

071412



**DEPARTMENT OF  
~~NATIONAL RESOURCES~~  
NATIONAL DEVELOPMENT**

**BUREAU OF MINERAL RESOURCES,  
GEOLOGY AND GEOPHYSICS**

Record 1979/77

**BMR PUBLICATIONS COMPACTUS  
(LENDING SECTION)**

**GEOLOGICAL AND GEOPHYSICAL INVESTIGATION  
OF THE PIALIGO LANDFILL SITE, ACT.**

by

**W.R. Evans, G. Jacobson, & D.G. Bennett**

The information contained in this report has been obtained by the Department of National Resources as part of the policy of the Australian Government to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus or statement without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

**BMR  
Record  
1979/77  
c.3**

Record 1979/77

GEOLOGICAL AND GEOPHYSICAL INVESTIGATION  
OF THE PIALIGO LANDFILL SITE, ACT.

by

W.R. Evans, G. Jacobson, & D.G. Bennett

## CONTENTS

|                                  | <u>Page</u> |
|----------------------------------|-------------|
| ABSTRACT                         |             |
| INTRODUCTION                     | 1           |
| PHYSIOGRAPHY AND GEOLOGY         | 2           |
| GROUNDWATER                      | 3           |
| WATER QUALITY                    | 4           |
| GEOPHYSICAL INVESTIGATIONS       | 5           |
| SEISMIC REFRACTION               | 6           |
| RESISTIVITY                      | 7           |
| FUTURE USES OF THE LANDFILL SITE | 8           |
| CONCLUSIONS AND RECOMMENDATIONS  | 9           |
| REFERENCES                       | 10          |

### TABLES

- 1 WATER-LEVEL FLUCTUATIONS IN BORES
- 2 SUMMARY OF CLIMATIC DATA
- 3 DISSOLVED ORGANIC CARBON
- 4 TOTAL HARDNESS AND CHLORIDE
- 5 CHEMICAL ANALYSES OF GROUNDWATER AND LEACHATE

### FIGURES

- 1 LOCATION MAP
- 2 DATES OF FILLING AND LOCATIONS OF SAMPLING POINTS
- 3 GEOLOGY
- 4 GEOLOGICAL SECTION
- 5 POTENTIOMETRIC CONTOURS
- 6 LOCATIONS OF GEOPHYSICAL TRAVERSES

### APPENDIX

- 1 LOGS OF DRILLHOLES
- 2 OBSERVATION BORE HYDROGRAPHS

### PLATES

- 1 SEISMIC REFRACTION AND RESISTIVITY RESULTS
- 2 RESISTIVITY TRAVERSING RESULTS

# ABSTRACT

A geological and geophysical investigation has been undertaken of the recently closed sanitary landfill site at Pialligo, in the Australian Capital Territory. Bores have been drilled to monitor the development of leachate and assess groundwater pollution. Water infiltrates the landfill to form a recharge mound, and groundwater flows generally westwards from the site towards the Molonglo River. Pollution of groundwater by leachate is apparent for at least 300 m from the landfill, but there is at present no groundwater utilisation in the area, and the pollution is expected to be diluted to a safe level by the time it reaches the Molonglo River. Compaction of the fill is poor, and remedial measures are recommended for reclamation of the land. Differential settlement of the landfill is expected to affect buildings and other engineering works located on the fill, and structures should be designed accordingly.



## INTRODUCTION

The Pialligo sanitary landfill site opened in the mid-1960s and was the main landfill site for Canberra's domestic and trade wastes until 1978, when it was closed because its attraction for birds was considered a hazard to aircraft landing at the nearby Canberra airport (Fig. 1). The site received various types of untreated wastes, including kitchen and garden refuse; waste oil and tyres were placed in separate compartments (Fig. 2). No toxic substances were allowed.

Geological criteria for the selection of landfill sites in the ACT have been formulated by Wilson (1975). Most of the Pialligo site was developed before the importance of geological factors in landfill operation was recognised. It was developed in an area which contained worked out sand-pits (Gardner & McCawley, 1967); the fill was placed in trenches or existing pits to depths of several metres, then covered with up to one metre of soil, and only slightly compacted by bulldozer. The most recent extension of the site to the south was designed by L.T. Frazer & Associates in 1976 using geotechnical data; it was filled in compartmentalised trenches 6 m deep, and covered with compacted soil. The approximate dates of filling the site are shown in Figure 2.

This investigation was undertaken at the request of the National Capital Development Commission in order to determine the extent of groundwater pollution, if present; to provide bores for monitoring groundwater pollution; and if possible to assess the degree of compaction of the fill using seismic techniques. Fifteen drillholes were drilled by contractors - Stewart Bros Pty Ltd, of Sydney - in December 1976. Eight drillholes intersected groundwater and were fitted with slotted PVC casing, and gravel-packed to serve as monitoring bores. An additional four holes were drilled in December 1977 and were also equipped as monitoring bores. Geophysical work was done by BMR between September 1976 and November 1977.

Monitoring has been done in conjunction with the Conservation and Agriculture Laboratory, Department of the Capital Territory.

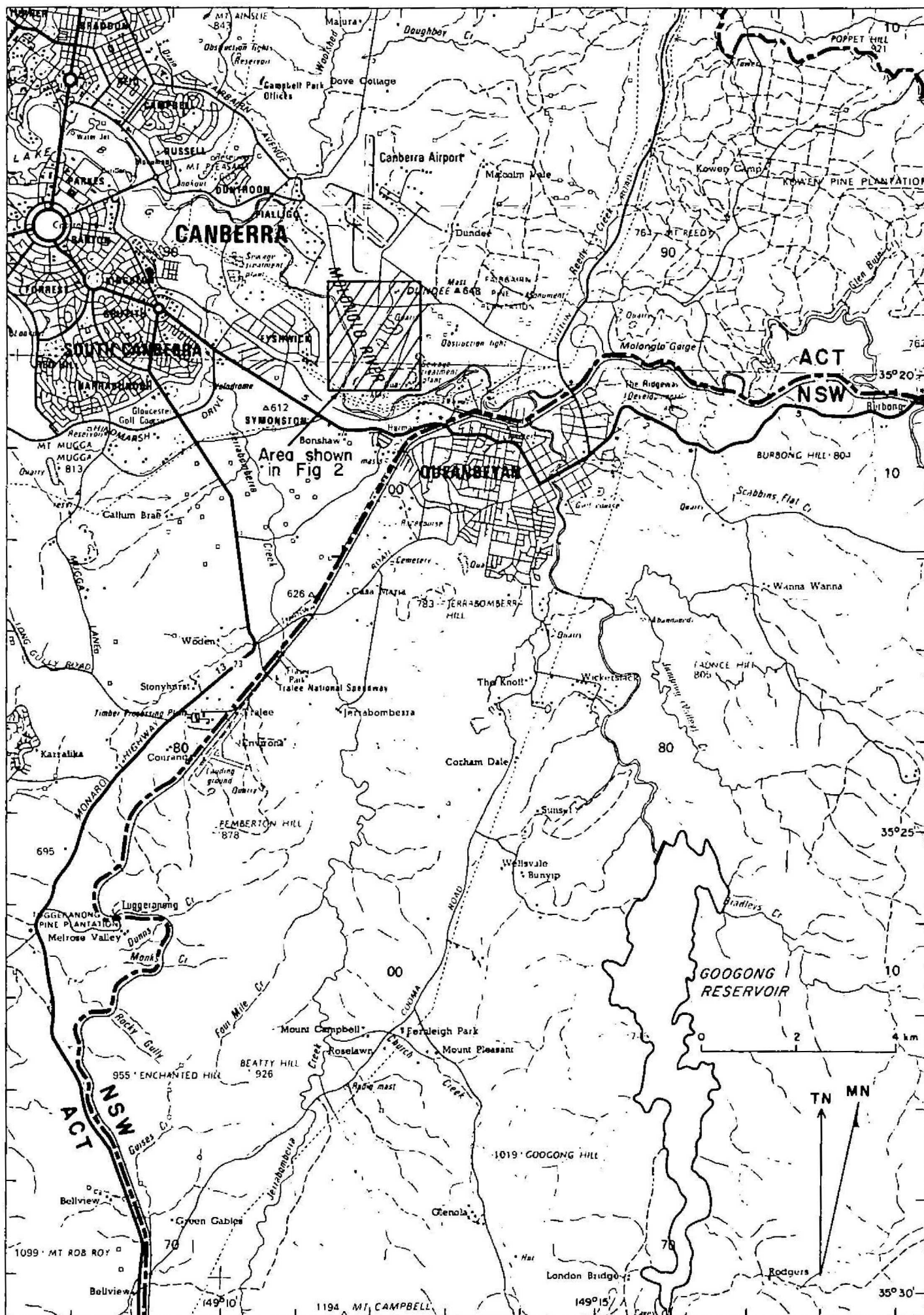


Fig 1. LOCATION MAP

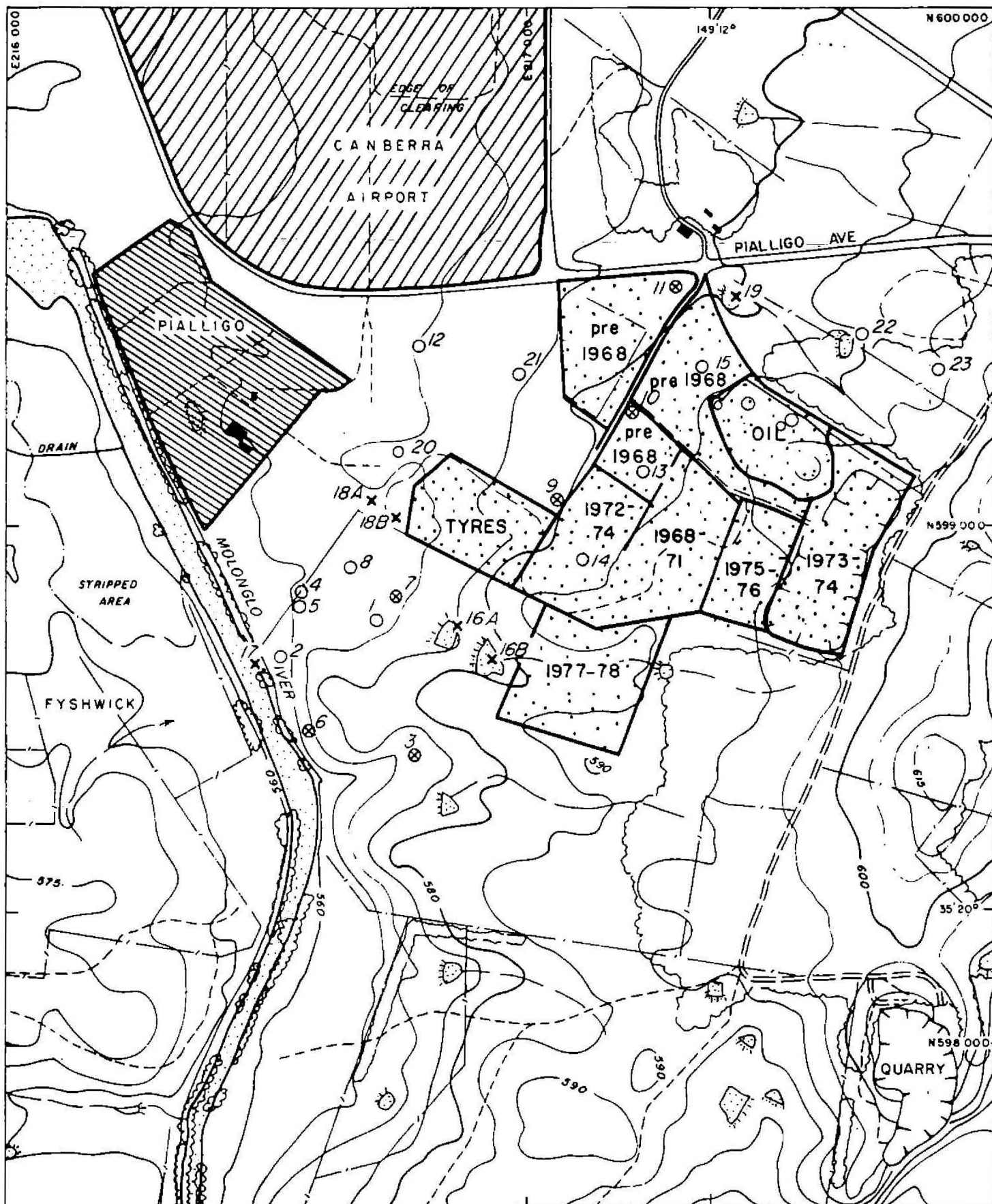


FIG: 2. PIALLIGO LANDFILL SITE  
DATES OF FILLING AND LOCATIONS OF SAMPLING POINTS

- |                                |                                                                                                                         |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| ○ Monitoring bore              |  Filled ground, and years of filling |
| ⊗ Drillhole                    |  Market gardens                      |
| × Surface water sampling point |                                                                                                                         |

0 500 1000 m

Samples have been analysed at that laboratory and also at the Australian Mineral Development Laboratory (AMDEL), in Adelaide.

The investigation forms part of an ongoing research project into groundwater conditions and leachate development at ACT landfill sites (Evans & Bennett, 1978; Jacobson, 1978).

#### PHYSIOGRAPHY AND GEOLOGY

The geology of the Pialligo landfill site is shown in Figure 3, and a geological section is given in Figure 4.

The landfill site is on aeolian and colluvial slope deposits between the Molonglo River to the west, and a low ridge to the east. To the north is Canberra Airport in the broad Majura Valley, drained by Woolshed Creek, and to the south are low hills of outcropping Silurian volcanic rocks.

Beneath the site, the bedrock consists of fault-bounded blocks of Upper Silurian calcareous mudstone, siltstone, and ashstone in the north, and Silurian dacitic tuff in the south.

Just east of the site is Sullivan's Fault, a major geological feature with an upthrown block of Lower Silurian Camp Hill Sandstone to the east (Strusz & Henderson, 1971). A number of minor faults are to be expected in the underlying rocks, but precise locations are not known.

A total of 19 holes were drilled during the investigation (nos. 1-15 and 20-23). The drillhole locations are shown in Figure 3 and logs are given in Appendix 1. All the drillholes encountered bedrock, except drillhole 4. Most intersected siltstone or mudstone; drillholes 3 and 6 encountered dacitic tuff. Drillhole 1 was completed at 12 m in extremely weathered bedrock that may represent a fault zone.

The surficial deposits are of two types: slope and terrace deposits of colluvial gravels, sands, silts, and clays, and aeolian sands; and flood plain deposits of silt and fine sand on the banks of the Molonglo River.





