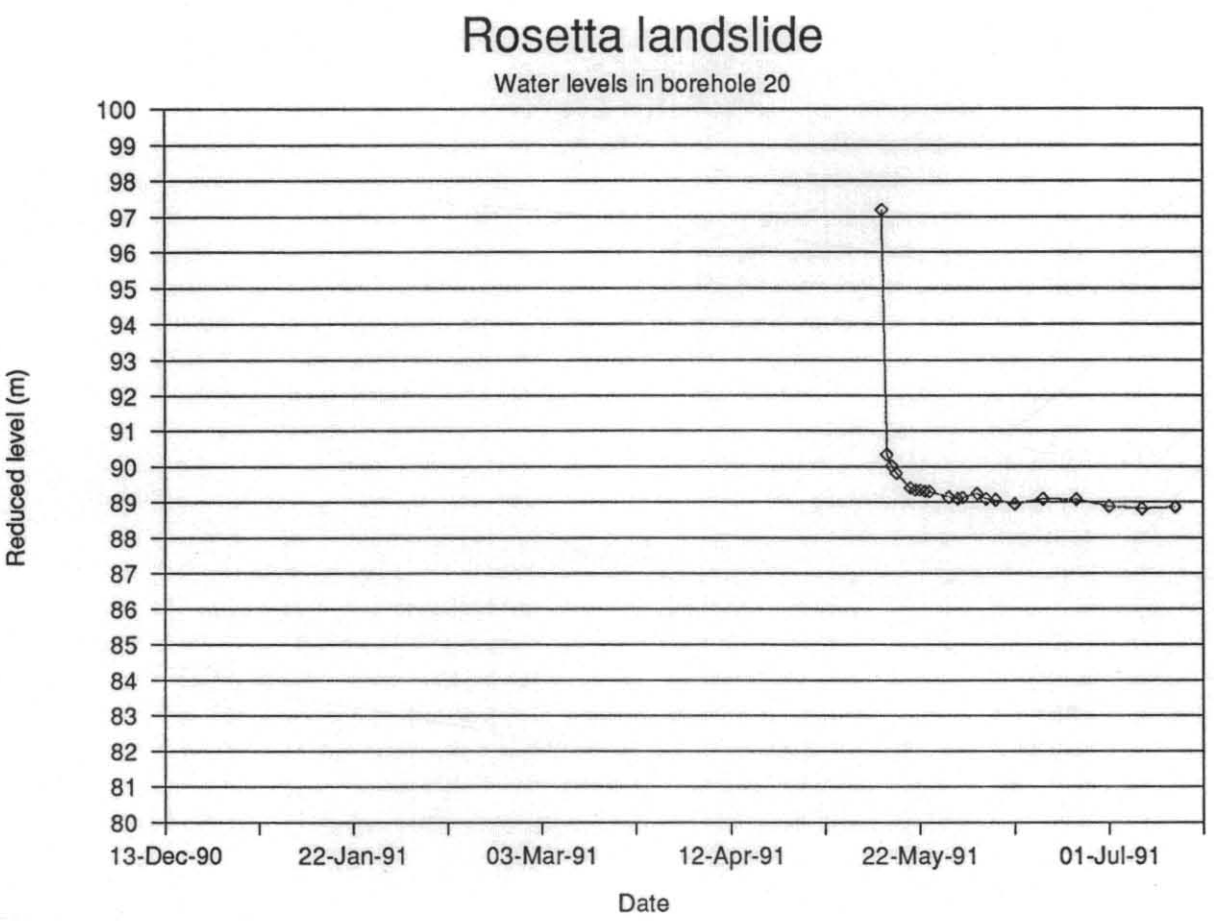
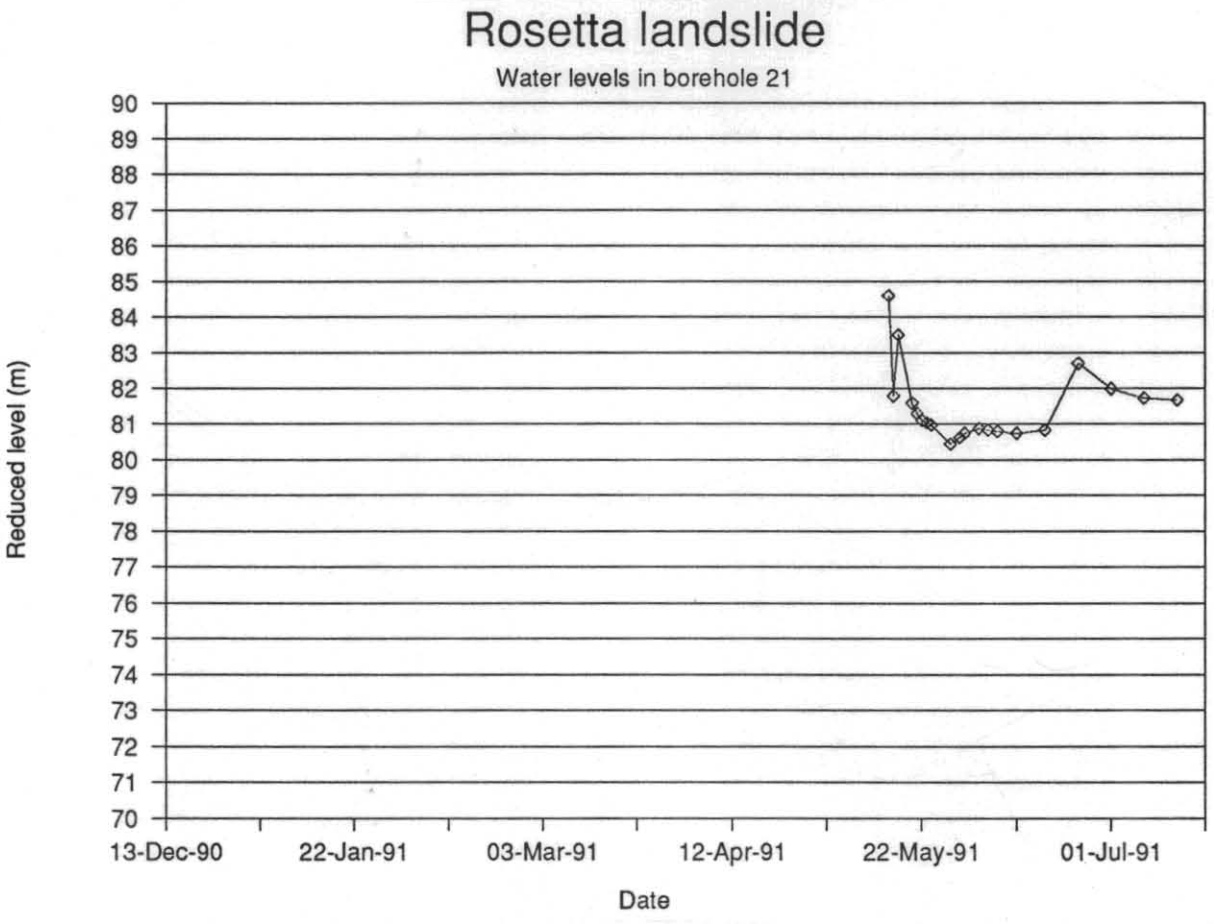
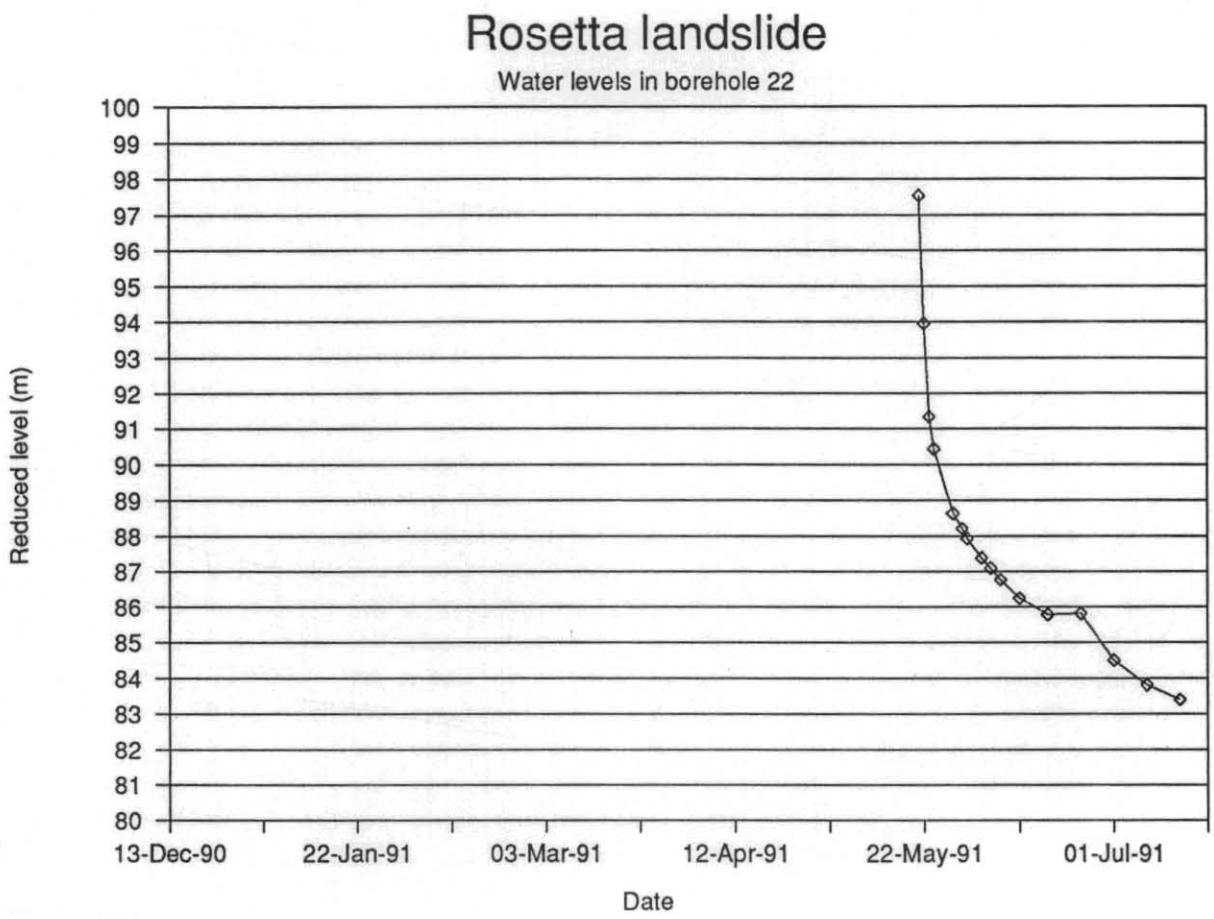
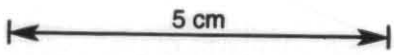
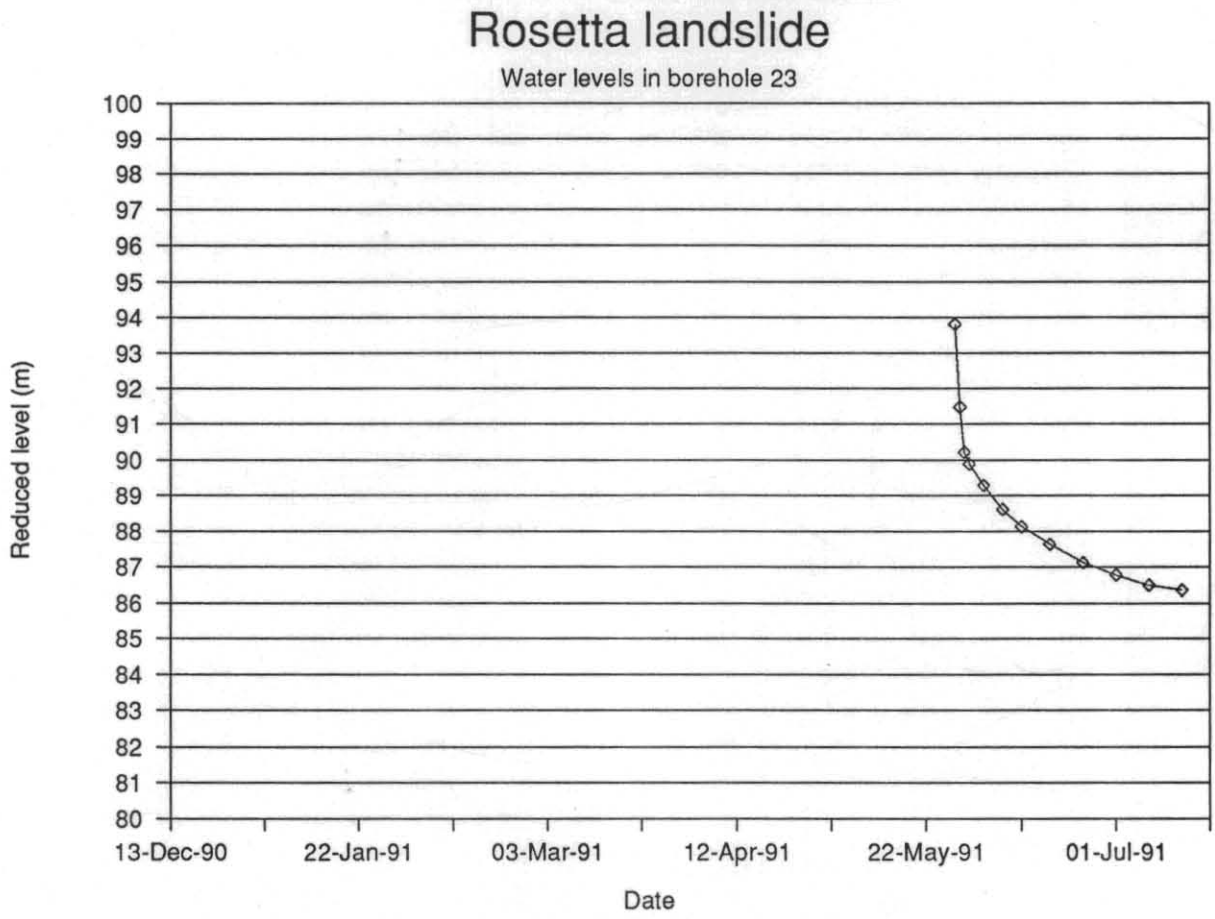

Rosetta landslide
Water levels in borehole 20
Reduced level (m)
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
83
82
81
80
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date

5 cm


Rosetta landslide
Water levels in borehole 21
Reduced level (m)
90
89
88
87
86
85
84
83
82
81
80
79
78
77
76
75
74
73
72
71
70
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date


Rosetta landslide
Water levels in borehole 22
Reduced level (m)
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
83
82
81
80
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date


5 cm


Rosetta landslide
Water levels in borehole 23
Reduced level (m)
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
83
82
81
80
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date

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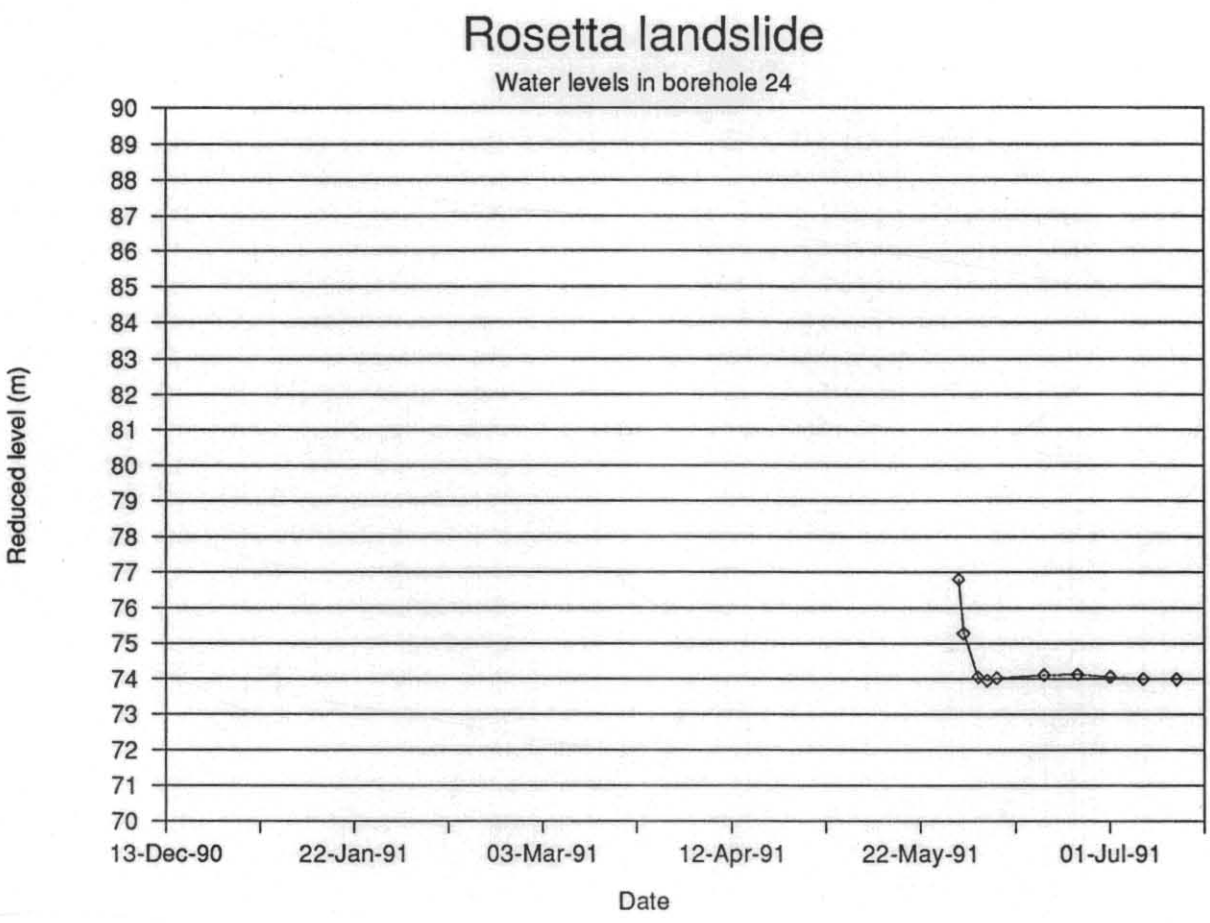
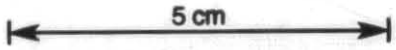
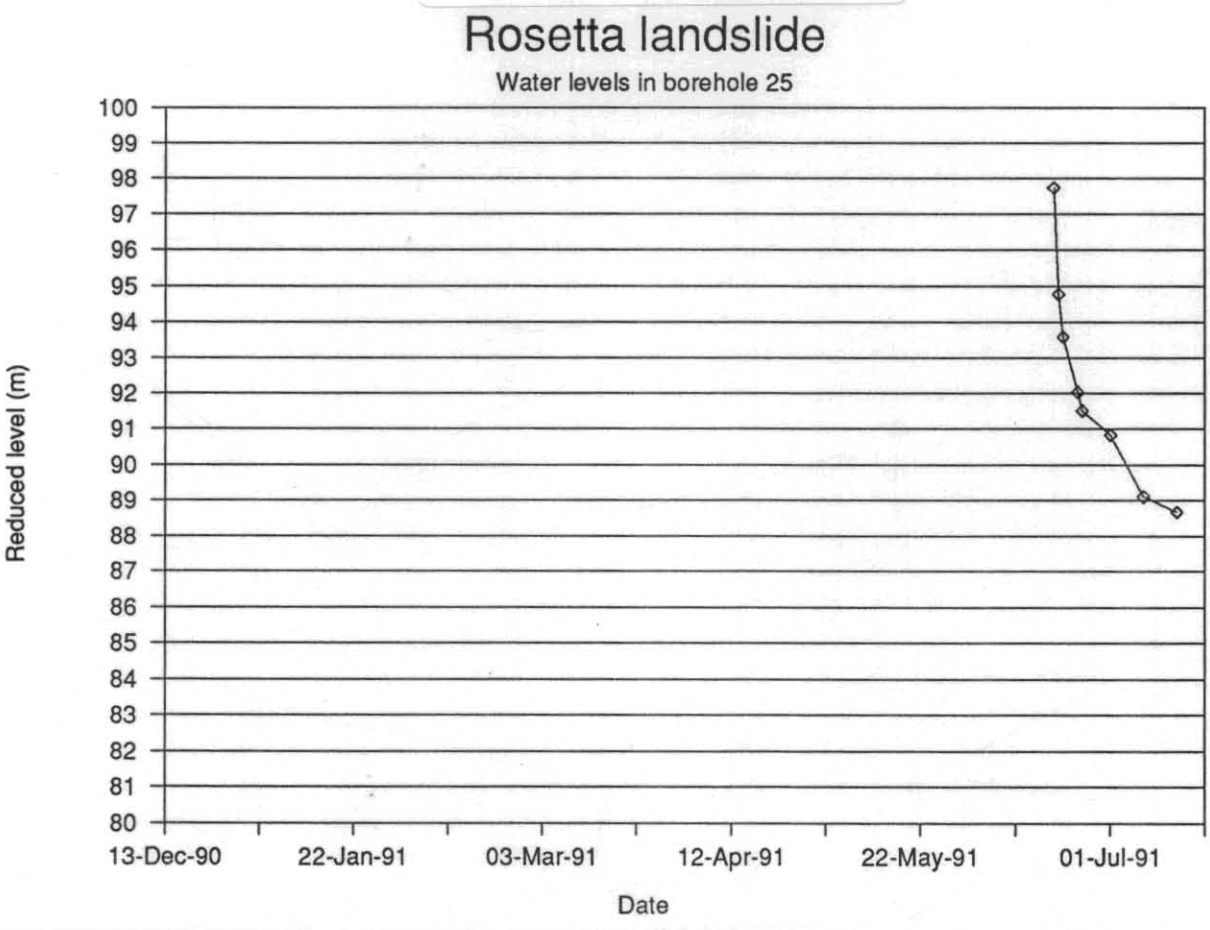
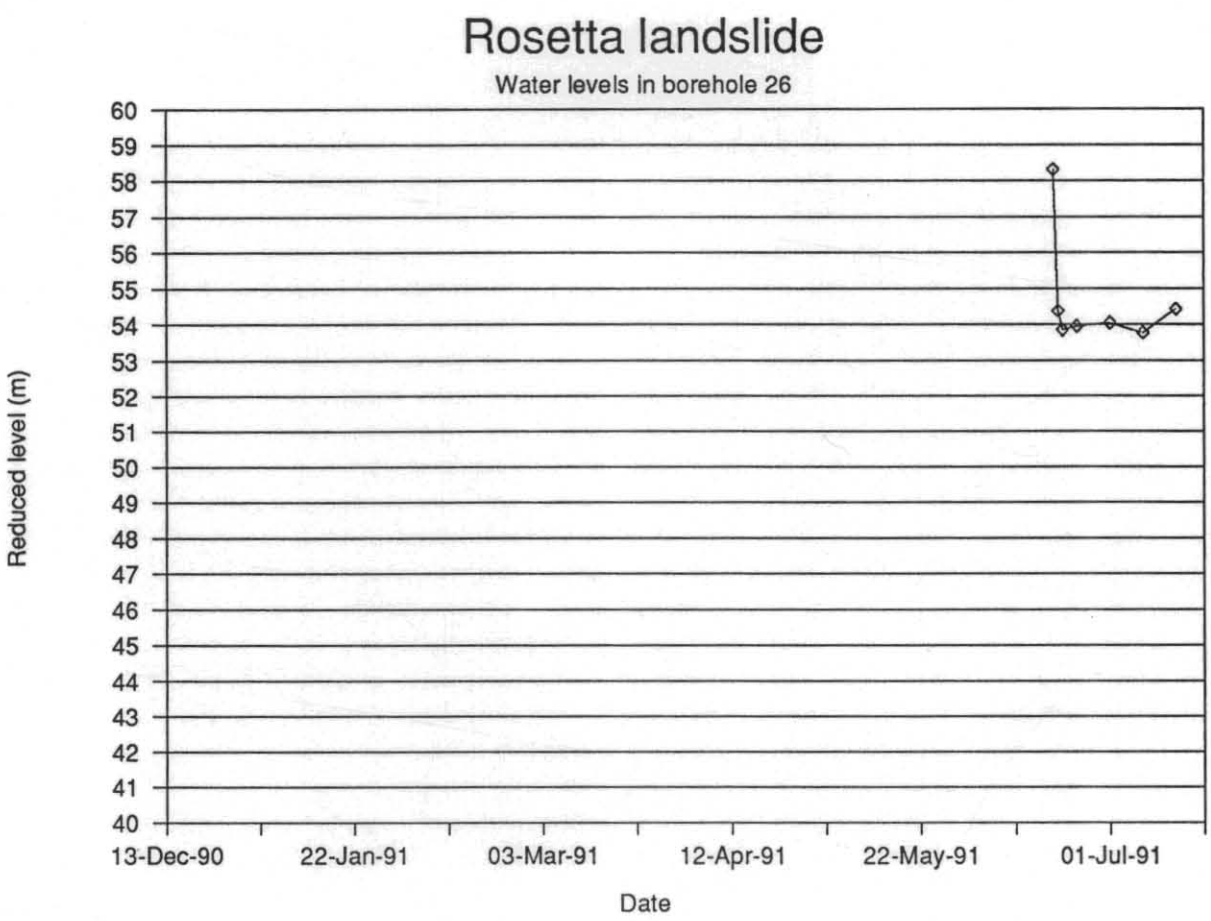
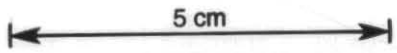
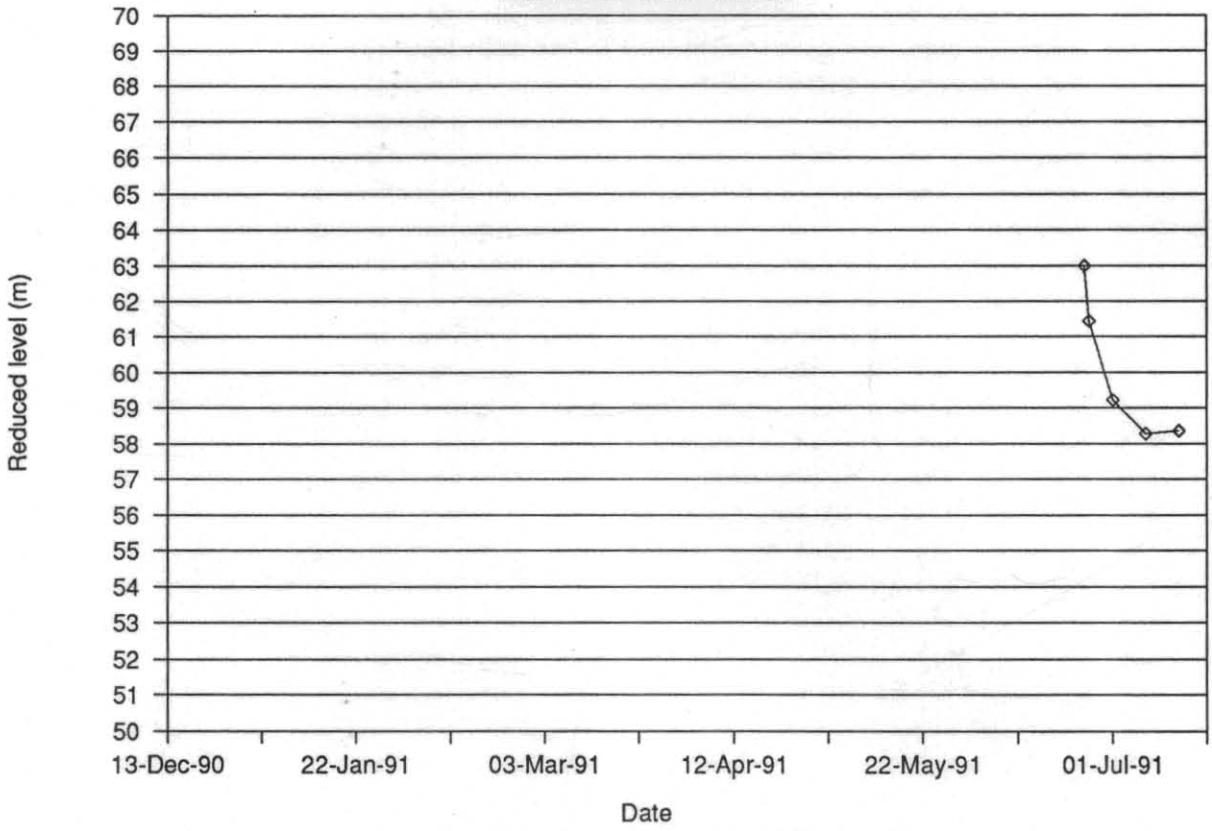

