

The sand and gravel resources of the country around Prees, Shropshire

Description of 1:25 000
sheet SJ 53

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In figures 7 to 12 the continuous line represents the mean grading of the block and the broken lines denote the envelope within which the grading curves for individual samples fall.

The compositional data given at the foot of page 42 relate to the log on page 43 and not to the log on page 42.

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The first twelve reports on the assessment of British sand and gravel resources appeared in the Report series of the Institute of Geological Sciences as a subseries. Report 13 and subsequent reports appear as Mineral Assessment Reports of the Institute.

Details of published reports appear at the end of this report.

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PREFACE

National resources of many industrial minerals may seem so large that stocktaking appears unnecessary, but the demand for minerals and for land for all purposes is intensifying and it has become increasingly clear in recent years that regional assessments of the resources of these minerals should be undertaken. The publication of information about the quantity and quality of deposits over large areas is intended to provide a comprehensive factual background against which planning decisions can be made.

Sand and gravel, considered together as naturally occurring aggregate, was selected as the bulk mineral demanding the most urgent attention, initially in the south-east of England, where about half the national output is won and very few sources of alternative aggregates are available. Following a short feasibility project, initiated in 1966 by the Ministry of Land and Natural Resources, the Industrial Minerals Assessment Unit (formerly the Mineral Assessment Unit) began systematic surveys in 1968. The work is now being financed by the Department of the Environment and is being undertaken with the cooperation of the Sand and Gravel Association of Great Britain.

This report describes the sand and gravel resources of the country around Prees, Shropshire, shown on the accompanying 1:25 000 resource map. The survey was conducted by J. W. C. James, who was assisted in the drilling and sampling programme by J. H. Lovell. The work is based on six-inch scale geological surveys by R. W. Pocock in 1919–21 and A. J. Whiteman in 1955–57. Amendments were made in 1982 to the solid geology by A. A. Wilson and to the drift geology by J. W. C. James. A. A. Wilson also contributed the account of the solid geology.

W. N. Pierce was responsible for negotiating access to land for drilling. The ready cooperation of landowners and tenants in this work is gratefully acknowledged.

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MAP

The sand and gravel resources of sheet SJ 53 (Prees, Shropshire) *in pocket*

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The sand and gravel resources of the country around Prees, Shropshire

Description of 1:25 000 sheet SJ 53

J. W. C. James

SUMMARY

The geological maps of the Institute of Geological Sciences, pre-existing borehole information, and 88 boreholes drilled for the Industrial Minerals Assessment Unit form the basis of the assessment of the sand and gravel resources of the country around Prees, Shropshire.

All the deposits in the district that might be potentially workable for sand and gravel have been investigated and a simple statistical method has been used to estimate the volume. The reliability of the volume estimates is given at the symmetrical 95 per cent probability level.

The 1:25 000 map is divided into six resource blocks, containing between 9.1 and 16.5 km² of potentially workable sand and gravel. For each block the geology of the deposits is described, and the mineral-bearing area, the mean thickness of overburden and mineral and the mean gradings are stated. Detailed borehole data are also given. The geology, the position of the boreholes and the outlines of the resource blocks are shown on the accompanying map.

As a result of this survey, the line of the Wem fault shown on the published one-inch map (sheet 138) has been realigned up to 0.7 km north-westwards, and a previously unknown subcrop, beneath drift, of Northwich Halite (Lower Keuper Saliferous Beds) probably exists south-east of this fault.

Extensive deposits of laminated clay, with rhythmite sequences in part, occur beneath the outwash plain of Prees Heath.

Bibliographical reference

JAMES, J. W. C. 1982. The sand and gravel resources of the country around Prees, Shropshire. Description of 1:25 000 resource sheet SJ 53. *Miner. Assess. Rep. Inst. Geol. Sci.*, No. 134.

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Notes

Each borehole registered with the Institute is identified by a four-element code (e.g. SJ 53 NW 25). The first two elements define the 10-km square (of the National Grid) in which the borehole is situated; the third element defines a quadrant of that square, and the fourth is the accession number of the borehole. In the text of the report boreholes are normally referred to by the last two elements (e.g. NW 25).

All National Grid references in this publication lie within the 100-km square SJ unless otherwise stated. Grid references may be given to eight figures, accurate to within 10 m, and four- or six-figures for more extensive locations.

INTRODUCTION

The survey is concerned with the estimation of resources, which include deposits that are not currently exploitable but have a foreseeable use, rather than reserves, which can only be assessed in the light of current, locally prevailing, economic considerations. Clearly, neither the economic nor the social factors used to decide whether a deposit may be workable in the future can be predicted; they are likely to change with time. Deposits not currently economically workable may be exploited as demand increases, as higher-grade or alternative materials become scarce, or as improved processing techniques are applied to them. The improved knowledge of the main physical properties of the resource and their variability, which this survey seeks to provide, will add significantly to the factual background against which planning policies can be decided (Archer, 1969; Thurrell, 1971, 1981; Harris and others, 1974).