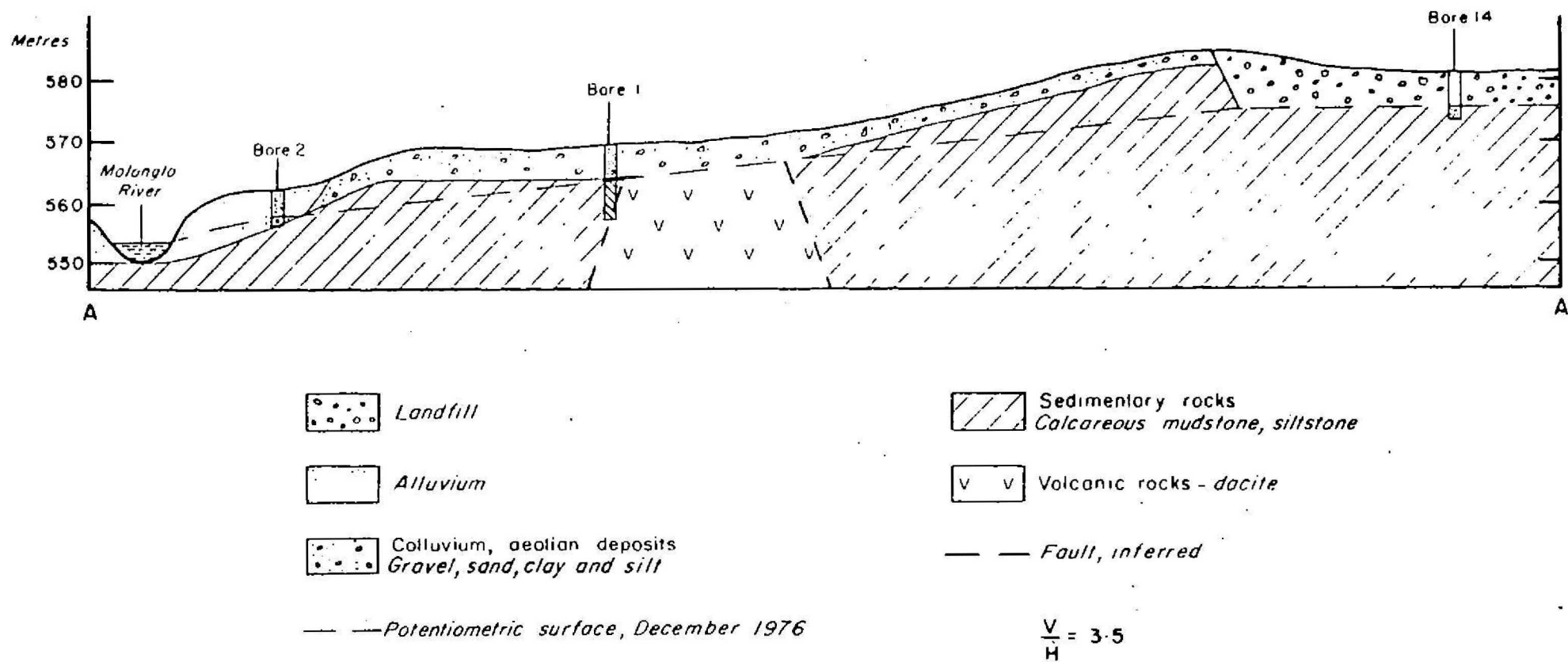


Fig 4 Geological section of the Pralligo landfill site

Butler (1958) and van Dijk (1959) described the periodic erosional and depositional history of surficial material in southeastern Australia. They identified soils with various profile characteristics related to phases of landscape development, and described them as the Kambah cycle ( $K_0$ ), Tharwa cycle ( $K_1$ ), Kurrumbene cycle ( $K_2$ ), Pialligo cycle ( $K_3$ ), Gundaroo cycle ( $K_4$ ) and Mugga cycle ( $K_5$ ). This classification has been used for the landfill site drill cores and appears on the drill logs (Appendix 1). Soils of the  $K_1$ ,  $K_2$  and  $K_3$  cycles occur at Pialligo.

#### GROUNDWATER

Groundwater was encountered in drillholes 1, 2, 4, 5, 8, 12, 13, 14, 15, 20, 21, 22, and 23. The aquifer was fractured bedrock in drillholes 1, and 22; surficial deposits in drillholes 2, 4, 5, 8, 20, 21, and 23; fill material in drillholes 13, 14, and 15; and was not determined in drillhole 12. The fractured-rock aquifer intersected by drillhole 1 shows confining conditions (see log, Appendix 1). The aquifers in holes 4, 20, and 21 are within the upper layers of the surficial deposits, and are perched above the level of the fractured-rock aquifer.

Potentiometric contours have been plotted in Figure 5, and show a general hydraulic gradient to the west with eventual discharge to the Molonglo River. Water in the fill material (bores 13, 14, and 15) is impounded by the less permeable, surrounding surficial deposits, and forms a groundwater mound. The mound is above the bedrock surface and slowly recharges the adjacent aquifers by lateral and vertical infiltration. The fill is recharged by the infiltration of rainfall and surface water through the covering material.

Drillholes 9, 10, and 11 were drilled to bedrock, through the oldest fill material, but no groundwater was encountered and the holes were backfilled. Drillholes 20 and 21 encountered perched aquifers within the top 5 m; these aquifers are probably recharged by the groundwater mound, as indicated by polluted groundwater in drillhole 21. The lateral discharge from the fill is spatially variable and probably depends on the distribution of sand and gravel lenses that are part of the  $K_2$  and  $K_3$  colluvial cycles.

Drillholes 22 and 23 to the north of the site were drilled to obtain control samples of groundwater, so that a comparison could be made between water sampled from these holes and from holes down-gradient of the landfill. However, preliminary analyses of groundwater from these holes indicate the presence of pollution as dissolved organic carbon, and confirm the northward movement of polluted groundwater in this area (Fig. 5).

Water-level fluctuations in monitoring bores are summarised in Table 1 and hydrographs of some of the bores are given in Appendix 2. Seasonal fluctuations generally range up to two metres and bores in the surficial aquifers dry up seasonally. Storage within the landfill was at its highest level in late 1978 and early 1979 (bores 13, 14, and 15) after the wet weather during late 1978, and this indicates that there is considerable infiltration into the fill material. The summary of monthly rainfall and evaporation data (Table 2) shows that potential evapotranspiration generally exceeds rainfall throughout the year. It is likely that groundwater recharge with leachate generation takes place after short periods of intensive rainfall.

#### WATER QUALITY

A water-quality monitoring program was instituted with a preliminary round of sampling in June 1977, and subsequent rounds periodically since then. Samples were tested for dissolved organic carbon (DOC), total hardness (as  $\text{CaCO}_3$ ) and chloride, by M.J. Storey at the Conservation and Agriculture Laboratory, Department of the Capital Territory, Canberra, (Tables 3 and 4). Chemical analyses of samples from selected bores were done by AMDEL, Adelaide, in July 1977 and February 1979 (Table 5).

For the purposes of this study we have taken DOC as the main pollution index (Hughes, Eccles, & Malcolm, 1974). Work in other parts of the ACT has established that background levels for DOC are 1 to 5 mg/l for natural groundwaters and 10-20 mg/l for dam waters (Evans & Bennett, 1978; Jacobson, 1978). Background values for chloride concentration and total hardness range from 10 to 800 mg/l and 30 to 1000 mg/l respectively for unpolluted groundwaters, and from 8 to 200 mg/l and 30 to 650 mg/l respectively for dam waters.



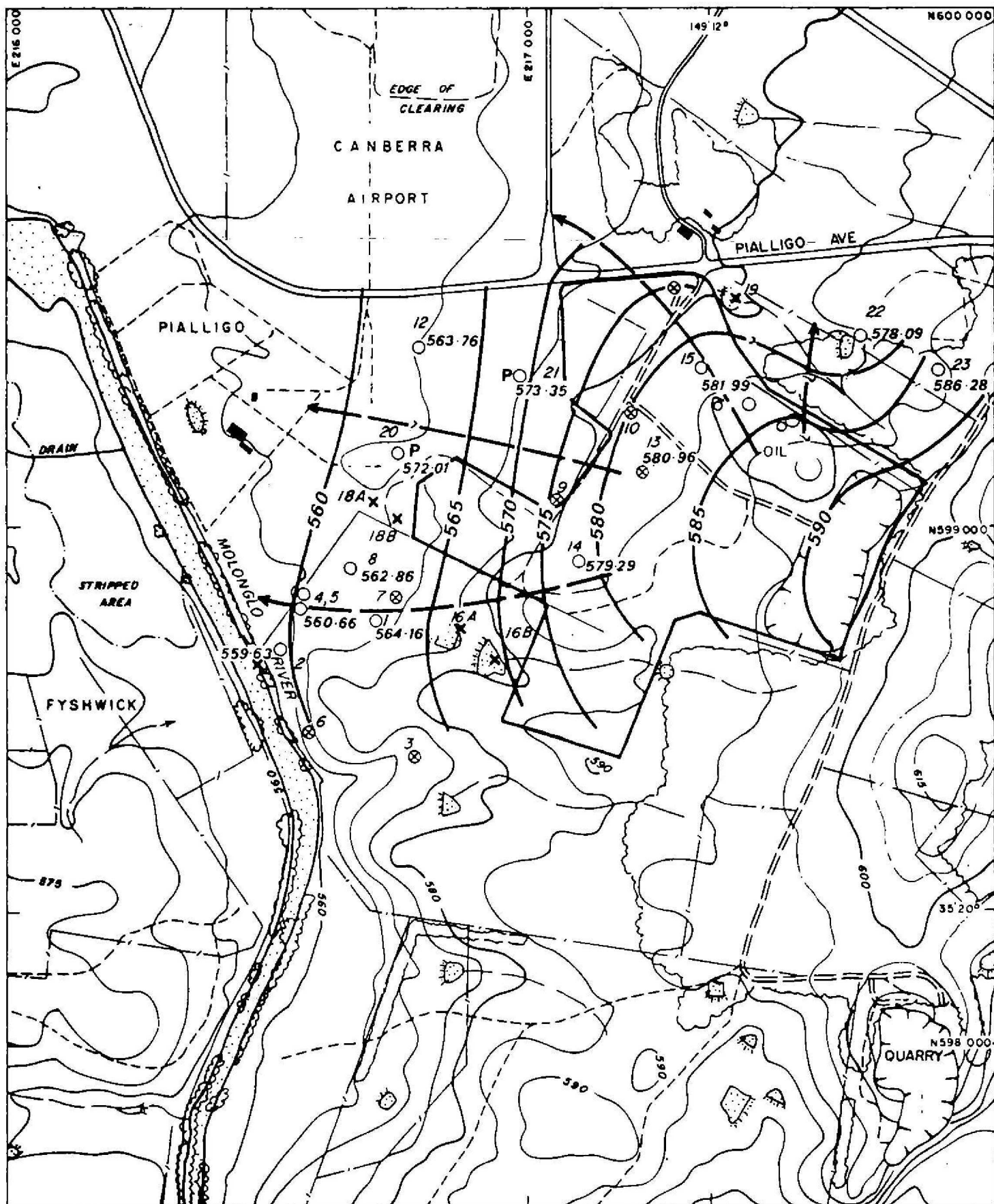


FIG 5. POTENTIOMETRIC CONTOURS - 27th November 1978

- 590 — ? — Potentiometric contour and R.L. (m); uncertain & inferred
- ← — ? — Groundwater flow lines; inferred
- 15 ○ 560.77 Bore No and R.L. (m) of groundwater
- P ○ 570.04 Bore No and R.L. (m) of perched groundwater
- 15 x 19 Surface sampling points

TABLE 1.  
WATER-LEVEL FLUCTUATIONS IN BORES

| Bore | Max. level<br>(m) | Date                    | Min. level<br>(m) | Date     | Fluctuation<br>(m) | Aquifer<br>type |
|------|-------------------|-------------------------|-------------------|----------|--------------------|-----------------|
| 1    | 564.48            | 29.06.77                | 562.33            | 19.06.79 | 2.15               | Bedrock         |
| 2    | 559.68            | 3.08.77                 | 559.46            | 19.06.79 | 0.22               | Surficial       |
| 4    | 564.35            | 3.03.77                 | 563.88            | 27.11.78 | 0.47               | Surficial       |
| 5    | 561.78            | 29.06.77                | 560.66            | 27.11.78 | 1.12               | Surficial       |
| 8    | 563.31            | 9.03.77                 | 561.53            | 19.06.79 | 1.78               | Surficial       |
| 12   | 563.76            | 27.11.78                | 562.87            | 3.02.78  | 0.89               | Undetermined    |
| 13   | 581.03            | 19.03.79                | 579.60            | 14.02.77 | 1.43               | Fill            |
| 14   | 579.29            | 9.03.77<br>and 27.11.78 | 578.55            | 3.02.78  | 0.74               | Fill            |
| 15   | 582.49            | 2.01.79                 | 580.89            | 3.08.77  | 0.68               | Fill            |
| 20   | 570.57            | 2.01.79                 | 569.88            | 19.03.79 | 0.69               | Surficial       |
| 21   | 572.68            | 19.03.79                | 567.05            | 19.06.79 | 5.63               | Surficial       |
| 22   | 576.19            | 19.03.79                | 572.43            | 8.06.79  | 3.76               | Bedrock         |

TABLE 2.

## SUMMARY OF CLIMATIC DATA, CANBERRA AIRPORT, 1940-78

|           | Mean temperature<br>°C | Monthly rainfall<br>mm | Pan evaporation<br>mm |
|-----------|------------------------|------------------------|-----------------------|
| January   | 20.1                   | 62                     | 241                   |
| February  | 19.7                   | 61                     | 192                   |
| March     | 17.4                   | 53                     | 158                   |
| April     | 13.0                   | 50                     | 104                   |
| May       | 8.9                    | 51                     | 71                    |
| June      | 6.4                    | 38                     | 49                    |
| July      | 5.4                    | 38                     | 53                    |
| August    | 6.7                    | 45                     | 67                    |
| September | 9.4                    | 54                     | 107                   |
| October   | 12.4                   | 72                     | 156                   |
| November  | 15.3                   | 62                     | 192                   |
| December  | <u>18.5</u>            | <u>54</u>              | <u>261</u>            |
| Year      | 12.8                   | 638                    | 1651                  |

Figures supplied by Bureau of Meteorology.

TABLE 3.

DISSOLVED ORGANIC CARBON  
—(in mg/l)—

| Location | 30.6.77 | 2.11.77 | 8.6.78 | 29.8.78* | 30.11.78 | 15.4.79 |
|----------|---------|---------|--------|----------|----------|---------|
| 1 Bore   | 2.5     | 1.5     | 1      | 4        | 4        | -       |
| 2 Bore   | 1.5     | 1.5     | 1      | 7        | 2        | -       |
| 5 Bore   | 14      | 2       | -      | 6        | -        | -       |
| 8 Bore   | 4       | 2.5     | 3      | 6        | 4        | -       |
| 12 Bore  | 3       | 2       | 18     | -        | 4        | 3       |
| 13 Bore  | 96      | 110     | 130    | -        | 112      | 96      |
| 14 Bore  | 13 100  | 15 500  | 8 000  | -        | 18 000   | 9 800   |
| 15 Bore  | 14 300  | 20 000  | 20 000 | -        | 28 000   | 19 600  |
| 16A Dam  | 13.5    | 8       | 8      | -        | -        | -       |
| 16B Dam  | -       | 8       | 8      | -        | -        | -       |
| 17 River | 6.5     | 8       | 9      | -        | -        | -       |
| 18A Dam  | 9       | -       | 8      | -        | -        | -       |
| 18B Dam  | -       | -       | 23     | -        | -        | -       |
| 19 Dam   | 30      | 125     | 42     | -        | -        | -       |
| 20 Bore  | -       | -       | 4      | 9        | 5        | 1.5     |
| 21 Bore  | -       | -       | -      | 38.6     | 45       | -       |
| 22 Bore  | -       | -       | 9      | 13.5     | 22       | 17      |
| 23 Bore  | -       | -       | 12     | 8        | -        | -       |

Determinations by

Department of Capital Territory Conservation

& Agriculture Laboratory, Canberra

\*Results for 29.8.79 may be higher than normal  
due to changed laboratory techniques.

For sample locations see Fig. 2.

TABLE 4.

TOTAL HARDNESS AND CHLORIDE  
(in mg/l)

| Location | Total hardness as CaCO <sub>3</sub> |        |         |          | Chloride |        |         |          |
|----------|-------------------------------------|--------|---------|----------|----------|--------|---------|----------|
|          | 2.11.77                             | 8.6.78 | 29.8.78 | 30.11.78 | 2.11.77  | 8.6.78 | 29.8.78 | 30.11.78 |
| 1 Bore   | 392                                 | 334    | 350     | 348      | 48       | 28     | 40      | 47       |
| 2 Bore   | 192                                 | 178    | 168     | 164      | 24       | 19     | 20      | 22       |
| 5 Bore   | 152                                 | -      | 104     | -        | 37       | -      | 37      | -        |
| 8 Bore   | 256                                 | 210    | 240     | 246      | 116      | 70     | 113     | 121      |
| 12 Bore  | 368                                 | 206    | -       | 400      | 236      | 116    | -       | 267      |
| 13 Bore  | 1 261                               | 696    | -       | 920      | 220      | 178    | -       | 186      |
| 14 Bore  | 4 300                               | 5 050  | -       | 7 750    | 560      | 870    | -       | 1 400    |
| 15 Bore  | 8 800                               | 17 000 | -       | 14 000   | 768      | 1 900  | -       | 2 040    |
| 16A Dam  | 96                                  | 116    | -       | -        | 24       | 19     | -       | -        |
| 16B Dam  | 72                                  | 74     | -       | -        | 22       | 14     | -       | -        |
| 17 River | 114                                 | 60     | -       | -        | 36       | 8      | -       | -        |
| 18A Dam  | 235                                 | 104    | -       | -        | 111      | 36     | -       | -        |
| 18B Dam  | 30                                  | 206    | -       | -        | 10       | 56     | -       | -        |
| 19 Dam   | 80                                  | 90     | -       | -        | 36       | 11     | -       | -        |
| 20 Bore  | -                                   | 60     | 40      | 28       | -        | 6      | 8       | 7        |
| 21 Bore  | -                                   | -      | 384     | 86       | -        | -      | 8       | 100      |
| 22 Bore  | -                                   | 50     | -       | 42       | -        | 76     | -       | 55       |
| 23 Bore  | -                                   | 76     | 80      | -        | -        | 16     | 25      | -        |

Determinations by Department of Capital Territory Conservation &amp;

Agriculture Laboratory, Canberra

For sample locations see Fig. 2

TABLE 5.