Rosetta landslide
Water levels in borehole 24
Reduced level (m)
90
89
88
87
86
85
84
83
82
81
80
79
78
77
76
75
74
73
72
71
70
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date

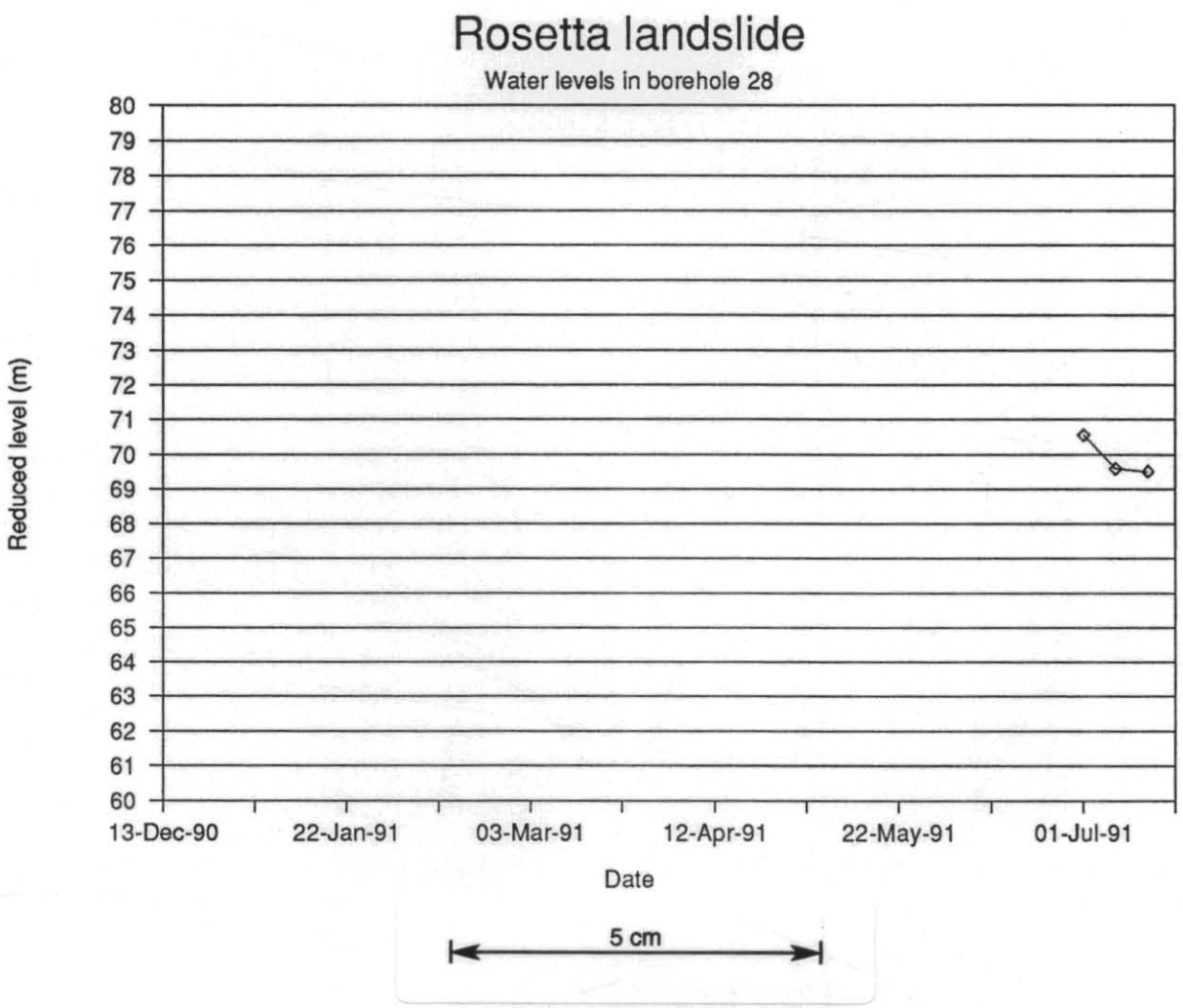

5 cm

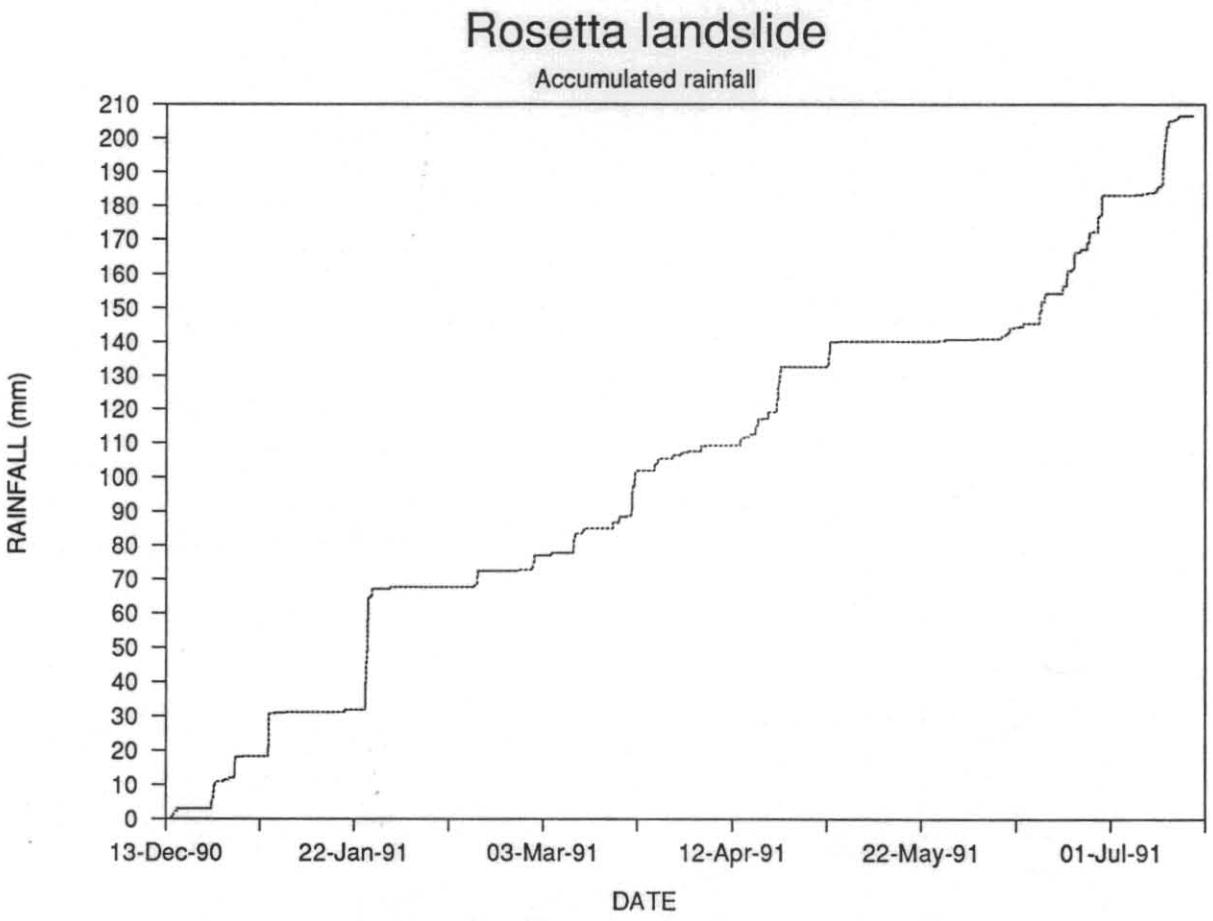

Rosetta landslide
Water levels in borehole 25
Reduced level (m)
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
83
82
81
80
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date


Rosetta landslide
Water levels in borehole 26
Reduced level (m)
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
40
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date


5 cm


Rosetta landslide
Water levels in borehole 27
Reduced level (m)
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date


Rosetta landslide
Water levels in borehole 28
Reduced level (m)
80
79
78
77
76
75
74
73
72
71
70
69
68
67
66
65
64
63
62
61
60
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
Date
5 cm


Rosetta landslide
Accumulated rainfall
RAINFALL (mm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
13-Dec-90
22-Jan-91
03-Mar-91
12-Apr-91
22-May-91
01-Jul-91
DATE

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APPENDIX 6

Chemical analyses of groundwater

Hole No.	Bore 6	Bore 7	Bore 8	Bore 8	Bore 9	Bore 9	Bore 10	Bore 10
Date	29/1/91	29/1/91	15/1/91	15/1/91	30/4/91	30/4/91	2/5/91	2/5/91
Reg. Nos.	910036	910037	910038	910039	910325	910326	910327	910328
pH	6.8	5.7	7.6	7.7	7.5	7.6	6.3	5.8
Conductivity (µS/cm)	5200	2100	11200	10700	4250	4150	6500	5600
Item (mg/L)								
CO_3	NIL	NIL	NIL	NIL	<5	<5	<5	<5
HCO_3	350	24	1880	1810	2030	1970	59	31
Cl	1490	590	3190	3140	960	890	2500	2130
SO_4	390	84	680	690	56	54	430	360
Ca	60	7.4	90	97	37	35	47	33
Mg	120	12	260	260	195	185	210	155
Fe	0.2	0.5	<0.1	<0.1	0.2	0.1	0.3	0.1
Al	<0.2	1.8	<0.2	<0.2	<0.1	<0.1	0.6	<0.1
K	10	11	65	57	85	83	28	23
Na	820	370	2120	2010	900	890	1350	1180
F	<0.3	<0.3	<0.3	<0.3	0.9	0.9	0.6	0.6
NO_3	<5	<5	<5	<5	<10	<10	<10	<10
TDS	3590	1490	7890	8060	3200	3200	5230	4340
Hardness — Perm.	360	57	NIL	NIL	NIL	NIL	940	695
Hardness — Temp.	290	20	1300	1310	900	850	48	25
Alkalinity	290	20	1540	1480	1660	1620	48	25

NOTES

Borehole No.	*Reg. No.*	*Comments*
9	910325	Sample taken at start of pump test
9	910326	Sample taken after 30 minutes of pumping
10	910327	Sample taken after 15 minutes of pumping
10	910328	Sample taken at end of pump test
8	910329	Sample taken after 15 minutes of pumping
8	910330	Sample taken at end of pump test
7	910342	Sample taken at start of pump test
7	910343	Sample taken after 120 minutes of pumping

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Hole No.	Bore 8	Bore 8	Bore 7	Bore 7	HD 1	HD 2
Date	8/5/91	8/5/91	16/5/91	16/5/91	15/7/91	15/7/91
Reg. Nos.	910329	910330	910342	910343	910508	910509
pH	7.6	7.6	5.6	5.5	8.2	7.3
Conductivity µS/cm	5900	5650	2300	2800	8300	9400
Item (mg/L)						
CO_3	<5	<5	<5	<5	<5	<5
HCO_3	1560	1570	24	23	1570	100
CL	1670	1550	710	890	3460	4130
SO_4	390	360	115	135	620	650
Ca	50	45	13.0	16.0	84	92
Mg	240	220	52.0	64.0	460	390
Fe	0.1	0.1	0.5	0.4	<0.1	0.1
Al	<0.1	0.2	0.2	<0.1	<0.2	<0.2
K	64	65	16.0	21	65	29
Na	1280	1250	420	520	1890	2000
F	0.5	0.6	0.4	0.4	1.2	0.7
NO_3	<10	<10	<10	<10	<10	<10
TDS	4630	4390	1500	1910	7930	8660
Hardness — Perm.	NIL	NIL	230	280	810	1760
Hardness — Temp.	1110	1020	20	18.5	1290	83
Alkalinity	1280	1290	20	18.5	1290	83

Analyses by K. Burt and T. Bishop, Division of Mines and Mineral Resources, Hobart

WATER CONDUCTIVITY AND pH, 18 JULY 1991

Bore No.	*Conductivity (µS/cm)*	*pH*
1	10 700	5.05
3	4 600	6.60
6	-	-
7	930	6.20
8	6 500	7.55
9	-	-
10	4 400	5.30
11	10 000	7.0
12	5 200	7.0
13	10 250	7.2
14	2 600	7.4
15	395	8.1
16	8 550	7.1
17	370	8.5
18	-	-
19	1 850	7.2
20	1 760	6.9
21	700	9.10
22	1 360	6.9
23	680	7.0
24	1 570	7.2
25	370	5.9
26	945	7.0
27	1 970	7.2

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APPENDIX 7

Summary of borehole details

Hole No.	Easting	Northing	Collar RL (m)	Total Depth (m)	Drilling Method	Piezometer Installations	
						Diam. (mm)	Interval (m)
1	520 477.8	5 258 764.3	97.2	21.45	auger & tricone roller	32	open standpipe*
2	520 428.7	5 258 756.6	102.38	40.0	tricone roller	15	open standpipe*
3	520 461.2	5 258 838.7	86.91	13.8	tricone roller	32	open standpipe*
4	520 440.0	5 258 693.9	107.13	8.4	diamond (NQ)	-	-
5	520 472.6	5 258 755.3	98.60	22.0	tricone & diamond	-	-
6	520 474.7	5 258 743.3	99.3	25.0	tricone roller	75	open standpipe*
7	520 482.4	5 258 790.1	94.9	34.5	tricone roller	90	open standpipe*
7A	520 482.4	5 258 791.3	94.9	18.5	diamond (NQ)	32	16.80–18.50
8	520 536.3	5 258 775.8	87.8	30.0	tricone roller	90	open standpipe*
9	520 428.0	5 258 842.3	87.9	25.0	tricone roller	90	open standpipe*
10	520 490	5 258 835	84.88	28.0	tricone & diamond	90	open standpipe*
11	520 559.4	5 258 891.2	65.3	14.5	diamond (NQ)	32	open standpipe*
12	520 653.9	5 258 780.8	55.2	13.0	diamond (NQ)	32	open standpipe*
13	520 370.4	5 258 903.6	86.3	64.0	diamond (NQ)	32	open standpipe*
14	520 304.4	5 258 953.5	84.43	34.0	diamond (NQ)	32	open standpipe*
15	520 446.2	5 258 914.7	70.9	22.0	diamond (NQ)	32	open standpipe*
16	520 638.4	5 258 655.2	58.15	31.0	diamond (NQ)	32	open standpipe*
17	520 360.9	5 258 826.4	102.20	31.0	diamond (NQ)	32	open standpipe*
18	520 577.6	5 258 629.9	65.48	15.0	diamond (NQ)	32	open standpipe*
19	520 212.9	5 258 859.9	113.78	29.9	diamond (NQ)	32	open standpipe*
20	520 420.9	5 258 762.6	102.54	20.0	diamond (NQ)	32	15.25–17.25
21	520 448.2	5 258 846.9	86.95	20.0	diamond (NQ)	32	9.0–11.0
22	520 459.1	5 258 737.2	100.89	20.0	diamond (NQ)	32	18.0–20.0
23	520 470.8	5 258 797.3	94.78	20.0	diamond (NQ)	32	9.5–11.0
24	520 545.2	5 258 806.9	79.21	15.0	diamond (NQ)	32	5.0–7.0
25	520 413	5 258 719	108.92	27.6	diamond (NQ)	32	5.0–7.0
26	520 624	5 258 857	58.30	19.3	diamond (NQ)	32	5.0–7.0
27	520 600.5	5 258 769.1	68.18	16.8	diamond (NQ)	32	5.0–7.0
28	520 146.1	5 259 033.1	73.6	8.0	diamond (NQ)	32	5.0–7.0
HD 1	520 488.9	5 258 853	79.35				
HD 2	520 490.6	5 258 852.7	79.0				

*Slotted over entire depth

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APPENDIX 8

Engineering borehole logs

NOTES

1. Boreholes 1–5 — refer Division of Mines and Mineral Resources Report 1990/29
   Borehole 6 — Cuttings misplaced, no log
   Test Pits M1–M9 — refer Division of Mines and Mineral Resources Report 1990/29

2. STRENGTH CHARACTERISTICS OF TERTIARY DEPOSITS

   The overall strength characteristics of these deposits are governed largely by the matrix materials supporting the cobbles and boulders. As a result the deposits are considered to have a very low to low strength, however individual boulders and rock fragments may be of very high strength, depending on their composition and degree of weathering.

3. DEFECTS

   The general nature, spacing and orientation of defects associated with the Tertiary deposits is shown in the photographs accompanying the logs. Clay-lined defects (joints) and slickensided surfaces occur throughout the deposits. The latter were probably formed by shearing caused by differential compression and compaction during the depositional process.

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SUMMARY OF LOGS IN TERMS OF GEOLOGICAL AGE

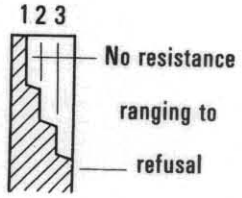
Hole No.	Tertiary Deposits			Permian sediments	Triassic sediments	Jurassic dolerite
	Permian*	Triassic*	Triassic/Jurassic*			
1	0–17	17–21.45				
2	0–14	14–40				
3	0–9	9–13.83				
4				0–8.4		
5	0–17.5		17.5–22.0			
6	Cuttings misplaced — no log					
7	0–28.5	28.5–34.5				
7A	0–18.5					
8	19.5–24.0	0–19.5				
8		24.0–30				
9		0–25.0				
10	0–5.5	5.5–13.4	13.4–28.0			
11						0–14.5
12						0–13.0
13		0–23.1	23.1–49.0			
13		49.0–64.0				
14			0–34.0			
15			0–22.0			
16		0–11.5	11.5–31.0			
17		0–31.0				
18	0–15.0					
19		0–29.9				
20	0–15.5	15.5–20.0				
21	0–2.0	2.0–6.0	6.0–20.0			
22	0–11.0	11.0–20				
23	0–20.0					
24		4.3–9.4	0–4.3			9.4–15.0
25				0–27.6		
26					0–19.3	
27			0–16.8			
28		0–8.0				

* Age of source rock from which material was derived
All depths in metres

EXPLANATION SHEET FOR ENGINEERING LOGS

Borehole and excavation log

Penetration



Water

22 Jan, 80 Water level on date shown.

Water inflow.

Water outflow.

Notes - samples and tests

U50	Undisturbed sample 50mm diameter.
D	Disturbed sample.
N	Standard penetrometer blow count for 300mm.
N *	SPT + sample.

Material classification

Based on Unified Soil Classification System.

In Graphic Log materials are represented by clear contrasting symbols consistent for each project.

Moisture content

D	Dry, looks and feel dry.
M	Moist, no free water on hand when remoulding.
W	Wet, free water on hand when remoulding.
LL	Liquid limit.
PL	Plastic limit.
PI	Plasticity Index.

eg. M > PL – Moist, moisture content greater than the plastic limit.

