

WELSH INDUSTRIAL ESTATES CORPORATION

PROPOSED DEVELOPMENT OF THE NORTHERN SECTION  
OF THE HIRWAUN INDUSTRIAL ESTATE

REPORT ON SITE INVESTIGATION

LAB. REF. NO. S/8731

JANUARY, 1972.

# NOTES

## GENERAL

(i) The comments given in this report and the opinions expressed are based on the soil conditions encountered in the boreholes and on the results of tests made in the field and in the laboratory. There may, however, be special conditions obtaining at the site which have not been disclosed by the boreholes and which have not been taken into account in the report.

(ii) The comments on ground-water conditions given on the borehole records are based on observations made at the time the boreholes were sunk. It should be noted, however, that ground-water levels vary due to seasonal or other effects.

## SPECIAL FIELD TESTS

Where there is reference in the report to the undermentioned tests they were made in the field by the methods given below:—

### Standard Penetration Test

This test is made using the procedure described by Terzaghi and Peck<sup>(1)</sup>. A 50mm (2in) diameter split spoon sampler is driven into the soil using a 63.50kg (140lb) hammer with a 760mm (30in) drop and the 'penetration resistance' is expressed as the number of blows required to obtain 305mm (12in) penetration of the sampler. With soil of high resistance it is not always possible to attain 305mm (12in) penetration; in this case the number of blows required to obtain the actual penetration achieved is shown on the borehole record.

### Dynamic Cone Penetration Test

This is made using a similar procedure to the standard penetration test, but with a 50mm (2in) diameter, 60 degree apex, solid cone fitted to the split spoon sampler.

## PROCEDURE FOR SHEAR STRENGTH TESTS

The various types of shear strength test, when made, are denoted in the tables of laboratory test results by the following symbols:—

- U1(1½) - Undrained Triaxial Compression Test on single 38mm (1½in) diameter specimen at a lateral pressure approximately equal to overburden pressure.
- U1(4) - Undrained Triaxial Compression Test on single 102mm (4in) diameter specimen at a lateral pressure approximately equal to overburden pressure.
- U(1½) - Undrained Triaxial Compression Test on set of three 38mm (1½in) diameter specimens at three different lateral pressures.
- UM(1½) - Modified Undrained Triaxial Compression Test on single 38mm (1½in) diameter specimen. In this test an initial low lateral pressure is applied to the specimen and the deviator stress increased until failure is imminent. The lateral pressure is then increased and the procedure repeated, where possible, until the failure stresses at three different lateral pressures have been determined.
- UM(4) - Modified Undrained Triaxial Compression Test on single 102mm (4in) diameter specimen. The procedure for this test is similar to that described above for a 38mm (1½in) diameter specimen.
- UC - Unconfined Compression Test on 38mm (1½in) diameter specimen.
- LV - Laboratory Vane Test.

- 1 -

(1) Terzaghi, K. and R. B. Peck, - 'Soil Mechanics in Engineering Practice', Second Edition, John Wiley, 1967, p. 304.

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1. Introduction

It is proposed to develop the northern section of the Hirwaun Industrial Estate at Hirwaun, South Wales. On the instructions of Wallace Evans and Partners, Consulting Engineers to the Welsh Industrial Estate Corporation, borings were sunk, trial pits excavated and in-situ and laboratory tests were made to provide information on the extent of peat deposits and on the soil conditions for foundation design.

Reports prepared by Soil Mechanics Ltd. which contain information relating to the southern section of the Industrial Estate were made available by the Consulting Engineers.

The site work was carried out during the period 12th to 30th November, 1971.

2. Topography of Site

The estate is situated about two miles west of Hirwaun, immediately north of the Heads of the Valleys road (A465) to Neath.

The northern section of the industrial estate has a complicated layout as shown on the site plan (Fig. 21). It is understood to be about 24 hectares in extent and is divided into three areas by a sewerage works, and a disused railway line which, together with an adjoining stream, crosses the site in a roughly north-west to south-east direction. The three areas referred to are described below:-

Northern Area: this is mainly waste ground which lies north of the disused railway line and was formerly occupied by an Ordnance Factory. The remains of this factory in the form of concrete roads, disused pill-boxes, old foundations and a rubbish tip are evident, together with sub-station buildings. To the east of the waste ground is a hill-grassed higher area: a stream crosses this area to flow into the one referred to above.

South-Eastern Area: this is an elongated expanse of generally high ground covered by hill grass. It rises to the south from the disused railway line to the reservation for the extension of the Heads of the Valleys road: the maximum difference in level is about 15m. There is a 400kV power line mounted on pylons which crosses part of this area.

South-Western Area: this is a small isolated hill-grassed area which is separated from the south-eastern area described above by the sewerage works. It also rises southwards from the disused railway line to the Heads of the Valleys reservation, where work was in progress at the time of the investigation; the maximum difference in level is about 13m.

### 3. Geology of Site

Geological records available are the 1/63360 scale map (sheet 231) and the 1/10560 scale map (sheet 49 Breconshire), which was mapped at a later date.

Both maps show that the site is covered by glacial drift (Boulder Clay) with areas of peat which is underlain by the Fairwell Rock sandstone of Carboniferous age. However, whilst both maps indicate a prominent peat deposit south of the disused railway line, only a small part of which occupies the site under consideration\*, there is conflicting information as to the extent of the peat deposit north of the disused railway line: the 1/63360 scale map shows an area of peat, whilst the 1/10560 scale map shows the same area mapped as alluvium. The results of the investigation, discussed in Section 6, et seq. below, tend to confirm that the information provided by the 1/10560 scale map is to be preferred.

### 4. Site Investigation

Eight boreholes (Nos. 1 to 3, 5 and 6, and 8 to 10) were sunk by shell and auger methods and sixteen trial pits were excavated by mechanical digger at the positions shown on the site plan (Fig. 21). The depths of the boreholes and trial pits, the descriptions of the soils encountered and comments on ground-water conditions are given in the borehole records (Figs. 1 to 8) and the trial pit records (Figs. 9 to 16).

Representative disturbed and, where possible undisturbed samples, were taken at the depths shown on the borehole and trial pit records, and were despatched to the Laboratory at Hayes for examination and testing. Standard and dynamic cone penetration tests were made in the boreholes in sand and gravel to assess the relative density of the material; the values of penetration resistance are given in the borehole records.

A total of fifty-one Mackintosh probes were made to determine the presence or otherwise of peat. Twenty-two probes were made in the northern area and the results are given in Table 1; a further twenty-nine probes were made in the south-eastern area, and the positions and results of these probes are shown in Fig. 17.

Two shallow trenches were excavated to investigate two areas of suspected peat in the northern area. Descriptions of the materials encountered in the trenches, together with their approximate location are given in Fig. 18.

The ground levels at the borehole and trial pit positions, given on the records, were interpolated from contours given on the site survey drawings provided by the Consulting Engineers.

\* the southern extremity of the south-eastern area, referred to in Section 2, above.

## 5. Laboratory Testing

The natural moisture contents of three 0.10m diameter undisturbed samples and ten disturbed samples were determined and the results are given in Table 2, where the result of a natural wet density determination made on an 0.10m undisturbed sample is also given.

The natural moisture content/dry density relationships of three selected samples from the presumed cut areas were determined using the British Standard Compaction test (2.5kg rammer method); the results of these tests are given in Figs. 19 and 20.

Chemical analyses were made on one ground-water and nine soil samples to determine their total sulphate contents and, in the case of the water sample, the pH value. The results of these tests are given in Table 3.

## 6. Comments on Soil Conditions in Relation to Foundation Design

### 6.1 General

In the boreholes and trial pits, glacial drift often overlain by fill or alluvium was generally penetrated to the full depths bored. Numerous large boulders in the glacial drift precluded the positive identification of bedrock in any borehole, but it is possible that bedrock was met in boreholes 2 and 10 at depths of 3.00m and 11.00m below ground level, respectively. The term 'boulder or bedrock' has been used in the records.

The glacial drift was either sandy clay containing gravel, cobbles and boulders or clayey sand and gravel with cobbles and boulders. Trial pits 1 and 2 located at the rubbish tip in the northern area of the site revealed 1.85m of building rubble and industrial refuse underlain by glacial drift: clay fill was found in trial pits 4, 7 and 11 excavated in the same area of the site and, in trial pits 7 and 11, the fill was underlain by topsoil, presumably the original topsoil present prior to placing the fill. Alluvium comprising sandy silty clay with occasional gravel and cobbles was encountered in trial pits 4, 6 and 8, also in the northern area: the trial pits were excavated in a region mapped as alluvium on the 1/10560 scale geological map (see Section 3, above). Compressible organic clay was met in the low-lying parts of the site.