CHEMICAL ANALYSES OF GROUNDWATER AND LEACHATE  
(in mg/l; electrical conductivity in microsiemens/cm)

|                                     | 1*    | 12*   | 12+   | 14*    | BORE<br>15* | 20+    | 21+   | 22+  |
|-------------------------------------|-------|-------|-------|--------|-------------|--------|-------|------|
| pH                                  | 7.4   | 6.9   | 7.0   | 5.1    | 5.3         | 6.4    | 6.7   | 7.8  |
| T.D.S. calculated                   | 301   | 852   | 906   | 9375   | 14 213      | 111    | 457   | 677  |
| T.D.S. evap. residue                | 285   | 833   | -     | 30 662 | 18 898      | -      | -     | -    |
| Electrical conductivity             | 576   | 1542  | 1760  | 16 000 | 18 799      | 219    | 819   | 1126 |
| Calcium                             | 71    | 63    | 74    | 1912   | 3500        | 6      | 42    | 17   |
| Magnesium                           | 21    | 42    | 49    | 575    | 1160        | 6      | 23    | 9    |
| Sodium                              | 17    | 214   | 212   | 945    | 1115        | 28     | 83    | 238  |
| Potassium                           | 3     | 2     | 2     | 475    | 392         | 6      | 11    | 6    |
| Bicarbonate                         | 319   | 530   | 573   | 8037   | 12 041      | 102    | 264   | 540  |
| Sulphate                            | 9     | 53    | 30    | 259    | 634         | 7      | 13    | 24   |
| Chloride                            | 23    | 217   | 256   | 1256   | 1490        | 8      | 89    | 67   |
| Fluoride                            | 0.20  | 0.10  | 0.10  | 0.05   | 0.10        | 0.05   | 0.15  | 0.60 |
| Phosphate                           | 0.07  | 0.04  | 0.09  | 0.35   | <0.01       | 0.17   | 0.09  | 0.34 |
| Boron                               | <0.05 | <0.05 | <0.05 | 2.50   | 3.35        | 0.05   | 0.05  | 0.10 |
| Total hardness as CaCO <sub>3</sub> | 264   | 330   | 387   | 7140   | 13 513      | 40     | 200   | 91   |
| Total alkalinity                    | 261   | 435   | 470   | 6588   | 9870        | 83     | 217   | 443  |
| Cadmium (µg/l)                      | 5     | <3    | <0.05 | <3     | <3          | 0.05   | <0.05 | 0.3  |
| Chromium (µg/l)                     | <3    | <3    | 1     | 25     | 41          | 10     | 5     | 5    |
| Copper (µg/l)                       | 80    | <10   | <0.05 | 60     | 30          | 9.1    | 5.4   | 13.1 |
| Iron                                | 0.20  | 0.11  | 0.24  | 1037   | 765         | 10.9** | 0.24  | 6.30 |
| Manganese                           | 1.65  | 0.95  | -     | 400    | 266         | -      | -     | -    |
| Nickel (µg/l)                       | 15    | 15    | 10    | 1170   | 600         | 10     | 5     | 5    |
| Lead (µg/l)                         | <30   | <30   | 27    | 220    | 220         | <0.5   | 3.4   | 7.2  |
| Zinc (µg/l)                         | 295   | 35    | 28    | 83 500 | 23 650      | 55     | 5.3   | 55   |
| Petroleum spirit extract            | <0.5  | <0.5  | -     | 98     | 53          | -      | -     | -    |
| Surfactants (µg/l)                  | 50    | <25   | 42    | 210    | 170         | <50    | 51    | <50  |
| Chemical oxygen demand              | 18    | 42    | -     | 45 500 | 50 000      | -      | -     | -    |
| Total nitrogen                      | 0.65  | 1.1   | -     | 1060   | 660         | -      | -     | -    |
| Ammonia                             | N.D.  | N.D.  | -     | 605    | 75          | -      | -     | -    |

Determinations by AMDEL, Adelaide

\* July 1977

+ February 1979

\*\* Iron is present as colloidal and possibly organic iron.

For bore locations see Fig. 2.



The DOC results from Pialligo samples (Table 3) indicate that most of the bores outside the landfill have background values, but bores 12 and 22 showed evidence of pollution, 18 mg/l DOC, on 8 June 1978, and greater than 13 mg/l during the period August 78 to April 79, respectively. Sampling from the perched aquifers, bores 20 and 21, has indicated pollution in bore 21. The quality of water in bore 8 is affected by leachate, but there is no evidence of any effect in bores 1, 2, and 5.

Table 5 shows the chemical composition of leachate from bores 14 and 15, and groundwater from bores 1, 12, 20, 21, and 22. The leachate has a calculated total dissolved solids content of 9000-14 000 mg/l, in contrast to slightly polluted groundwater, 400-900 mg/l, and apparently unpolluted groundwater, 100-300 mg/l. The electrical conductivity and chemical oxygen demand of the leachate are correspondingly high. The leachate is acid, with a pH of 5.1-5.3 (Table 5).

Infiltration of the leachate into the surficial material is expected to cause deterioration of water quality down-gradient from the landfill site. However, there is no extraction of groundwater at present in the immediate vicinity of the site. The quality of groundwater discharging into the Molonglo River will eventually be affected by leachate, but the extent of the pollution can be determined only by regular monitoring. Two additional bores should be drilled between the landfill and the Molonglo River, in order to monitor water quality in the bedrock aquifer.

There is no immediate pollution hazard.

#### GEOPHYSICAL INVESTIGATIONS

Seismic refraction and resistivity surveys were carried out at the Pialligo landfill site between September 1976 and November 1977. Seismic refraction traverses were done in order to measure the thickness and seismic velocity of the fill and underlying material, and to try to determine if compaction of the refuse had increased

with age. Resistivity depth probes were used to estimate the depth to the water-table and the water quality. Resistivity traversing was carried out downslope of the landfill area to try to locate any preferred channels for leachate drainage.

#### SEISMIC REFRACTION

Thirteen seismic refraction spreads were shot along a northeast-southwest traverse (Fig. 6) crossing various ages of fill and three spreads were shot along an intersecting northwest-southeast traverse. Each spread consisted of 24 geophones in a line spaced 2 m apart and 7 shots were fired per spread. The northern part of spread 1 and the western part of spread 14 were located on what appeared to be undisturbed ground and all other spreads were on landfill.

The results are presented as seismic cross-sections in Plate 1. The thick layer of low-velocity fill caused problems with interpretation of the seismic refraction data. Seismic energy transmission through fill is poor, and first arrivals could not be picked clearly on some records. In places the fill also masks layers between it and bedrock. This is known as the 'hidden layer' problem, where the thickness of a layer is insufficient to produce first arrivals even though its seismic velocity is intermediate between the overlying and underlying layers. The introduction of such a layer reduces the estimated thickness of the overlying layer and increases the depth to the underlying layer on the seismic sections. During excavation of the landfill trenches, part of the normal weathering sequence was removed or disturbed, and in areas where low-velocity fill overlies slightly weathered bedrock it is difficult to tell whether or not a layer of intermediate velocity exists between these layers. The three drillholes along the traverse do not provide sufficient information to clarify the problem.

In general the seismic velocity of the fill layer has not increased significantly with age. In areas identified as pre-1968 landfill the surface layer velocity varies between 340 and 470 m/s. In the area identified as 1972-74 landfill the surface layer velocity varies between 320 and 380 m/s. An exception occurs near drillhole 15,

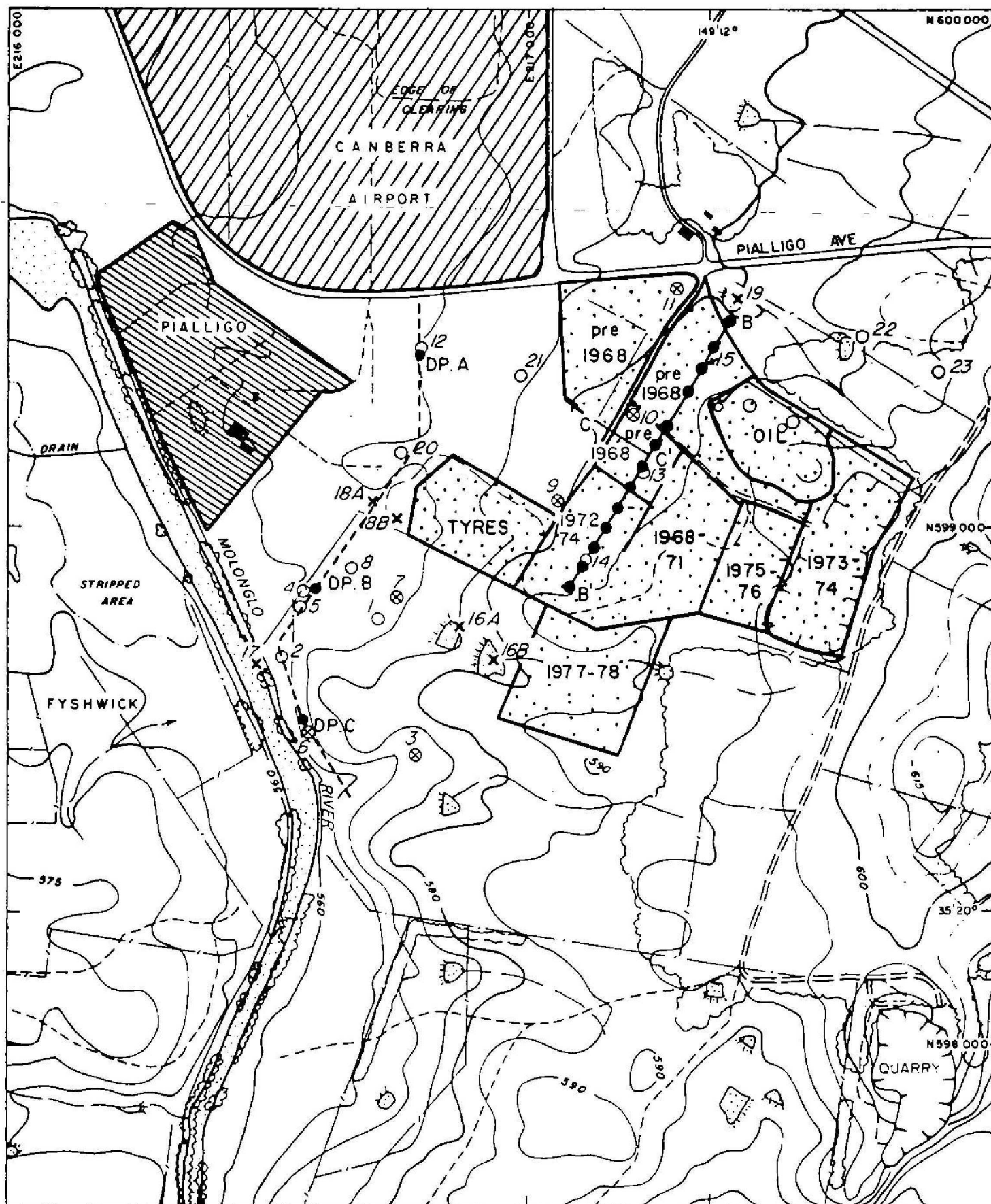


FIG. 6. LOCATIONS OF GEOPHYSICAL TRAVERSES

- |        |                                |                                                                                     |                                     |
|--------|--------------------------------|-------------------------------------------------------------------------------------|-------------------------------------|
| ○      | Monitoring bore                | ●                                                                                   | Resistivity depth probe             |
| ⊗      | Drillhole                      |  | Filled ground, and years of filling |
| ×      | Surface water sampling point   |  | Market gardens                      |
| B'———B | Seismic traverse (Plate 1)     |                                                                                     |                                     |
| -----  | Resistivity traverse (Plate 2) |                                                                                     |                                     |

in which refuse was logged to a depth of 6.1 m, and the seismic section shows a velocity of 700 m/s between 2.1 and 5.7 m. The similarity in seismic velocity between the area below the present access road near spread 6 and this area suggests that there may have been another access road near drillhole 15, and that traffic increased the compaction.

The seismic velocity of slightly weathered bedrock varies between 2500 and 3200 m/s.

### RESISTIVITY

#### Depth probes

Thirteen Wenner depth probes were recorded along the northeast-southwest seismic traverse (Fig. 6). A depth probe was centred at the start of each seismic spread and the electrode spacing was expanded to a maximum of 24 m. The results are shown in Plate 1. Because Wenner depth probes are sensitive to near-surface lateral inhomogeneities, and owing to the variable electrical nature of the refuse/fill (e.g., buried metal objects), the results were inconclusive. In general the resistivity of the fill is low compared with measurements taken outside the landfill area.

Three depth probes were recorded along the western perimeter of the site outside the refuse area and the results are shown in Plate 2. These probes - A, B, and C - were near drillholes 12, 4, and 6 respectively, but the correlation with drillhole data was poor.

#### Resistivity traverses

A Wenner traverse was recorded along the western and southern perimeters downslope from the landfill area (Fig. 6). A constant electrode spacing of 10 m was used and the results are shown in Plate 2. Traversing provides qualitative data on lateral variations of resistivity to a depth roughly equal to the electrode separation. The purpose of the survey was to locate better sorted, coarse-grained lenses in the colluvium which might act as preferred drainage paths for leachate from the landfill. On the northeast-

southwest sections of the traverse, resistivity values increased gradually towards the river. This could be due to either a decrease in the clay content of the sediments or a decrease in the depth to the water-table towards the river. There were no isolated increases in resistivity which might represent permeable lenses. On the north-northwest/south-southeast section the large increase in resistivity values corresponds with the change in rock type from calcareous mudstone and siltstone in the west to dacitic tuff in the east.

It may be possible to use resistivity techniques to monitor gross changes in leachate composition, with time.

#### FUTURE USES OF THE LANDFILL SITE

Future land use of the site may include building development or recreational activities. At present the site is undergoing continued differential settlement and large cracks have developed in the clean spoil cover. The cracks are up to 5 cm wide and 30 m long. Piping within the cover has occurred in places.

It has been suggested (Sowers, 1968) that sanitary landfill sites can support foundation loads to a maximum of 3.5-5.5 kPa (500 to 800 lb/ft<sup>2</sup>) without failure. The bearing capacity can be increased to some extent by the placement and compaction of additional cover over the site. The thickness of new cover should be about 1.5 times the width of the building footings placed on it. Alternatively, if the buildings are to be relatively light and one-storey, then the low bearing capacity of the fill can be overcome by using continuous slab or strip foundations. Failing the above two methods, piles or piers founded on bedrock should be used.

Because of the possibility of methane gas being generated in the fill, structures should be designed with gas-tight membranes beneath the ground floor slab.

The engineering characteristics of the Pialiigo site are unknown. Preliminary seismic results could not provide any definition within the landfill with regard to compaction characteristics.

The fill was derived from all types of wastes and this makes quantifying of compaction parameters impossible. Surface testing is of no value because of the abrupt change in conditions between the cover and the fill materials.

Any land-use requiring irrigation for the maintenance of the area will cause additional groundwater recharge. With the higher moisture content of the soil owing to continued watering, any additional rainfall on the area would infiltrate to groundwater store. In terms of infiltration, the area would be at or near field capacity continuously and additional water would promote leachate generation.

#### CONCLUSIONS AND RECOMMENDATIONS

1. Leachate is being generated at the Pialligo landfill site. Monitoring of observation bores shows that groundwater pollution has occurred in the area of bores 12 and 21, that is, over distances of up to 300 m from the landfill. There is no immediate pollution hazard to the Molonglo River, but monitoring should continue, and the drilling of two additional bores is recommended.