Consistency

		hand penetrometer (kPa)
VS	Very soft.	< 25
S	Soft.	25 - 50
F	Firm.	50 - 100
St	Stiff.	100 - 200
VSt	Very stiff.	200 - 400
H	Hard.	> 400
Fb	Friable.	

Notes: X on log is test result

— is range of results.

Density index

		%
VL	Very loose.	0 - 15
L	Loose.	15 - 35
MD	Medium dense.	35 - 65
D	Dense.	65 - 85
VD	Very Dense	85 - 100

Cored borehole log

Case - lift

Casing used.

Barrel withdrawn.

Fluid loss

No loss

50% loss

100% loss.

Lugeons

Lugeon units (μL) are a measure of rock mass permeability. For a 46 to 74mm diameter borehole 1 Lugeon is defined as a rate of loss of 1 litre per metre per minute. 1 Lugeon is roughly equivalent to a permeability of 1×10^{-4} mm/sec.

Graphic log

No core.

Rock substances represented by clear, contrasting symbols consistent for each project.

Weathering

Fr	Fresh.
SW	Slightly weathered.
HW	Highly weathered.
EW	Extremely weathered.

Strength

		point load strength index $I_{s\,(50)}$ (MPa)
EL	Extremely low.	< 0·03
VL	Very low.	0·03 - 0·1
L	Low.	0·1 - 0·3
M	Medium.	0·3 - 1
H	High	1 - 3
VH	Very high.	3 - 10
EH	Extremely high.	> 10

Note: X on log is test result.

Significant defects

Significant defects shown graphically.

Joint.

Sheared zone.

Crushed seam.

Infill seam.

Extremely weathered seam.

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – BOREHOLE

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borehole no. 7
sheet 1 of 2

80/164

project ROSETTA LANDSLIDE location 5 OFFICER STREET.

co-ordinates 520 482·4mE
5 258 790·1mN
R.L. 94·9m
inclination VERTICAL
bearing —

drill type GEMCO 210D
drill method TRICONE ROLLER
drill fluid —

hole commenced 12 Dec '90
hole completed 13 Dec '90
drilled by G. Baker - DMMR
logged by R.C Donaldson
checked by

5 cm

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
							FILL: Sandy GRAVEL - fine to medium siltstone and dolerite road aggregate, sand fine to coarse, trace CH clay.				FILL
				2			SILTSTONE: coarse, light grey to fawn, moderately to highly weathered, low to medium strength trace light grey high plasticity clay.				TERTIARY DEPOSITS - materials derived from Permian age sediments.
				4							
				6							
				8							
				10			similar to above, some grey and yellow brown high plasticity clay.				
				12							
				14			colour variation - mid grey to fawn. trace only of grey high plasticity clay.				
				16			similar to above - some grey high plasticity clay.				
				18		GC	Gravelly sandy CLAY: high plasticity, yellow brown and red brown, fine-coarse sand and fine gravel comprising grey siltstone and oxidised fine sandstone rock fragments.				
				20			similar to above - colour variation to yellow brown and grey.				

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ENGINEERING LOG – BOREHOLE

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sheet 2 of 2

81/164

project ROSETTA LANDSLIDE location 5 OFFICER STREET.

co-ordinates

R.L.

inclination

bearing

drill type

drill method

drill fluid

hole commenced

hole completed

drilled by

logged by

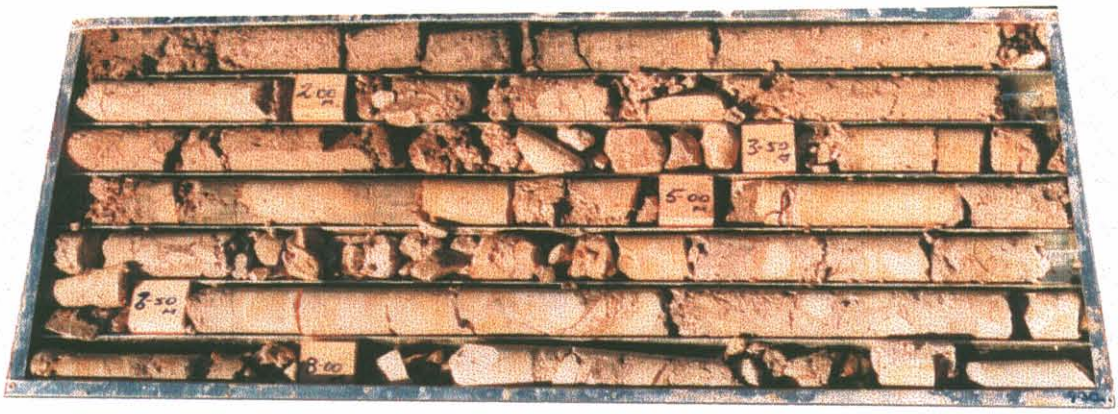
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
							SILTSTONE: coarse, light grey to fawn, moderately to highly weathered, low to medium strength, some yellow brown and grey high plasticity clay.				
				22		GC	Gravelly sandy CLAY: high plasticity, brown, fine to medium sand and fine gravel comprising grey siltstone rock fragments.				
				24							
				26							
				28							
						SP	SAND: fine, grey brown, some clay and carbonaceous matter.				materials derived from Triassic age sediments. (sandstone)
				30			similar to above, slight colour variation to brown, trace black organic matter.				
				32							
				34							
				36			HOLE TERMINATED AT REQUIRED DEPTH OF 34.5m IN TERTIARY DEPOSITS.				

5 cm

ROSETTA LANDSLIDE — BOREHOLE NUMBER 7A

82/164



0–9.30 m

5 cm

9.30–18.50 m

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – CORED BOREHOLE

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borehole no. 7A

sheet 1 of 1

83/164

project ROSETTA LANDSLIDE location 5 OFFICER ST.

co-ordinates 520 482·4 m E, 5 258 791·3 m N
R.L. 94·9 m
inclination VERTICAL
bearing —

drill type GEMCO 210 D
drill method NQ Triple Tube
drill fluid WATER

hole commenced 22 May '91
hole completed 23 May '91
drilled by G. Baker - DMMR
logged by R.C. Donaldson.
checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. / depth	graphic log	substance description: rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description: thickness, type, inclination, planarity, roughness, coating. significant / general
							NO CORE, tricone roller bit, - Fill material.				
					2		COLLUVIUM: sub angular fine - medium gravel size fragments of mudstone, siltstone and sandstone in a light grey clayey sand - silt matrix.				
					4		CONGLOMERATE: sub angular to sub rounded fine to coarse gravel and boulder size grey and yellow brown mudstone / siltstone rock fragments in a grey brown to brown sandy and silty CH clay matrix.				← 40 mm soft grey CH clay. Some fine gravel.
					6						
					8						
					10						← 100 mm brecciated rock.
					12						← 40 mm soft grey CH clay. Some fine gravel. ← 50 mm soft grey CH clay. ← 120 mm V. soft yellow brown clay.
					14						← 70 mm soft grey gravelly clay.
					16						← 20 mm soft grey clay ← 40 mm soft grey gravelly clay.
					18						← 250 mm brecciated rock.
					20		HOLE TERMINATED AT REQUIRED DEPTH OF 17·5 m IN TERTIARY DEPOSITS.				

5 cm

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ENGINEERING LOG – BOREHOLE

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84/164

project ROSETTA LANDSLIDE location COUNCIL RESERVE - OFF CROSBY RD (No 25)

co-ordinates 520 536·3 m E
5 258 775·8 m N

R.L. 87·8 m

inclination VERTICAL

bearing —

drill type GEMCO 210D

drill method TRICONE ROLLER

drill fluid —

hole commenced 18 Dec '90

hole completed 18 Dec '90

drilled by G Baker - DMR

logged by R.E. Donaldson.

checked by

5 cm

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				2		GC	Sandy clayey GRAVEL: fine to medium, comprising sandstone, carbonaceous mudstone, dolerite, and travertine rock fragments; yellow brown, sand fine to medium, clay of medium to high plasticity				TERTIARY DEPOSITS
				4		GW	GRAVEL: fine to coarse, angular fragments of dolerite, mudstone, quartz sandstone, some yellow brown sandy clay.				
				6		GC	Sandy clayey GRAVEL: similar to the 0 - 8.0 m interval.				
				8			Sandy clayey GRAVEL: fine to medium, comprising light grey to dark grey (carbonaceous) mudstone, and yellow brown fine to medium grained sandstone rock fragments; yellow brown, sand fine to medium, clay of medium to high plasticity. Dolerite absent.				materials derived from Triassic age sediments.
				10			colour variation to mid grey brown				
				12			colour variation to dark grey brown				
				14			colour variation to mid grey brown.				
				16			colour variation to grey and yellow brown				
				18			colour variation to yellow brown				
				20			clayey GRAVEL: fine to medium, light grey				materials

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sheet 2 of 2

85/164

project ROSETTA LANDSLIDE location COUNCIL RESERVE - OFF 25 CROSBY RD.

co-ordinates

R.L.

inclination

bearing

drill type

drill method

drill fluid

hole commenced

hole completed

drilled by

logged by

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
				22			to fawn, coarse siltstone to fine sandstone rock fragments of low to medium strength, clay of medium to high plasticity.				derived from Permian age sediments (siltstone)
				24		SC	Clayey SAND: fine, some medium to coarse sand and fine gravel comprising fine grained very low strength sandstone, clay of medium to high plasticity.				materials derived from Triassic age sediments (sandstone)
				26			colour variation to mid grey				
				28			colour variation to mid-dark grey.				
				30			HOLE TERMINATED AT REQUIRED DEPTH OF 30.0m IN TERTIARY DEPOSITS.				

5 cm

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ENGINEERING LOG – BOREHOLE

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86/164

project ROSETTA LANDSLIDE location ON ROADWAY OUTSIDE 9 OFFICER ST.

co-ordinates 520 428.0 m E
5 258 842.3 m N.
R.L. 87.9 m
inclination VERTICAL
bearing —

drill type GEMCO 210 D
drill method TRICONE ROLLER
drill fluid —

hole commenced 30 Jan '91
hole completed 4 Feb '91
drilled by G. Baker DMR
logged by R.C. Donaldson
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
							GRAVEL: fine to medium, blue grey dolerite (road aggregate) some yellow brown to grey sandy clay (CH)				FILL
				2		SC CH	Sandy CLAY: high plasticity, brown to yellow brown, sand fine to medium some coarse, some fine gravel comprising yellow brown fine grained sandstone rock fragments.				TERTIARY DEPOSITS. materials derived from Triassic age sediments and Jurassic age dolerite
				4		GC	Sandy clayey GRAVEL: fine to medium, comprising grey (some carbonaceous) mudstone and yellow brown fine grained sandstone rock fragments, yellow brown sand fine to medium, some coarse sand, clay of high plasticity.				
				6		GC					
				8			Gravelly sandy CLAY: high plasticity, green grey to brown, sand fine to medium, gravel fine to medium comprising mudstone, sandstone rock fragments as above with a trace of dolerite.				
				10							
				12			Sandy clayey GRAVEL: fine to coarse comprising light and dark grey mudstone, sandstone and dolerite rock fragments, green grey to brown, sand fine to coarse, clay of high plasticity.				
				14							
				16			Gravelly sandy CLAY: similar to the 4.5 – 10.5 m interval.				
				18			Sandy clayey GRAVEL: similar to the 10.5 – 16.0 m interval.				
				20							

5 cm

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87/164

project ROSETTA LANDSLIDE location ON ROADWAY OUTSIDE 9 OFFICER ST.

co-ordinates

R.L.

inclination

bearing

drill type

drill method

drill fluid

hole commenced

hole completed

drilled by

logged by

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
				22							
				24							
				26			HOLE TERMINATED AT 25.0m DUE TO DRILLING DIFFULTIES. N.B. At 25.0m on tricone roller bit, a high plasticity, black to dark grey sandy clay (carbonaceous) was noted.				

5 cm

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ENGINEERING LOG – CORED BOREHOLE

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88/164

project ROSETTA LANDSLIDE location ON ROADWAY OUTSIDE 1 OFFICER ST.

co-ordinates 520 490 m E, 5 258 835 m N
R.L. 84.88 m
inclination VERTICAL
bearing —

drill type GEMCO 210D
drill method NQ Triple Tube
drill fluid WATER

hole commenced 9 April '91
hole completed 11 April '91
drilled by G. Baker – DMMA
logged by R.C. Donaldson.
checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. / depth	graphic log	substance description: rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description: thickness, type, inclination, planarity, roughness, coating. significant / general
							PAVEMENT + ROAD BASE METAL				
					2		CONGLOMERATE: sub angular to sub rounded fine to coarse gravel size grey siltstone rock fragments in a light grey and yellow brown sandy and silty clay matrix.				
					4						
			SHEAR ZONE? DIRECT SHEAR TEST $\phi' = 17°$, $C' = 4$ kPa		6		CONGLOMERATE: sub angular to sub rounded fine to coarse gravel and some cobble size sandstone (some carbonaceous), siltstone and minor sandstone rock fragments in a yellow brown to grey sandy clay (CH) matrix. Matrix dominant over some sections, generally has a very stiff consistency.				← 50 mm firm grey + yellow brown CH clay.
					8						← 400 mm soft-firm yellow brown CH clay.
					10						
					12		similar to above, sandstone fragments dominant.				
					14		as above, some slightly to highly weathered dolerite boulders and rock fragments appearing.				
					16						
					18						
					20						

5 cm

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ENGINEERING LOG – CORED BOREHOLE

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project ROSETTA LANDSLIDE location ON ROADWAY OUTSIDE 1 OFFICER ST.

co-ordinates
R.L.
inclination
bearing

drill type
drill method
drill fluid

hole commenced
hole completed
drilled by
logged by
checked by

drilling information							rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L	metres depth	graphic log	substance description rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. significant / general
						22		CONGLOMERATE: fine to coarse gravel size sandstone and carbonaceous mudstone rock fragments in a grey-black sandy silt matrix.				
						24		dominantly a yellow brown to grey green sandy clay with some gravel (and cobble) size fragments of dolerite, carbonaceous mudstone and sandstone				
						26						
						28						
								HOLE TERMINATED AT REQUIRED DEPTH OF 28.0m IN TERTIARY DEPOSITS.				

5 cm

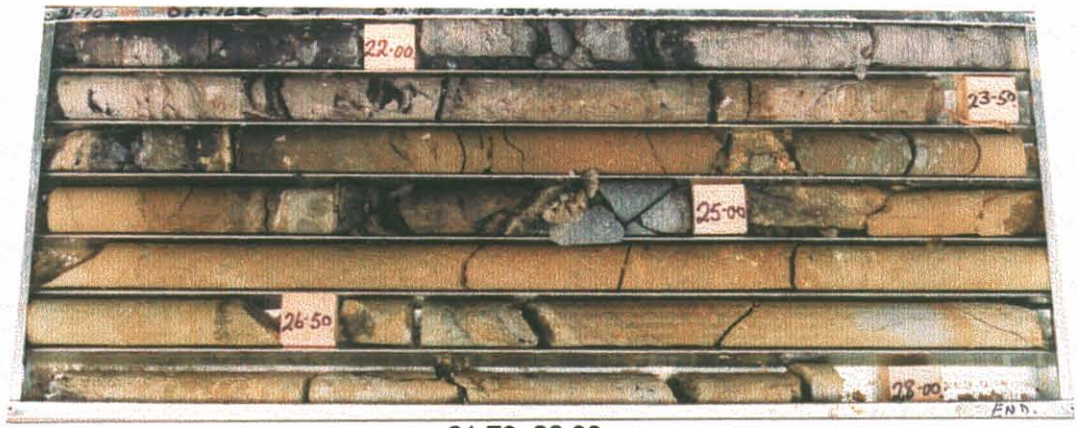
ROSETTA LANDSLIDE — BOREHOLE NUMBER 10

90/164

0–9.00 m

9.00–15.40 m

15.40–21.70 m

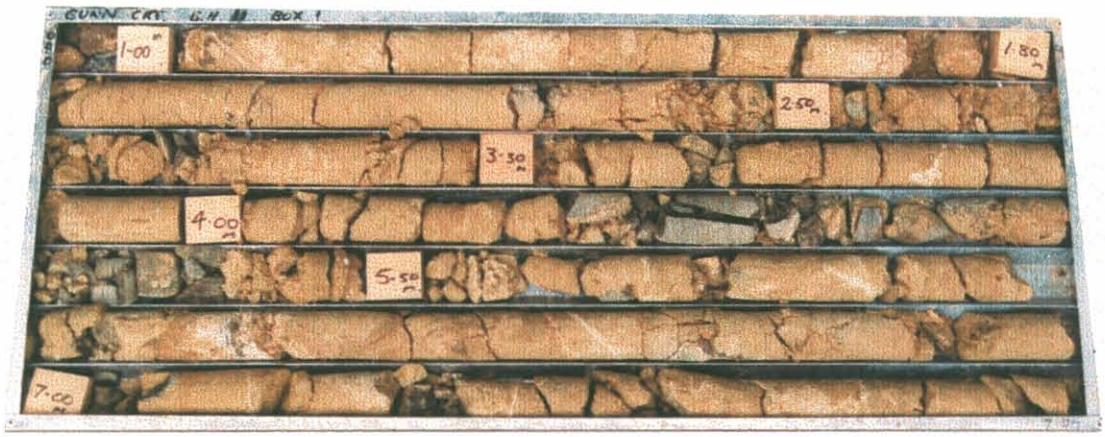


21.70–28.00 m

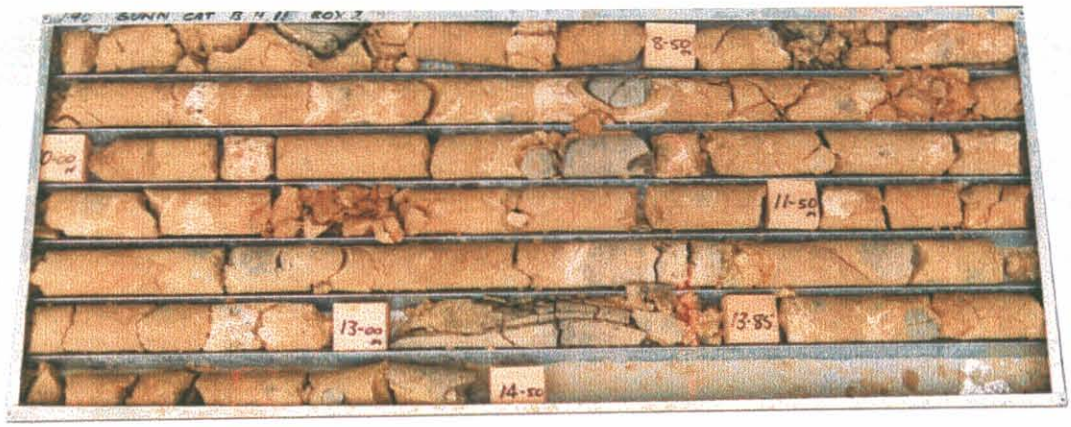
5 cm

91/164

ROSETTA LANDSLIDE — BOREHOLE NUMBER 11



0–7.90 m



7.90–14.50 m

5 cm

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project ROSETTA LANDSLIDE location 8 GUNN COURT

co-ordinates 520 559·4 m E
5258 891·2 m N

R.L. 65·8 m

inclination VERTICAL

bearing —

drill type GEMCO 210D

drill method NQ – Triple Tube

drill fluid Water

hole commenced 12 Feb '91

hole completed 13 Feb '91

drilled by G. Baker-Dmmr

logged by R. L. Donaldson.

checked by

drilling information							rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L.	metres depth	graphic log	substance description rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. significant / general
								Sandy CLAY: high plasticity, brown, some sand and fine gravel.				
						2		DOLERITE: fine to medium grained, brown, some medium to slightly weathered (mw-sw) dappled blue grey and brown dolerite kernels. White carbonate seams and veining present.	EW to HW			
						4						
						6						
						8						
						10						
						12						
						14						
						16		HOLE TERMINATED AT REQUIRED DEPTH OF 14·5 m IN DOLERITE.				

5 cm

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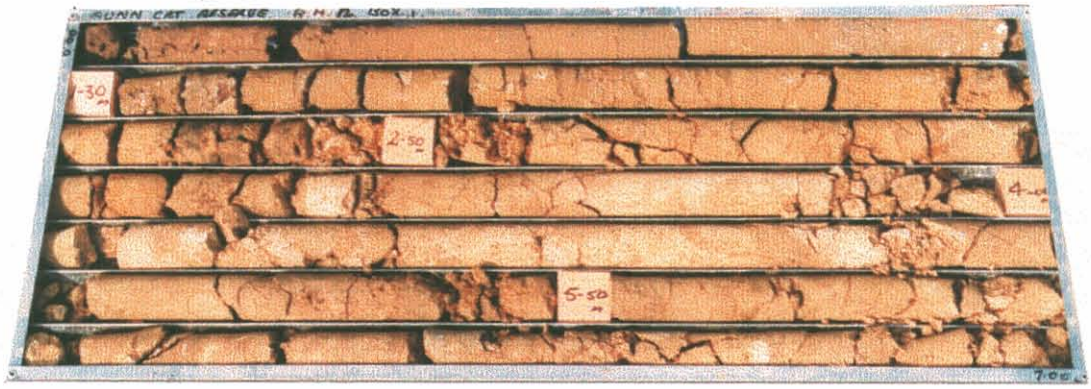
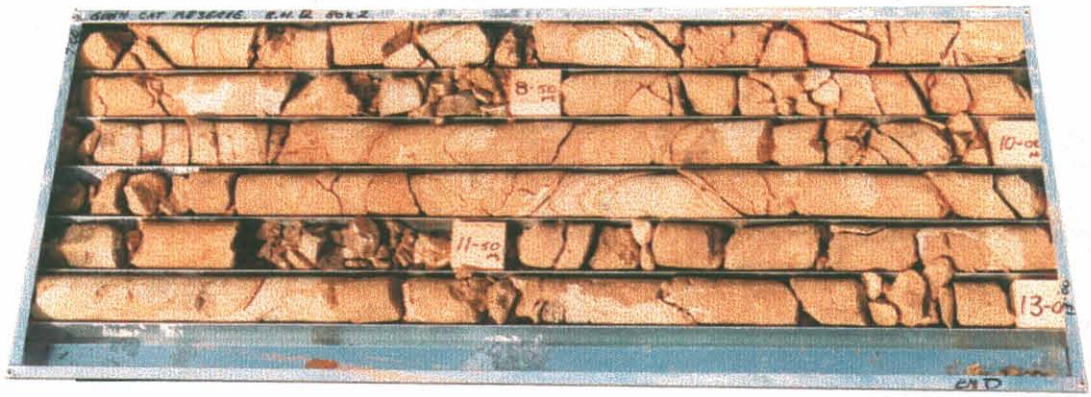
ROSETTA LANDSLIDE — BOREHOLE NUMBER 12



0–7.00 m

5 cm



7.00–13.00 m

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project ROSETTA LANDSLIDE location HEC RESERVE - ADJACENT 20 OFFICER ST.

co-ordinates 520 653·9m E
5 258 780·8m N

R.L. 55·2m

inclination VERTICAL

bearing —

drill type GEMCO 210D

drill method NQ Triple Tube

drill fluid WATER

hole commenced 13 Feb '91

hole completed 14 Feb '91

drilled by G. Baker - D. Mark

logged by R.C. Donaldson

checked by

drilling information							rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L.	metres depth	graphic log	substance description rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. significant / general
						2		COLLUVIUM: sub angular fine to medium gravel size black (carbonaceous), grey & white fine sandstone & siltstone rock fragments in a brown clayey clay matrix.				
						4		DOLERITE: fine to medium grained, brown, stone moderately to slightly weathered (MW-SW) dappled blue grey and brown dolerite kernels. white carbonate seams and veining abundant.	EW to HW			
						6						
						8						
						10						
						12						
						14		HOLE TERMINATED AT 13·0m IN DOLERITE.				