Ground-water was present in all boreholes and was observed at depths between 0.35m and 1.30m below ground level in the northern area, and at depths between ground level and 10.00m below ground level in the south-eastern and south-western areas of the site. Ground-water was also met in all trial pits except trial pits 12 and 14; it quickly filled trial pits 1, 2, 4, 6 and 9 to the respective ground-water levels, and the sides of the trial pits collapsed.

Ground-water is unlikely to present problems when excavating the higher parts of the site, providing that cuts are shallow and that proper attention is paid to drainage. As much of the glacial drift is essentially granular, it should not be difficult to work even when ground-water is met.

## 6.2 Peat Deposits

### 6.2.1 Northern Area

The Mackintosh probes sunk in the northern area failed to establish the presence of any extensive deposits of peat. It is understood that two confined areas of peat were disclosed during demolition of the factory buildings near the service ring road\*: one near the south-west corner, and the other roughly between borehole 5 and fifth avenue. The areas were probably backfilled with hardcore and building rubble at the time of demolition, as there is now no surface evidence of peat in the areas. Two trial trenches excavated in the areas referred to revealed small thicknesses of organic clay, and near trial pit 6, some peat, sometimes overlain by hardcore and rubble; however, no extensive deposits of the peat were found (see Fig. 16).

### 6.2.2 South-Eastern Area

The extent of the peat deposits in the southern section of the estate is clearly shown on the 1/10560 scale geological map; information on the peat at this location is also given in the reports prepared by Soil Mechanics Ltd. (see Section 1, above). On the basis of this information, the peat deposits located in the south-eastern area of the site under consideration were explored by Mackintosh probes using a 15m grid. Reference to Fig. 17, where the results are shown, indicates that the peat deposits do not extend far into the south-eastern area of the site, and they decrease in thickness rapidly.

## 6.3 Foundation Design

### 6.3.1 General

It is understood that the site will be regraded by forming shallow cuts in the high ground and that where suitable, the excavated material will be used as fill over the remainder of the site. A maximum fill thickness of 2m is proposed; excess cut material will be run to spoil.

Detailed information as to the type of structures to be built was not available at the time of writing this report, but they are expected to be light industrial buildings, some to be sited in the areas of cut, and others in areas of fill.

### 6.3.2 Foundations in Cut

Where glacial drift is exposed, conventional spread foundations should be taken to a minimum depth of 0.75m below final ground level where, based on visual inspection of the soils exposed in the trial pits and the results of in-situ penetration tests made in the boreholes, an allowable net bearing pressure of 200kN/m<sup>2</sup> may be adopted. This bearing pressure allows for a factor of safety generally in excess of about three: settlement should be small. Foundation bases should be inspected after excavation and where boulders have been removed the voids should be filled with mass concrete or suitable granular fill. As pointed out in Section 6.1, above, ground-water was present at shallow depths in places: consequently, a

\* the names and locations of roads referred to in the text are given on the site plan (Fig. 21).

blinding layer of concrete should be placed over the foundation bases where an essentially clayey glacial drift is exposed, to prevent softening.

Because its presence is confined to the low-lying parts of the northern area of the site, alluvium and compressible organic clay are not expected to be exposed in cut, which as already pointed out will be made in the high ground.

### 6.3.3 Foundations on Fill

Compressible clay fill and organic clay are present at the site as follows:-

- (a) in the southern portion of the northern area, bounded by the ring road, where up to 1.00m of soft to firm organic clay and, in places, peat were encountered beneath hardcore, rubble and old foundations (see Section 6.2.1, above).
- (b) in the low-lying part of the south-eastern area of the site where general probing suggested the presence of up to about 1m of soft organic topsoil and clay, overlying glacial drift.
- (c) in the low-lying western margin of the northern area where general probing again suggested about 0.5m of organic clay underlain by glacial drift.

As the parts of the site occupied by compressible material are essentially low-lying, they will probably be covered by fill; consequently if large settlements of structures placed on fill are to be avoided, the compressible material should be removed prior to filling. Providing that this is done, and that the fill is adequately spread and compacted (see Section 6.4, below), conventional spread foundations placed on the fill at a minimum depth of 0.75m below final ground level may be designed to an allowable net bearing pressure of about 100kN/m<sup>2</sup>. In the case of structures sensitive to differential settlement, or large or heavily loaded areas, foundations should be taken through the fill to the glacial drift using deep strip footings, piles or piers; structures supported in this manner should be separated from structures placed on fill by construction joints.

As an alternative to removal of all compressible material prior to site filling, consideration may be given to leaving it in place, filling over it, and then leaving for a period (say three years) before structures are built. In this way, much of the settlement due to the load of the fill on the compressible material should have taken place. However, in this case, it would be prudent to carry out a further investigation prior to construction to check that there is no extensive thickness of compressible material beneath the structure likely to give rise to further significant settlement. This would of course be especially necessary for structures sensitive to differential movement.

#### 6.4 Compaction

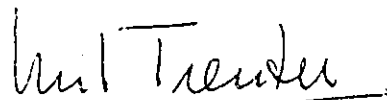
The results of the moisture content determinations indicate that the natural moisture content of the essentially clayey glacial drift is wet of optimum as determined by the British Standard Compaction test (2.5kg rammer method), as will be seen by reference to Table 2, and Figs. 19 and 20. However, visual inspection of this material suggests that it should be suitable as fill, bearing in mind its relatively high granular content, and this conclusion is supported by the fact that in the cut and fill works now in progress for the Heads of the Valleys extension (see Section 2, above) glacial drift is extensively and apparently successfully employed. Compressible soils (if encountered in the cut areas) together with material from the rubbish tip should be run to spoil. The presence of cobbles and boulders in the glacial drift may well make compaction in layer thicknesses less than about 0.3m impracticable; this is considered too large a layer thickness where spread foundations are involved (see Section 6.3.3, above) and in these areas control should be exercised to ensure that cobbles and boulders are removed, so that adequate compaction using thinner layer thicknesses may be achieved (see below). Complete removal would be ensured by screening the fill; this would of course be expensive, involving as it does rehandling. Sufficient cobbles and boulders would probably be removed, however, by using a grader with a toothed attachment allowing material of cobble and boulder size to be removed prior to compaction. If this latter method were employed, it would again be prudent to carry out a further investigation prior to construction to check that adequate compaction has been achieved to support the structures without undue settlement.

Several passes of suitable compaction equipment, such as a medium vibrating roller, using layer thicknesses of about 0.15m will be required in foundation areas. Depending on weather conditions during placing, it may be preferable to use smooth-wheel equipment, but with layer thicknesses of about 0.10m.

The comments made on ground-water in Section 6.1, above, will be relevant here.

#### 7. Chemical Attack of Buried Concrete

The results of the chemical analyses indicate that deterioration of good quality normal Portland cement concrete in foundations or other buried structures, due to sulphate attack, is unlikely to occur at this site. It is, however, well known that the water contained in streams in hilly or moorland areas is often acidic, and care should be taken to provide site drainage so that such water does not come into contact with concrete structures, unless suitable precautions are taken. Likewise, surface water may also become contaminated through contact with organic topsoil or peat and again site drainage should take this into account.