The survey provides information at the 'indicated' level "for which tonnage and grade are computed partly from specific measurements, samples or production data and partly from projection for a reasonable distance on geologic evidence. The sites available for inspection, measurement, and sampling are too widely or otherwise inappropriately spaced to permit the mineral bodies to be outlined completely or the grade established throughout" (Bureau of Mines and Geological Survey, 1948, p. 15).

It follows that the whereabouts of reserves must still be established and their size and quality proved by the customary detailed exploration and evaluation undertaken by the industry. However, the information provided by this survey should assist in the selection of the best targets for such further work. The following arbitrary physical criteria have been adopted:

- a The deposit should average at least 1 m in thickness.
- b The ratio of overburden to sand and gravel should be no more than 3:1.
- c The proportion of fines (particles passing the No. 240-mesh B.S. sieve, about $\frac{1}{16}$ mm) should not exceed 40 per cent.
- d The deposit should lie within 25 m of the surface, this being taken as the likely maximum working depth under most circumstances. It follows from the second criterion that boreholes are drilled no deeper than 18 m if no sand and gravel has been proved.

A deposit of sand and gravel that broadly meets these criteria is regarded as 'potentially workable' and is described and assessed as 'mineral' in this report. As the assessment is at the indicated level, parts of such a deposit may not satisfy all the criteria.

Pre-Pleistocene rocks, which are usually consolidated and devoid of potentially workable sand and gravel, are referred to as 'bedrock'; 'waste' is any material other than bedrock or mineral; 'overburden' is waste that occurs between the surface and an underlying