5 cm

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ENGINEERING LOG – CORED BOREHOLE

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borehole no. 13

sheet 1 of 4

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project ROSETTA LANDSLIDE location 5 SHERWIN COURT

co-ordinates 520 370·4m E
5 258 903·6m N

R.L. 86·3m

inclination VERTICAL

bearing —

drill type GEMCO 210D

drill method NQ Triple Tube

drill fluid WATER

hole commenced 18 Feb '91

hole completed 27 Feb '91

drilled by G. Baker DMR

logged by R C Donaldson.

checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. / depth	graphic log	substance description: rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description: thickness, type, inclination, planarity, roughness, coating. significant / general
			DIRECT SHEAR TEST $\phi'_r = 15°$, $c'_r = 4$ kPa.		2 4 6 8 10 12 14 16 18 20		Sandy CLAY: high plasticity, dark brown, sand fine-medium, some coarse, V. stiff consistency.	HW			
							CONGLOMERATE: sub angular to sub rounded fine to coarse gravel, cobble and some boulder size grey carbonaceous mudstone, siltstone, and dominantly green grey sandstone rock fragments in a sandy and silty clay matrix				
							similar to above - colour variation to green grey. Sandstone rock fragments dominant.	MW			

5 cm

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project ROSETTA LANDSLIDE location 5 SHERWIN COURT.

co-ordinates

R.L.

inclination

bearing

drill type

drill method

drill fluid

hole commenced

hole completed

drilled by

logged by

checked by

drilling information							rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L.	metres depth	graphic log	substance description rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. significant / general
						22						
						24		CONGLOMERATE: Similar to above, some S.W - Fr blue grey dolerite boulders now present				
						26		colour variation to yellow brown - grey brown	HW			
						28		colour variation to green grey with yellow brown mottles.	MW			
						30						
						32						
						34						
						36						
						38			MW - HW			
						40		slight colour variations yellow brown - grey brown.				

5 cm

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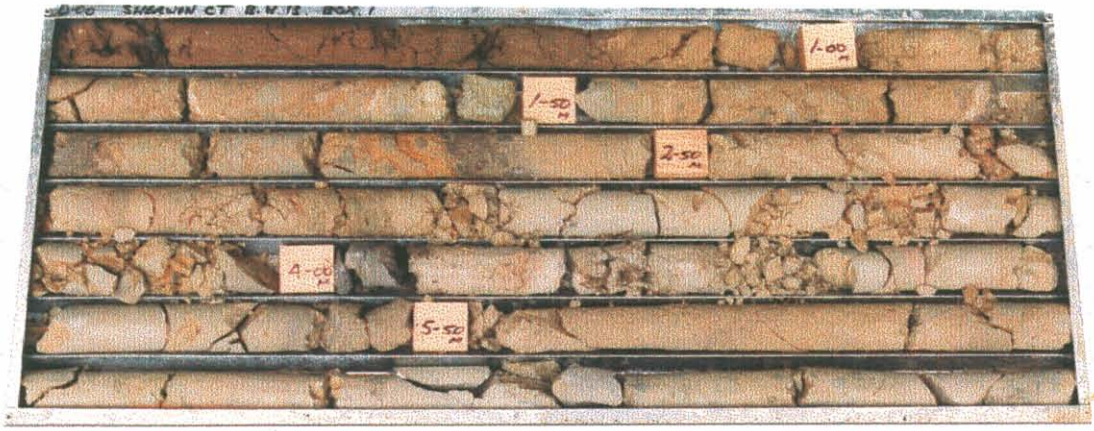
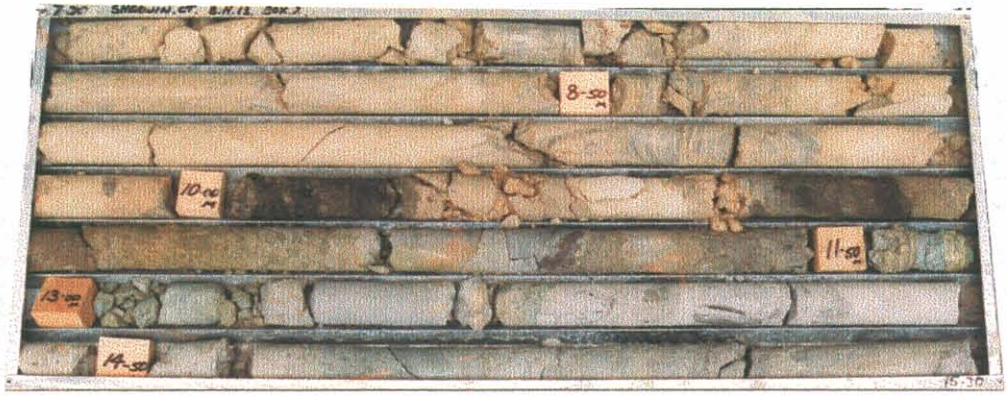
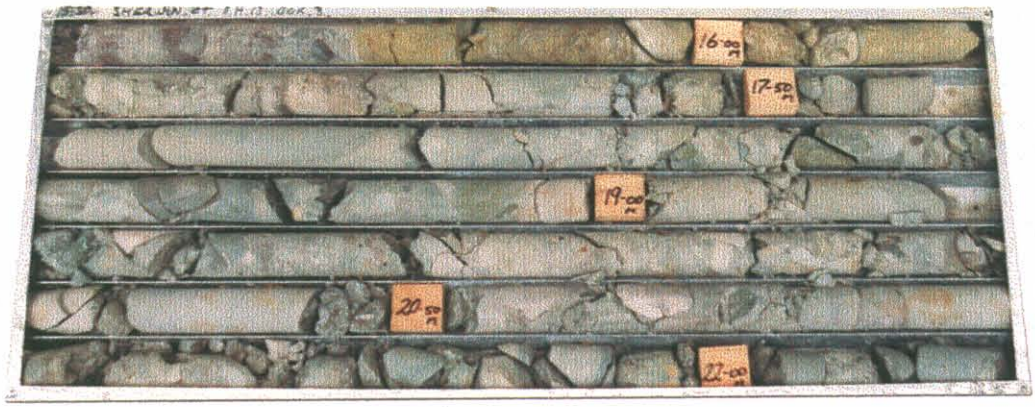
ROSETTA LANDSLIDE — BOREHOLE NUMBER 13



0–7.00 m



7.00–15.30 m



15.30–22.25 m

5 cm

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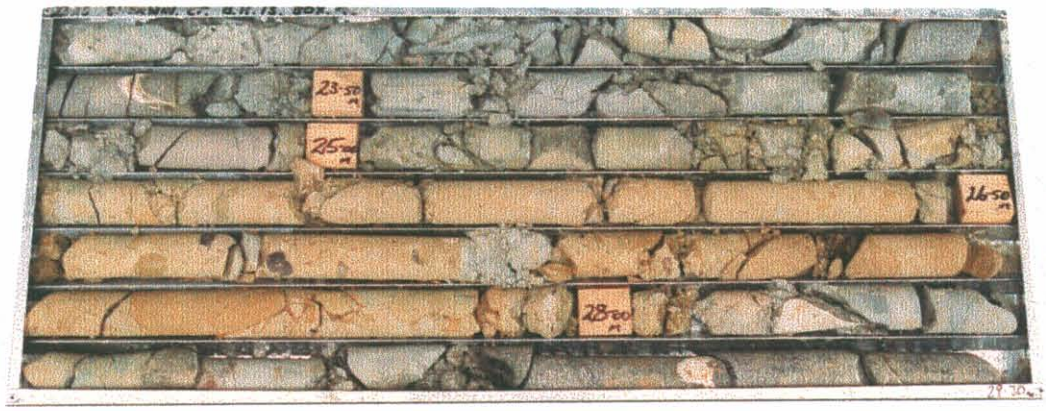
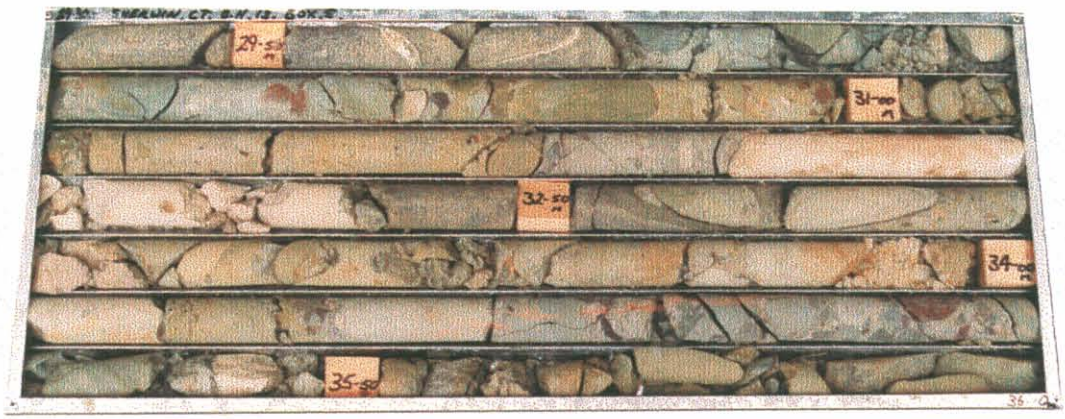
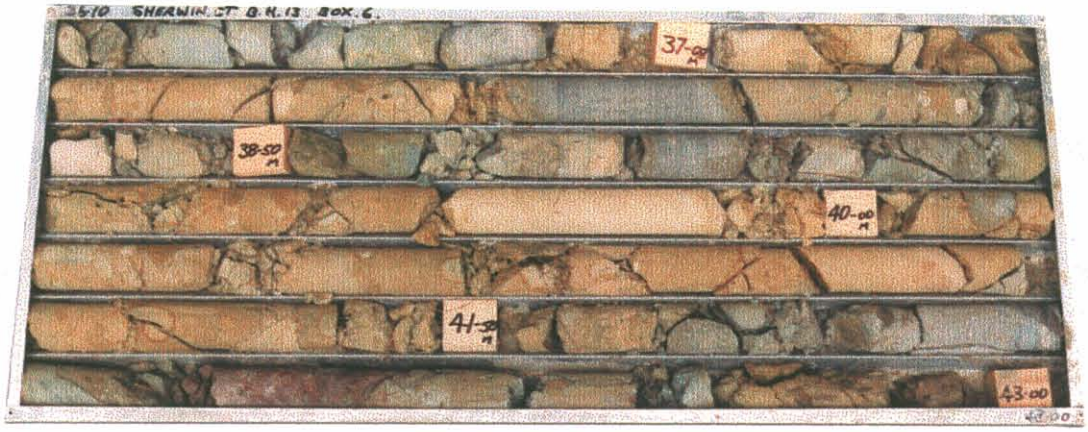
ROSETTA LANDSLIDE — BOREHOLE NUMBER 13 (cont.)



22.25–29.30 m



29.30–36.10 m



36.10–43.00 m

5 cm

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ENGINEERING LOG – CORED BOREHOLE

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project ROSETTA LANDSLIDE location 5 SHERWIN COURT

co-ordinates

R.L.

inclination

bearing

drill type

drill method

drill fluid

hole commenced

hole completed

drilled by

logged by

checked by

drilling information

case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L.	metres depth
						42
						44
						46
						48
						50
						52
						54
						56
						58
						60

rock substance

graphic log	substance description (rock type: grain characteristics, colour, structure, minor components.)	weathering	strength EL VL L M H VH EH
	Some mauve coloured horizons.		
	slight colour variation to grey green-grey brown.		
	CONGLOMERATE: (sub rounded) gravel and cobble size fine grained sandstone with carbonaceous laminae rock fragments in a sand (clay) matrix.		
	CONGLOMERATE: sub angular to sub rounded fine to medium gravel size mudstone, carbonaceous shale and dolerite rock fragments in a sandy green to brown matrix.		

rock mass defects

defect spacing mm. 30 100 300 1000 3000	defect description (thickness, type, inclination, planarity, roughness, coating.) significant	general

5 cm

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project ROSETTA LANDSLIDE location 5 SHERWIN COURT.

co-ordinates

R.L.

inclination

bearing

drill type

drill method

drill fluid

hole commenced

hole completed

drilled by

logged by

checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. / depth	graphic log	substance description rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. significant / general
					62						
					64						
							HOLE TERMINATED AT REQUIRED DEPTH OF 64.0m IN TERTIARY DEPOSITS				

5 cm

ROSETTA LANDSLIDE — BOREHOLE NUMBER 13 (cont.)

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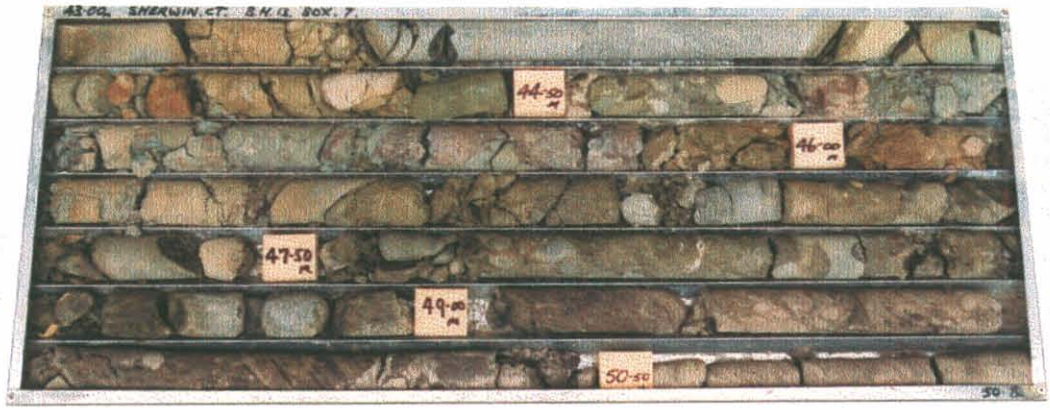

43.00–50.87 m

50.87–57.35 m

57.35–64.00 m

5 cm

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project ROSETTA LANDSLIDE location 11 SHERWIN COURT.

co-ordinates 520 304·4m E
5 258 953·5m N

R.L. 84·43 m

inclination VERTICAL

bearing —

drill type GEMCO 210 D

drill method NQ Triple Tube

drill fluid WATER

hole commenced 5 Mar '91

hole completed 7 Mar '91

drilled by G. Baker DMMR

logged by R. C. Donaldson.

checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L.	graphic log	substance description rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. significant / general
							Silty sandy CLAY				
					2		CONGLOMERATE sub angular to sub rounded fine to coarse gravel and cobble size mudstone, sandstone and dolerite rock fragments in a clayey sand (SC) matrix. Dolerite is dominant with some HW-fw boulders upto 200 mm in diameter.	HW			
					4						
					6						
					8						
					10						
					12						
					14						
					16						
					18						
					20		CONGLOMERATE: sub angular	MW			

5 cm

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project ROSETTA LANDSLIDE location 11 SHERWIN COURT

co-ordinates | drill type | hole commenced

drill method | hole completed

R.L. | drilled by

inclination | drill fluid | logged by

bearing | checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. depth	graphic log	substance description rock type: grain characteristics, colour, structure, minor components.	weathering	strength FL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. significant / general
					22		to sub rounded fine to coarse gravel and cobble size sandstone (dominant) and mudstone rock fragments in a clayey sand matrix. Dolerite occurs as a minor component only.				
					24						
					26						
					28						
					30						
					32						
					34		Similar to above, colour variation to red with light grey mottles. Matrix has higher clay content (CH)	HW			
							HOLE TERMINATED AT REQUIRED DEPTH OF 34.0m IN TERTIARY DEPOSITS				

5 cm

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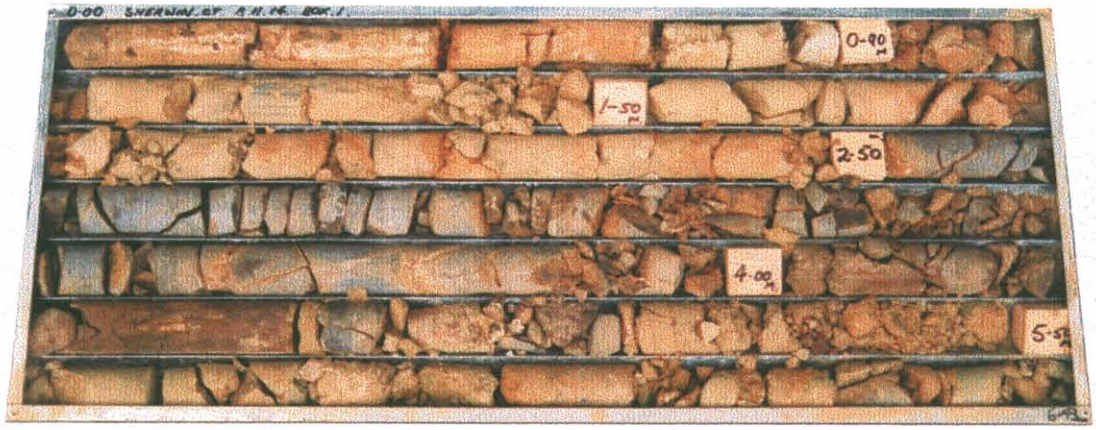
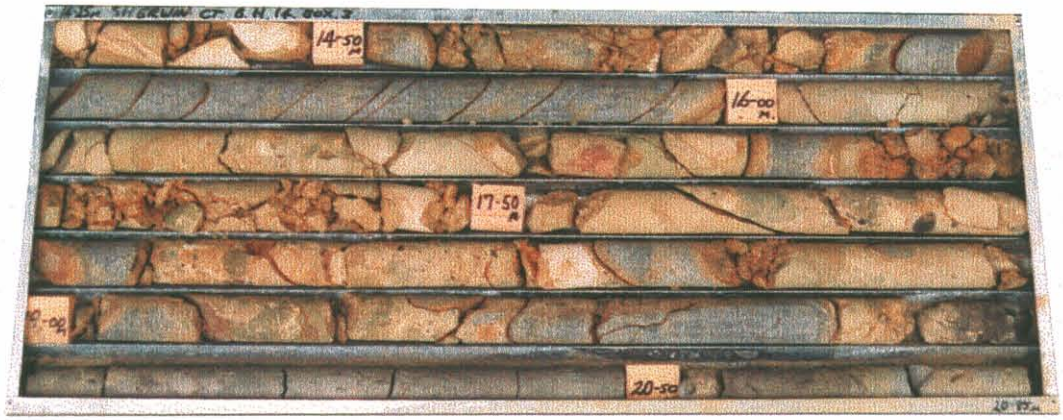
ROSETTA LANDSLIDE — BOREHOLE NUMBER 14



0–6.43 m

6.43–14.25 m



14.25–20.85 m

5 cm

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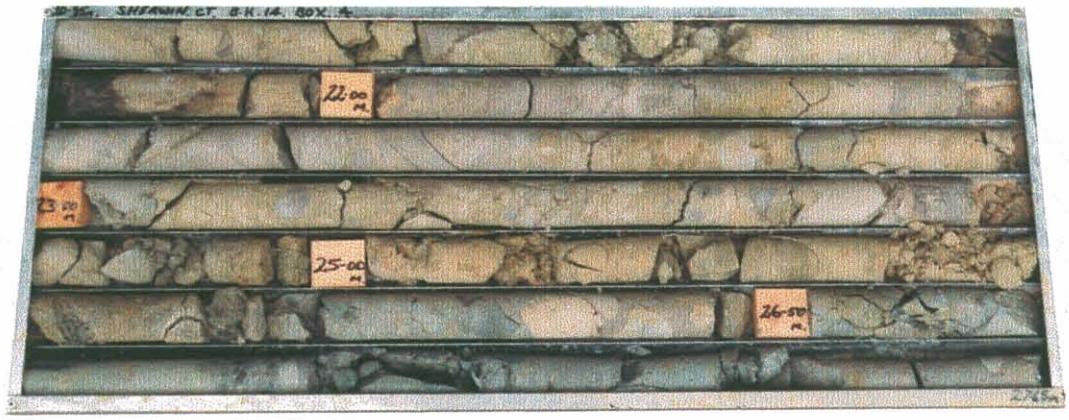
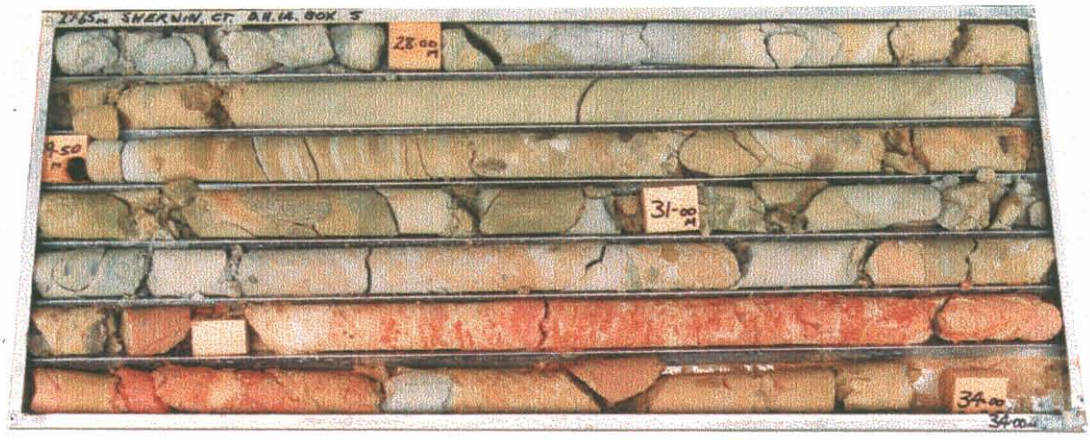
ROSETTA LANDSLIDE — BOREHOLE NUMBER 14 (cont.)



20.85–27.65 m



27.65–34.00 m

5 cm

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ENGINEERING LOG – CORED BOREHOLE

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project ROSETTA LANDSLIDE location ON ROADWAY OUTSIDE 33 SHERWIN CRT.

co-ordinates 520 446·2m E
5 258 914·7m N.
R.L. 70·9m
inclination VERTICAL
bearing —

drill type GEMCO 210 D
drill method NQ Triple Tube
drill fluid WATER

hole commenced 12 Mar '91
hole completed 17 Mar '91
drilled by G. Baker D Mark
logged by R. e Donaldson.
checked by

drilling information							rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L.	metres depth	graphic log	substance description rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. significant / general
						2		CONCRETE - Kerb + guttering.				
								DOLERITE - road base gravel.				
								Sandy CLAY: CH, some gravel.				
						4		CONGLOMERATE: fine to coarse gravel and boulder size mudstone + sandstone rock fragments in a light grey - fawn sandy clay (SC - CH) matrix.	MW & HW			
						6		Dominantly comprised of slightly weathered to highly weathered dolerite boulders. Some gravel size dolerite and mudstone rock fragments	SW & HW			
						8						
						10						
								- fine to medium gravel size carbonaceous mudstone + sandstone rock fragments in a sandy (SP) matrix of grey colouration.	HW			
						12		CONGLOMERATE: gravel to boulder size EW - SW dolerite rock fragments in a yellow brown sand - clay matrix. Similar to the 5·0 - 10·4 m interval.				
						14						
						16		colour variation to green grey. Dolerite rock fragments dominantly gravel size.				← 70mm carbonaceous clay.
						18		CONGLOMERATE: fine to coarse gravel size dolerite carbonaceous mudstone and sandstone rock fragments in a				
						20						

5 cm

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project ROSETTA LANDSLIDE location ON ROADWAY OUTSIDE 33 SHERWIN CRT

co-ordinates

R.L.

inclination

bearing

drill type

drill method

drill fluid

hole commenced

hole completed

drilled by

logged by

checked by

drilling information						rock substance			rock mass defects		
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. / depth	graphic log	substance description (rock type: grain characteristics, colour, structure, minor components.)	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description (thickness, type, inclination, planarity, roughness, coating.) significant / general
					22		green grey sand - clay matrix				
							HOLE TERMINATED AT REQUIRED DEPTH OF 22.0 m IN TERTIARY DEPOSITS.				