2. Preliminary foundation investigations give little indication of conditions within the fill, though differential settlement and cracking still occur in the overlying cover. The placing of additional cover over the site would assist compaction.

3. In reclamation, the site should be landscaped so that runoff from adjacent areas is diverted from the site, and runoff within the site is collected. Cracks should be covered and irrigation minimised, in order to reduce infiltration. An extra layer of compacted clean spoil would reduce infiltration to the landfill and would provide additional storage for soil moisture.



REFERENCES

- BUTLER, B.E., 1958 - Depositional systems of the Riverina Plain of southeastern Australia, in relation to soils. CSIRO Soil Publication 10.
- EVANS, R., & BENNETT, D.G., 1978 - Geological and geophysical investigation of the proposed Mugga South landfill site, A.C.T., 1977. Bureau of Mineral Resources, Australia, Record 1978/69 (unpublished).
- GARDNER, D.E., & McCAWLEY, J.L., 1967 - Unconsolidated sediments of the Pialligo refuse disposal area, A.C.T. Bureau of Mineral Resources, Australia, Record 1967/135 (unpublished).
- HUGHES, J.L., ECCLES, L.A., & MALCOLM, R.L., 1974 - Dissolved Organic Carbon (DOC) an index of organic contamination in groundwater near Barstow, California. Ground Water 12, 283-90.
- JACOBSON, G., 1978 - The establishment of a leachate monitoring system at the West Belconnen landfill site, A.C.T., 1976-7. Bureau of Mineral Resources, Australia, Record 1978/83 (unpublished).
- SOWERS, G.F., 1968 - Foundation problems in sanitary landfills. Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, SA 1, 103-116.
- STRUSZ, D.L., & HENDERSON, G.A.M., 1971 - Canberra City, A.C.T. - 1:50 000 Geological Map and Explanatory Notes. Bureau of Mineral Resources, Australia.
- VAN DIJK, D.C., 1959 - Soil features in relation to erosional history in Canberra. CSIRO Soil Publication 13.
- WILSON, E.G., 1975 - The influence of geology and hydrogeology on landfill disposal of solid waste, and its application in Canberra. Bureau of Mineral Resources, Australia, Record 1975/99 (unpublished).



APPENDIX 1

PIALLIGO LANDFILL SITE

LOGS OF DRILLHOLES

1 to 15 AND 20 to 23 INCLUSIVE

BUREAU OF MINERAL RESOURCES.  
GEOLOGY & GEOPHYSICS

Geological Log of Auger Hole  
R.L. 568.8m.

Project: Pialligo Landfill  
Site

Hole: 1

Date: 8-11-76

Logged by: R.E.  
J.R.K.

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, Plast)  | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col.<br>E-S, Y-B | Moisture<br>D, M, S, PL, W | In Situ<br>Permeability<br>(k)<br>Groundwater<br>Observations | Moisture<br>Permeability<br>Structure<br>Crumb etc. | Sampling method | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Beller Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|----------------------------------------------------|----------------|--------------------------------------------------|----------------------------|---------------------------------------------------------------|-----------------------------------------------------|-----------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| 1              |     | Silty medium sand<br><br>Gravelly towards base     | SM             | Greyish<br>Brown                                 | D                          | High k                                                        | Apedal<br>porous                                    | Aug.            | 40                | Minimal<br>Prairie<br>Soil                                                                                                                   |
| 2              |     | Clayey Medium Gravel<br>(more clayey towards base) | GC             | Yellow-<br>Brown                                 | D                          | High k<br>less permeable at<br>base                           | Apedal                                              | "               | 75                | Yellow-<br>Brown<br>Earth.                                                                                                                   |
| 2              |     | Silty clay                                         | CL             | Pale yellow-<br>brown, some red                  | D                          | Low k<br>persistent giv.                                      | Massive                                             | "               |                   | Hardpan                                                                                                                                      |
| 3              |     | Gravelly clay                                      | CL             | Red-<br>Brown                                    | D                          | Med. k                                                        | Apedal                                              | "               | 45                | Podzolic<br>B <sub>1</sub>                                                                                                                   |
| 3              |     | Coarse sandy clay<br>Disseminated gravel           | CL             | Brown                                            | D                          | Low k                                                         | Weak<br>incipient<br>large<br>peds                  | "               | 52                | Podzolic<br>B <sub>2</sub>                                                                                                                   |
| 4              |     | Sandy clay<br>Gravelly towards base                | CL             | Yellow-<br>Brown                                 | D                          | Low k.                                                        | Apedal                                              | "               | 65                | Sub-Solum                                                                                                                                    |
| 5              |     | Clayey Silt<br>shows some layering                 | CL             | Brown-<br>Yellow<br>to<br>Red-Brown              | D                          | Low k                                                         | Apedal                                              | "               | 40                | Decomposed<br>Bed rock.                                                                                                                      |
| 6              |     |                                                    |                |                                                  |                            | WATER LEVEL<br>1.1.77                                         |                                                     |                 | 60                | Extremely<br>Weathered<br>Mudstone                                                                                                           |
| 7              |     |                                                    |                |                                                  |                            |                                                               |                                                     |                 | 60                |                                                                                                                                              |
| 8              |     |                                                    |                |                                                  |                            |                                                               |                                                     |                 | 100               |                                                                                                                                              |
| 9              |     |                                                    |                |                                                  |                            |                                                               |                                                     |                 | 35                |                                                                                                                                              |
| 10             |     |                                                    |                |                                                  |                            |                                                               |                                                     |                 |                   |                                                                                                                                              |

Driller: Stewart Bros. Drill type: Genco

Not sampled

Checked by:

**BUREAU OF MINERAL RESOURCES.  
GEOLOGY & GEOPHYSICS**

**Geological Log of Auger Hole**

Project: Pialligo Landfill Site

Hole: 1 (cont.) Date: 8-11-76

Logged by: R.E. J.R.K.

| DEPTH (metres) | LOG                                                                               | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plot)                                     | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col.<br>B-B, Y-B | Moisture<br>D.M. > PLW | In Situ<br>Permeability<br>(k)                                                                 | Moisture<br>Permeability<br>Comb. etc. | Sampling method | Cone Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Soil on Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|----------------|--------------------------------------------------|------------------------|------------------------------------------------------------------------------------------------|----------------------------------------|-----------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
|                |                                                                                   |                                                                                      |                |                                                  |                        | Groundwater<br>Observations                                                                    |                                        |                 |                   |                                                                                                                                               |
| 11             |  | As Above                                                                             |                |                                                  |                        |                                                                                                |                                        |                 |                   | Extremely<br>Weathered<br>Mudstone                                                                                                            |
| 12             |  |                                                                                      |                |                                                  |                        | Ground water<br>encountered                                                                    |                                        |                 |                   |                                                                                                                                               |
|                |                                                                                   | Hole Depth: <u>12.19</u> m<br>Bedrock: E.W. Mudstone.<br>Ground water depth: 11.58 m |                |                                                  |                        | Equipped with<br>slotted casing.<br>Ground water<br>rose to<br>approx. 6.0 m<br>after drilling |                                        |                 |                   |                                                                                                                                               |

Driller: Stewart Bros. Drill type: Genco



Not sampled

Checked by:

**BUREAU OF MINERAL RESOURCES.**  
**GEOLOGY & GEOPHYSICS**

Geological Log of Auger Hole  
RL 563.0m

Project: Palling Landfill Site

Hole: 2

Date: 9-11-76

Logged by: R.E.  
J.R.K.

| DEPTH (metres)                                                                                                                                                     | 100 | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plot) | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col.<br>R-B, Y-B | Moisture<br>D.M. < PLV | In Situ Permeability (k) |              | Massive<br>Pore<br>Crumb etc. | Sampling method | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Eolian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|--------------------------------------------------|----------------|--------------------------------------------------|------------------------|--------------------------|--------------|-------------------------------|-----------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                    |     |                                                  |                |                                                  |                        | Groundwater              | Observations |                               |                 |                   |                                                                                                                                              |
| 1                                                                                                                                                                  |     | Black micaceous organic clayey silt              | OL             | Black                                            | D                      | Low k                    |              | Apedal Aug<br>Friable         |                 | 47                | Floodplain Alluvium (K1)                                                                                                                     |
| 2                                                                                                                                                                  |     | Clayey Silt<br>Slight silica enrichment at top   | ML             | Red. Brown                                       | D                      | Low k                    |              | Apedal "                      |                 | 45<br>40          | Red Earth (K2)                                                                                                                               |
| 3                                                                                                                                                                  |     | Clayey Coarse Sand<br>fine gravel                | SC             | Red. Brown                                       | D                      | Med k                    |              | Apedal "                      |                 | 80                | Sub-Solum                                                                                                                                    |
|                                                                                                                                                                    |     | cohesionless fine gravel                         | GP             | Brown                                            | D                      | High k                   |              | Apedal "                      |                 |                   | Potential Aquifer                                                                                                                            |
|                                                                                                                                                                    |     | cohesionless med. coarse sand                    | SP             | Brown                                            | D                      | High k                   |              | Apedal "                      |                 |                   |                                                                                                                                              |
| 4                                                                                                                                                                  |     | Clayey Gravelly Sand                             | GC             | Mainly red and yellow-brown                      | W                      | High k                   |              | Apedal "                      |                 | 50                | Sub-Solum of K3 soil                                                                                                                         |
| 5                                                                                                                                                                  |     | Clayey Coarse Gravel and Cobbles                 | GP             | Grey-Brown                                       | Sat                    | High k                   |              | Apedal "                      |                 | 70                | Alluvium                                                                                                                                     |
|                                                                                                                                                                    |     | Clayey Gravel                                    | GC             | Grey                                             | Sat                    |                          |              | Apedal "                      |                 |                   | E.W. Mudstone                                                                                                                                |
| <p>Hole Depth: 5.58m</p> <p>Bedrock: Grey Mudstone</p> <p>Groundwater: 5.10m after drilling completed<br/>4.21m on 1/11/77</p> <p>Equipped with slotted casing</p> |     |                                                  |                |                                                  |                        |                          |              |                               |                 |                   |                                                                                                                                              |

Driller: Stewart Bros. Drill type: Semco.

Not sampled

Checked by:

**BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS**

**Geological Log of Auger Hole**

Project: Piallage Landfill Site

Hole: 3

Date: 9-11-76

Logged by: R.E. J.R.K.

| DEPTH (metres)                                                                           | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plast.) | Unified symbol | COLOUR<br>Pale or dark<br>— Comb. col.<br>R-B, Y-B | Moisture<br>D, M, S, PL, W | In Situ<br>Permeability<br>(k)<br>Groundwater<br>Observations | Massive<br>Pore<br>Crumb etc.<br>Structure | Sampling method | Core Auger (g) | GEOLOGICAL<br>Petrological<br>DESCRIPTION<br><br>[Solon Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|------------------------------------------------------------------------------------------|-----|----------------------------------------------------|----------------|----------------------------------------------------|----------------------------|---------------------------------------------------------------|--------------------------------------------|-----------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                          |     | Clayey Silt                                        | ML             | dull grey                                          | D                          | Med. k                                                        | Apedal                                     | Aug             | 60             | Minimal<br>Prairie                                                                                                                           |
| 1                                                                                        |     | Silty Clay (Min. Fe pisolites)                     | CL             | Pale grey                                          | D                          | Low k                                                         | Apedal                                     | -               |                | Gray Earth                                                                                                                                   |
| 2                                                                                        |     | Sandy Clay                                         | CL             | Pale<br>brown                                      | D                          | Low k                                                         | Apedal                                     | "               | 65             | Extremely<br>weathered<br>Bedrock.                                                                                                           |
|                                                                                          |     |                                                    |                |                                                    |                            |                                                               |                                            |                 | 60             | Dacite                                                                                                                                       |
| Hole Depth: 2.71 m<br>Bedrock: Dacite<br>Groundwater: Not encountered<br>Hole Backfilled |     |                                                    |                |                                                    |                            |                                                               |                                            |                 |                |                                                                                                                                              |

Driller: Stewart Bros. Drill type: Genco.

☒ Not sampled

Checked by:

**BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS**

Geological Log of Auger Hole  
R.L. 566.1m

Project: Pilling Landfill Site

Hole: 4

Date: 9.11.76

Logged by: R.E. J.R.K.

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plot)                                                                 | Unified symbol | COLOUR<br>Pole or dark<br>Comb. col.<br>R-B, Y-B | Moisture<br>D <sub>max</sub> PL <sub>max</sub> | In Situ<br>Permeability<br>(k)<br>Groundwater<br>Observations | Moisture<br>Permeability<br>Structure<br>Crumb etc. | Sampling method | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Solon Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|------------------------------------------------------------------------------------------------------------------|----------------|--------------------------------------------------|------------------------------------------------|---------------------------------------------------------------|-----------------------------------------------------|-----------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
|                |     | Organic clayey Sand                                                                                              | OL             | Black                                            | D                                              | High k                                                        | Apedal                                              | Aug             | 25                | Alluvium<br>(K1)                                                                                                                            |
| 1              |     | Coarse Sand                                                                                                      | SC             | Red-Brown                                        | O                                              | High k                                                        | Apedal                                              | "               |                   |                                                                                                                                             |
|                |     | Medium Coarse Sand<br>(Cohesionless)                                                                             | SP             | Brown                                            | D                                              | High k                                                        | Apedal                                              | "               | 35                |                                                                                                                                             |
| 2              |     | Coarse Sandy Gravel                                                                                              | GC             | Brown                                            | W                                              | High k<br>Sat.                                                | Apedal                                              | "               | 50                | Alluvial<br>(Eolian?)<br>Red-Brown<br>Earth<br>(K2)                                                                                         |
| 3              |     | Clayey Silt                                                                                                      | ML             | Red-Brown                                        | D                                              | Low k                                                         | Earthy<br>Fabric                                    | "               | 70                |                                                                                                                                             |
| 4              |     | becoming clayey towards<br>base.                                                                                 |                |                                                  |                                                |                                                               |                                                     |                 | 55                |                                                                                                                                             |
|                |     | some mottling                                                                                                    |                |                                                  |                                                |                                                               |                                                     |                 |                   |                                                                                                                                             |
| 5              |     | Not cored, samples too wet.                                                                                      |                |                                                  |                                                |                                                               |                                                     |                 | 0                 |                                                                                                                                             |
|                |     | Hole Depth: 5.46 m<br>Bedrock: Not encountered<br>Groundwater: 1.82 m after drilling completed<br>2.57m on 11.77 |                |                                                  |                                                |                                                               |                                                     |                 |                   |                                                                                                                                             |
|                |     | Equipped<br>with slotted<br>casing 1.80-5.40 m                                                                   |                |                                                  |                                                |                                                               |                                                     |                 |                   |                                                                                                                                             |

Drill: Stewart Bros Drill type: Genco

Not sampled

Checked by:

BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS

Geological Log of Auger Hole

R.L 566.1m

Project: Pialligo Landfill  
Site

Hole: 5

Date: 9/11/76

Logged by: R.E.  
J.R.K.

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plast.)                                   | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col<br>R-B-Y-B | Moisture<br>D.M. < P.L.W. | Permeability<br>(k)                | Moisture<br>Pore<br>Structure<br>Crumb etc. | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br>[Eolian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|--------------------------------------------------------------------------------------|----------------|------------------------------------------------|---------------------------|------------------------------------|---------------------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------|
|                |     |                                                                                      |                |                                                |                           | Groundwater<br>Observations        |                                             |                   |                                                                                                                                          |
| 0              |     | Hole not cored                                                                       |                |                                                |                           |                                    |                                             |                   |                                                                                                                                          |
| 1              |     |                                                                                      |                |                                                |                           |                                    |                                             |                   |                                                                                                                                          |
| 2              |     |                                                                                      |                |                                                |                           |                                    |                                             |                   |                                                                                                                                          |
| 3              |     |                                                                                      |                |                                                |                           | 2.7m<br>Groundwater<br>encountered |                                             |                   |                                                                                                                                          |
| 4              |     |                                                                                      |                |                                                |                           |                                    |                                             |                   |                                                                                                                                          |
| 5              |     |                                                                                      |                |                                                |                           | Water level<br>1.1.77              |                                             |                   |                                                                                                                                          |
| 6              |     |                                                                                      |                |                                                |                           |                                    |                                             |                   |                                                                                                                                          |
| 7              |     |                                                                                      |                |                                                |                           |                                    |                                             |                   |                                                                                                                                          |
| 7.9            |     | Siltstone bedrock at 7.9m                                                            |                |                                                |                           |                                    |                                             |                   |                                                                                                                                          |
|                |     | Adjacent to bore 4<br>Hole augered to 7.9m, equipped<br>with slotted casing 5.5-7.9m |                |                                                |                           |                                    |                                             |                   |                                                                                                                                          |

Driller: Stewart Bros. Drill type: Gemco

Not sampled Checked by:



**BUREAU OF MINERAL RESOURCES.  
GEOLOGY & GEOPHYSICS**

**Geological Log of Auger Hole**

Project: Piallago Landfill  
Site

Hole: 6

Date: 10/11/76

Logged by: R.E.  
J.R.K.