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TABLE 1

RESULTS OF MACKINTOSH PROBES MADE IN THE NORTHERN AREA OF THE SITE

Probe No.	Depth Penetrated m	Material Encountered
1	push to 0.45 drive to 1.40	Brown sandy silty clay
2	drive to 1.25	Brown sandy silty clay
3	push to 0.60 drive to 1.00	Peat Blue grey silty clay
4	drive to 0.08	Grey sandy silty clay with gravel, cobbles and boulders (rubble at surface)
5	drive to 0.45	Grey sandy silty clay with gravel, cobbles and boulders (rubble at surface)
6	drive to 0.30	Grey sandy silty clay with gravel, cobbles and boulders (rubble at surface)
7	drive to 0.25	Probable fill (hardcore)
8	drive to 1.00 drive to 1.15	Dark brown sandy silty clay Yellow-brown sandy silty clay
9	drive to 0.30	Grey sandy silty clay with gravel, cobbles and boulders (boulders at surface)
10	drive to 0.45	Grey sandy silty clay with gravel, cobbles and boulders
11	push to 0.25 drive to 0.30	Organic topsoil Grey sandy silty clay with gravel, cobbles and boulders
12	drive to 0.08	Probable fill (hardcore)
13	drive to 0.25	Grey sandy silty clay with gravel, cobbles and boulders (boulders at surface)
14	push to 0.30 drive to 0.60	Organic topsoil Mottled yellow-brown and blue-grey sandy silty clay
15	push to 0.75 drive to 1.05	Dark brown sandy silty clay Mottled yellow-brown and blue-grey sandy silty clay
16	push to 0.20 drive to 0.75 drive to 1.00	Topsoil Firm grey sandy silty clay with gravel Very stiff grey sandy silty clay with gravel, cobbles and boulders

Cont'd./.....1

TABLE 1 (Cont'd.)

RESULTS OF MACKINTOSH PROBES MADE IN THE NORTHERN AREA OF THE SITE

Probe No.	Depth Penetrated m	Material Encountered
17	push to 0.08 drive to 0.15	Topsoil Grey sandy silty clay with gravel, cobbles and boulders
18	drive to 0.08	Grey sandy silty clay with gravel, cobbles and boulders
19	drive to 0.15	Grey sandy silty clay with gravel, cobbles and boulders
20	drive to 0.08	Grey sandy silty clay with gravel, cobbles and boulders
21	drive to 0.45	Dark brown sandy silty clay
22	push to 0.20 drive to 0.75	Organic topsoil Mottled yellow-brown and blue-grey silty clay

TABLE 2  
RESULTS OF LABORATORY TESTS

Borehole No.	Sample Depth m	Natural Moisture Content %	Natural Wet Density Mg/m <sup>3</sup>
2	1.50	21	-
3	1.50	9	-
5	1.90 3.50	15 11	- -
6	1.50 4.00	7 14	- -
8	6.20	13	-
9	1.50 - 1.85 3.00 - 3.45	14 13	2.18 -
10	1.50 - 1.90 3.00 - 3.50 6.50	12 13 13	- - -
<u>Trial Pit</u>			
10	1.85	15	-

TABLE 3  
RESULTS OF CHEMICAL ANALYSES ON GROUND-WATER AND SOIL SAMPLES

Borehole No.	Sample Depth m	Total Sulphate Content (as SO <sub>3</sub> )		pH Value
		parts/100,000	per cent dry weight	
2	1.50	-	<0.01	-
3	1.50	-	0.01	-
5	1.90 3.50	- -	<0.01 <0.01	- -
6	0.90 1.50	2* -	- 0.01	6.0 -
8	5.20	-	<0.01	-
9	3.00 - 3.45	-	<0.01	-
<u>Trial Pit</u>				
10	0.60 1.20	- -	<0.01 <0.01	- -





\* test made on ground-water sample.

Ground level: 199.30m above C.D.

Dia. of boring: 0.20m

Method of boring: Shell and Auger

Lining tubes: 0.20m to 4.50m

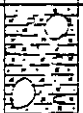






Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
19.11.71				1.50	197.80	Dark grey silty CLAY
	3.00	D		3.00	196.30	BOULDER
	3.50 - 3.80 3.80	U(4)★ D		4.00	195.30	Firm grey sandy silty CLAY with gravel, cobbles and boulders
	4.00 - 4.50 4.65 - 4.80	BD C 56		4.50	194.80	Very dense grey slightly clayey sandy fine to coarse GRAVEL with cobbles
<div> <div> <p><b>Key to type of sample:</b></p> <p><b>U(4)</b> — 102mm (4in.) dia. undisturbed sample</p> <p><b>D</b> — disturbed sample</p> <p><b>BD</b> — bulk disturbed sample</p> <p><b>V</b> — vane test</p> <p><b>S ( )</b> — standard penetration test</p> <p><b>C ( )</b> — dynamic cone penetration test</p> <p>Figure in brackets is No. of blows for penetration given in depth column (see Notes, page 1).</p> </div> <div> <p><b>Remarks: (Observations on ground-water, etc.)</b></p> <p>Ground-water was encountered at a depth of 3.95m below ground level and was at a depth of 1.80m on removal of the lining tubes. Ground-water was at a depth of 1.00m below ground level on the morning of 22.11.71. The borehole was chiselled between depths of 1.50m and 3.00m below ground level.</p> <p>★ Full penetration of sampler not attained.</p> </div> </div>						
Lab. Ref. No.	HIRWAUN INDUSTRIAL ESTATE					FIG. 1
S/8731						

Ground level: 201.20m above O.D.

Dia. of boring: 0.20m

Method of boring: Snell and Auger

Lining tubes: 0.20m to 3.00m


Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
20.11.71	0.00 - 1.50	BD		1.50	199.70	Brown sandy silty CLAY with gravel, cobbles and some organic matter
				2.00	199.20	BOULDER
	2.00 - 3.00	BD		3.00	198.20	Very dense brown fine to coarse GRAVEL and medium to coarse SAND
	2.65 - 2.88	C/SUB		4.00	197.20	Fine grey SANDSTONE with brown staining on fracture planes 'Boulder or Bedrock'
	3.00	BD				
	4.00	D				
	4.00 - 4.08	C/SUB		4.00	197.20	
<div> <div> <p><b>Key to type of sample:</b></p> <p><b>U(4)</b> — 102mm (4in.) dia. undisturbed sample</p> <p><b>D</b> — disturbed sample</p> <p><b>BD</b> — bulk disturbed sample</p> <p><b>V</b> — vane test</p> <p><b>S ( )</b> — standard penetration test</p> <p><b>C ( )</b> — dynamic cone penetration test</p> <p>Figure in brackets is No. of blows for penetration given in depth column (see Notes, page 1).</p> </div> <div> <p><b>Remarks: (Observations on ground-water, etc.)</b></p> <p>Ground-water was encountered at a depth of 1.50m below ground level and was at a depth of 0.80m on removal of the lining tubes. Ground-water was at a depth of 0.35m below ground level on the morning of 22.11.71. The borehole was chiselled between depths of 1.50m to 2.00m and 3.00m to 4.00m below ground level.</p> <p>* Seating blows only.</p> </div> </div>						
Lab. Ref. No.	HILSWAUN INDUSTRIAL ESTATE					FIG. 2
S/8731						

Ground level:..... 204.60m above O.D.

Dia. of boring:..... 0.20m

Method of boring:..... Shell and Auger

Lining tubes:..... 0.20m to 3.00m








Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
22.11.71	1.50 - 1.95	U(4)†		2.00	202.60	Stiff grey sandy silty CLAY with gravel, cobbles and boulders
	1.50 - 2.00	BD				
	2.15 - 2.45	C(49)		4.00	200.60	Dense grey clayey fine to coarse GRAVEL with cobbles and boulders
	3.00 - 4.00	BD				
	3.65 - 3.95	C(38)				
<p>Key to type of sample:</p> <p>U(4) — 102mm (4in.) dia. undisturbed sample</p> <p>D — disturbed sample</p> <p>BD — bulk disturbed sample</p> <p>Y — vane test</p> <p>S ( ) — standard penetration test</p> <p>C ( ) — dynamic cone penetration test</p> <p>Figure in brackets is No. of blows for penetration given in depth column (see Notes, page 1).</p>			<p>Remarks: (Observations on ground-water, etc.)</p> <p>Ground-water was encountered at a depth of 1.50m below ground level and was at a depth of 0.80m on removal of the lining tubes. The borehole was chiselled between depths of 2.00m to 3.00m below ground level.</p> <p>† Unable to recover sample.</p>			
Lab. Ref. No. S/ 8731	HIRWAUN INDUSTRIAL ESTATE					FIG. 3

Ground level: 197.50m above O.D.