5 cm

ROSETTA LANDSLIDE — BOREHOLE NUMBER 15

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0–8.80 m

8.80–16.00 m

16.00–22.00 m

5 cm

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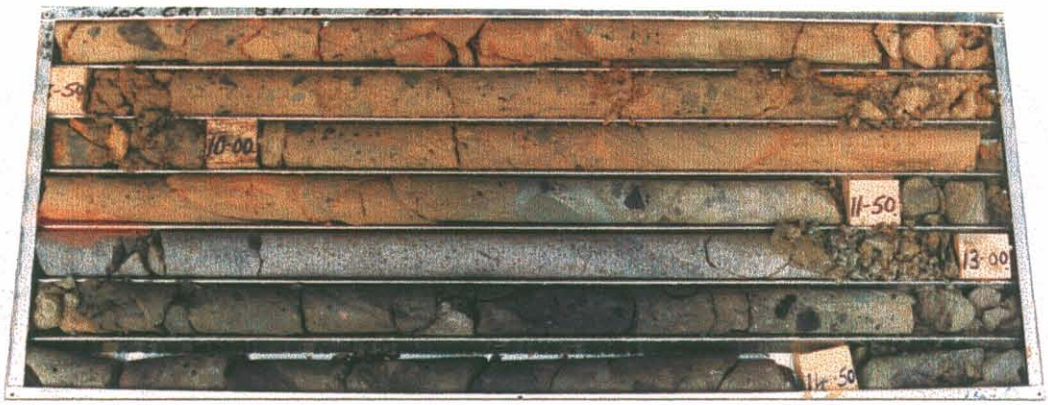
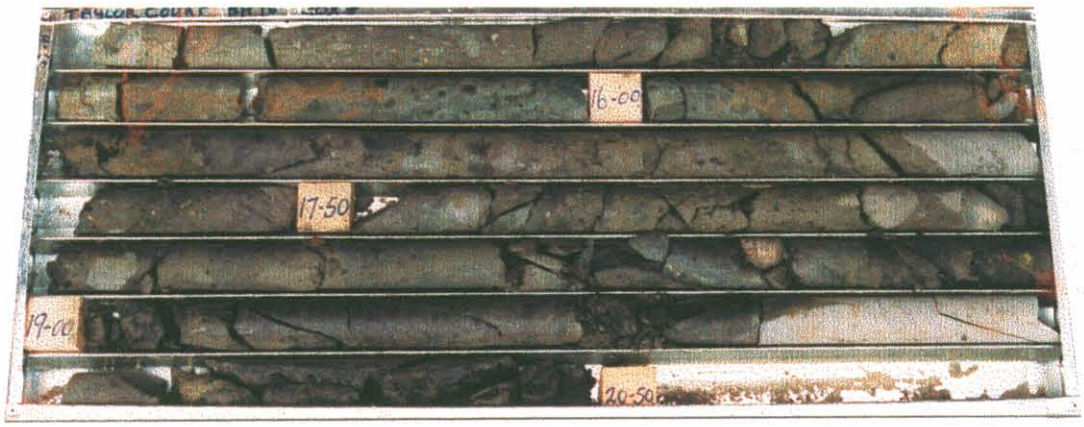
ROSETTA LANDSLIDE — BOREHOLE NUMBER 16

0–7.55 m



7.55–14.60 m



14.60–20.50 m

5 cm

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project ROSETTA LANDSLIDE location 19 TAYLOR COURT.

co-ordinates 520 638·4 m E
5258 655·2 m N

R.L. 58·15 m

inclination VERTICAL

bearing –

drill type GEMCO 210 D

drill method NQ Triple Tube

drill fluid WATER

hole commenced 18 Mar '91

hole completed 26 Mar '91

drilled by G. Baker-D Marr

logged by R.C. Donaldson.

checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. / depth	graphic log	substance description (rock type: grain characteristics, colour, structure, minor components.)	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description (thickness, type, inclination, planarity, roughness, coating.) significant / general
							Sandy CLAY: high plasticity, brown, sand fine-medium, some fine gravel.				
					2		CONGLOMERATE: sub angular to sub rounded fine to coarse gravel and some cobble size mudstone (some carbonaceous), sandstone and dolerite rock fragments in a yellow to brown sandy clay matrix.	HW			
					4						
					6						
					8						
					10						
					12		similar to above, colour variation to greenish grey Dolerite rock fragments and boulders becoming more prominent.	MW to SW			
					14						
					16						
					18						
					20						

5 cm

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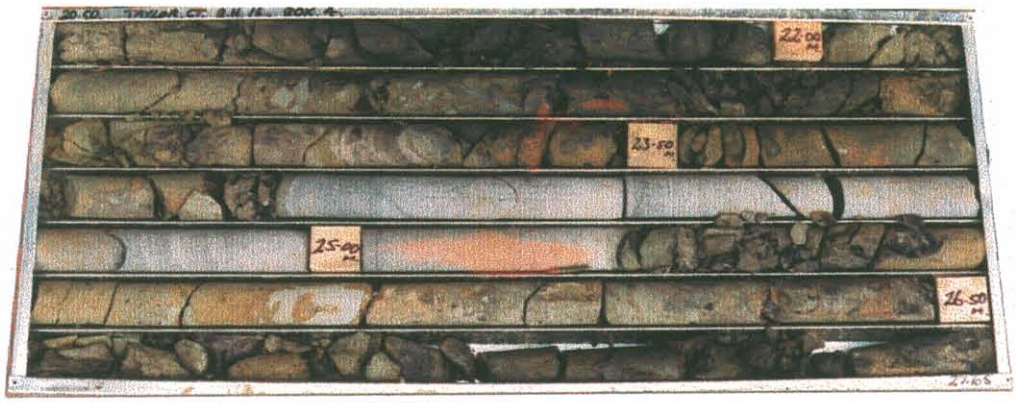
ROSETTA LANDSLIDE — BOREHOLE NUMBER 16 (cont.)



20.50–27.65 m

27.65–31.00 m

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – CORED BOREHOLE

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project ROSEFTA LANDSLIDE location 19 TAYLOR COURT.

co-ordinates

R.L.

inclination

bearing

drill type

drill method

drill fluid

hole commenced

hole completed

drilled by

logged by

checked by

drilling information

case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L.	metres depth
						22
						24
						26
						28
						30
						32

rock substance

graphic log	substance description (rock type: grain characteristics, colour, structure, minor components.)	weathering	strength EL VL L M H VH EH
	HOLE TERMINATED AT REQUIRED DEPTH OF 31.0 m IN TERTIARY DEPOSITS.		

rock mass defects

defect spacing mm. 30 100 300 1000 3000	defect description (thickness, type, inclination, planarity, roughness, coating.) significant	general

5 cm

ROSETTA LANDSLIDE — BOREHOLE NUMBER 17

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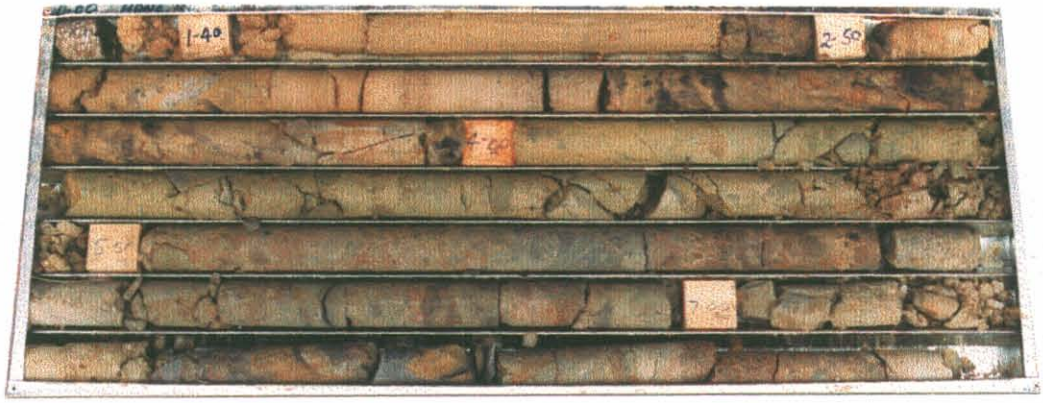
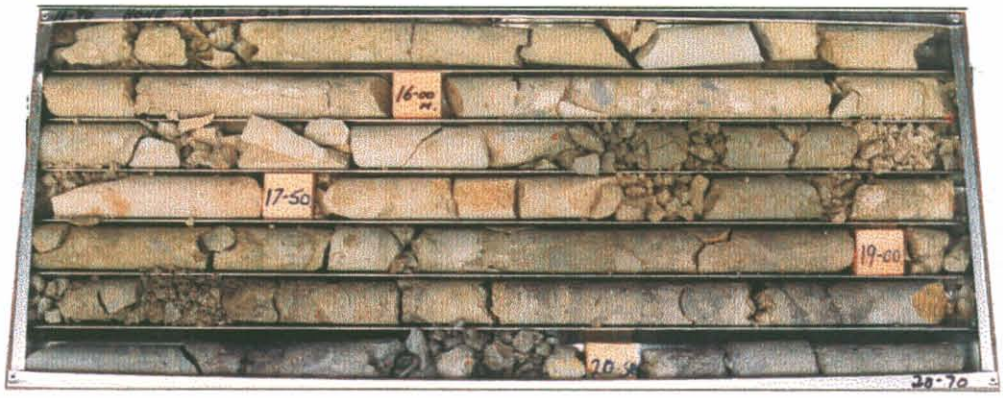


0–8.30 m

8.30–14.70 m



14.70–20.70 m

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – CORED BOREHOLE

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project ROSETTA LANDSLIDE location HONE ROAD - NEAR JUNCTION OF OFFICER ST.

co-ordinates 520360·9mE 5258826·4mN
R.L. 102·20m
inclination VERTICAL
bearing —

drill type GEMCO 210D
drill method NQ Triple Tube
drill fluid WATER

hole commenced 27 Mar '91
hole completed 4 April '91
drilled by G. Baker - DMMR
logged by R.C. Donaldson
checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. / depth	graphic log	substance description (rock type: grain characteristics, colour, structure, minor components.)	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description (thickness, type, inclination, planarity, roughness, coating.) significant / general
							CONCRETE - Kerb + guttering.				
					2		Sandy CLAY: high plasticity yellow brown, sand fine & medium, V. stiff consistency.				
							CONGLOMERATE:	MW			
					4		sub angular to sub rounded fine to coarse gravel and some cobble and boulder size mudstone (some carbonaceous) and sandstone rock fragments in a green-grey-brown sandy clay matrix (SC)				
					6						
					8						
					10		fine to coarse gravel size carbonaceous mudstone and sandstone rock fragments in a grey sandy (CH) matrix.				← 50mm yellow-red CH clay with some fine gravel
					12		similar to previous interval (2·4 – 9·5 m)				
					14						
					16						
					18						
					20		CONGLOMERATE: sub angular to sub rounded				

5 cm

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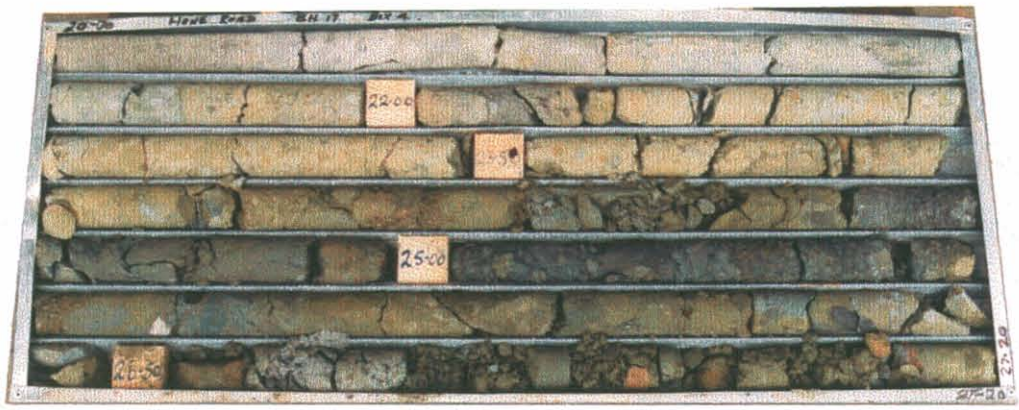
ROSETTA LANDSLIDE — BOREHOLE NUMBER 17 (cont.)



20.70–27.20 m

5 cm

27.20–31.00 m

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – CORED BOREHOLE

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project ROSETTA LANDSLIDE location HONE RD - NEAR JUNCTION OF OFFICER ST.

co-ordinates | drill type | hole commenced

drill method | hole completed

R.L. | drilled by

inclination | drill fluid | logged by

bearing | checked by

drilling information | **rock substance** | **rock mass defects**

case-lift	fluid loss	water	notes	lugeons (0.3 1 3 10 30 100)	metres R.L.	metres depth	graphic log	substance description (rock type: grain characteristics, colour, structure, minor components.)	weathering	strength (EL VL L M H VH EH)	defect spacing mm. (30 100 300 1000 3000)	defect description (thickness, type, inclination, planarity, roughness, coating.) significant	defect description general
						22		fine to medium and some coarse gravel sized mudstone (dominant) and sandstone rock fragments in a grey clay matrix (CL-CH).					
						24		similar to above, sandstone and mudstone rock fragments present. Matrix more representative of a sandy clay (CL-CH)					
						26		colour variation to a blue grey and brown				← 100 mm brecciated zone ← 500 mm — " " — .	
						28							
						30		colour variation to yellow brown				← 130 mm brecciated zone	
						32		HOLE TERMINATED AT REQUIRED DEPTH OF 31.0 m IN TERTIARY DEPOSITS.					

5 cm

ROSETTA LANDSLIDE — BOREHOLE NUMBER 18

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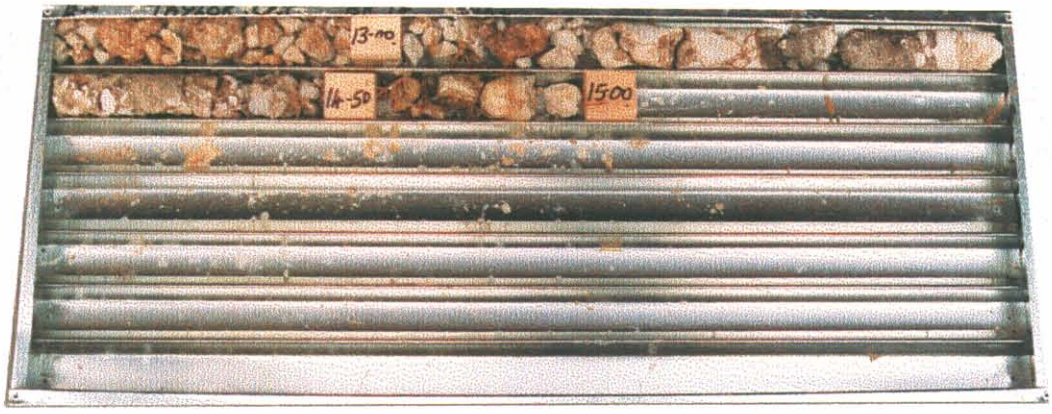
0–12.00 m

5 cm



12.00–15.00 m

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – CORED BOREHOLE

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project ROSETTA LANDSLIDE location 12 TAYLOR COURT.

co-ordinates 520 577·6m E
5258 629·9m N

R.L. 65·48m

inclination VERTICAL

bearing –

drill type GEMCO 210D

drill method NQ Triple Tube

drill fluid WATER

hole commenced 16 April '91

hole completed 17 April '91

drilled by G. Baker - DMMR

logged by R.C. Donaldson.

checked by

drilling information							rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L	metres depth	graphic log	substance description rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL L M H VH	defect spacing mm. 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. significant / general
						2		COLLUVIUM: angular to sub angular fine to medium gravel size black, grey and white fine sandstone rock fragments in a light to dark grey medium to high plasticity silty and sandy clay matrix	HW			← 100 mm firm CH clay
						4						
						6						
						8						
						10		CONGLOMERATE (BRECCIA?) sub-angular fine to coarse gravel size light grey siltstone rock fragments in a grey-brown sandy and silty clay matrix.				
						12						
						14						
						16		HOLE TERMINATED AT REQUIRED DEPTH OF 15·0m IN TERTIARY DEPOSITS.				

5 cm

ROSETTA LANDSLIDE — BOREHOLE NUMBER 19

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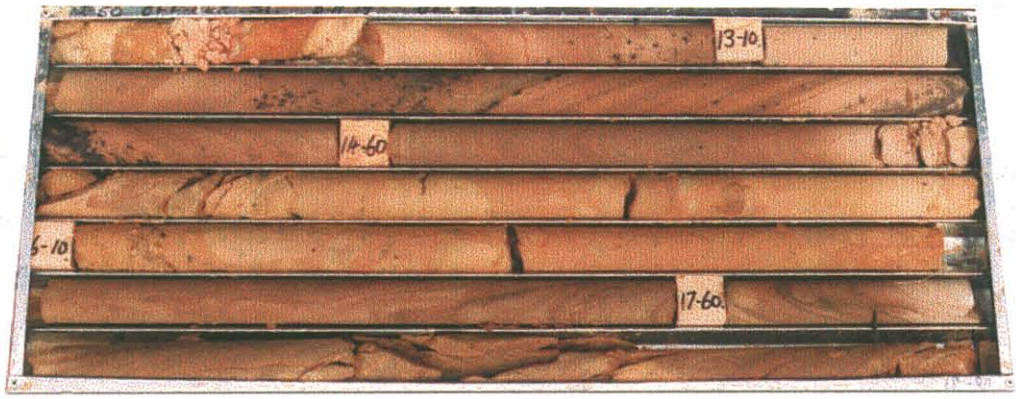
0–6.40 m

6.40–12.50 m



12.50–18.80 m

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – CORED BOREHOLE

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project ROSETTA LANDSLIDE location 27 OFFICER STREET.

co-ordinates 520 212·9mE
5258 859·9mN

R.L. 113·78 m

inclination VERTICAL

bearing –

drill type GEMCO 210D

drill method NQ Triple Tube

drill fluid WATER

hole commenced 18 April '91

hole completed 22 April '91

drilled by G. Baker D MMR

logged by R C Donaldson.

checked by

drilling information

case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L.	metres depth

rock substance

graphic log	substance description (rock type: grain characteristics, colour, structure, minor components.)	weathering	strength EL VL L M H VH EH

Silty SAND - dark grey.

CONGLOMERATE: Sub angular to sub rounded fine-coarse gravel to boulder size rock fragments of sandstone in a yellow brown to grey clayey sand (SC) matrix. HW

mottled red brown to grey and yellow brown colouration. Rock fragments dominantly fine to medium gravel size sandstone and fine sandstone. Matrix - sandy clay (CH).

Similar to the 0·3–2·0 m interval described above. fine to medium gravel size sandstone rock fragments in a sandy to clayey sand (SC) yellow brown matrix.

red brown colouration, some brown mudstone rock fragments as for the 2·0–3·9 m interval.

CONGLOMERATE: dominantly fine-medium quartz sandstone boulders between 1·5 & 2·0 m diameter interspersed with material similar to those described previously (3·9–9·1 m interval).

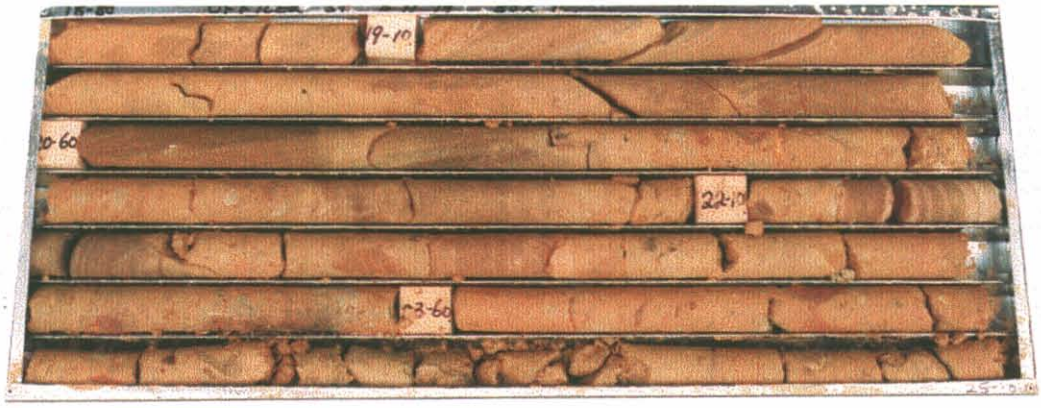
rock mass defects

defect spacing mm. 30 100 300 1000 3000	defect description (thickness, type, inclination, planarity, roughness, coating.) significant	general

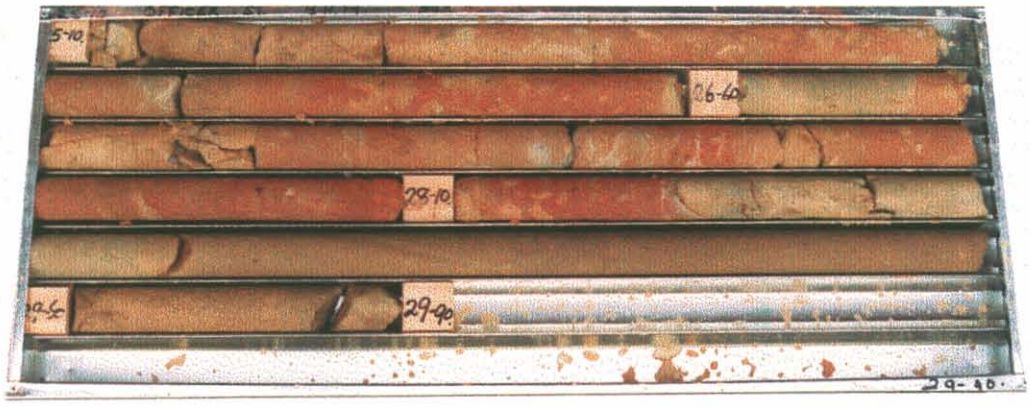
← 30 mm firm grey CH sandy clay @ 30° to horizontal.

← 30 mm firm grey + yellow brown CH sandy clay @ 30° as above.