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plot)    | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col.<br>1-3.Y-8 | Moisture<br>D. 28-100 PL, % | In Situ                     |             | Moisture<br>Permeability<br>Structure<br>Pore<br>Content or<br>Observations | Sampling method | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Eolian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|-----------------------------------------------------|----------------|-------------------------------------------------|-----------------------------|-----------------------------|-------------|-----------------------------------------------------------------------------|-----------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
|                |     |                                                     |                |                                                 |                             | Permeability<br>(k)         | Groundwater |                                                                             |                 |                   |                                                                                                                                              |
|                |     | Organic fine sand                                   | OL             | Black                                           | D                           | High k                      |             | Apedal                                                                      | Aug.            |                   | Eolian                                                                                                                                       |
| 1              |     | Silty medium sand<br><br>Well sorted, no mottling   | SM             | Red. Brown                                      | D                           | Med. k                      |             | Apedal                                                                      | "               | 60                |                                                                                                                                              |
| 2              |     |                                                     |                |                                                 |                             |                             |             |                                                                             |                 | 50                |                                                                                                                                              |
| 3              |     |                                                     |                |                                                 |                             |                             |             |                                                                             |                 | 90                |                                                                                                                                              |
| 4              |     |                                                     |                |                                                 |                             |                             |             |                                                                             |                 | 100               |                                                                                                                                              |
| 5              |     | Coarse Clayey Gravel                                | GC             | Red.<br>Brown                                   | D                           | High k                      |             | Apedal                                                                      | "               | 70                | Alluvial<br>(K3)                                                                                                                             |
| 6              |     |                                                     |                |                                                 |                             |                             |             |                                                                             |                 | 80                |                                                                                                                                              |
| 7              |     | Coarse Clayey Sand<br>(Indurated)                   | SC             | Red. Brown                                      | D                           | Low k                       |             | Apedal                                                                      | "               | 70                |                                                                                                                                              |
|                |     | Bedrock (M.W.) Some Carbonate<br>on bedrock surface |                |                                                 |                             |                             |             |                                                                             |                 | 40                | M.W. Dacite                                                                                                                                  |
|                |     |                                                     |                |                                                 |                             | Hole backfilled<br>No water |             |                                                                             |                 |                   |                                                                                                                                              |

Driller: Stewart Bros. Drill type: Senco

Not sampled

Checked by:

**BUREAU OF MINERAL RESOURCES.  
GEOLOGY & GEOPHYSICS**

**Geological Log of Auger Hole**

Project: Pialling Landfill Site Hole: 7

Date 11.11.76

Logged by: R.E.  
J.R.K.

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plot)                         | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col.<br>R-B, Y-B | Moisture<br>D.M. - PLW | In Situ<br>Permeability<br>(k)<br>Groundwater<br>Observations | Massive<br>Porous<br>Crumbly etc.<br>Structure | Sampling method | Cut Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Eolian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|--------------------------------------------------------------------------|----------------|--------------------------------------------------|------------------------|---------------------------------------------------------------|------------------------------------------------|-----------------|------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| 1              |     | Gravelly Clay<br>contains pisolites                                      | SC             | Red<br>Yellow-Grey                               |                        | Med. k                                                        | Apedal                                         | Aug             | 60               | Yellow Grey<br>Earth<br>(K2)<br><br>Colluvial                                                                                                |
|                |     | Clayey gravel                                                            | GC             | Yellow-Brown                                     | D                      | Med. k                                                        | Apedal                                         | "               | 65               |                                                                                                                                              |
| 2              |     | Silty Gravel                                                             | SM             | Light Yellow<br>Brown                            | D                      | Med. k                                                        | Apedal                                         | "               | 55               |                                                                                                                                              |
|                |     | Gravelly Silt                                                            | MC             | Light Brown                                      | D                      | Low k                                                         | "                                              | "               |                  |                                                                                                                                              |
| 3              |     | Clayey Gravel                                                            | GC             | Red-Brown                                        | D                      | Low k                                                         | "                                              | "               | 60               | Siliceous<br>Sand                                                                                                                            |
| 4              |     | Silty-Clayey Medium Sand                                                 | SM             | Red-Brown                                        | D                      | Med. k                                                        | Apedal                                         | "               | 65               |                                                                                                                                              |
| 5              |     |                                                                          |                |                                                  |                        |                                                               |                                                |                 | 70               |                                                                                                                                              |
|                |     | Fractured Bedrock (Siltstone)                                            |                | Yellow Brown                                     |                        |                                                               |                                                |                 |                  | M.W. Bedrock<br>Siltstone                                                                                                                    |
|                |     | Hole Depth: 5.46 m<br>Bedrock: Siltstone<br>Groundwater: Not encountered |                |                                                  |                        | Hole back filled                                              |                                                |                 |                  |                                                                                                                                              |

Driller: Stewart Bros. Drill type: Semco.

Not sampled

Checked by:

**BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS**

**Geological Log of Auger Hole**  
R.L. 568.0 m

Project: Pia Higo Landfill  
Site

Hole: 8

Date: 11-11-76

Logged by: R.E. J.R.K.

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plot)                | Unified symbol | COLOUR<br>Pole or dirt<br>Comb. col.<br>2-8, Y-8 | Moisture<br>D.M. & P.L.W. | In Situ               |                                                                                    | Structure<br>Pore spaces<br>Cracks etc. | Sampling method | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Bolton Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|-----------------------------------------------------------------|----------------|--------------------------------------------------|---------------------------|-----------------------|------------------------------------------------------------------------------------|-----------------------------------------|-----------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
|                |     |                                                                 |                |                                                  |                           | Permeability<br>(k)   | Groundwater<br>Observations                                                        |                                         |                 |                   |                                                                                                                                              |
| 1              |     | Fill (Sandy Gravel)                                             | GM             |                                                  |                           |                       |                                                                                    | Porous                                  | Aug             | 70                | Fill                                                                                                                                         |
| 2              |     | Silty Sand                                                      | ML             | Yellow-Brown                                     | D                         | High k                |                                                                                    | Apedal                                  | "               | 70                | Grey Earth<br>(K2)                                                                                                                           |
| 3              |     | Silty Gravel<br>(Pallid Zone)                                   | GM             | Brown                                            | D                         | Low-Med.<br>k         |                                                                                    | Apedal                                  | "               | 80                |                                                                                                                                              |
| 4              |     |                                                                 |                | to                                               |                           |                       |                                                                                    |                                         |                 | 50                |                                                                                                                                              |
| 5              |     |                                                                 |                | Yellow<br>Brown                                  |                           | High k                |                                                                                    |                                         |                 | 40                | Colluvial<br>(Sub-Solom?)                                                                                                                    |
| 6              |     | Gravel, slightly clayey                                         | GC             | Yellow-Brown                                     | D                         | High k                |                                                                                    | "                                       |                 | 65                |                                                                                                                                              |
| 7              |     |                                                                 |                |                                                  |                           | Water level<br>1.1.77 |                                                                                    |                                         |                 | 25                |                                                                                                                                              |
| 8              |     | Silt-fine grained sand                                          | SM             | Brown                                            | D                         | High k                |                                                                                    | "                                       | "               | 25                | A Lower K1<br>cycle member                                                                                                                   |
|                |     |                                                                 |                |                                                  |                           | possible<br>aquifer   |                                                                                    |                                         |                 | 25                |                                                                                                                                              |
|                |     | Fractured Bedrock: Siltstone                                    |                | Yellow-Brown                                     | W                         | Sat.                  |                                                                                    |                                         |                 |                   | M.H. Bedrock<br>Siltstone                                                                                                                    |
|                |     | Hole Depth: 8.90 m<br>Bedrock: Siltstone<br>Groundwater: 8.80 m |                |                                                  |                           |                       | Equipped with<br>Slotted casing.<br>Groundwater<br>rose to 6.1 m<br>after drilling |                                         |                 |                   |                                                                                                                                              |

Driller: Stewart Bros. Drill types: Seneca

Mass sampled

Checked by:

Record 1979/77

IST/A16/2H2

MPT/288

**BUREAU OF MINERAL RESOURCES.  
GEOLOGY & GEOPHYSICS**

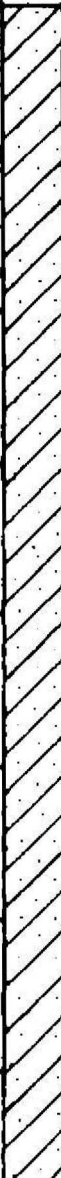
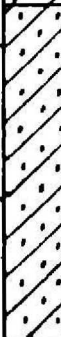
**Geological Log of Auger Hole**

Project: Piallago Landfill Site

Hole: a

Date: 23-11-76

Logged by: R.E. J.R.K.

| DEPTH (metres)                                                  | LOG                                                                                 | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plot) | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col.<br>R-B, Y-B | Moisture<br>D.M. > P.L.W | In Situ             |                             | Massive<br>Structure<br>Porous<br>Crumb etc. | Sampling method | Core Recovery (%)         | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Eolian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|-----------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------|----------------|--------------------------------------------------|--------------------------|---------------------|-----------------------------|----------------------------------------------|-----------------|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                 |                                                                                     |                                                  |                |                                                  |                          | Permeability<br>(k) | Groundwater<br>Observations |                                              |                 |                           |                                                                                                                                              |
| 1                                                               |   | Fill (Silty Clay)                                | SC             |                                                  |                          | Med - High<br>k     | Porous                      | Aug                                          | 20              | Fill                      |                                                                                                                                              |
|                                                                 |                                                                                     |                                                  |                |                                                  |                          |                     |                             |                                              | 60              |                           |                                                                                                                                              |
| 2                                                               |                                                                                     |                                                  |                |                                                  |                          |                     |                             |                                              | 35              |                           |                                                                                                                                              |
| 3                                                               |                                                                                     |                                                  |                |                                                  |                          |                     |                             |                                              | 95              |                           |                                                                                                                                              |
| 4                                                               |                                                                                     |                                                  |                |                                                  |                          |                     |                             |                                              | 20              |                           |                                                                                                                                              |
| 5                                                               |                                                                                     |                                                  |                |                                                  |                          |                     |                             |                                              | 90              |                           |                                                                                                                                              |
| 6                                                               |                                                                                     |                                                  |                |                                                  |                          |                     |                             |                                              | 80              |                           |                                                                                                                                              |
| 7                                                               |                                                                                     |                                                  |                |                                                  |                          |                     |                             |                                              | 80              |                           |                                                                                                                                              |
|                                                                 | 60                                                                                  |                                                  |                |                                                  |                          |                     |                             |                                              |                 |                           |                                                                                                                                              |
| 8                                                               |  | Gravelly clay                                    | GC             | Yellow-<br>Brown                                 | D                        | High k              | Apedal                      | "                                            |                 | E.W. Bedrock<br>Siltstone |                                                                                                                                              |
|                                                                 |                                                                                     |                                                  |                |                                                  |                          |                     |                             |                                              | 60              |                           |                                                                                                                                              |
| 9                                                               |                                                                                     |                                                  |                |                                                  |                          |                     |                             |                                              |                 |                           |                                                                                                                                              |
| Hole Depth: 9.94m - backfilled<br>Groundwater: Not Encountered. |                                                                                     |                                                  |                |                                                  |                          |                     |                             |                                              |                 |                           |                                                                                                                                              |

Driller: Stewart Bros. Drill type: Genco

Not sampled

Checked by:

**BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS**

**Geological Log of Auger Hole**

Project: Piallago Landfill Site

Hole: 10

Date: 24.11.76

Logged by: R.E. J.R.K.

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plot)                 | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col.<br>R-B, Y-B | Moisture<br>D.M. > P.L.W | In Situ<br>Permeability<br>(k) | Massive<br>Porous<br>Crumb etc.<br>Structure | Sampling method | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Solian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|------------------------------------------------------------------|----------------|--------------------------------------------------|--------------------------|--------------------------------|----------------------------------------------|-----------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
|                |     |                                                                  |                |                                                  |                          | Groundwater<br>Observations    |                                              |                 |                   |                                                                                                                                              |
| 1              |     | Fill (generally sandy clay)                                      | SC             | Black                                            |                          | High k                         | Porous                                       | Aug             | 20                | Fill                                                                                                                                         |
| 2              |     |                                                                  |                |                                                  |                          |                                |                                              |                 | 20                |                                                                                                                                              |
| 3              |     | Exhibits pungent odour                                           |                | Stained<br>Red                                   |                          |                                |                                              |                 | 80                |                                                                                                                                              |
| 4              |     |                                                                  |                |                                                  |                          |                                |                                              |                 | 60                |                                                                                                                                              |
| 5              |     |                                                                  |                |                                                  |                          |                                |                                              |                 | 20                |                                                                                                                                              |
| 6              |     |                                                                  |                |                                                  |                          |                                |                                              |                 | 75                |                                                                                                                                              |
| 7              |     |                                                                  |                |                                                  |                          |                                |                                              |                 | 60                |                                                                                                                                              |
| 8              |     | Clayey Gravel                                                    | GC             | Yellow-<br>Brown                                 | D                        | Low-Med.<br>k                  |                                              | "               | 50                | Extremely<br>Weathered<br>Siltstone                                                                                                          |
| 9              |     |                                                                  |                |                                                  |                          |                                |                                              |                 | 80                |                                                                                                                                              |
|                |     | Note Depth: 9.94 m - backfilled<br>Groundwater: Not encountered. |                |                                                  |                          |                                |                                              |                 | 80                |                                                                                                                                              |

Driller: Stewart Bros. Drill type: Gemco.

Not sampled

Checked by:

**BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS**

**Geological Log of Auger Hole**

Project: Piattigo Landfill Site

Hole: 11

Date: 24 11 76

Logged by: R.E. J.R.K.

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plot)                                                        | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col.<br>R-B, Y-B | Moisture<br>D.M. & P.L.W. | In Situ          |                          | Relative<br>Permeability<br>Structure<br>Pore size<br>Crumb etc. | Sampling method | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Solon Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|---------------------------------------------------------------------------------------------------------|----------------|--------------------------------------------------|---------------------------|------------------|--------------------------|------------------------------------------------------------------|-----------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
|                |     |                                                                                                         |                |                                                  |                           | Permeability (k) | Groundwater Observations |                                                                  |                 |                   |                                                                                                                                             |
| 1              |     | Silly Sand                                                                                              | SM             | Dark Brown                                       | D                         | High k           |                          | Apical Aug                                                       |                 | 5                 | Prairie Soil (K2)                                                                                                                           |
| 2              |     | Silly Sand<br>(Oil stained, clayey)                                                                     | SM             | Yellow-Brown                                     | D                         | Low k            |                          |                                                                  |                 | 5                 | Fill                                                                                                                                        |
| 3              |     |                                                                                                         |                |                                                  |                           |                  |                          |                                                                  |                 | 5                 |                                                                                                                                             |
| 4              |     |                                                                                                         |                |                                                  |                           |                  |                          |                                                                  |                 | 30                |                                                                                                                                             |
| 5              |     | Clay and Rock Fragments                                                                                 |                | Yellow-Brown                                     | D                         |                  |                          |                                                                  |                 | 60                | M.W. Bedrock<br>Siltstone & Sandstone                                                                                                       |
| 6              |     | Bedded Siltstone and fine gr. Sandstone.                                                                |                |                                                  |                           |                  |                          |                                                                  |                 | 70                |                                                                                                                                             |
|                |     |                                                                                                         |                |                                                  |                           |                  |                          |                                                                  |                 | 70                |                                                                                                                                             |
|                |     | Hole depth: 6.37m<br>Groundwater: Not encountered.<br>Bedrock: Siltstone, Sandstone.<br>Hole backfilled |                |                                                  |                           |                  |                          |                                                                  |                 |                   |                                                                                                                                             |

Driller: Stewart Bros. Drill type: Gemco.