Dia. of boring: 0.20m

Method of boring: Shell and Auger

Lining tubes: 0.20m to 4.50m


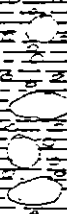



Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
18.11.71	1.90 - 2.15	U(4)†		1.00	196.50	FILL (concrete)
	1.90 - 2.15	BD				Firm, becoming stiff, grey sandy silty CLAY with gravel, cobbles and boulders
	3.50 - 3.80	U(4)†				
	3.50 - 3.80	BD		4.00	193.50	Grey slightly clayey sandy fine to coarse GRAVEL with cobbles
	4.00 - 4.50	BD		4.50	193.00	
	4.55 - 5.00	U(4)		5.00	192.50	Firm grey sandy silty CLAY with gravel, cobbles and boulders
	5.00	D				
<div> <div> <p>Key to type of sample:</p> <p>U(4) — 102mm (4in.) dia. undisturbed sample</p> <p>D — disturbed sample</p> <p>BD — bulk disturbed sample</p> <p>V — vane test</p> <p>S ( ) — standard penetration test</p> <p>C ( ) — dynamic cone penetration test</p> <p>Figure in brackets is No. of blows for penetration given in depth column (see Notes, page 1).</p> </div> <div> <p>Remarks: (Observations on ground-water, etc.)</p> <p>Water was added to assist boring from ground level and the depth to any ground-water could not be determined. On removal of the lining tubes water was at a depth of 1.30m below ground level. Water, probably, surface run off, was measured at a depth of 0.10m below ground level on the morning of 22.11.71. The borehole was chiselled between depths of 0.10m and 1.00m below ground level.</p> <p>† Unable to recover sample.</p> </div> </div>						
Lab. Ref. No. S/ 8731	HIRWAUN INDUSTRIAL ESTATE					FIG. 4

Ground level: 206.50m above O.D.

Dia. of boring: 0.20m

Method of boring: Shell and Auger

Lining tubes: 0.20m to 5.00m

Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
				0.20	206.30	Organic TOPSOIL
	1.50 - 1.95 1.50 - 2.00	U(4)† BD				Grey clayey medium to coarse GRAVEL, COBBLES and BOULDERS; very dense below 3.00m
	3.00 - 4.00 3.15 - 3.45 4.00	BD C(62) D		4.00	202.50	Firm mottled blue-grey and yellow-brown sandy silty CLAY with gravel, cobbles and boulders
	4.65 - 4.90	C(67)		5.00	201.50	
23.11.71	5.65 - 5.68	C(50)				BOULDERS
	7.15 - 7.21	C(77)				
24.11.71	8.65 - 8.68	C(50)				
25.11.71	10.15 - 10.18	C(50)		10.00	196.50	
<p><b>Key to type of sample:</b>            U(4) — 102mm (4in.) dia. undisturbed sample            D — disturbed sample            BD — bulk disturbed sample            V — vane test            S ( ) — standard penetration test            C ( ) — dynamic cone penetration test            Figure in brackets is No. of blows for penetration given in depth column (see Notes, page 1).</p>						
<p><b>Remarks:</b> (Observations on ground-water, etc.) † Unable to recover sample. Water was added to assist boring from ground level and the depth to any ground-water could not be determined. On the evening of 23.11.71 with the borehole advanced to a depth of 6.00m below ground level and the lining tubes to a depth of 5.00m, water was at a depth of 1.00m below ground level. It was at this depth the following morning. On the evening of 24.11.71 with the borehole advanced to a depth of 8.30m and the lining tubes to a depth of 5.00m water was measured at a depth of 1.00m below ground level and was at this depth the following morning. On removal of the lining tubes water rose to a depth of 0.90m. A sample was taken. The borehole was chiselled between depths of 5.00m to 10.00m below ground level.</p>						
Lab. Ref. No. S/8731	HIRWAUN INDUSTRIAL ESTATE					FIG. 5



Dia. of boring: 0.20m

Method of boring: Snell and Auger

Lining tubes:..... 0.20m to 8.50m




Daily Progress	Samples		Change of Strata			Description of Strata			
	Depth	Type	Legend	Depth	O.D. Level				
27.11.71	2.00 - 3.00	BD		2.40	202.10	Brown slightly clayey sandy medium to coarse GRAVEL with cobbles; very dense below 3.00m			
	3.15 - 3.38	C(32)							
29.11.71	5.15 - 5.45	C(40)				Dense, becoming very dense, brown clayey sandy fine to coarse GRAVEL with cobbles; boulders below 7.00m			
	5.20 - 6.50	BD							
	6.65 - 6.95	C(35)							
30.11.71	7.00 - 8.50	BD		8.50	197.00	Dense brown clayey sandy fine to coarse GRAVEL with cobbles and boulders			
	8.15 - 8.45	C(87)							
							8.00	196.50	BOULDER
							10.00	195.50	
Remarks: 'Observations on ground-water, etc.'									
<p>The borehole was initially started 2.00m away. A boulder was encountered at a depth of 1.00m below ground level and as little progress was made in chiselling from this depth to a depth of 2.00m the borehole was abandoned, the rig moved and the borehole restarted. On the evening of 27.11.71 with the borehole and lining tubes advanced to a depth of 3.00m below ground level the borehole was dry and was also dry on the morning of 29.11.71. Ground-water was encountered at a depth of 6.30m below ground level. On the evening of 29.11.71 with the borehole and lining tubes advanced to a depth of 7.00m below ground level water was at a depth of 6.00m below ground level. It rose to 3.75m overnight. With the borehole advanced to a depth of 10.00m below ground level on removal of the lining tubes, water was at a depth of 3.00m below ground level. The borehole was chiselled between depths of 3.50m to 4.75m and 8.50m to 9.00m below ground level.</p>									
<p>Key to type of sample:</p> <p>U(4) — 102mm (4in.) dia. undisturbed sample</p> <p>D — disturbed sample</p> <p>BD — bulk disturbed sample</p> <p>V — vane test</p> <p>S ( ) — standard penetration test</p> <p>C ( ) — dynamic cone penetration test</p> <p>Figure in brackets is No. of blows for penetration given in depth column (see Notes, page 1).</p>									
Lab. Ref. No. S/8731		HIRWAUN INDUSTRIAL ESTATE				FIG. 6			

Ground level:..... 205.50m above O.D.

Dia. of boring:..... 0.20m

Method of boring:..... Shell and Auger

Lining tubes:..... 0.20m to 4.00m



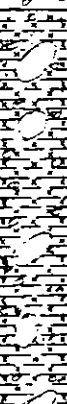

Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
17.11.71				0.75	204.75	BOULDERS
	1.50 - 1.85 1.95 2.25	U(4)★ D D		2.70	202.80	Firm mottled blue-gray and yellow-brown sandy silty CLAY with gravel, cobbles and boulders
	3.50 - 3.85 3.45	U(4) D		4.00	201.50	Stiff yellow-brown sandy silty CLAY with gravel, cobbles and boulders
<div> <div> <p>Key to type of sample:</p> <p>U(4) — 102mm (4in.) dia. undisturbed sample</p> <p>D — disturbed sample</p> <p>BD — bulk disturbed sample</p> <p>V — vane test</p> <p>S ( ) — standard penetration test</p> <p>C ( ) — dynamic cone penetration test</p> <p>Figure in brackets is No. of blows for penetration given in depth column (see Notes, page 1).</p> </div> <div> <p>Remarks: (Observations on ground-water, etc.)</p> <p>Ground-water was encountered at ground level. Water was added to assist boring between depths of 3.50m to 4.00m below ground level. On removal of the lining tubes water was at a depth of 2.00m below ground level. The borehole was cased between 3.50m to 4.00m below ground level.</p> <p>★ Full penetration of sampler not attained.</p> </div> </div>						
Lab. Ref. No. S/ 8731	HIRWAUN INDUSTRIAL ESTATE					FIG.7

Ground level: 212.00m above O.D.