5 cm



18.80–25.10 m



25.10–29.90 m

5 cm

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project ROSETTA LANDSLIDE location 27 OFFICER STREET.

co-ordinates

R.L.

inclination

bearing

drill type

drill method

drill fluid

hole commenced

hole completed

drilled by

logged by

checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. / depth	graphic log	substance description: rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description: thickness, type, inclination, planarity, roughness, coating. significant / general
					22		CONGLOMERATE: sub angular to subrounded fine to coarse gravel and cobble size sandstone rock fragments in a yellow brown sandy to clayey sand (SC) matrix (similar to the 3·9–9·1m interval)				
					24						
					26		mottled red brown and grey colouration.				
					28						
					30		HOLE TERMINATED AT REQUIRED DEPTH OF 29·90m IN TERTIARY DEPOSITS				

5 cm

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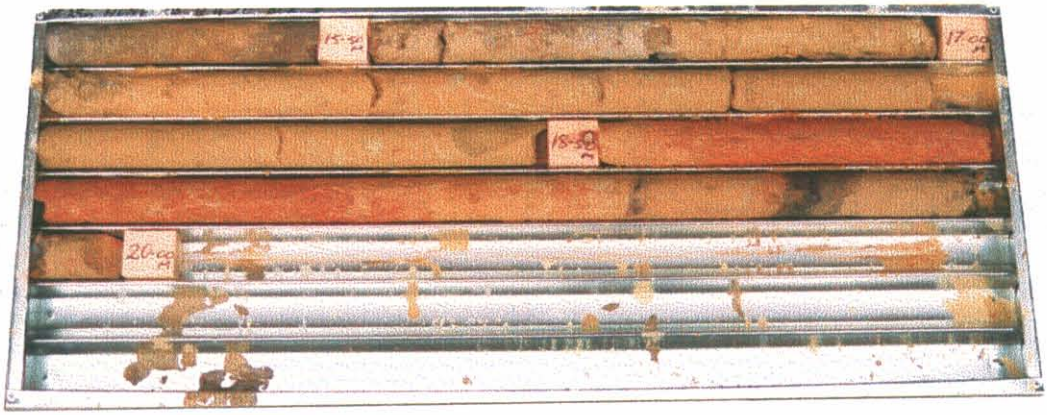
ROSETTA LANDSLIDE — BOREHOLE NUMBER 20

0–8.10 m

8.10–15.25 m



15.25–20.00 m

5 cm

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project ROSETTA LANDSLIDE location ON ROADWAY OUTSIDE 4+6 HONE RD

co-ordinates 520 420·9mE
5 258 762·6mN

R.L. 102·54m

inclination VERTICAL

bearing —

drill type GEMCO 210D

drill method NQ Triple Tube

drill fluid WATER

hole commenced 13 May '91

hole completed 14 May '91

drilled by G. Baker DMMR

logged by R C Donaldson

checked by

drilling information

case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L.	metres depth
			DIRECT SHEAR TEST #5 $\phi' = 11°$, $c' = 2$ kPa. POSSIBLE SLIP ZONE.			2, 4, 6, 8, 10, 12, 14, 16, 18, 20

rock substance

graphic log	substance description (rock type: grain characteristics, colour, structure, minor components.)	weathering	strength EL VL L M H VH EH
	Sandy silty CLAY: medium to high plasticity, grey brown, sand fine to coarse, some fine gravel.		
	COLLUVIUM: sub angular fine gravel size carbonaceous mudstone, siltstone + sandstone rock fragments in a dark grey brown sandy and silty clay matrix.	HW	
	sub angular fine-medium + some coarse gravel size grey + yellow brown siltstone fragments in a mottled grey + yellow brown sandy + silty clay matrix.		
	Similar to above, dark to mid grey brown colouration.		
	CONGLOMERATE: fine to coarse gravel and cobble size grey + yellow brown siltstone rock fragments in a grey-yellow brown sandy + silty clay matrix.	HW	
	CONGLOMERATE: sub angular fine-coarse gravel size mudstone + sandstone rock fragments in a mottled yellow brown and grey clay (CH) matrix. - dominantly CH clay (F-St) between 15.50 – 17.20 m.		
	reddish colouration mottled yellow brown + grey as before.		

rock mass defects

defect spacing mm. 30 100 300 1000 3000	defect description (thickness, type, inclination, planarity, roughness, coating.) significant	general
	← 700mm dominantly Firm to Stiff CH clay.	

5 cm

ROSETTA LANDSLIDE — BOREHOLE NUMBER 21

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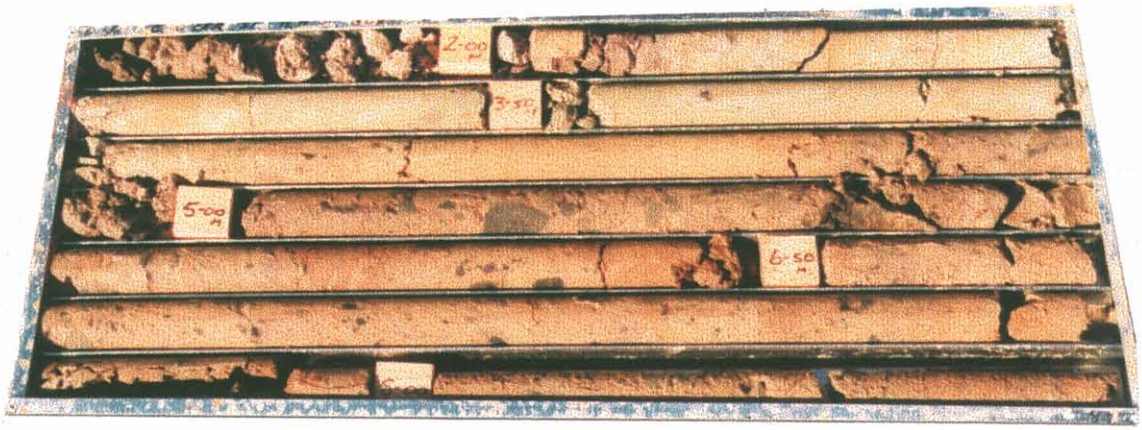
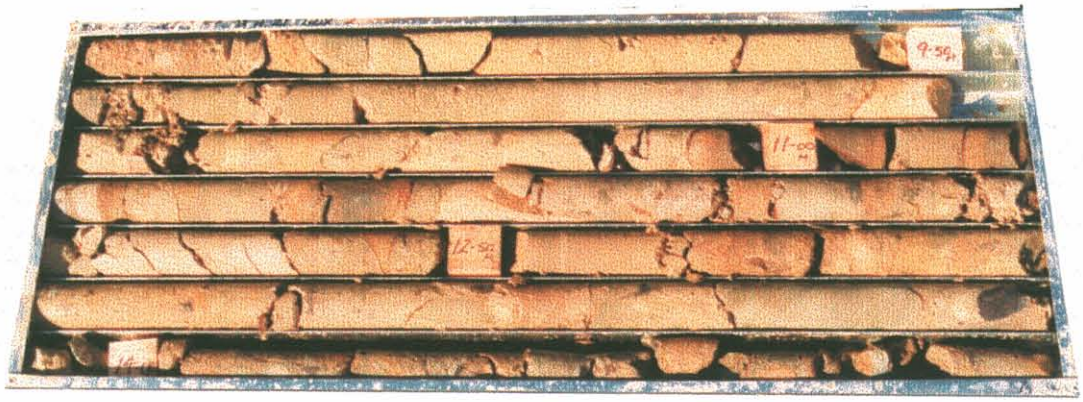
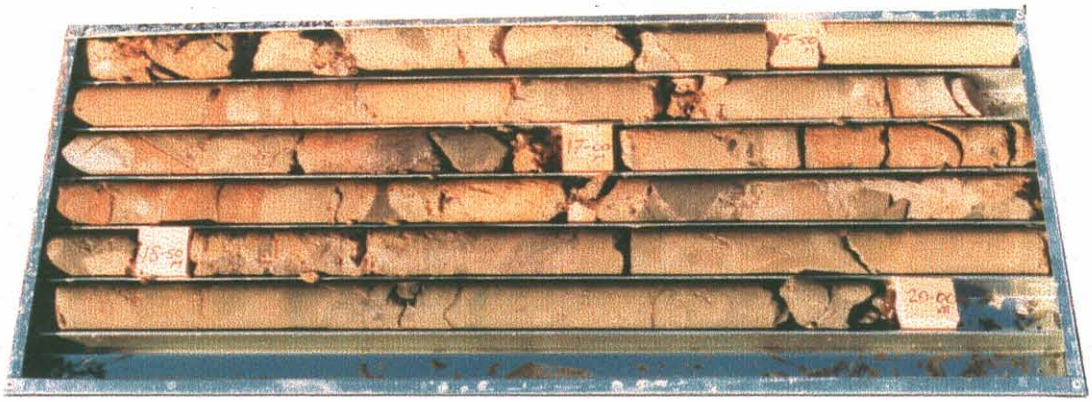


0.80–8.70 m



8.70–14.80 m



14.80–20.00 m

5 cm

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project ROSETTA LANDSLIDE location ON ROADWAY OUTSIDE 2 OFFICER ST.

co-ordinates 520 448·2m E
5258 846·9m N

R.L. 86.95m

inclination VERTICAL

bearing –

drill type GEMCO 210D

drill method NQ Triple Tube

drill fluid WATER

hole commenced 15 May '91

hole completed 15 May '91

drilled by G. Baker - DMMR

logged by R. E. Donaldson.

checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. / depth	graphic log	substance description rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH	defect spacing mm. 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. significant / general
							NO CORE - tricone roller bit				
					2		CONGLOMERATE: sub angular to sub rounded fine-coarse gravel size grey siltstone rock fragments in a grey + brown sandy clay (CH) matrix				
					4		CONGLOMERATE: sub angular to sub rounded fine-coarse gravel and some cobble size sandstone + sandstone rock fragments in a mottled grey + yellow brown sandy and silty clay matrix. - matrix had a St-V.St consistency.				
					6		similar to above, some gravel to cobble size H.W. dolerite rock fragments				
					8						
					10		CONGLOMERATE: sub rounded to sub angular fine-coarse gravel, cobble and boulder size mudstone (some carbonaceous), sandstone and dolerite rock fragments in a light brown to greenish grey sandy clay (CH) matrix.				
					12						
					14						
					16						
					18		similar to above, grey carbonaceous mudstone more prominent.				
					20						

5 cm

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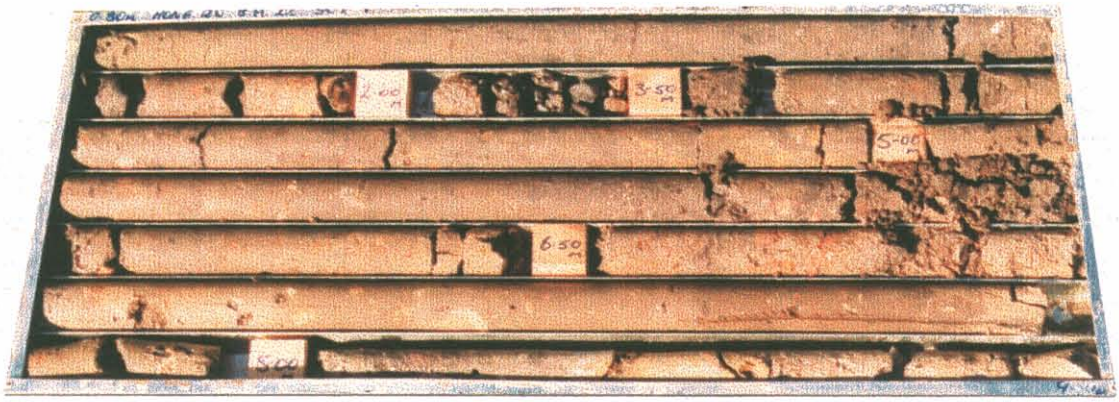
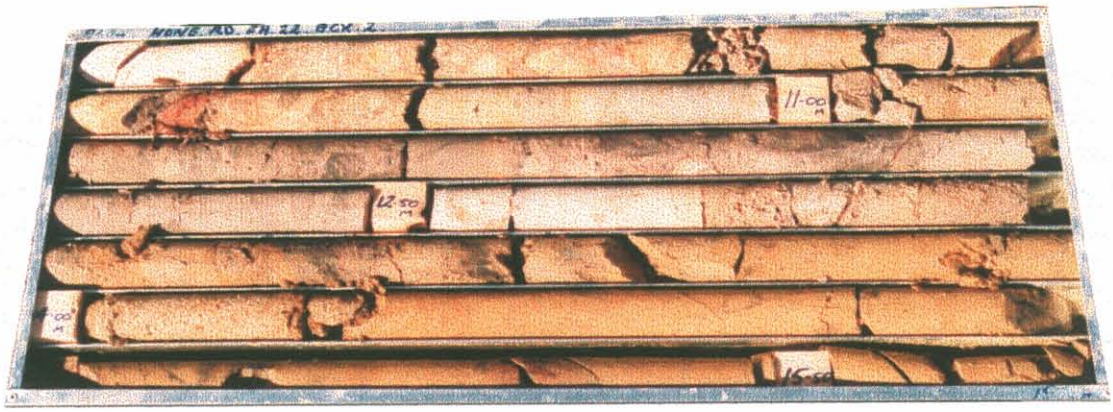
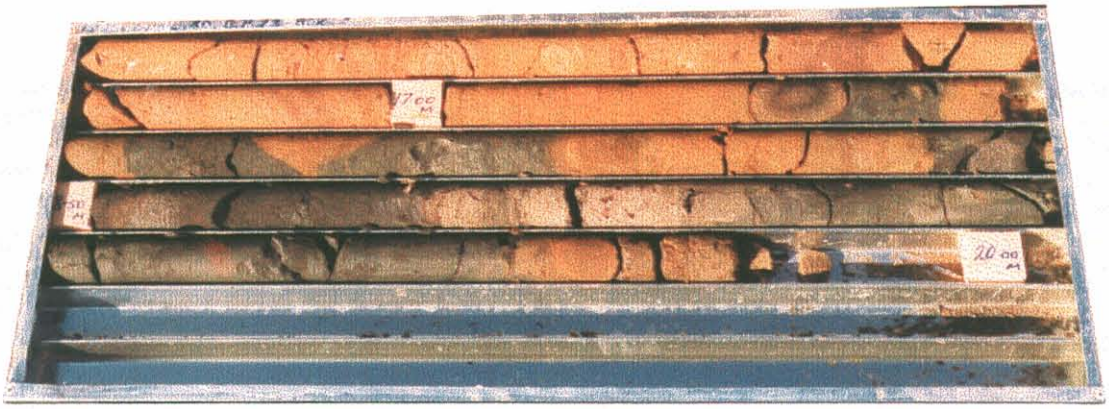
ROSETTA LANDSLIDE — BOREHOLE NUMBER 22



0.80–9.50 m



9.50–15.70 m



15.70–20.00 m

5 cm

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project ROSETTA LANDSLIDE location ON ROADWAY OUTSIDE 10/12 HONE RD.

co-ordinates 520 459.1mE 5258 737.2mN

R.L. 100.89m

inclination VERTICAL

bearing –

drill type GEMCO 210D

drill method NQ Triple Tube

drill fluid WATER

hole commenced 20 May '91

hole completed 21 May '91

drilled by G. Baker – D Mark

logged by R C Donaldson.

checked by

drilling information							rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1–3 10 30 100	metres R.L.	metres depth	graphic log	substance description rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. significant / general
								NO CORE - Tricone roller bit.				
						2		COLLUVIUM: sub angular fine to medium gravel size fragments of siltstone – fine sandstone in a dark grey to brown sandy and silty clay matrix. – matrix generally St – V.St. consistancy.				
						4						
						6						
						8						
						10		CONGLOMERATE: sub angular to sub rounded fine to coarse gravel and cobble size grey siltstone rock fragments in a grey – grey brown sandy and silty clay matrix.	HW			← 150 mm firm clay matrix. ← 25 mm soft grey CH clay @ 45° to core axis.
						12		– fine to coarse gravel size fragments of carbonaceous mudstone/sandstone with sandstone boulders in a grey brown clay (CH) matrix. – as above, some yellow brown colouration				← 100 mm firm light grey CH clay ← 200 mm firm–stiff clay matrix.
						14		CONGLOMERATE: comprised dominantly of H.W. – E.W. dolerite cobbles and boulders in a yellow brown consolidated sand–clay matrix.				
						16						
						18		– similar to above, alternating yellow brown and blue green to grey colourations.				
						20						

5 cm

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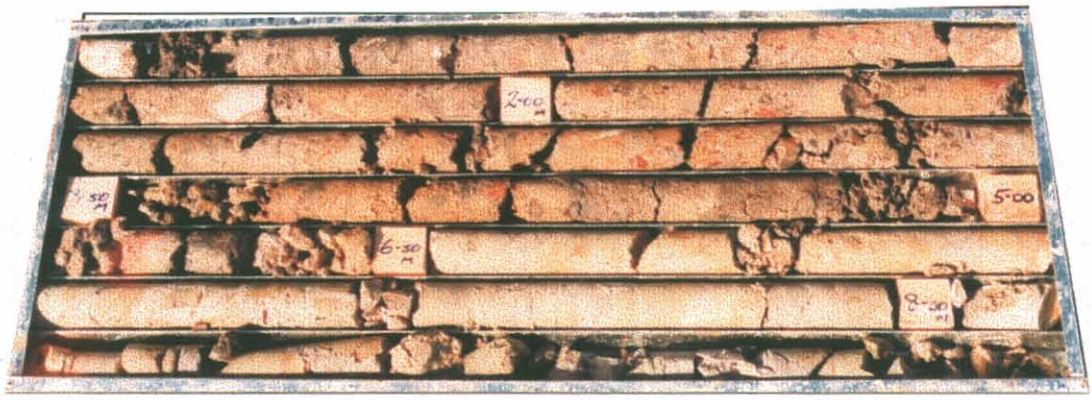
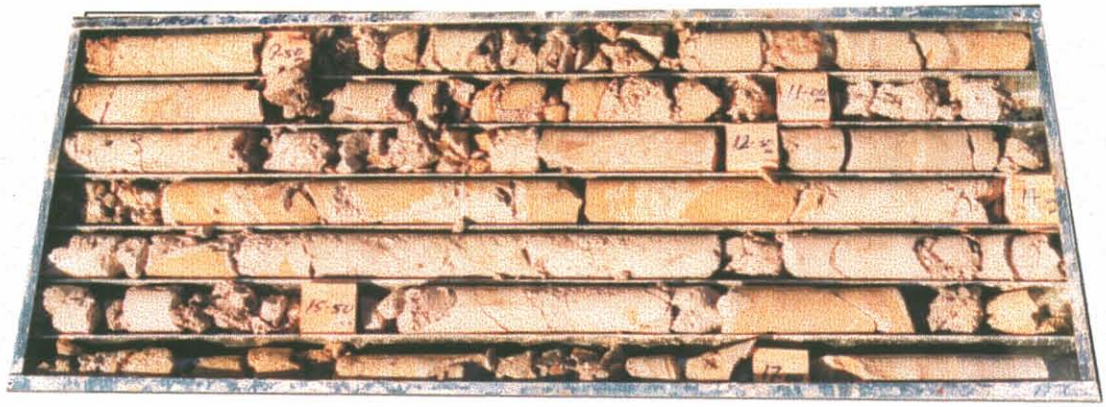
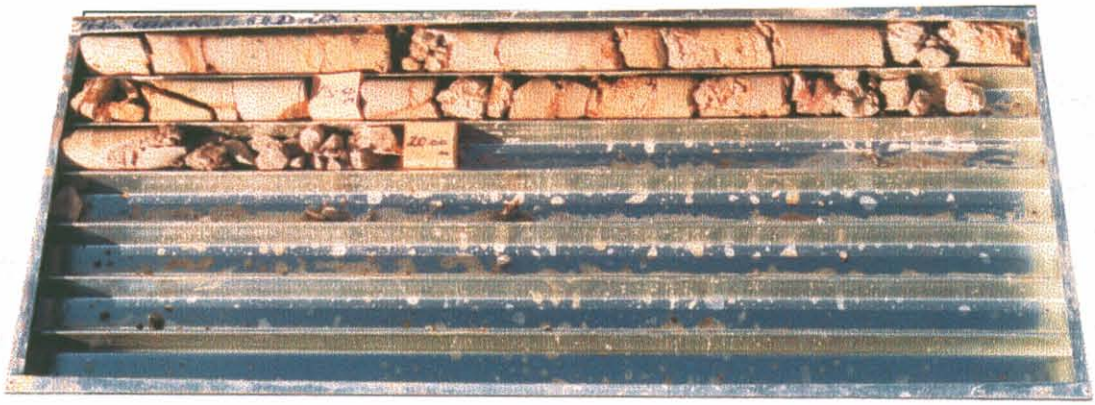
ROSETTA LANDSLIDE — BOREHOLE NUMBER 23



0–9.30 m



9.30–17.20 m



17.20–20.00 m

5 cm

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ENGINEERING LOG – CORED BOREHOLE

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project ROSETTA LANDSLIDE location 5 OFFICER STREET.

co-ordinates 520 470.8 mE
5258 797.3 mN

R.L. 94.78 m

inclination VERTICAL

bearing —

drill type GEMCO 210D

drill method NQ Triple Tube

drill fluid WATER

hole commenced 27 May '91

hole completed 28 May '91

drilled by G. Baker - DMMR

logged by R C Donaldson

checked by

drilling information

case-lift	fluid loss	water	notes	lugeons (0.3 – 3 – 10 – 30 – 100)	metres R.L.	metres depth
						2, 4, 6, 8, 10, 12, 14, 16, 18, 20

rock substance

graphic log	substance description (rock type: grain characteristics, colour, structure, minor components.)	weathering	strength (EL – VL – L – M – H – VH – EH)
	COLLUVIUM: sub angular to sub rounded fine to medium size gravel fragments of siltstone - sandstone in a light grey to yellow brown clayey sand - silt matrix.		
	CONGLOMERATE sub angular to sub rounded fine to coarse gravel, and cobble size grey and yellow brown siltstone rock fragments in a grey brown to grey sandy and silty clay matrix of medium to high plasticity.	MW to HW	

rock mass defects

defect spacing mm. (30 – 100 – 300 – 1000 – 3000)	defect description (thickness, type, inclination, planarity, roughness, coating.) significant / general
	← 20mm soft grey CH clay, some gravel
	← 40mm —"— "— "— "—
	← 150mm soft grey clay, some gravel
	← 200mm stiff —"— "— "—
	← 200mm stiff grey CH clay, some gravel
	← 60mm soft grey CH clay, some gravel.

5 cm

ROSETTA LANDSLIDE — BOREHOLE NUMBER 24

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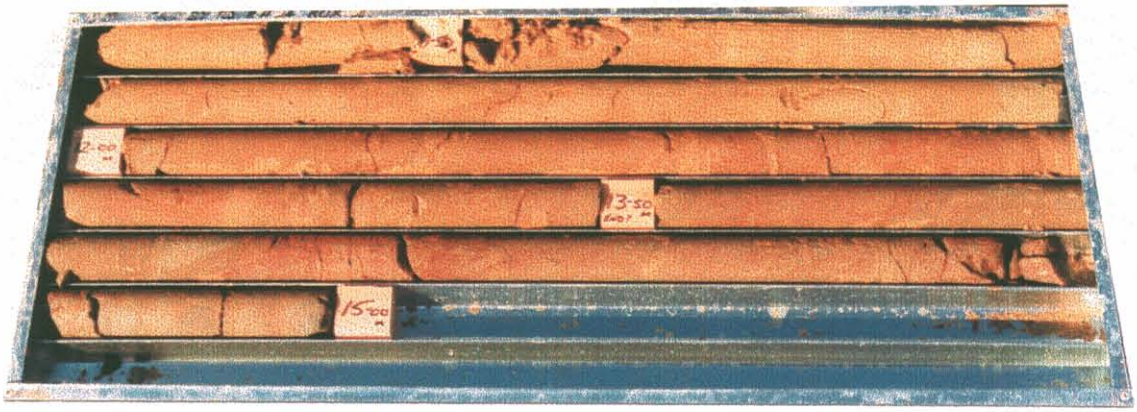
0.80–10.20 m



10.20–15.00 m

5 cm

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project ROSETTA LANDSLIDE location 25 CROSBY ROAD.

co-ordinates 520 545·2 m E
5 258 806·9 m N

R.L. 79·21 m

inclination VERTICAL

bearing —

drill type GEMCO 210 D

drill method NQ Triple Tube

drill fluid WATER

hole commenced 29 May '91

hole completed 30 May '91

drilled by G. Baker

logged by R C Donaldson

checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. / depth	graphic log	substance description: rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description: thickness, type, inclination, planarity, roughness, coating. significant / general
							NO CORE - Tricone roller bit				
					2		CONGLOMERATE: sub angular to sub rounded fine-coarse gravel size mudstone (some carbonaceous) + sandstone rock fragments with MW-EW dolerite and sandstone boulders in a grey brown sandy clay matrix.	HW			← 100 mm firm grey CH gravelly clay: ← 80 —"— "— "—
					4						
			SLIP ZONE?		6		- fine to medium gravel size carbonaceous sandstone + mudstone rock fragments in a grey and yellow brown firm-stiff high plasticity sandy clay				← firm CH clay matrix ← —"— "— — ← —"— "— —
					8		- similar to above, matrix generally very stiff - hard consistency.				
					10		DOLERITE: fine-medium grained, reddish brown with some grey green mottles - remnants of kernels evident.				
					12						
					14						
					16		HOLE TERMINATED AT REQUIRED DEPTH OF 15·0 m IN DOLERITE?				