☒ Not sampled

Checked by:

**BUREAU OF MINERAL RESOURCES.  
GEOLOGY & GEOPHYSICS**

Geological Log of Auger Hole  
RL. 570.20m

Project: Piliapp Landfill  
Site

Hole: 12

Date: 25.11.76

Logged by: R.E.  
J.R.K.

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plot)                  | Unified<br>symbol | COLOUR<br>Pale or dark<br>Comb. col.<br>R-B, Y-B | Moisture<br>D.M. > P.L.W. | In Situ.             |                             | Massive<br>Porous<br>Crumb etc. | Sampling<br>method | Core<br>Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Soil on Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|-------------------------------------------------------------------|-------------------|--------------------------------------------------|---------------------------|----------------------|-----------------------------|---------------------------------|--------------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
|                |     |                                                                   |                   |                                                  |                           | Permeability.<br>(k) | Groundwater<br>Observations |                                 |                    |                      |                                                                                                                                               |
| 1              |     | Organic Silty Sand                                                | SM                | Dark<br>Brown                                    | D                         | High k               |                             | Apedal                          | Aug                | 20                   | Yellow-<br>Brown<br>Earth<br><br>[Alluvial]<br>(K2)                                                                                           |
| 2              |     | Silty coarse Sand<br>top 50cm slightly indurated                  | SM                | Yellow-<br>Brown                                 | D                         | Med. k.              |                             | Apedal                          | "                  | 65                   |                                                                                                                                               |
| 3              |     | shows some sesqui-oxides                                          |                   |                                                  |                           | High k               |                             |                                 |                    | 20                   |                                                                                                                                               |
| 4              |     |                                                                   |                   |                                                  |                           |                      |                             |                                 |                    | 85                   |                                                                                                                                               |
| 5              |     | Clayey coarse Sand<br>becomes mottled with depth                  | SC                | Red-Brown<br>to<br>Yellow-<br>Brown              | D                         | Med. k               |                             | Apedal                          | "                  | 65                   |                                                                                                                                               |
| 6              |     |                                                                   |                   |                                                  |                           |                      |                             |                                 |                    | 95                   |                                                                                                                                               |
| 7              |     | shows some sesqui-oxide<br>development.                           |                   |                                                  |                           |                      |                             |                                 |                    | 60                   |                                                                                                                                               |
| 8              |     |                                                                   |                   |                                                  |                           |                      |                             |                                 |                    | 60                   |                                                                                                                                               |
| 9              |     | Bedded Silts and clays.<br>E.W. Bedrock                           | MA<br>CH          | Brown                                            | W                         | Low k.               |                             |                                 |                    |                      | E.W. Bedrock.                                                                                                                                 |
| 10             |     | Interbedded fine-grained<br>sandstone, siltstone and<br>mudstone. |                   |                                                  |                           | Saturated            |                             |                                 |                    | 100                  |                                                                                                                                               |
|                |     |                                                                   |                   |                                                  |                           |                      |                             |                                 |                    | 45                   |                                                                                                                                               |
|                |     |                                                                   |                   |                                                  |                           |                      |                             |                                 |                    | 30                   |                                                                                                                                               |

Driller: Stewart Bros Drill type: Genco.

Not completed

Checked by:



BUREAU OF MINERAL RESOURCES.  
GEOLOGY & GEOPHYSICS

Geological Log of Auger Hole

Project: Pialligo Landfill Site Hole: 12 (cont.) Date: 25 11 76

Logged by R.E. J.R.K.

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plot)                                                                            | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col.<br>E-S, Y-S | Moisture<br>D, M, & PLW | In Situ<br>Permeability<br>(k)<br>Groundwater<br>Observations | Massive<br>Porous<br>Crumb etc<br>Structure | Sampling method | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Eolian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|-----------------------------------------------------------------------------------------------------------------------------|----------------|--------------------------------------------------|-------------------------|---------------------------------------------------------------|---------------------------------------------|-----------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| 11             |     | As Above                                                                                                                    |                |                                                  |                         |                                                               |                                             |                 | 0                 | E.W. Bedrock                                                                                                                                 |
| 12             |     |                                                                                                                             |                |                                                  |                         |                                                               |                                             |                 | 0                 |                                                                                                                                              |
| 12             |     |                                                                                                                             |                |                                                  |                         |                                                               |                                             |                 | 90                |                                                                                                                                              |
| 13             |     |                                                                                                                             |                |                                                  |                         |                                                               |                                             |                 | 90                |                                                                                                                                              |
|                |     | Hole Depth: 13.2 m<br>Groundwater: 7.31m on completion of drilling<br>Bedrock Interbedded sandstone,<br>siltstone, mudstone |                |                                                  |                         | Equipped with<br>slotted casing<br>5.50 to 13.10 m            |                                             |                 |                   |                                                                                                                                              |

Driller: Stewart Bros. Drill type: Gemco.

Not sampled

Checked by:

Record 1979/77

Sheet 2 of 2

ISS/ARG/21K6

M (P) 200

**BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS**

Geological Log of Auger Hole  
R.L. 582.60m

Project: Dialligo Landfill Site Hole: 13

Date: 25.11.76

Logged by: G. J.

| DEPTH<br>(metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plast.)                                                         | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col<br>R-B, Y-B | Moisture<br>D, M, < PL, W | Permeability<br>(k)                     | Massive<br>Porous<br>Crumbly<br>Structure | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br>[Eolian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|-------------------|-----|------------------------------------------------------------------------------------------------------------|----------------|-------------------------------------------------|---------------------------|-----------------------------------------|-------------------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------|
|                   |     |                                                                                                            |                |                                                 |                           | Groundwater<br>Observations             |                                           |                   |                                                                                                                                          |
| 0<br>Δ            |     | Landfill Refuse                                                                                            |                |                                                 |                           |                                         |                                           |                   | Landfill                                                                                                                                 |
| 1<br>Δ            |     |                                                                                                            |                |                                                 |                           |                                         |                                           |                   |                                                                                                                                          |
| 2<br>Δ            |     |                                                                                                            |                |                                                 |                           |                                         |                                           |                   |                                                                                                                                          |
| 3<br>Δ            |     |                                                                                                            |                |                                                 |                           |                                         |                                           |                   |                                                                                                                                          |
| 4<br>Δ            |     |                                                                                                            |                |                                                 |                           |                                         |                                           |                   |                                                                                                                                          |
| 5<br>Δ            |     |                                                                                                            |                |                                                 |                           |                                         |                                           |                   |                                                                                                                                          |
| 6<br>Δ            |     |                                                                                                            |                |                                                 |                           |                                         |                                           |                   |                                                                                                                                          |
| 6<br>Δ            |     | clayey Gravel                                                                                              | cc             |                                                 |                           |                                         |                                           |                   |                                                                                                                                          |
| 7<br>Δ            |     |                                                                                                            |                |                                                 |                           |                                         |                                           |                   |                                                                                                                                          |
| 7<br>Δ            |     | Auger refusal at 7.0m, bedrock<br>Bedrock: siltstone<br>Groundwater: Leachate<br>encountered approx. 3.00m |                |                                                 |                           | Hole equipped<br>with slotted<br>casing |                                           |                   |                                                                                                                                          |

water level  
1.1.77

Auger Cuttings Only

? Colluvium  
or  
? Compacted base  
fill

Driller Stewart Bros. Drill type, Genco.

Not sampled Checked by:

**BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS**

**Geological Log of Auger Hole**

R.L. 583.40m

Project: Pialligo Landfill Site Hole: 14

Date: 25.11.76

Logged by: G. J.

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plast)                                                           | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col.<br>R-B, Y-B | Moisture<br>DM > PL, Y | Permeability<br>(k)                      | Massive<br>Porous<br>Crumbly<br>Structure | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br>[Eolian Residual<br>Alluvial: Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|-------------------------------------------------------------------------------------------------------------|----------------|--------------------------------------------------|------------------------|------------------------------------------|-------------------------------------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
|                |     |                                                                                                             |                |                                                  |                        | Groundwater<br>Observations              |                                           |                   |                                                                                                                                           |
| 0<br>Δ         |     | Refuse                                                                                                      |                |                                                  |                        |                                          |                                           |                   | Landfill                                                                                                                                  |
| 1<br>Δ         |     |                                                                                                             |                |                                                  |                        |                                          |                                           |                   |                                                                                                                                           |
| 2<br>Δ         |     |                                                                                                             |                |                                                  |                        |                                          |                                           |                   |                                                                                                                                           |
| 3<br>Δ         |     |                                                                                                             |                |                                                  |                        |                                          |                                           |                   |                                                                                                                                           |
| 4<br>Δ         |     |                                                                                                             |                |                                                  |                        |                                          |                                           |                   |                                                                                                                                           |
| 5<br>Δ         |     |                                                                                                             |                |                                                  |                        |                                          |                                           |                   |                                                                                                                                           |
| 6<br>Δ         |     |                                                                                                             |                |                                                  |                        | Water level<br>1.1.77                    |                                           |                   |                                                                                                                                           |
| 6<br>Δ         |     | Clayey Sand                                                                                                 | SC             |                                                  |                        |                                          |                                           |                   | ? Colluvium                                                                                                                               |
| 7<br>Δ         |     | Auger Refusal at 7.00m, bedrock<br>Bedrock: sillstone<br>Groundwater: Leachate<br>encountered approx. 5.00m |                |                                                  |                        | Hole equipped<br>with slotted<br>casing. |                                           |                   |                                                                                                                                           |

Driller: Stewart Bros. Drill type: Cemco

Not sampled Checked by:

**BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS**

**Geological Log of Auger Hole**

R.L. 582.90m

**Project:** Pialligo Landfill Site Hole: 15

**Date:** 26-11-76

**Logged by:** G.J

| DEPTH (metres) | LOG      | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plast)                                                           | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col.<br>R-S, Y-S | Moisture<br>$\Delta M = \frac{P}{L} \times 100$ | Permeability<br>(k)                     | Massive<br>Porens<br>Crumbles | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br>[Eolian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|----------|-------------------------------------------------------------------------------------------------------------|----------------|--------------------------------------------------|-------------------------------------------------|-----------------------------------------|-------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------|
|                |          |                                                                                                             |                |                                                  |                                                 | Groundwater<br>Observations             |                               |                   |                                                                                                                                          |
| 0              | $\Delta$ | Refuse                                                                                                      |                |                                                  |                                                 |                                         |                               |                   | Landfill                                                                                                                                 |
| 1              | $\Delta$ |                                                                                                             |                |                                                  |                                                 |                                         |                               |                   |                                                                                                                                          |
| 2              | $\Delta$ |                                                                                                             |                |                                                  |                                                 |                                         |                               |                   |                                                                                                                                          |
| 3              | $\Delta$ |                                                                                                             |                |                                                  |                                                 | water level<br>1.1.77                   |                               |                   |                                                                                                                                          |
| 4              | $\Delta$ |                                                                                                             |                |                                                  |                                                 |                                         |                               |                   |                                                                                                                                          |
| 5              | $\Delta$ |                                                                                                             |                |                                                  |                                                 |                                         |                               |                   |                                                                                                                                          |
| 6              | $\Delta$ |                                                                                                             |                |                                                  |                                                 |                                         |                               |                   |                                                                                                                                          |
| 6-10           |          | Auger refusal at 6.10m, bedrock<br>Bedrock: Siltstone<br>Groundwater: Leachate<br>encountered approx. 1.50m |                |                                                  |                                                 | Hole equipped<br>with slotted<br>casing |                               |                   |                                                                                                                                          |

Auger Cuttings Only.

Driller Stewart Bros. Drill type: Genco

☒ Not sampled Checked by:

**BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS**

**Geological Log of Auger Hole**

R.L. 574.34

Project: Pialligo Landfill Site Hole: 20

Date: Dec 1977

Logged by: R E

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plast)                                                              | Unified symbol | COLOUR<br><br>Pale or dark<br>Comb. col.<br>R-B, Y-B | Moisture<br>D, M, PL, W | Permeability<br>(k)                      | Aggregate<br>Structure<br>Crumbly etc. | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Eolian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|----------------------------------------------------------------------------------------------------------------|----------------|------------------------------------------------------|-------------------------|------------------------------------------|----------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
|                |     |                                                                                                                |                |                                                      |                         | Groundwater<br>Observations              |                                        |                   |                                                                                                                                              |
|                |     | Sandy Silt                                                                                                     | SM             | Light grey                                           | D                       | High k                                   | Porous                                 |                   | Horizons A <sub>1</sub> and A <sub>2</sub>                                                                                                   |
| 1              |     | Clayey Sand<br>Shows some layering                                                                             | SC             | Yellow-brown<br>to<br>Brown                          | D                       | High to Mod. k                           | Porous                                 | 30                | Weak B Horizon                                                                                                                               |
|                |     | Clay content decreases                                                                                         |                |                                                      | W                       | Water level 2174                         |                                        | 40                | Colluvium                                                                                                                                    |
| 2              |     | Clayey Sand, slightly indurated                                                                                | SC             | Red-Brown                                            | D                       | Mod. to Low k                            | Massive                                | 20                | Colluvium                                                                                                                                    |
| 3              |     | Contains rock fragments                                                                                        |                |                                                      |                         |                                          |                                        | 30                |                                                                                                                                              |
| 4              |     |                                                                                                                |                |                                                      |                         |                                          |                                        |                   |                                                                                                                                              |
| 5              |     | Sandy Gravel<br>Unconsolidated                                                                                 | GM             | Red Brown                                            | W                       | High k<br>Groundwater<br>aquifer         | Highly<br>Porous                       | 70                | Colluvium<br>Alluvium                                                                                                                        |
| 5.30           |     |                                                                                                                |                |                                                      |                         |                                          |                                        | 75                |                                                                                                                                              |
|                |     | Hole finished 5.30m, due to<br>excessive cave-in,<br>not auger refusal<br><br>Groundwater encountered<br>4.10m |                |                                                      |                         | Hole equipped<br>with slotted<br>casing. |                                        |                   |                                                                                                                                              |

Driller Stewart Bros. Drill type: Pioneer  
'Mole'

Not sampled Checked by:

**BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS**

Geological Log of Auger Hole

R.L. 572.44m

Project: Diahgo Landfill Site Hole: 21

Date: Dec. 1977

Logged by: R.E.

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plot) | Unified symbol | COLOUR<br><br>Pole or dark<br>Comb. col.<br>R-B, Y-B | Moisture<br>D.M.P., W | Permeability<br>(k)                      | Massive<br>Porous<br>Crumbly<br><br>Structure | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br><br>[Eolian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|--------------------------------------------------|----------------|------------------------------------------------------|-----------------------|------------------------------------------|-----------------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
|                |     |                                                  |                |                                                      |                       | Groundwater<br>Observations              |                                               |                   |                                                                                                                                              |
| 0              |     | Sandy silt                                       | SM             | Light Grey<br>Bleached                               | D                     | High k                                   | Porous                                        | 10                | Horizon A <sub>1</sub><br>Horizon A <sub>2</sub>                                                                                             |
| 1              |     | Well-sorted sand                                 | SW             | Grey                                                 | W                     | High k<br><br>Groundwater<br>Aquifer     | Porous                                        | 50                | Colluvium - Alluvium                                                                                                                         |
| 2              |     |                                                  |                |                                                      |                       | WATER LEVEL ▼<br>2.1.79                  |                                               |                   |                                                                                                                                              |
| 3              |     | Clayey Sand                                      | SC             | Yellow<br>Brown                                      | D                     | Low k.                                   | Apedal<br>Massive                             | 40                | Colluvium                                                                                                                                    |
| 4              |     | Gravel content increases<br>with depth           |                |                                                      |                       |                                          |                                               | 40                |                                                                                                                                              |
| 5              |     | Manganese and Iron pisolites<br>and staining     |                |                                                      |                       |                                          |                                               | 50                |                                                                                                                                              |
| 6              |     | Indurated towards base                           |                | Red to<br>Yellow-<br>Brown                           |                       |                                          |                                               | 5                 |                                                                                                                                              |
| 7              |     |                                                  |                |                                                      |                       |                                          |                                               | 60                |                                                                                                                                              |
|                |     |                                                  |                |                                                      |                       |                                          |                                               | 100               |                                                                                                                                              |
|                |     | Hole finished 7.50m, not auger<br>refusal        |                |                                                      |                       | Hole equipped<br>with slotted<br>casing. |                                               |                   |                                                                                                                                              |
|                |     | Groundwater encountered<br>approx 1.00 to 2.00m  |                |                                                      |                       |                                          |                                               |                   |                                                                                                                                              |

Driller: Stewart Bros. Drill type: Pioneer 'Mole' ☒ Not sampled Checked by:

**BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS**

**Geological Log of Auger Hole**

R L 582 94 m

Project: Pilling Landfill Site Hole: 22

Date: Dec 1977

Logged by: R.E.