Dia. of boring: 0.20m




Method of boring: Shell and Auger

Lining tubes: 0.20m to 11.00m

Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
				0.20	211.80	Organic TOPSOIL
	1.50 - 1.90 1.90 2.25	U(4)★ D D		1.80	210.20	Yellow-brown silty fine to coarse SAND with gravel
	3.00 - 3.50 3.15 - 3.45	BD C(65)				Firm to stiff brown sandy silty CLAY with gravel, cobbles and boulders and some organic matter
	4.65 - 4.95 5.00	C(45) BD				
	6.15 - 6.45 6.50	C(22) BD				
12.11.71	7.65 - 7.95 8.20	C(44) BD		7.50	204.50	Dense brown slightly clayey sandy fine to coarse GRAVEL with cobbles and boulders
	9.15 - 9.45 9.50	C(45) BD				
13.11.71	10.65 - 10.95 11.00	C(40) BD		10.50 11.00	201.50 201.00	
16.11.71	12.00 - 12.05	C(50)		12.00	200.00	BOULDER or BEDROCK
<p><b>Key to type of sample:</b>  <b>U(4)</b> — 102mm (4in.) dia. undisturbed sample  <b>D</b> — disturbed sample  <b>BD</b> — bulk disturbed sample  <b>V</b> — vane test  <b>S ( )</b> — standard penetration test  <b>C ( )</b> — dynamic cone penetration test            Figure in brackets is No. of blows for penetration given in depth column (see Notes, page 1).</p> <p><b>Remarks: (Observations on ground-water, etc.)</b> * Seating blows only.            On the evening of 12.11.71 with the borehole and lining tubes advanced to a depth of 8.00m below ground level the borehole was dry and was dry the following morning. Ground-water was encountered at a depth of 10.00m below ground level and rose to 9.50m in 30 minutes. On the evening of 13.11.71 with the borehole and lining tubes advanced to a depth of 10.50m water was at a depth of 9.50m. On the morning of 16.11.71 water was at a depth of 7.00m. With the borehole at a depth of 12.00m below ground level on removal of the lining tubes water was at a depth of 5.00m below ground level. The borehole was chiselled between depths of 3.50m to 4.00m, 8.00m to 9.00m and 11.00m to 12.00m. * Full penetration of sampler not attained.</p>						
Lab. Ref. No. S/9731	HURWAUN INDUSTRIAL ESTATE					FIG. 8

Rubbish Tip Level: 202.10m above O.D.



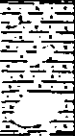
Size of Pit: 0.60m x 2.00m x 2.75m approx.

Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
23.11.71				1.20	200.90	FILL (binders, bricks, glass, metal and wood fragments)
				1.85	200.25	FILL (pulp cardboard and bricks)
				2.75	199.35	Soft to firm, becoming stiff, blue-grey sandy silty CLAY with gravel, cobbles and boulders; trace of organic matter

### RECORD OF TRIAL PIT 2



Rubbish Tip Level: 202.00m above O.D.

Size of Pit: 0.60m x 2.00m x 2.75m approx.

23.11.71				0.15	201.85	FILL binders
				1.85	200.15	FILL bricks, building rubble, reinforcing steel, concrete and some brown sandy silty clay
				2.75	199.25	Soft to firm, becoming stiff, grey sand, silty CLAY with gravel, cobbles and boulders
Key to Type of Sample			Remarks: (Observations on ground-water, etc.)			
			<p>T.P.1 Ground-water was encountered at a depth of 1.85m below rubbish tip level and quickly filled the trial pit to this level. Unable to excavate below a depth of 2.75m as bricks collapsed into trial pit.</p> <p>T.P.2 Ground-water was encountered at a depth of 1.20m below rubbish tip level and quickly filled the trial pit to this level. Unable to excavate below a depth of 2.75m as bricks and rubble collapsed into trial pit.</p>			
Lab. Ref. No.	WIRSWAIN INDUSTRIAL ESTATE					FIG. 9
S18731						

Ground Level: 201.20m above O.D.



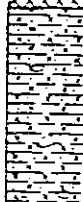

Size of Pit: 0.40m x 3.00m x 2.75m approx.

Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
23.11.71				0.15	201.05	TOPSOIL
				2.75	198.45	Very stiff, becoming firm, mottled blue-grey and yellow-brown sandy silty CLAY with gravel, cobbles and boulders

### RECORD OF TRIAL PIT 4

Ground Level: 197.40m above O.D.

Size of Pit: 0.60m x 3.00m x 2.45m approx.

20.11.71				0.10	197.30	TOPSOIL
				0.75	195.65	Probable FILL: mottled blue-grey and yellow-brown sandy silty clay with gravel, cobbles and boulders
				2.15	195.25	Firm blue-grey silty sandy CLAY with occasional gravel and cobbles
				2.45	194.95	Grn. clayey sand, red up to coarse GRAVEL with cobbles

#### Key to Type of Sample

#### Remarks: (Observations on ground-water, etc.):

T.P.3 A slight seepage of ground-water was encountered at a depth of 0.15m. Steady seepages of ground-water were encountered at and below a depth of 1.55m. Partial collapse of the sides of the trial pit occurred below a depth of 1.55m. A large boulder at 2.75m prevented deeper excavation.

T.P.2 A seepage of ground-water was encountered at a depth of 0.30m. Ground-water filled the trial pit to a depth of 2.15m below ground level. The sides of the trial pit collapsed from a depth of 0.75m below ground level.

Lab. Ref. No.


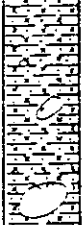
S 5731

HIRVAUN INDUSTRIAL ESTATE

FIG. 10

Ground Level: 198.39m above O.D.





Size of Pit: 0.60m x 3.00m x 2.15m approx.

Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
23.11.71				0.60	197.70	FILL cinders, gravel, cobbles and boulders.
				2.15	196.15	Very stiff, becoming hard below 1.55m, blue-gray sandy silty CLAY with gravel, cobbles and boulders

### RECORD OF TRIAL PIT 6

Ground Level: 197.00m above O.D.

Size of Pit: 0.60m x 3.00m x 1.75m approx.

23.11.71				0.60	196.40	Dark brown PEAT with some organic clay
				1.20	195.80	Soft to firm blue-gray, sandy, silty, CLAY with some gravel, cobbles and boulders
				2.45	194.35	Stiff mottled blue-gray and grey sand silty CLAY with gravel, cobbles and boulders
				2.75	194.05	Brown sand, fine to coarse GRAVEL with cobbles and occasional boulders

#### Key to Type of Sample

#### Remarks: Observations on ground-water, etc.

- T.P.5 A slight seepage of ground-water was encountered at a depth of 0.60m below ground level. A large boulder at 2.15m prevented further excavation.
- T.P.6 Surface water was present at the trial pit location and the presence of ground-water seepages could not always be determined. Ground-water flowed in and filled the trial pit at a depth of 2.45m below ground level.

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BIRWAUM INDUSTRIAL ESTATE

FIG. 11

# RECORD OF TRIAL PIT

Ground Level: 200.00m above O.D.


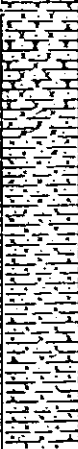
Size of Pit: 0.60m x 3.00m x 2.75m approx.

Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
				0.60	199.40	FILL (mottled blue-grey, and yellow-brown sandy silty clay with gravel, cobbles and boulders)
				0.95	199.05	FILL (cinders and fine to medium gravel)
				1.20	198.80	TOPSOIL (black organic clay with some peat)
				2.75	197.25	Stiff to very stiff blue-grey, sandy silty CLAY with gravel, cobbles and boulders
23.11.71						

## RECORD OF TRIAL PIT 8

Ground Level: 198.00m above O.D.

Size of Pit: 0.60m x 3.00m x 3.55m approx.

				0.95	197.05	FILL (black silty fine sand)
				3.65	194.35	Firm, becoming stiff, grey sand, silty CLAY with occasional cobbles
23.11.71						

### Key to Type of Sample

### Remarks: (Observations on ground-water, etc.)

T.P.7 A slight seepage of ground-water was encountered at a depth of 1.20m below ground level.

T.P.8 A slight seepage of ground-water was encountered at a depth of 0.95m below ground level. The sides of the trial pit partially collapsed below a depth of 0.95m below ground level.


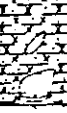
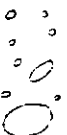
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S 3731

WIRSWAIN INDUSTRIAL ESTATE

FIG. 12

Ground Level: 206.50m above O.D.




Size of Pit: 0.50m x 3.00m x 2.15m approx.

Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
23.11.71				0.30	206.20	TOPSOIL
				1.20	205.30	Stiff mottled blue-grey and yellow-brown sandy silty CLAY with gravel, cobbles and boulders
				2.15	204.35	Brown clayey sand, fine to coarse GRAVEL with cobbles and occasional boulders

### RECORD OF TRIAL PIT 10

Ground Level: 206.50m above O.D.

Size of Pit: 0.50m x 3.00m x 2.15m approx.