5 cm

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project ROSETTA LANDSLIDE location SOUTHERN END OF CUL DE SAC OFF MONA RD.

co-ordinates 520 413 m E
5 258 719 m N

R.L. 108·92 m

inclination VERTICAL

bearing —

drill type GEMCO 210D

drill method NQ Triple Tube

drill fluid WATER

hole commenced 17 June '91

hole completed 18 June '91

drilled by G. Baker - DMMR

logged by R. C. Donaldson.

checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. / depth	graphic log	substance description: rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description: thickness, type, inclination, planarity, roughness, coating. significant / general
							NO CORE - Tricone roller bit.				
					2		clayey GRAVEL (GC): fine to medium angular siltstone fragments in a grey brown sandy clay.	MW to HW			
					4		SILTSTONE: medium to coarse grained, dark to mid grey, bedding poorly developed, dips at 20°-30°.				
					6		General tendency for material to coarsen gradually with depth to a fine grained sandstone - boundary indistinct.				
					8						
					10		SANDSTONE: medium to coarse grained, light grey with ferruginous mottles, massive.	MW			
					12						
					14						
					16		similar to above, some fine gravel size sub angular quartz pebbles.	HW			
					18		SILTSTONE: medium grained, mid to dark grey, poorly bedded.	MW to SW			
					20						

5 cm

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project ROSETTA LANDSLIDE location SOUTHERN END OF CUL DE SAC OFF HONE RD

co-ordinates

R.L.

inclination

bearing

drill type

drill method

drill fluid

hole commenced

hole completed

drilled by

logged by

checked by

drilling information

case-lift | fluid loss | water | notes | lugeons (0.3 | 1 | 3 | 10 | 30 | 100) | metres: R.L. | depth

rock substance

graphic log | substance description (rock type: grain characteristics, colour, structure, minor components.) | weathering | strength (EL | VL | L | M | H | VH | EH)

rock mass defects

defect spacing mm. (30 | 100 | 300 | 1000 | 3000) | defect description (thickness, type, inclination, planarity, roughness, coating.) significant | general

22

24

26

28

HOLE TERMINATED AT REQUIRED DEPTH OF 27.6m IN SILTSTONE

5 cm

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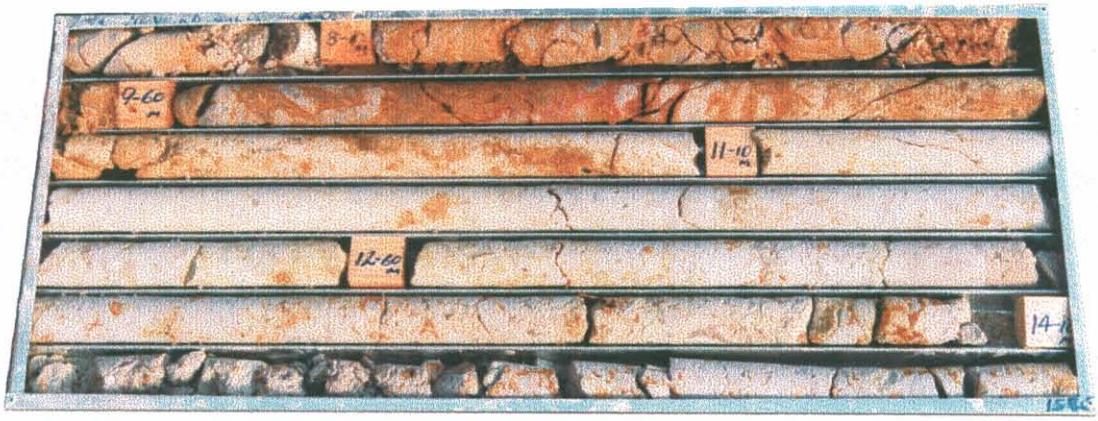
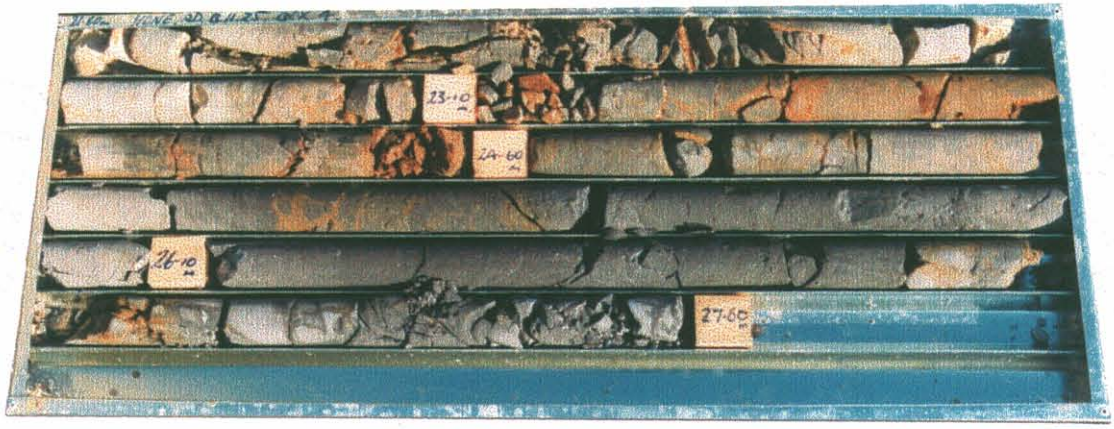
ROSETTA LANDSLIDE — BOREHOLE NUMBER 25

1.0–7.90 m



7.90–15.05 m

15.05–21.60 m



21.60–27.60 m

5 cm

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ROSETTA LANDSLIDE — BOREHOLE NUMBER 26

0–6.70 m

6.70–13.10 m

13.10–19.30 m

5 cm

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project ROSETTA LANDSLIDE location HEC RESERVE ADJACENT TO 14 GUNN CRT.

co-ordinates 520 624 m E
5 258 857 m N

R.L. 58.30 m

inclination VERTICAL

bearing –

drill type GEMCO 210D

drill method NQ Triple Tube

drill fluid WATER

hole commenced 19 June '91

hole completed 20 June '91

drilled by G. Baker DMMR

logged by R. e Donaldson.

checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. / depth	graphic log	substance description rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. significant / general
							Sandy CLAY: high plasticity, brown, sand fine-medium some coarse.	MW & HW			
					2		SANDSTONE: fine grained, light green grey with pinkish mottles. Bedding dips at 5°–15° average. Some evidence of depositional brecciation.				
					4						
					6						
					8						
					10		Colour variation – mid brown with black carbonaceous laminae prominent over certain intervals.				
					12						
					14		SANDSTONE: very fine grained, light grey, with black carbonaceous laminae dipping at 10°–20°. Disrupted nature of material considered to be a result of soft sediment deformation during deposition and compaction.				
					16						
					18						
					20		HOLE TERMINATED AT REQUIRED DEPTH IN SANDSTONE				

5 cm

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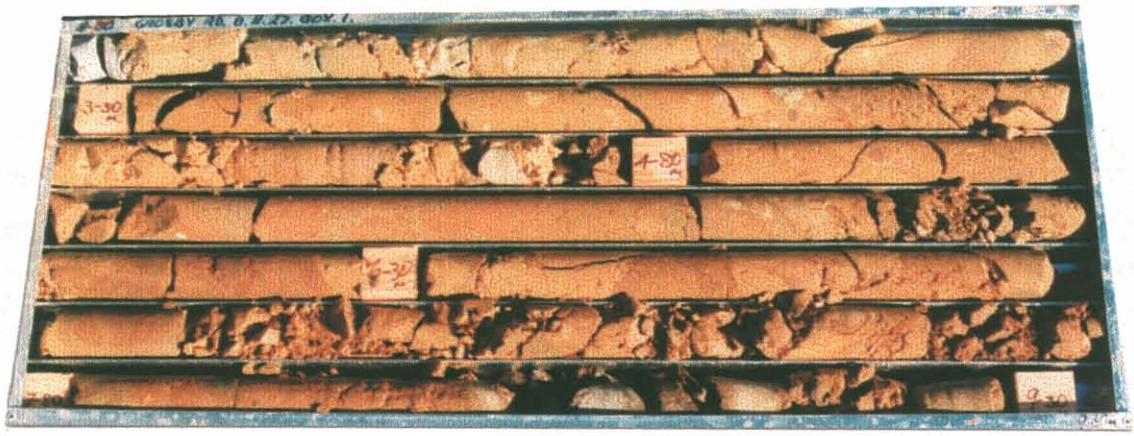
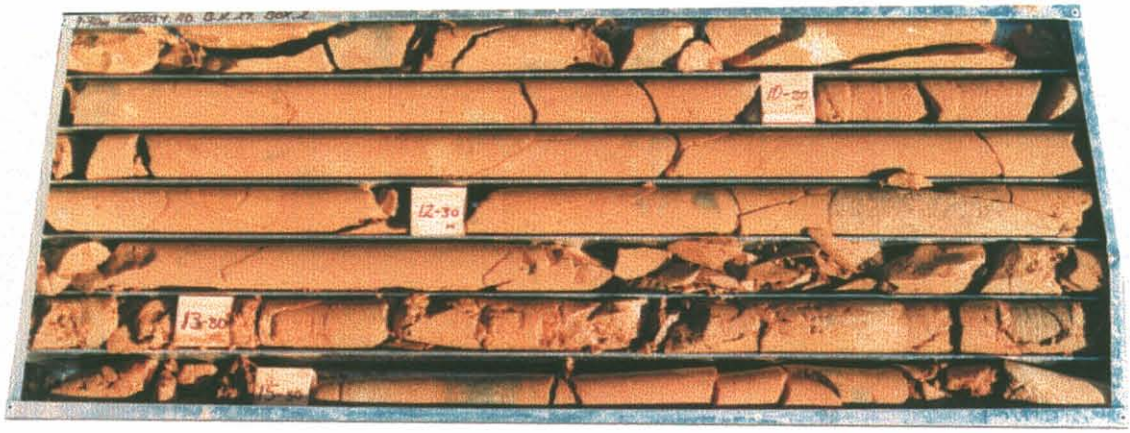
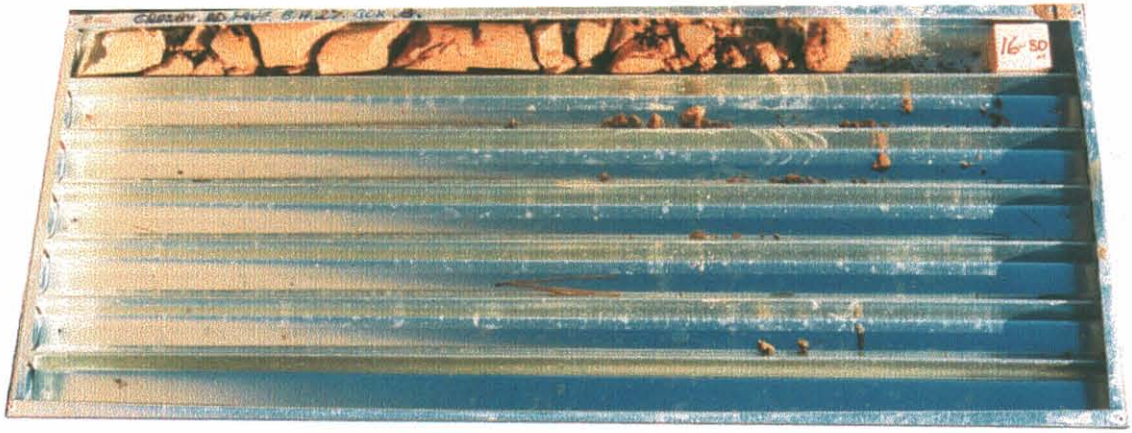


1.80–9.30 m



9.30–16.00 m



16.00–16.80 m

5 cm

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sheet 1 of 1

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project ROSETTA LANDSLIDE location ON ROADWAY OUTSIDE 21 CROSBY RD.

co-ordinates 520 600·5 mE
5258 769·1 mN
R.L. 68·18m
inclination VERTICAL
bearing –

drill type GEMCO 210 D
drill method NQ Triple Tube
drill fluid WATER

hole commenced 24 June '91
hole completed 25 June '91
drilled by G. Baker D MMR
logged by R C Donaldson.
checked by

drilling information							rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L.	metres depth	graphic log	substance description rock type: grain characteristics, colour, structure, minor components.	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description thickness, type, inclination, planarity, roughness, coating. significant / general
								NO CORE - Tricone roller bit				
						2		CLAY: high plasticity, grey brown to yellow brown, some fine sand, F-St. consistency				
						4		CONGLOMERATE: sub angular to sub rounded gravel and cobble size dolerite, mudstone and sandstone rock fragments in a reddish brown sandy clay matrix				← 120mm CH clay matrix, firm - stiff consistency.
						6						
						8						
						10						
						12						
						14						
						16						
						18		HOLE TERMINATED AT REQUIRED DEPTH OF 16·8m IN TERTIARY DEPOSITS.				

5 cm

140/164

ROSETTA LANDSLIDE — BOREHOLE NUMBER 28

1.0–8.0 m

5 cm

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ENGINEERING LOG – CORED BOREHOLE

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borehole no. 28
sheet 1 of 1

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project ROSETTA LANDSLIDE location OFF SOUTHERN END OF NATHAN CRT.

co-ordinates 520 146·1m E, 5 259 033·1m N.
R.L. 73·6 m
inclination VERTICAL
bearing —

drill type GEMCO 210 D
drill method NQ Triple Tube
drill fluid WATER

hole commenced 25 June '91
hole completed 26 June '91
drilled by G. Baker - D. Mohr
logged by R. C Donaldson.
checked by

drilling information						rock substance				rock mass defects	
case-lift	fluid loss	water	notes	lugeons 0.3 1 3 10 30 100	metres R.L. / depth	graphic log	substance description (rock type: grain characteristics, colour, structure, minor components.)	weathering	strength EL VL L M H VH EH	defect spacing mm. 30 100 300 1000 3000	defect description (thickness, type, inclination, planarity, roughness, coating.) significant / general
							NO CORE - Tricone roller bit.				
			DIRECT SHEAR TEST $\phi_r' = 15°$, $c_r' = 2$ kPa		2		Sandy CLAY: high plasticity, mottled yellow brown + light grey sand fine to medium, some fine to medium gravel size mudstone + sandstone fragments.	HW			
					4		CONGLOMERATE: sub angular to subrounded fine-coarse gravel and stone boulder size mudstone and sandstone rock fragments in a yellow brown and grey sandy clay-clayey sand matrix of F – V. St consistency.				
					6						
					8						
							HOLE TERMINATED AT REQUIRED DEPTH OF 8.0m IN TERTIARY DEPOSITS.				

5 cm

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ENGINEERING LOG – EXCAVATION

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excavation no. 1

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project Roseltin Landslide location Corner of Officer and Crosby Streets

co-ordinates

R.L.

excavation dimensions 1 X 3m

exposure type

equipment Backhoe

operator Glenorchy Council

pit commenced

pit completed

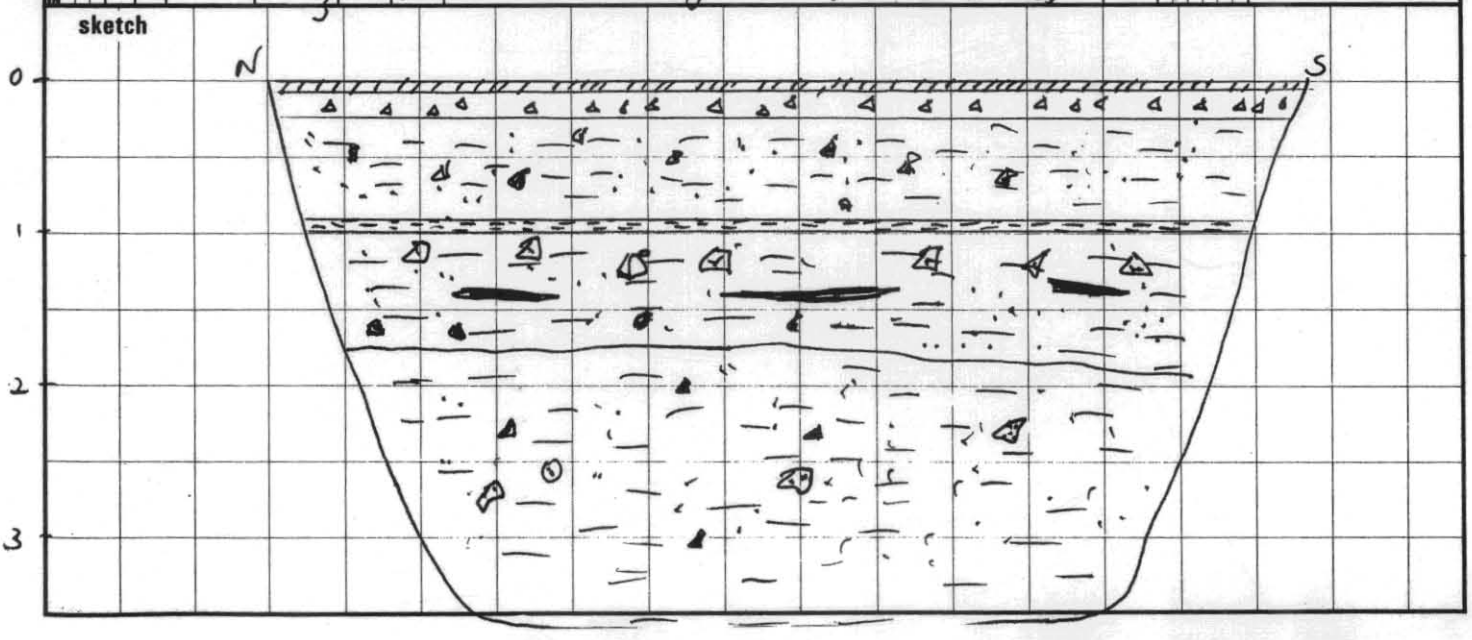
logged by F Baynes, L. Matthews

checked by

5 cm

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
								Footpath – concrete and bitumen				Fill
								Crushed metal road base	W			Fill
							GC to GM	Clayey sand, sandy clay, brown mottled, fragmental. Boulders of sandstone, shale, carbonaceous shale, dolerite (weathered)	M			Tertiary Deposits
			C', Φ' XRD ← LL PL LS				CH	Clay, grey, plastic.	M	S		~~Tertiary Deposits~~
					1		GC to GM	Weathered dolerite boulders upto 0.6m in brown clay and sandy matrix	M			Tertiary Deposits
								Sandy clay with shale fragments dipping carbonaceous band with slickensides	M			Tertiary Deposits
	NONE	NIL			2		GC SC OH	Sandy clay with occasional hard shale boulders. On east end dipping carbonaceous band moist and slickensided	M			Tertiary Deposits
			C' Φ' XRD ← LL PL LS									
							ML to CL to GC	Silty clay with siltstone and grey sandstone fragments Some irregular slickensides	M			Tertiary Deposits
					3							

sketch



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excavation no. 1

sheet 2 of 2

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project | location

co-ordinates | exposure type | pit commenced

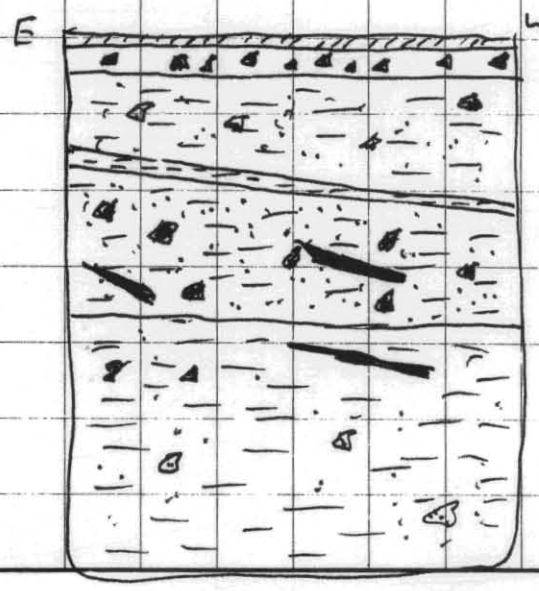
R.L. | equipment | pit completed

excavation dimensions | operator | logged by | checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
								Occasional carbonaceous mudstone fragments and concretions of carbonate.	M			Tertiary Deposits

5 cm

sketch



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ENGINEERING LOG – EXCAVATION

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excavation no. 2
sheet 1 of 1

144/164

project Rosetta Landslide location Corner of Officer and Crosby Streets

co-ordinates
R.L.
excavation dimensions 1 X 2.5m

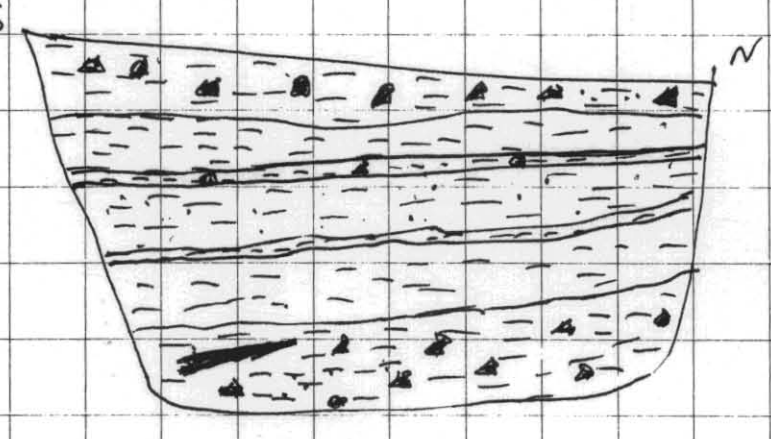
exposure type
equipment Backhoe
operator Glenorchy Council

pit commenced
pit completed
logged by F Baynes, L Matthews
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
						GC	Loose rock fragments in a grey clay matrix (fragments 2cm)	W			Tertiary Deposits
						CH	Grey clay.	W			"
						GC	Brown mudstone fragments in clay	M			"
				1		CL	Brown and grey silty clay.	M			"
						OH	Dark grey clay, carbonaceous shale pieces	M			"
		NONE				SC	Light grey and brown clayey sand.	M			"
						CL-GC	Dark grey and black silty clay carbonaceous rock fragments slickensides	M			"
				2		GC OH	Brown and light grey weathered siltstone (Triassic?) in a clay matrix with interbedded carbonaceous layers	M			"
				3							

5 cm

sketch



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ENGINEERING LOG – EXCAVATION

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excavation no. 3
sheet 1 of 1