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text plast.)                                                                  | Unified symbol | COLOUR<br>Pale or dark<br>Comb col<br>R-B Y-B | Moisture<br>D.M. > PLW | Permeability<br>(k)<br>Groundwater<br>Observations                                        | Massive<br>Porous<br>Structure<br>Crumbly | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br>[Eolian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|--------------------------------------------------------------------------------------------------------------------|----------------|-----------------------------------------------|------------------------|-------------------------------------------------------------------------------------------|-------------------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 0              |     | Sandy Silt                                                                                                         | SM             | Light Grey<br>Bleached                        | D                      | High k                                                                                    | Porous                                    | 10                | Horizon A <sub>1</sub> and A <sub>2</sub>                                                                                                |
| 1              |     | Silty clayey sand<br>Shows Manganese staining and<br>Iron oxides                                                   | SC             | Grey, with<br>Yellow Brown<br>staining        | D                      | Mod to Low k                                                                              | Apedal<br>Porous                          |                   | Weak B Horizon                                                                                                                           |
| 2              |     | Sandy Clay<br>Manganese nodules and staining                                                                       | SC             | Yellow<br>Brown                               | D                      | High to Mod k                                                                             | Porous                                    | 60                | Sub. solum,<br>Colluvium.                                                                                                                |
| 3              |     | Indurated sandy clay<br>Contains angular gravel<br>Manganese stained                                               | SC             | Yellow brown<br>to<br>grey                    | D                      | Low k                                                                                     | Massive                                   | 70                | Colluvium                                                                                                                                |
| 4              |     | Coarse gravel est. base                                                                                            |                |                                               |                        |                                                                                           |                                           |                   |                                                                                                                                          |
| 5              |     | Olive brown mudstone<br>All structure destroyed by<br>drilling fracture towards the<br>top<br>Moderately weathered |                | Olive<br>brown                                | D                      | Low to Mod k<br><br>Possible<br>fractured rock<br>aquifer                                 |                                           | 30<br>40          | Bedrock                                                                                                                                  |
| 6              |     | Fossiliferous layer, shells and<br>crinoids                                                                        |                |                                               |                        |                                                                                           |                                           | 100               |                                                                                                                                          |
| 7              |     |                                                                                                                    |                |                                               |                        |                                                                                           |                                           |                   |                                                                                                                                          |
| 8              |     | Slightly calcareous                                                                                                |                | Black to<br>Blue-grey                         |                        | Hole drilled<br>with water<br>No standing<br>water level<br>immediately<br>after drilling |                                           | 100               |                                                                                                                                          |
| 9              |     |                                                                                                                    |                |                                               |                        |                                                                                           |                                           |                   |                                                                                                                                          |
| 10             |     |                                                                                                                    |                |                                               |                        |                                                                                           |                                           |                   |                                                                                                                                          |

Groundwater levels 7.57 m on 2.1.79

10.51 m on 8.6.79

Driller Stewart Bros. Drill type: Pioneer  
"Mole"

Not sampled Checked by:



BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS

Geological Log of Auger Hole

Project: Pialligo Landfill Site Hole: 22 (cont.) Date: Dec 1977 Logged by: R E

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text plast.)                   | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col.<br>R-B-Y-B | Moisture<br>D.M. & P.L.W | Permeability<br>(k)                      | Massive<br>Porous<br>Structure<br>Crumbly etc | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br>[Eolian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|---------------------------------------------------------------------|----------------|-------------------------------------------------|--------------------------|------------------------------------------|-----------------------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------|
|                |     |                                                                     |                |                                                 |                          | Groundwater<br>Observations              |                                               |                   |                                                                                                                                          |
| 11             | 0   | Calcareous mudstone<br>Contains calcite piebs,<br>calcite stringers |                |                                                 |                          |                                          |                                               | 100               | Bedrock                                                                                                                                  |
|                | -   | Slightly weathered to fresh                                         |                | Black to<br>Blue grey                           |                          | Low to<br>Mod k                          |                                               |                   |                                                                                                                                          |
| 12             | -   | No natural fracturing.<br>All joints calcite healed                 |                |                                                 |                          |                                          |                                               |                   |                                                                                                                                          |
| 13             | -   |                                                                     |                |                                                 |                          |                                          |                                               | 100               |                                                                                                                                          |
| 14             | -   |                                                                     |                |                                                 |                          |                                          |                                               |                   |                                                                                                                                          |
| 14.50          | -   |                                                                     |                |                                                 |                          |                                          |                                               |                   |                                                                                                                                          |
|                |     | Hole finished 14.50m<br>Bedrock                                     |                |                                                 |                          | Hole equipped<br>with slotted<br>casing. |                                               |                   |                                                                                                                                          |

Driller Stewart Bros. Drill type: Pioneer  
'Mole'



Not sampled Checked by:

**BUREAU OF MINERAL RESOURCES,  
GEOLOGY & GEOPHYSICS**

**Geological Log of Auger Hole**

R.L. 589.22 m

Project: Djaligo Landfill Site Hole: 23

Date: Dec 1977 Logged by: R E

| DEPTH (metres) | LOG | ENGINEERING<br>SOILS DESCRIPTION<br>(Text, plast)                                                            | Unified symbol | COLOUR<br>Pale or dark<br>Comb. col<br>R-B-Y-B | Moisture<br>D.M. & P.L.W | Permeability<br>(k)                  | Massive<br>Porous<br>Crumbly etc. | Core Recovery (%) | GEOLOGICAL<br>PEDOLOGICAL<br>DESCRIPTION<br>[Eolian Residual<br>Alluvial Colluvial<br>Decomposed rock<br>Horizon A, B, C<br>Buried soil] |
|----------------|-----|--------------------------------------------------------------------------------------------------------------|----------------|------------------------------------------------|--------------------------|--------------------------------------|-----------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------|
|                |     |                                                                                                              |                |                                                |                          | Groundwater<br>Observations          |                                   |                   |                                                                                                                                          |
|                |     | Silt, slightly sandy                                                                                         | SM             | Light Grey<br>Bleached                         | D                        | High to Mod k                        | Porous                            | 25                | Horizon A, and A <sub>c</sub>                                                                                                            |
| 1              |     | Clayey Sandy Gravel                                                                                          | GC             | Red Brown                                      | D                        | Low k                                | Apedal<br>Massive                 |                   | Weak B Horizon                                                                                                                           |
|                |     | Sesqui-oxide pisolites<br>Clay content increases with<br>depth<br>Some large gravel - 2.5 x 2 cm             |                |                                                |                          | Low to Mod k                         |                                   | 25                |                                                                                                                                          |
| 2              |     | Indurated Clayey Sand<br>Contains occasional small<br>angular quartz grains<br>Some areas are very<br>sandy. | SC             | Yellow-<br>Grey<br>to<br>White-<br>tan         | D                        | Low k<br><br>water level<br>2.1.79   | Massive                           | 20                | Colluvium                                                                                                                                |
| 3              |     |                                                                                                              |                |                                                |                          |                                      |                                   | 30                |                                                                                                                                          |
| 4              |     |                                                                                                              |                |                                                |                          |                                      |                                   |                   |                                                                                                                                          |
| 5              |     |                                                                                                              |                |                                                |                          |                                      |                                   | 20                |                                                                                                                                          |
|                |     | Hole finished 5.00 m<br>Auger refusal<br>No groundwater encountered<br>during drilling                       |                |                                                |                          | Hole cased<br>with slotted<br>casing |                                   |                   |                                                                                                                                          |

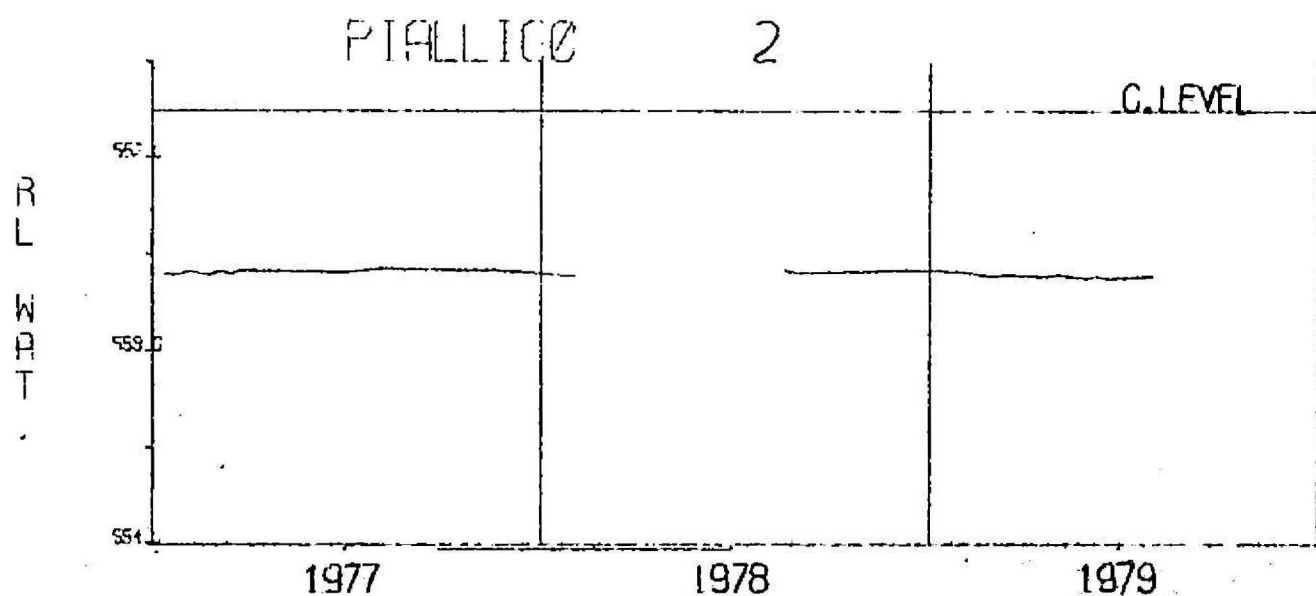
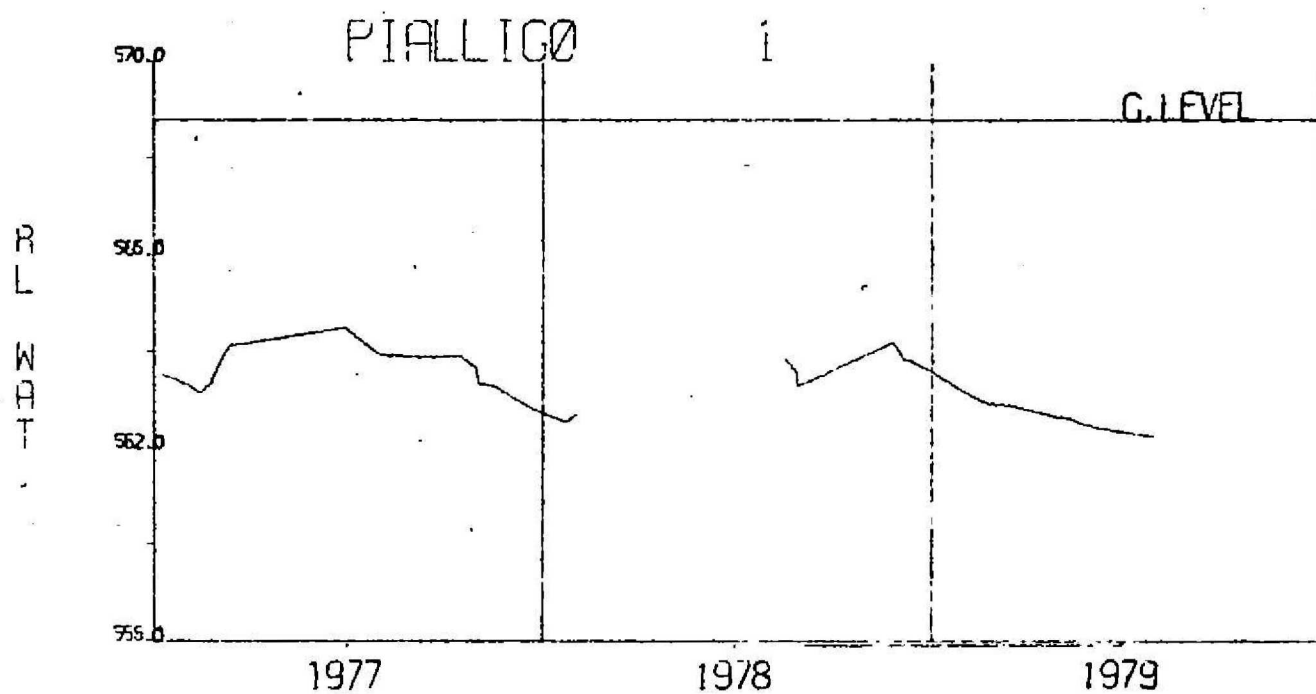
Driller Stewart Bros. Drill type. Pioneer  
'Mole'

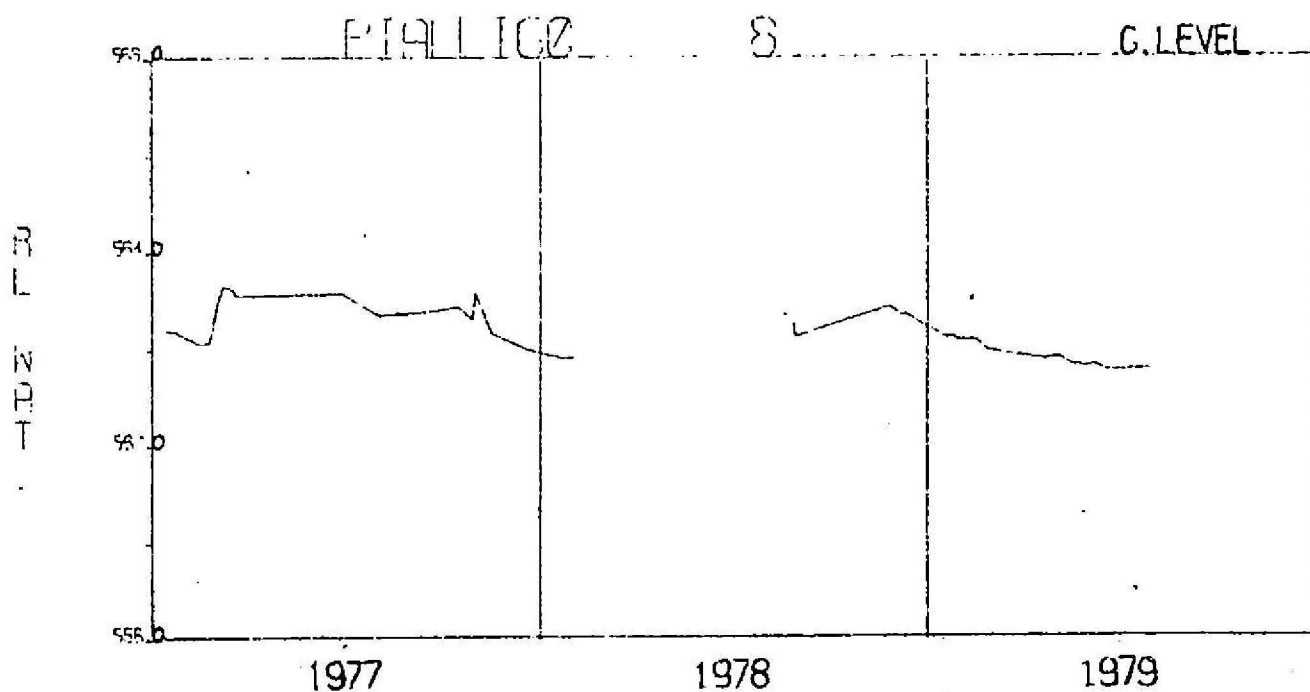
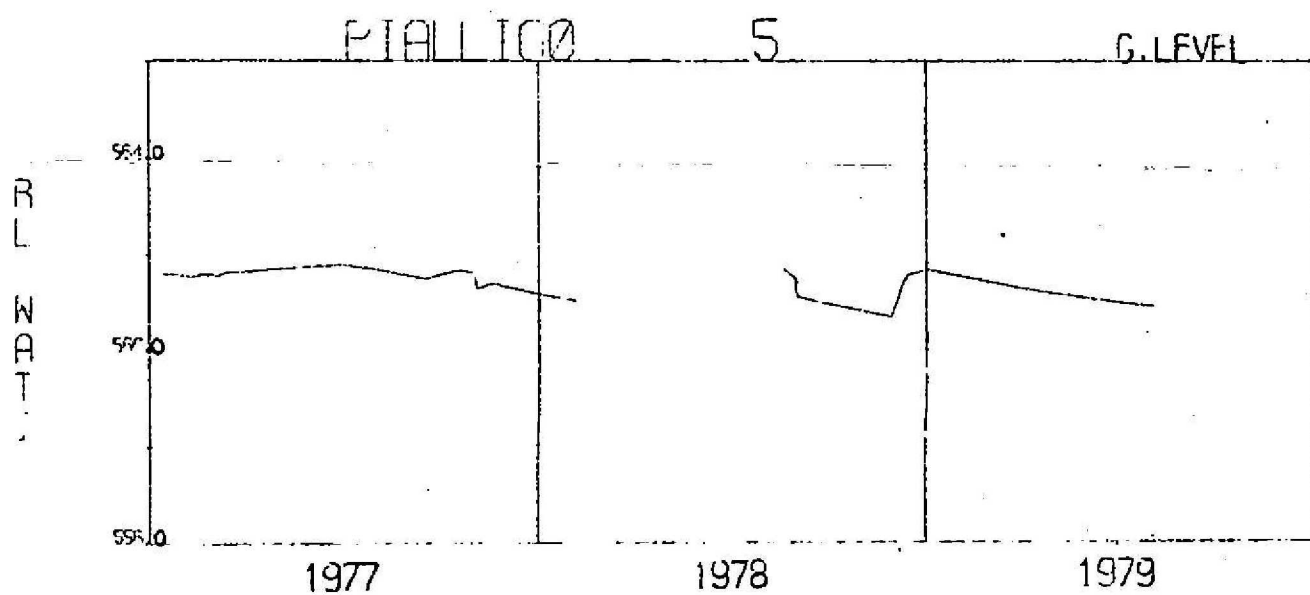
Not sampled Checked by:

APPENDIX 2

OBSERVATION BORE HYDROGRAPHS, 1977-79

Bores 1, 2, 5, 8, 12, 13, 14, and 15

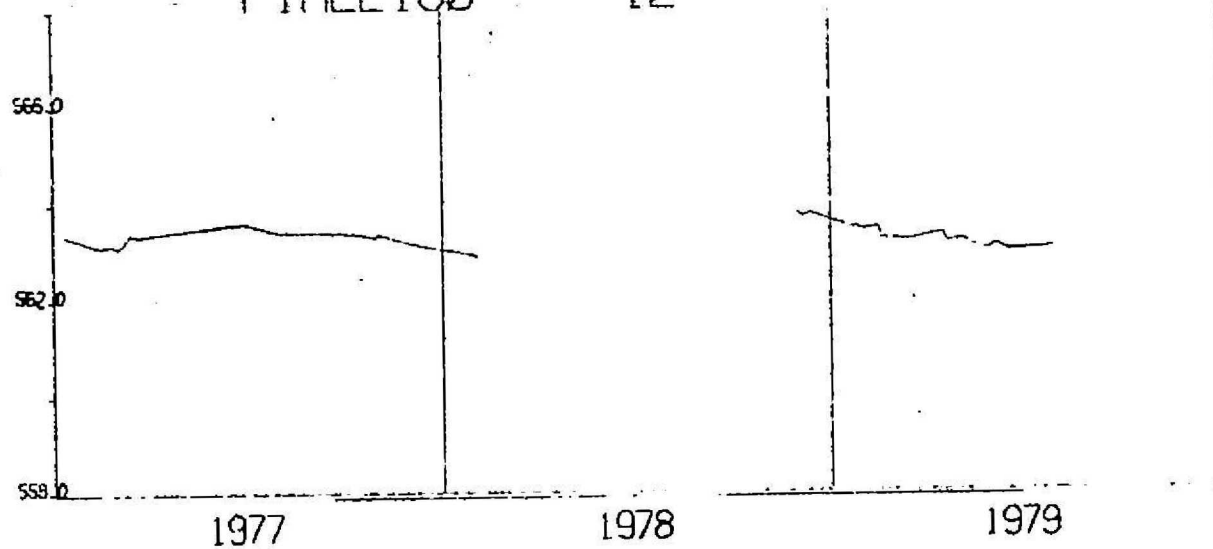




G. LEVEL

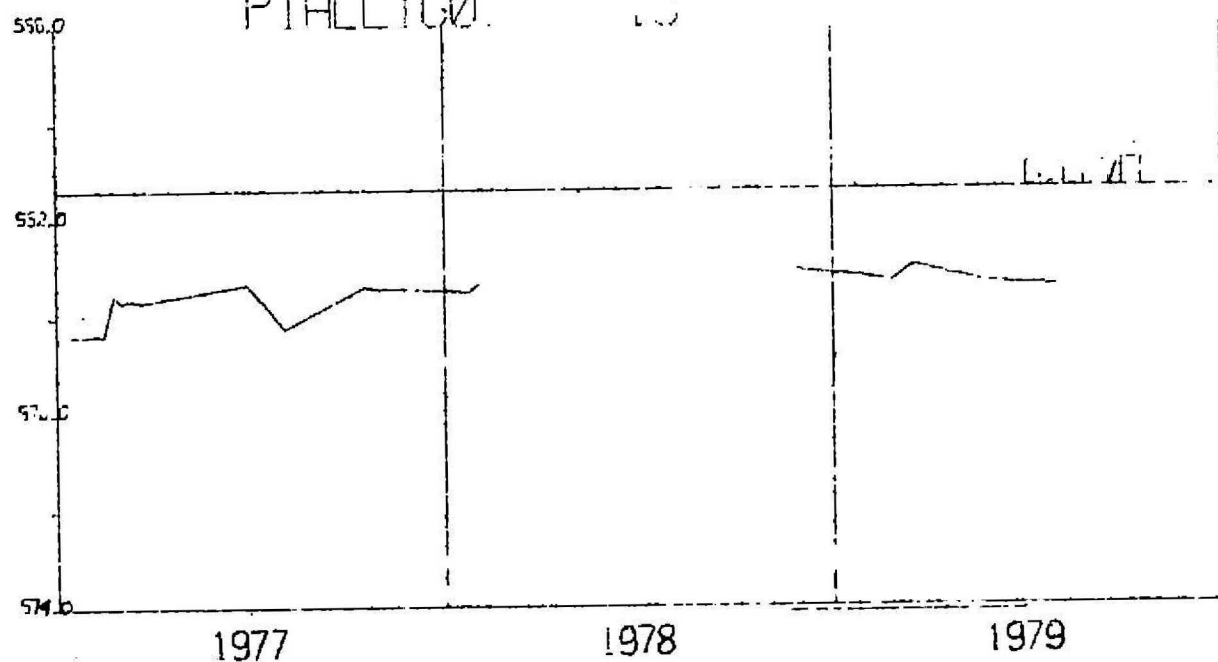
PIALLIGØ 12

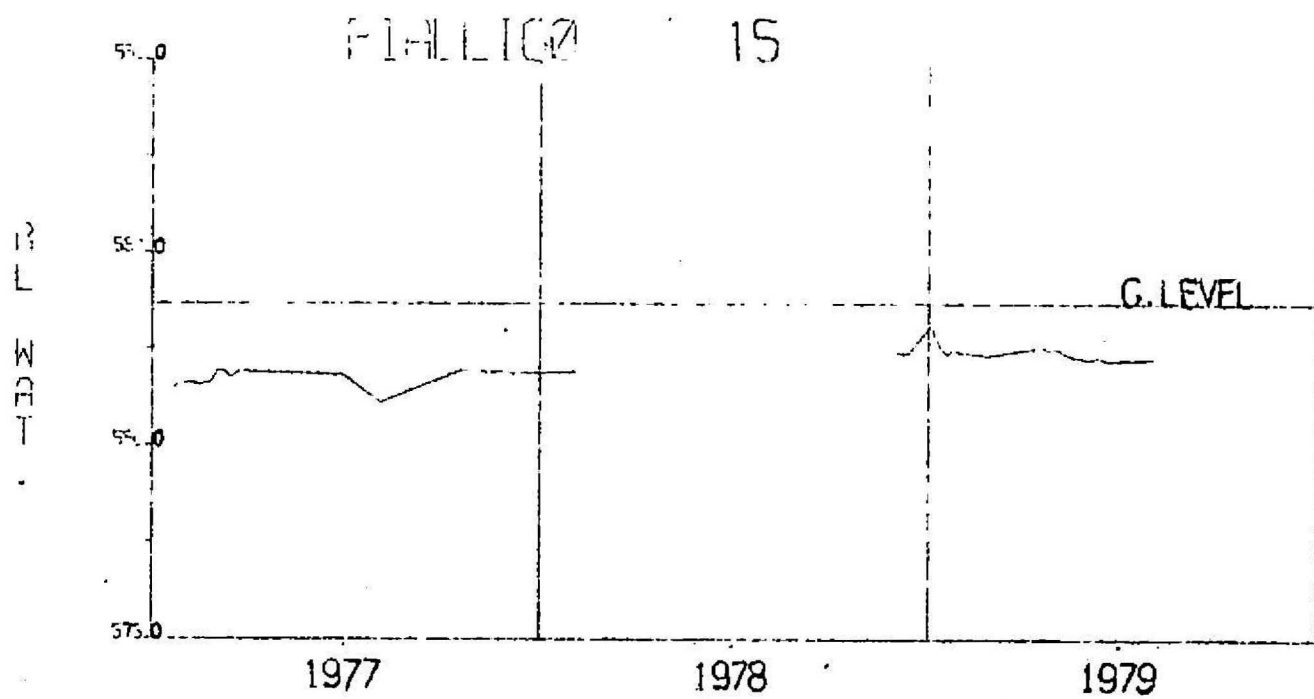
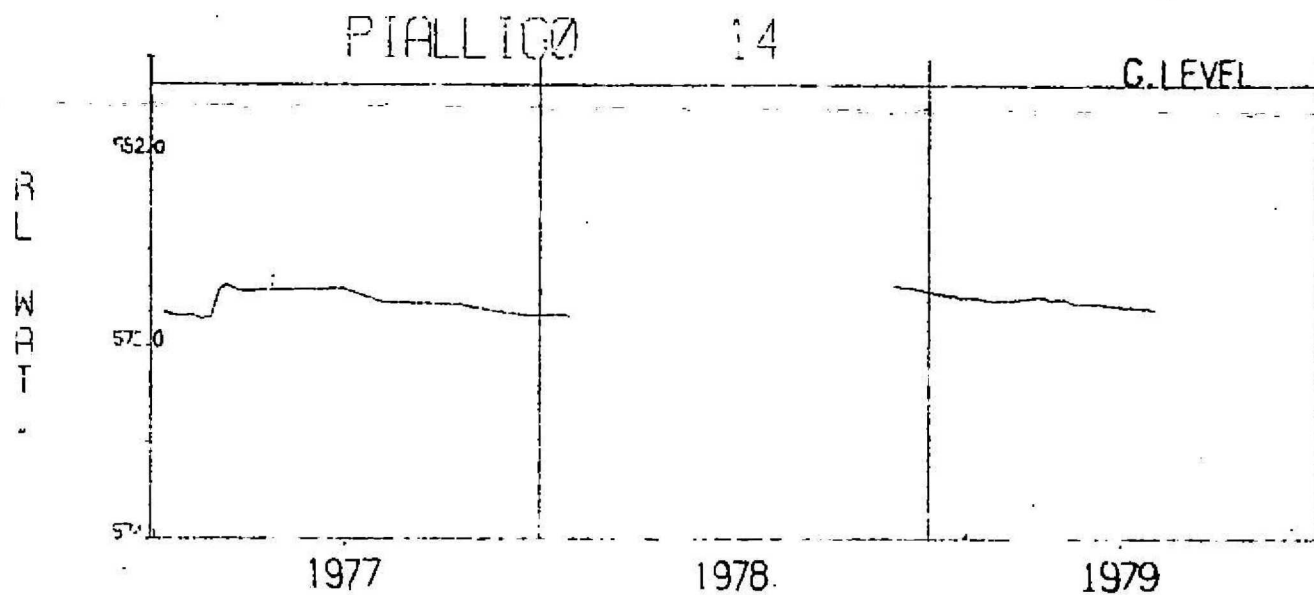
R  
L  
W  
A  
T



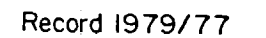
PIALLIGØ 10

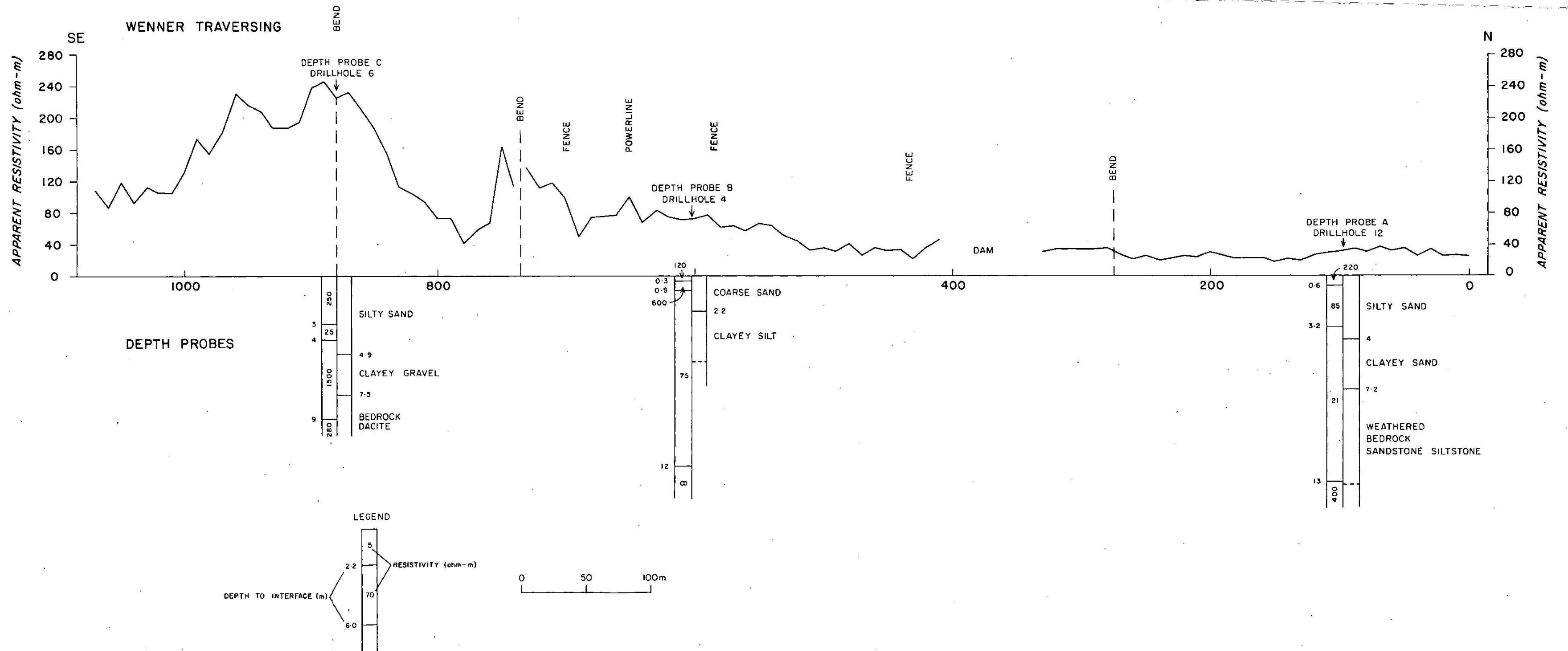
R  
L  
W  
A  
T











PIALLIGO-RESISTIVITY TRAVERSING RESULTS