24.11.71		1		0.30	206.20	TOPSOIL black organic clay
	0.30	0				Stiff mottled blue-grey and yellow-brown sandy silty CLAY with gravel, cobbles and boulders
	0.90	0				
	1.20	0		1.20	205.30	Firm blue-grey sandy silty CLAY with gravel, cobbles and boulders
	1.35	0				
				2.15	204.35	

#### Key to Type of Sample

0 - a disturbed sample

#### Remarks: (Observations on ground-water, etc.)

- T.P.9 Ground-water was encountered at a depth of 1.20m and quickly filled the trial pit to this level. The trial pit sides collapsed in below this depth and excavation below 2.15m was not possible.
- T.P.10 Seepages of ground-water were encountered at and below a depth of 1.20m below ground level. The sides of the trial pit partially collapsed below a depth of 1.20m and completely below 2.00m, preventing excavation below 2.15m below ground level.

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HIRWAUN INDUSTRIAL ESTATE



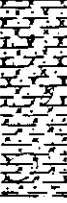
FIG. 13



# RECORD OF TRIAL PIT 11

Ground Level: 201.10m above O.D.




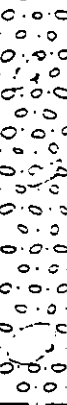
Size of Pit: 0.60m x 3.00m x 2.45m approx.

Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
24.11.71				0.95	200.15	FILL cobbles, boulders with blue-grey sandy silty clay
				1.15	199.95	TOPSOIL
				2.45	198.65	Stiff blue-grey sand/silty CLAY with gravel, cobbles and boulders

## RECORD OF TRIAL PIT 12




Ground Level: 211.50m above O.D.

Size of Pit: 0.60m x 3.00m x 3.53m approx.

24.11.71				0.20	211.30	TOPSOIL
				0.40	211.10	Firm light grey sand, silty CLAY
				0.75	210.75	Firm, becoming stiff, orange-brown sand, silty CLAY with gravel and cobbles
						Light brown slightly clayey, fine to medium SAND with gravel, cobbles and boulders
				3.55	207.95	
Key to Type of Sample			Remarks: (Observations on ground-water, etc.)			
			T.P.11 Seepages of ground-water were encountered at and below a depth of 1.25m below ground level.			
			T.P.12 Ground-water was not encountered during excavation.			
Lab. Ref. No.	HIRMANN INDUSTRIAL ESTATE					FIG. 14
S 8731						

Ground Level: 204.50m above O.D.


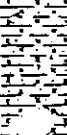
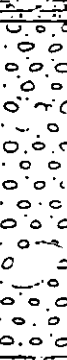
Size of Pit: 0.60m x 3.00m x 3.55m approx.

Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
24.11.71				0.30	204.20	TOPSOIL
				0.95	203.55	Stiff mottled blue-grey and yellow-brown sandy silty CLAY with gravel, cobbles and boulders
				3.35	200.95	Light brown slightly clayey fine to medium SAND with gravel, cobbles and boulders

### RECORD OF TRIAL PIT 14

Ground Level: 203.50m above O.D.

Size of Pit: 0.60m x 3.00m x 3.55m approx.

24.11.71				0.30	203.20	TOPSOIL
				1.35	202.15	Stiff mottled blue-grey and yellow-brown sandy silty CLAY with gravel, cobbles and boulders
				3.55	199.95	Light brown slightly clayey SAND with gravel, cobbles and boulders

#### Key to Type of Sample

#### Remarks: (Observations on ground-water, etc.)

T.P.13 Seepages of ground-water were encountered at and below a depth of 1.35m below ground level. The sides of the trial pit also partially collapsed below this depth.

T.P.14 Ground-water was not encountered during excavation. The sides of the trial pit partially collapsed below a depth of 1.35m below ground level.

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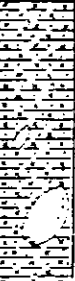
HIRWAUN INDUSTRIAL ESTATE

FIG. 15

# RECORD OF TRIAL PIT 15

Ground Level: 198.40m above 0.0.




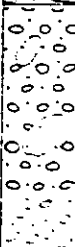
Size of Pit: 0.60m x 3.00m x 2.35m approx.

-Daily Progress	Samples		Change of Strata			Description of Strata
	Depth	Type	Legend	Depth	O.D. Level	
24.11.71				0.95	197.45	TOPSOIL organic peaty silty clay
				2.35	196.25	Stiff blue-grey sandy silty CLAY with gravel, cobbles and boulders

## RECORD OF TRIAL PIT 16

Ground Level: 199.30m above 0.0.

Size of Pit: 0.60m x 3.00m x 3.00m approx.

24.11.71				0.25	199.05	TOPSOIL
				0.95	198.35	Stiff mottled blue-grey and yellow-brown sandy silty CLAY with occasional gravel
				1.25	197.95	Stiff blue-grey sandy silty CLAY with gravel, cobbles and boulders
				3.00	196.30	Light brown silty clayey SAND with gravel, cobbles and boulders

### Key to Type of Sample

### Remarks: (Observations on ground-water, etc.)

T.P.15 A slight seepage of ground-water was encountered at a depth of 0.95m below ground level.

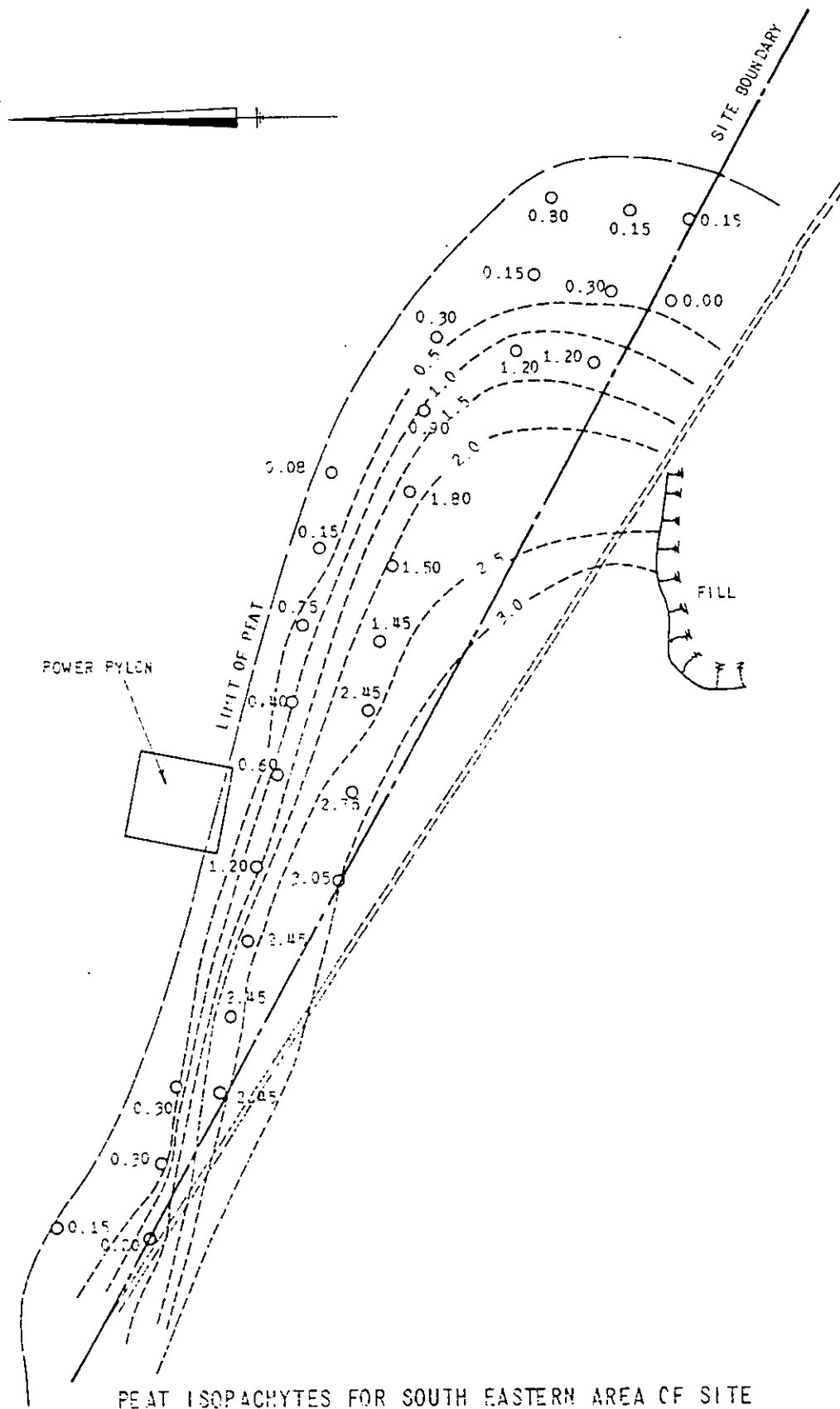
T.P.16 A slight seepage of ground-water was encountered at and below a depth of 1.25m below ground level. A steady seepage of water was encountered at and below a depth of 2.05m below ground level with partial collapse of the sides of the trial pit.