145/164

project Rosetta Landslide location Corner of Officer and Crosby Streets

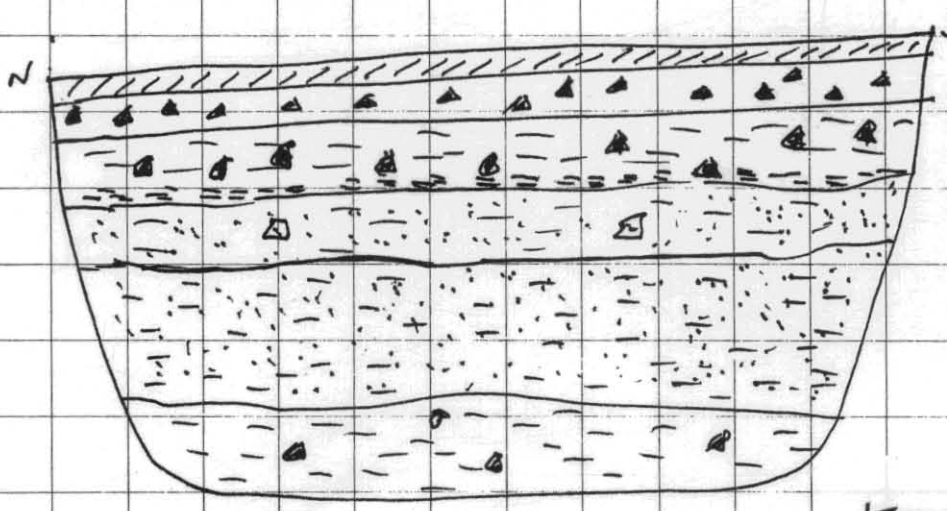
co-ordinates
R.L.
excavation dimensions 1X 4m

exposure type
equipment Backhoe
operator Glenorchy Council

pit commenced
pit completed
logged by F. Bagnus, L Matthews
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
								Concrete				Fill
								Road base course				"
					1		GC CH	Rock fragments (Permian!) in silty clay, grey Soft grey clay layer at 1.05 m	M	S		Tertiary Deposits
							SM SC	Sand and clayey sand with weathered sandstone and dolerite boulders to 0.5 m size				"
							SC	Dark grey clayey sand, carbonaceous				"
					2		SC	Brown and grey mottled clayey sand			X	"
					3		CL MH GC	Light brown silty clay fissured, some coal and shale fragments.				"

sketch



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ENGINEERING LOG – EXCAVATION

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G1

excavation no. 1

sheet of

146/164

project NATHAN ST SUBDIVISION location

co-ordinates

R.L.

excavation dimensions

exposure type test pit

equipment Mitsubishi excavator MS230

operator

pit commenced 22-6-90

pit completed 22-6-90

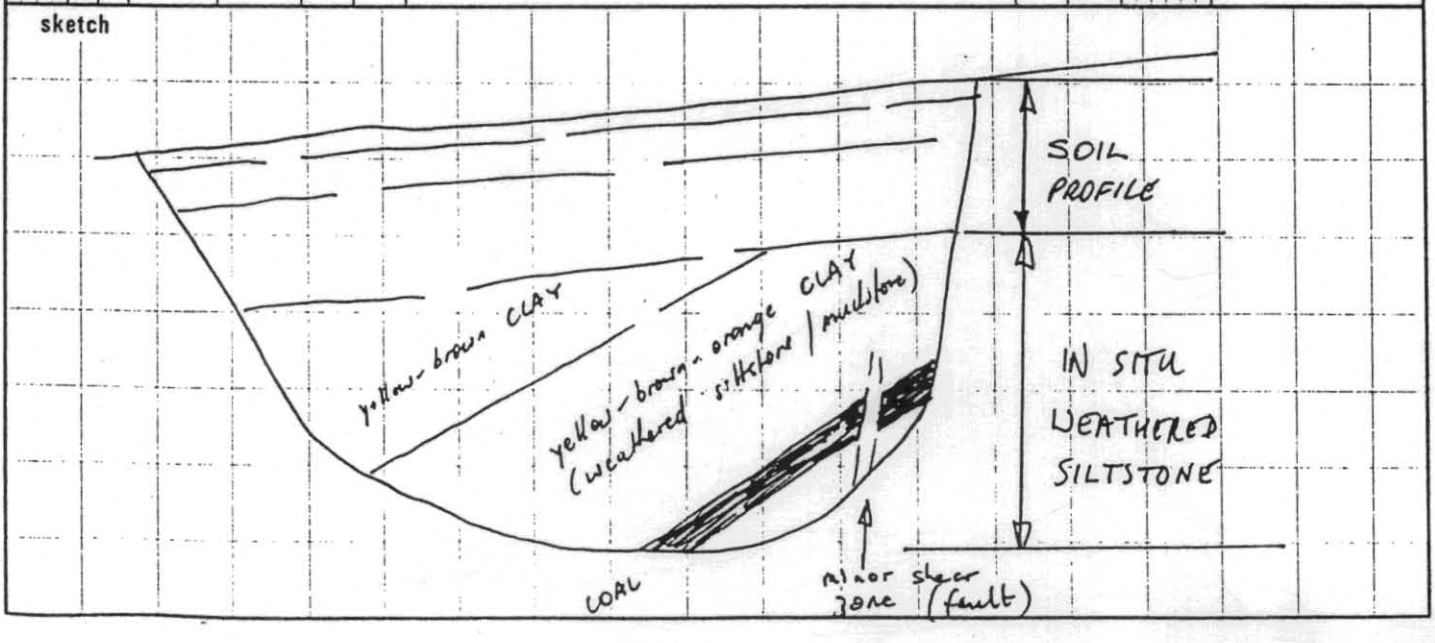
logged by A.D.W.

checked by

5 cm

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0.10		CH	SILTY CLAY: dk brown high plasticity		F-St		
				0.35		CH	CLAY: medium brown becoming grey with depth, high plasticity, some fine gravel	M	St-VSt		
				0.90		CH	CLAY: grey – brown – yellow, high plasticity, roots, mottles etc	M	St-VSt		
				1.80		CH	CLAY: yellow-brown, high plasticity (derived by in situ weathering of angular to sub angular siltstone rock to Extremely weathered state)	M	VSt		
				2.05		OL	COAL: black, low plasticity silt size carbonaceous material	M-D			
				2.15		CH	CLAY: yellow-brown (HW-EW siltstone)	M	St		
				2.50		GC	GRAVELLY CLAY: grey, medium to high plasticity (EW-HW siltstone)	M-D	VSt-H		
							END OF EXCAVATION				

sketch



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ENGINEERING LOG – EXCAVATION

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G2

excavation no. 2
sheet of

147/164

project NATHAN ST SUBDIVISION location

co-ordinates
R.L.
excavation dimensions

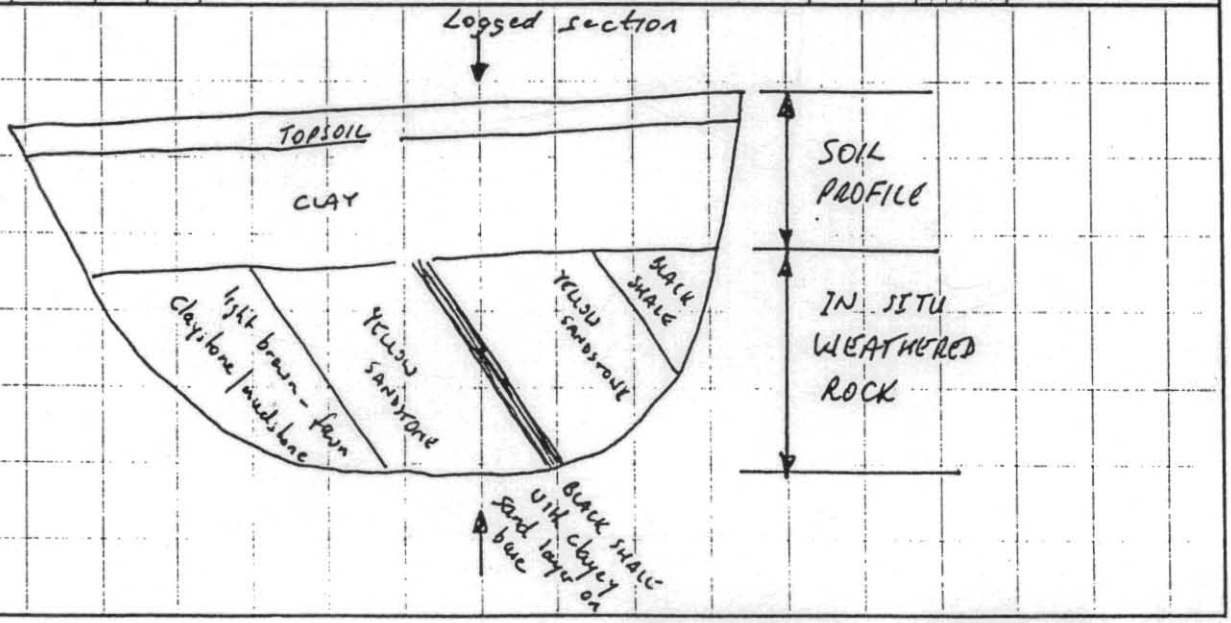
exposure type test pit
equipment Mitsubishi excavator MS220
operator

pit commenced 22-6-90
pit completed 22-6-90
logged by SDW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0.20		CH	SILTY CLAY: dk brown TOPSOIL, high to medium plasticity, roots, rootlets	M	Fb		
				1.00		CH	CLAY: dark brown to black, high plasticity with some medium to fine grained sand fines and some fine size gravel (sub angular to angular siltstone)	M	VSt		
				1.50			SANDSTONE: yellow-cream, low plasticity although contains some weathered feldspar grains		H		Bedding: 56°/178° 54°/166° 60°/178° Joints: 34°/245° 83°/087°
				1.70			SHALE: black		H		
				2.40			SANDSTONE: as above		H		

5 cm

sketch



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ENGINEERING LOG – EXCAVATION

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G3

excavation no. 3
sheet of

148/164

project NATHAN ST SUBDIVISION location

co-ordinates
R.L.
excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS 230
operator

pit commenced 22-6-90
pit completed 22-6-90
logged by BDW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0.70		CH	CLAY: black to dark brown becoming more brown with depth, roots, rootlets	M	St. VSt		
				2.30			DOLERITE: brown highly to extremely weathered dolerite with occassional kernels of moderately to slightly weathered dark blue/grey dolerite. About 20% white silty calcareous material as veins/veinlets throughout the dolerite				possible hydrothermally altered zone or fault zone Joints: 42°/087° 43°/204° 61°/330°
							End of Excavation				

sketch

5 cm

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ENGINEERING LOG – EXCAVATION

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G4

excavation no. 4
sheet 4 of

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project NATHAN ST SUBDIVISION location

co-ordinates
R.L.
excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS230
operator

pit commenced 22-6-90
pit completed 22-6-90
logged by SDW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
				0.10		SC	SANDY SILTY CLAY: dark brown TOPSOIL	D	Fb		SOIL PROFILE
				0.20		SM	SILT: light grey-white, some fine SAND	D	Fb		
						CH	CLAY: yellow-brown-orange, medium to high plasticity	M	St-VSt		
				0.80		GC	GRAVELLY CLAY with BOULDERS: About 45% clay matrix - usually yellow-brown but some grey, medium to high plasticity clay with some silt and fine sand; rootlets. About 55% gravel (fine-coarse size) and boulders consisting of sub angular: light brown-fawn mudstone (about 35-40% of total) yellow-light grey sandstone, coarse-medium sand size, bedded (about 10% of total) some green, fine size sandstone, some red, fine size sandstone and	M-D	VSt-H		? SLOPE DEPOSITS derived from TRIASSIC AGE ROCKS
				2.60			some dark grey shale End of Excavation at -2.6m				

sketch

5 cm

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ENGINEERING LOG – EXCAVATION

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GS

excavation no. 5
sheet of

150/164

project NATHAN ST SUBDIVISION location

co-ordinates
R.L.
excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS 230
operator

pit commenced 22-6-90
pit completed 22-6-90
logged by GDW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
				0.10			SM	SANDY SILT: light brown organic TOPSOIL	D	Fb		SOIL PROFILE
					0.70		SC-CH	SANDY CLAY: orange-yellow-brown medium-high plasticity clay with ≈ 15% medium grain size, subrounded quartz sand.	M	Fb-St		
				1.00			GC	GRAVELLY CLAY with BOULDERS: About 50% clay matrix – usually yellow-orange, medium-high plasticity with some silt and fine sand. About 50% fine-coarse size gravel and boulders consisting of subangular:- green/grey to light yellow/brown siltstone; yellow-brown coarse-medium size feldspathic sandstone; brown variably weathered dolerite	M	VSt-H		SLOPE DEPOSITS derived from Triassic and Jurassic age rocks
				2								
				2.30				End of Excavation at -2.3 m				

sketch

5 cm

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ENGINEERING LOG – EXCAVATION

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excavation no. 6
sheet of

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project NATHAN ST SUBDIVISION location

co-ordinates
R.L.
excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS 230
operator

pit commenced 22-6-90
pit completed 22-6-90
logged by ADW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
					0.25		GP	SANDY GRAVEL: light grey, low plasticity, some clay fines and sandstone boulders.	M	MD		SOIL PROFILE
					0.70		SC	SANDY CLAY: light grey-brown, medium to high plasticity clay with roots and rootlets. Clay has prismatic pedal structure.	M	St-VSt		
					0.90		CL-CH	CLAY: mottled orange-grey-brown and light grey, medium plasticity, occassional pockets of MOIST fine grained quartz sand. Trace of charcoal(?) Some sandstone and siltstone med. gravel to boulder size rocks	M	VSt		SLOPE DEPOSIT derived from Triassic age rocks
					2							
					2.5			End of Excavation				

sketch

5 cm

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excavation no. 7
sheet of

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project NATHAN ST SUBDIVISION location

co-ordinates
R.L.
excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS230
operator

pit commenced 22-6-90
pit completed 22-6-90
logged by SDW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
					0.20		GP	SANDY GRAVEL: light grey, low plasticity, some clay and sand fines	M	MD		SOIL PROFILE
					0.30		SM	SILTY SAND: light grey, low plasticity	M	MD		
					0.70		SC	SANDY CLAY: light grey - brown medium - high plasticity clay with roots & rootlets. Clay has prismatic pedal structure	M	St-VSt		
					1.00		CL-CH	CLAY: light grey mottled orange-brown - deep red (purple), medium plasticity, occassional pockets of MOIST, fine grained quartz sand, some red sandstone coarse gravel, some siltstone coarse - medium size gravel	M	St-VSt		SCREE DEPOSIT derived from Triassic age rocks
					2							
					2.60			End of Excavation				

sketch

5 cm

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excavation no. 8
sheet of

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project NATHAN ST SUBDIVISION location

co-ordinates
R.L.
excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS230
operator

pit commenced 22-6-90
pit completed 22-6-90
logged by ADW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0.20		SM	SILTY SAND: grey, fine-medium grain size, roots, rootlets	M	MD		
				0.80		SM	SILTY SAND: light brown-fawn, mostly fine grained quartz sand with silt size fines which become clay with increasing depth.	M	MD		
				1		CH	CLAY: mottled yellow-brown-grey medium to high plasticity clay with medium size gravel to boulder size red to brown sandstone and yellow-brown mudstone. In places a mottled red/grey high plasticity clay with fissures (tight) of brown infilling sandy clay (moist, 2-3 mm wide) – possible desiccation cracks ??	M	VSt		
				2							
				2.5							

sketch

5 cm

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excavation no. 9
sheet of

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project NATHAN ST SUBDIVISION location

co-ordinates
R.L.
excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS230
operator

pit commenced 22-6-90
pit completed 22-6-90
logged by SDW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
				0.70			CLAY: dark brown, high plasticity, some fine-medium sand to gravel particles of dolerite	M	VSt-St		
				2.90			GRAVELLY CLAY: reddish brown to dark brown coarse grained extremely weathered dolerite with some fine to coarse sand size particles. Occassional seam-like to semi-circular shaped bodies of dark stained (?? manganese or carbonaceous) material. Remnant doleritic texture and joint plans evident	M-D	VSt		dark stain on defect surfaces ? Manganese or carbonaceous material joints 51°/200° 82°/113° 69°/003° 60°/072°
							End of Excavation				

sketch

5 cm

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excavation no. 10
sheet of

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project NATHAN ST SUBDIVISION location

co-ordinates
R.L.
excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS 230
operator

pit commenced 22-6-90
pit completed 22-6-90
logged by SDW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0.15		CH	CLAY: brown, medium-high plasticity	D	Fb		
				0.60		CH	CLAY: dark brown, high plasticity, rootlets, prismatic pedal structure peds 50-60 mm across.	D	VSt		
				1.60		GC	CLAYEY GRAVEL: light yellow-brown extremely to highly weathered siltstone with brown clay (high to medium plasticity, moist to dry)				Bedding: 46°/143° Joint: 62°/244°
							End of Excavation				

sketch

5 cm

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ENGINEERING LOG – EXCAVATION

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excavation no. 11
sheet of

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project NATHAN ST SUBDIVISION location

co-ordinates
R.L.
excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS 230
operator

pit commenced 22-6-90
pit completed 22-6-90
logged by BDW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0.6		CH	CLAY: dark brown – black, high plasticity clay with silt – fine gravel size siltstone particles, roots, rootlets, prismatic pedal structure	M	St VSt		
				1.2		CH	CLAY: yellow brown, high plasticity clay with silt to fine gravel size siltstone particles, fine rootlets.	M	VSt		
				2.0			SILTSTONE: extremely to moderately weathered brown, dark grey siltstone, shale, fine–medium grained sandstone and carbonaceous shale.	M	Fb		unable to measure bedding & joint orientations
							End of Excavation				

sketch

5 cm

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excavation no. 12
sheet of

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project NATHAN ST SUBDIVISION location

co-ordinates
R.L.
excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS 230
operator

pit commenced 22-6-90
pit completed 22-6-90
logged by BDW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
					0.60		CH	CLAY: dark brown-black, high plasticity with silt to fine sand size particles of siltstone	M	St. VSt		
					1.00		CH	CLAY: dark brown, high plasticity, with fine sand to medium gravel size particles of siltstone	M	VSt		
					1.60			SILTSTONE: extremely to moderately weathered brown siltstone with micaceous and carbonaceous medium to fine grained sandstone and medium grained feldspathic sandstone	M			bedding:- 31°/142°

sketch

5 cm

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excavation no. 13

sheet of

158/164

project NATHAN ST SUBDIVISION location

co-ordinates

R.L.

excavation dimensions

exposure type test pit

equipment Mitsubishi excavator MS 230

operator

pit commenced 22-6-90

pit completed 22-6-90

logged by SDC

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0.60		CH	CLAY: dark brown to black, high plasticity, roots, rootlets, prismatic pedal structure	M	VSt		
				1.00		CH	CLAY: brown-yellow, high plasticity, derived from weathering of dolerite with sand-fine gravel size dolerite particles	M	VSt		
				1.50			DOLERITE: blue/grey to brown, fine to medium grained, variably weathered (fresh to moderately/highly)	M-D			
							End of Excavation				

sketch

5 cm

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excavation no. 1
sheet of

159/164

project OFFICER/NATHAN STS SUBDIVISION location

co-ordinates

R.L.

excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS230
operator

pit commenced 28-6-90
pit completed 28-6-90
logged by BDW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0.10		SM	SILTY SAND: black, organic	D	Fb		SOIL PROFILE
				0.60		CH	CLAY: mottled yellow-brown-orange medium to high plasticity clay with rootlets. Blocky pedal structure	M	VSt		
				1.80			BOULDERS: quartz, feldspathic and carbonaceous fine to medium grained sandstone, fine gravel to boulder size in a clay matrix. Clay matrix is dominantly yellow-brown, some grey, medium to high plasticity clay with some fracture/fissure surfaces which are coated with a lighter grey clay. One coarse gravel size red, bedded sandstone fragment				SLOPE DEPOSITS derived from Triassic age rocks

sketch

5 cm

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excavation no. 2
sheet of

160/164

project OFFICER/NATHAN STS SUBDIVISION location

co-ordinates
R.L.
excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS 230
operator

pit commenced 28-6-90
pit completed 28-6-90
logged by SDW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0.25		SM	SILTY SAND: dark brown/grey becoming lighter in depth, roots, rootlets	M-W	Fb		SOIL PROFILE
				0.60		SC	SANDY CLAY to CLAYEY SAND: yellow-brown, medium to low plasticity fine-medium size sandstone gravels	M-W	Fb		
				1.40			BOULDERS: brown/yellow sandstone and yellow to fawn siltstone, medium gravel to boulder size particles in clayey matrix. Clay matrix light brown, medium plasticity, with some sand and silt. One very large sandstone boulder c bedding in near vertical position				SLOPE DEPOSITS derived from Triassic age rocks
							End of Excavation				

sketch

5 cm

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excavation no. 3

sheet of

161/164

project OFFICER / NATHAN STS SUBDIVISION location

co-ordinates

R.L.

excavation dimensions

exposure type test pit

equipment Mitsubishi excavator MS230

operator

pit commenced 28-6-90

pit completed 28-6-90

logged by DDW

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0.10		SM	SILTY SAND: black, organic	M	Fb		
				0.30		SC	SAND: grey with clay + silt fines (medium plasticity)	M-W	Fb		
				1.40			CLAY: yellow-brown, some cream/grey mottling, medium-high plasticity, About 15% sandstone (med-fine grained) medium gravel to boulder size particles to 800 mm Ø at various orientations. Boulders becoming larger with depth. Some boulders are coated with a grey high plasticity clay.	M			
							End of Excavation				

sketch

5 cm

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excavation no.
sheet 4 of

162/164

project OFFICER/NATHAN STS SUBDIVISION location

co-ordinates
R.L.
excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS 230
operator

pit commenced 28-6-90
pit completed 28-6-90
logged by BDW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0.15		SP	SAND: grey, medium sand size, organic	M-W	MD		
				0.6		SP	SAND: light brown, medium-fine sand size, occassional fine gravel size sandstone/siltstone particles	M-W	MD		
				1.2		CH	CLAY: mottled yellow-brown/grey with occasional red mottles, high to medium plasticity, some coarse gravel size, medium-fine grained sandstone particles	M	St-VSt		
				2.0			CLAY with BOULDERS: yellow, medium plasticity clay (about 55%) with coarse gravel size medium grained quartz + feldspathic sandstone particles and some boulders to 600 mm ϕ. Boulders in various orientations.				
							End of Excavation				

sketch

5 cm

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excavation no. 5
sheet of

163/16A

project OFFICER/NATHAN ST SUBDIVISION location

co-ordinates

R.L.

excavation dimensions

exposure type test pit
equipment Mitsubishi excavator MS 220
operator

pit commenced 25-6-90
pit completed 25-6-90
logged by BDW
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
				0.60		SP	SAND: light grey, fine-medium sand size, subangular to subrounded, occassional charcoal fragments, roots, rootlets	M	MD		
				1.40		CH	CLAY: mottled yellow-brown with some red/grey mottles, medium plasticity, some course gravel to boulder size sandstone/siltstone and rover claystone particles, becoming more common at depth				
							End of Excavation				

sketch

5 cm

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excavation no. 6

sheet of 164/164

project OFFICER/NATHAN ST SUBDIVISION location

co-ordinates

R.L.

excavation dimensions

exposure type test pit

equipment Mitsubishi excavator MS230

operator

pit commenced 28-6-90

pit completed 28-6-90

logged by B.D.W.

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
				0.15			SP	SAND: black, organic, fine-med. grained.	W	MD		
							SP	SAND: grey, fine - medium grained	W	MD		
				0.50			CH	CLAY: mottled orange-yellow-brown, medium plasticity with coarse gravel size to boulder size (max 800mm ϕ) quartz sandstone	M	VSt		
				1.00				End of Excavation				

sketch

5 cm