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HIRWAH INDUSTRIAL ESTATE

FIG. 16



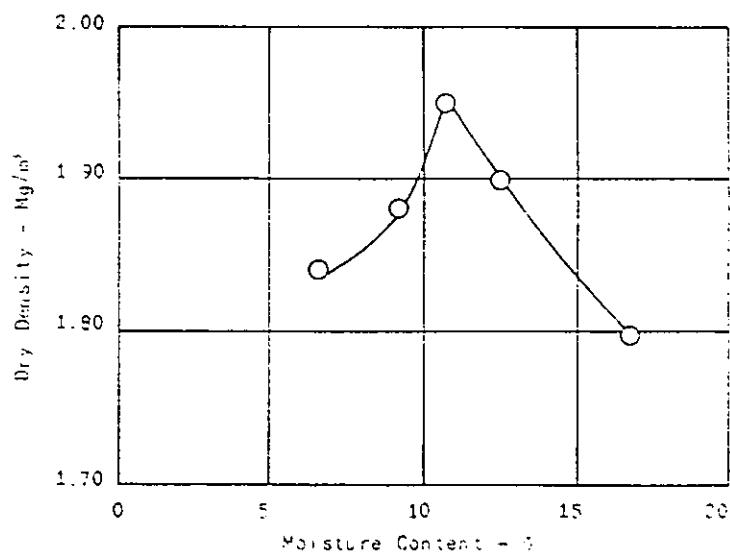
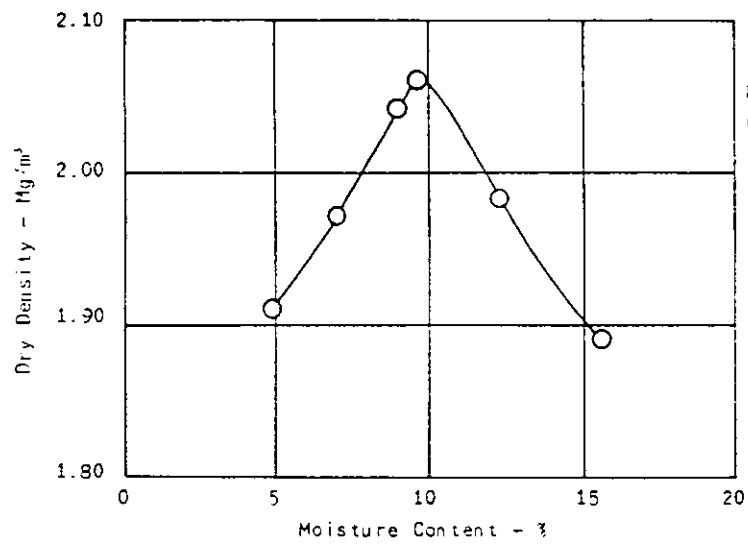
○ Mackintosh Probes  
Depth of penetration in metres

Scale: 1/1250

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S/9731

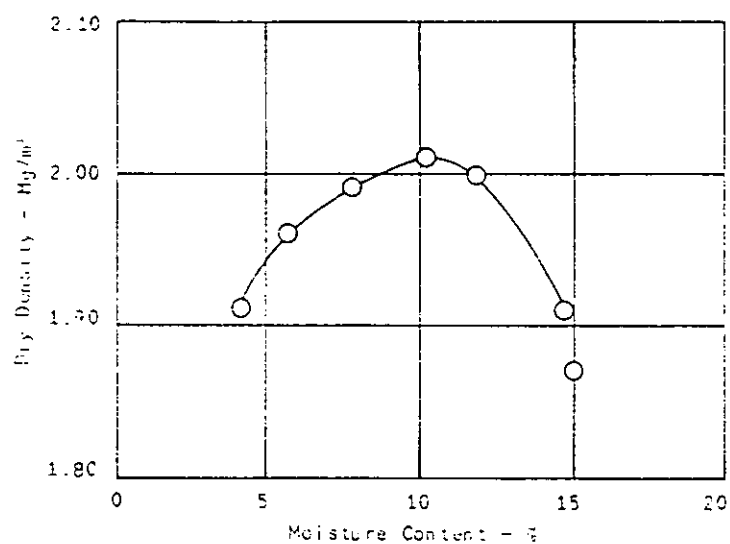
WIRWAUN INDUSTRIAL ESTATE

FIG. 17



# COMPACTION TESTS (2.5kg RAMMER METHOD)

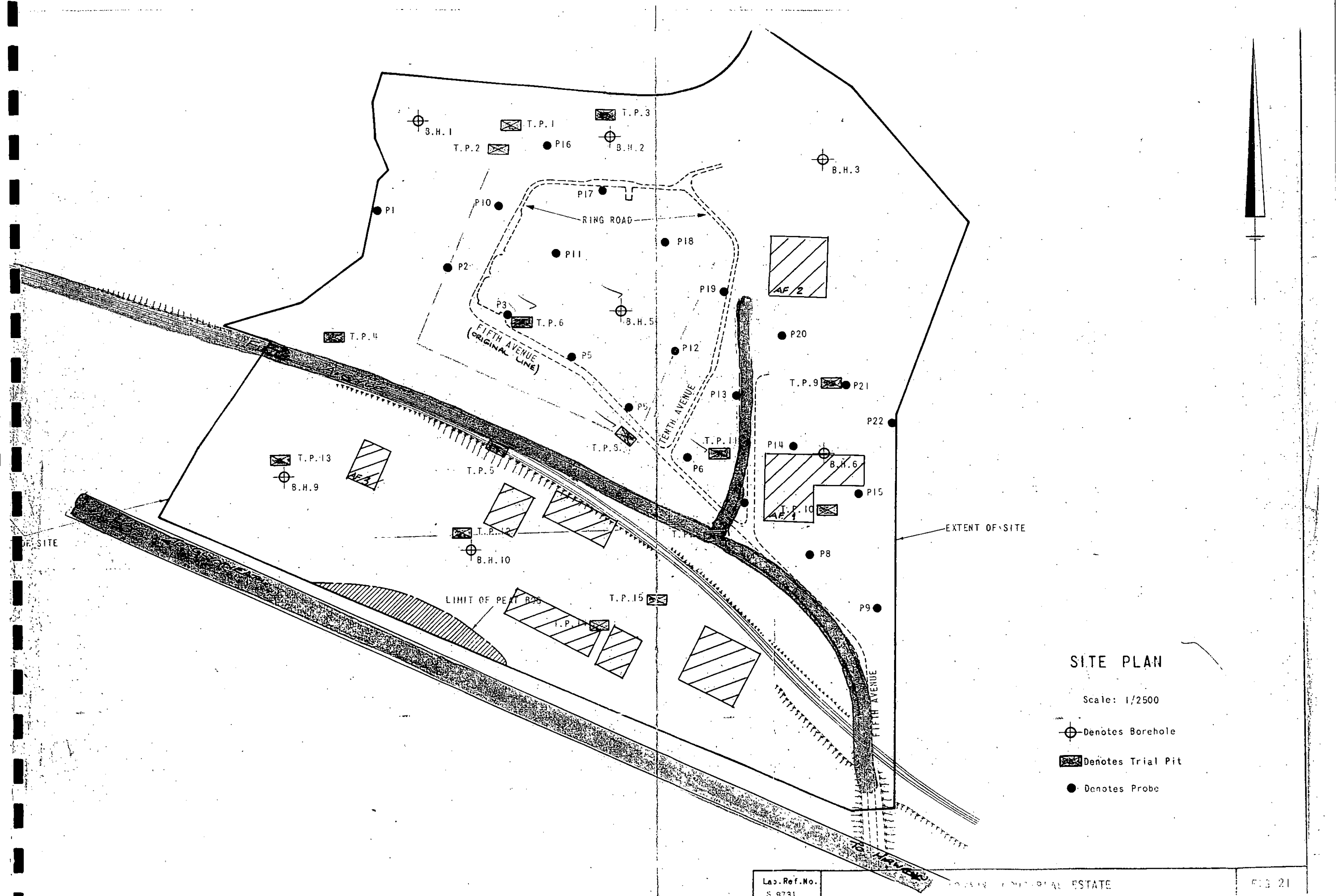
Lab. Ref. No. S 9731	HIRWAUN INDUSTRIAL ESTATE	FIG 19
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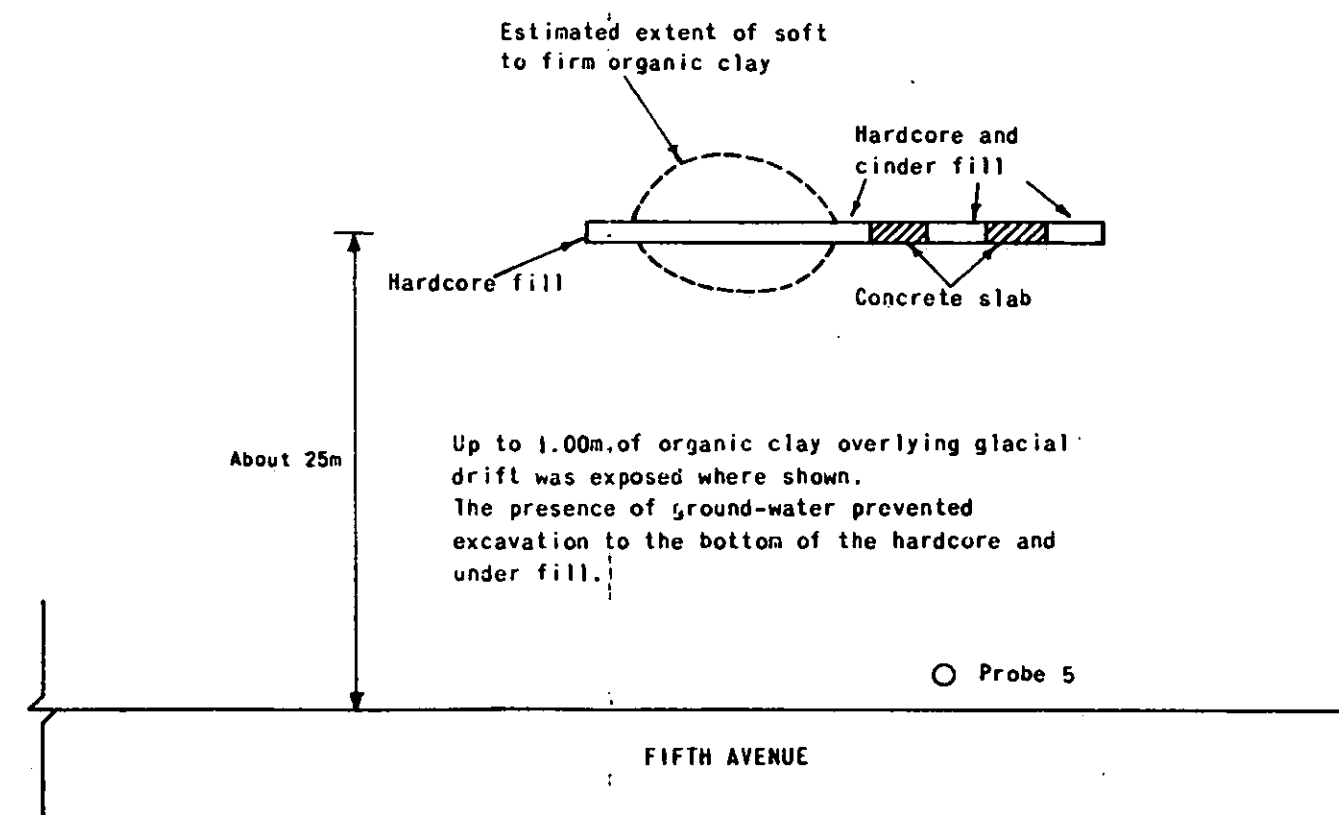
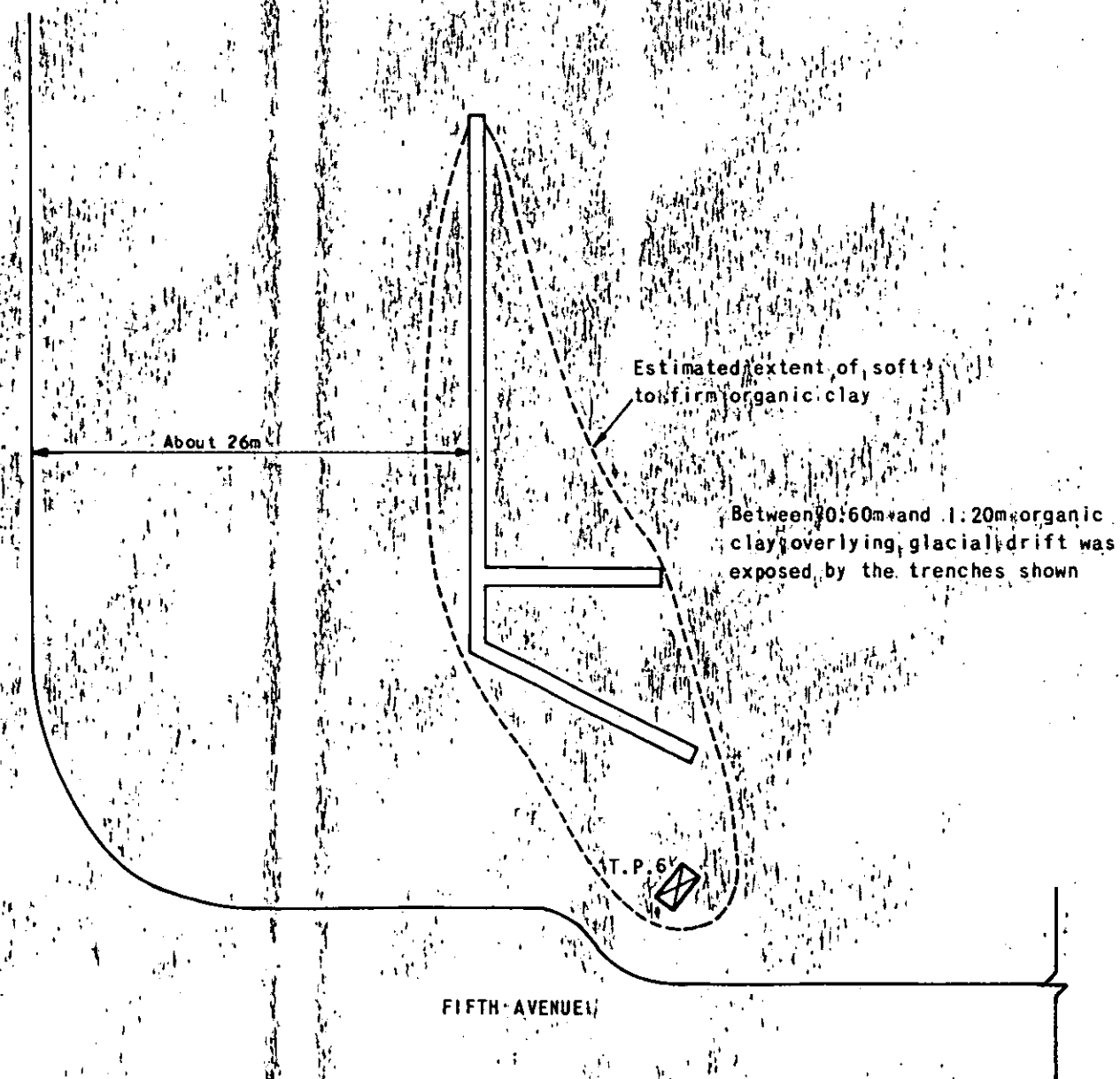


S.H.10  
 Depth: 5.00m - 3.50m  
 5.00m  
 Maximum Dry Density: 2.01  $\text{Mg/m}^3$   
 Optimum Moisture Content: 10.5%

COMPACTION TEST (2.5kg RAMMER METHOD)

Lab. Ref. No. S 8731	HIRWAUN INDUSTRIAL ESTATE	FIG. 20
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TRENCHES EXCAVATED TO LOCATE PEAT

SCALE: 1/400

Lab. Ref. No.  
S/8731

HIRWAUN INDUSTRIAL ESTATE

FIG. 18