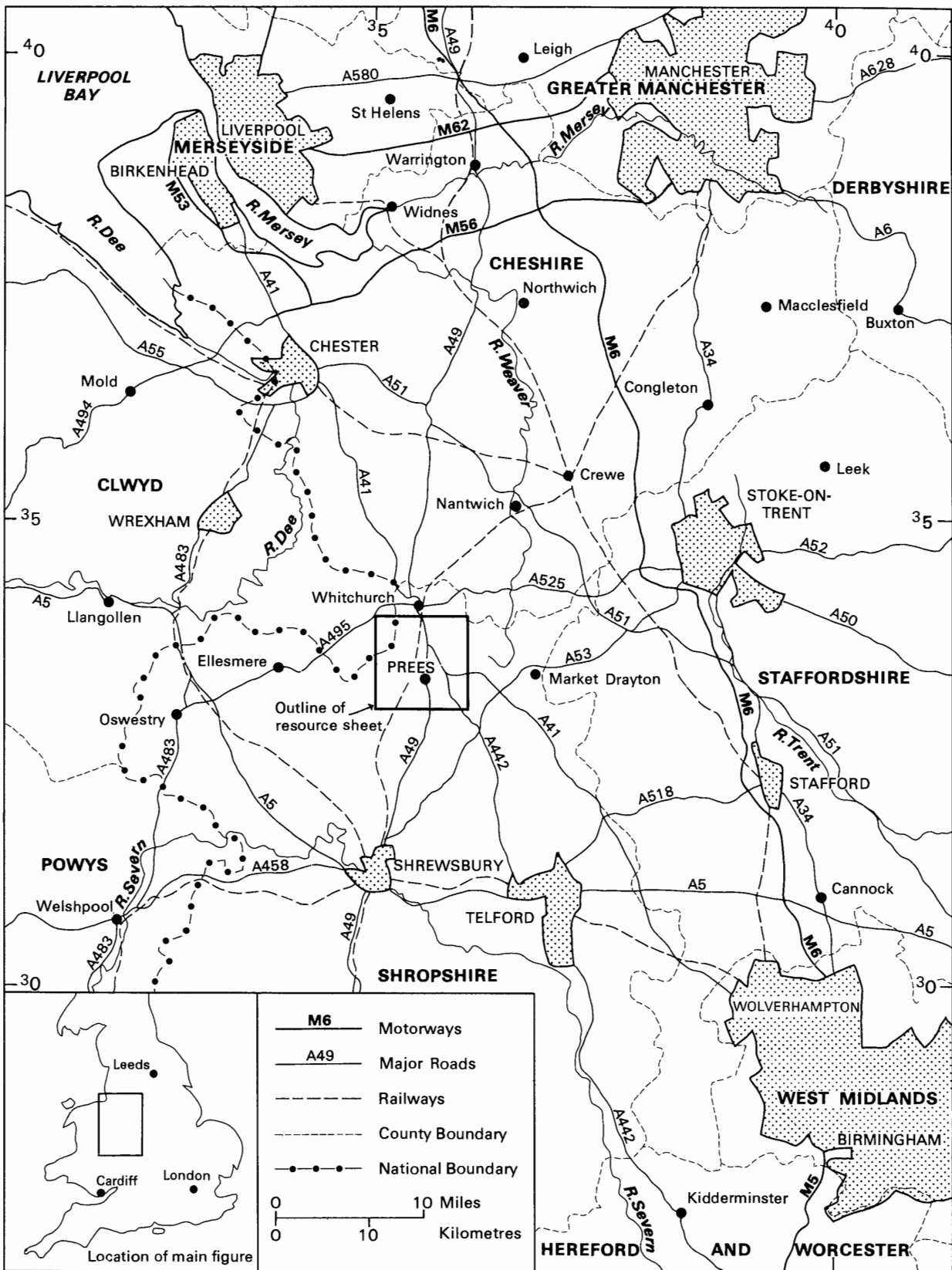


Figure 1 Sketch-map showing the location of the district.

ing body of mineral.

For the particular needs of assessing sand and gravel resources, a grain-size classification based on the geometric scale $\frac{1}{8}$ mm, $\frac{1}{4}$ mm, 1 mm, 4 mm, 16 mm, 64 mm has been adopted. The boundaries between fines (that is, the clay and silt fractions) and sand, and between sand and gravel material, are placed at $\frac{1}{8}$ mm and 4 mm respectively (see Appendix C).

The volume and other characteristics are assessed within resource blocks, each of which, ideally, contains approximately 10 km² of sand and gravel. No account is taken of any factors, for example roads, villages or land of high agricultural or landscape value, which might stand in the way of sand and gravel being exploited, although towns are excluded. The estimated total volume therefore bears no simple relationship to the amount that could be extracted in practice.

It must be emphasised that the assessment applies to the resource block as a whole; valid conclusions cannot be drawn about mineral in parts of a block, except in the immediate vicinity of the actual sample points.

DESCRIPTION OF THE DISTRICT

GENERAL

The district lies within Shropshire, close to its northern boundary with Cheshire, but includes a small part of Clwyd in the north-west (Figure 1).

The plain of Prees Higher and Lower Heath, which occupies the centre of the district, declines from about 100 m above Ordnance Datum in the north, where it is approximately 2 kilometres wide, to below 80 m above OD at the southern margin of the district, where it is over 5 kilometres wide. At Prees [557 335] an outcrop of Middle Lias rocks forms a hill over 120 m above OD, rising above the plain.

To the west the land becomes hummocky and rises to over 110 m above OD along an approximately north-south ridge before falling to below 92 m above OD towards Fenn's Moss [500 370]. In the north-east and south-east of the district, the plain is bounded by ridges that rise quite sharply to exceed 125 m above OD.

Small streams and brooks characterise the district and drainage can be poor locally, especially in the hummocky clay-covered areas.

Small villages and hamlets characterise a predominantly pastoral district in which any light industry is usually associated with agriculture. Peat is dug at Fenn's Moss, mainly for horticultural purposes.

GEOLOGY

The drift deposits of the district and the 'solid' formations which crop out beneath them, and at the surface, are listed in Table 1 and described briefly below. Further details may be found in the Wem Memoir (Pocock and Wray, 1925) for the southern part of the district and in the Nantwich and Whitchurch Memoir (Poole and Whiteman, 1966) for the northern part. However, it should be noted that as a result of this assessment survey, amendments to the solid and drift geology as described in both memoirs have been incorporated in this report and accompanying map.

SOLID

Solid formations crop out in a number of areas in the south-east of the district, namely, around Marchamley Wood [590 310] and Faulsgreen [590 327], the hill at

Prees (Figure 2) and the ridge between Sandford [583 342] and Willaston [598 358]. Except for a small outcrop of solid rocks north of Ashford Grange [596 346], the ridge is mapped as till, but two IMAU boreholes, SE 17 and NE 57, drilled on its summit, proved solid at the surface and therefore only its lower slopes are now thought to be mantled by thin drift.

The structure of the district is dominated by the Wem-Audlem syncline and the Wem fault on its south-eastern limb. On the evidence of the distribution of solid strata derived from the IMAU drilling programme, the fault has been realigned farther north-west (compared with the published one-inch map). It is now quite likely that it passes through the Prees Borehole at 3761 m depth, thereby juxtaposing probable Westphalian against Lower Palaeozoic sediments (Figure 3).

Triassic

These sediments crop out on the limbs of the Wem-Audlem syncline (Figure 3), which crosses the district on a SW-NE axis. In the north and west the drift cover is complete, but some exposures in Lower Keuper Marl and one of Helsby Sandstone occur in the south-east where the drift is discontinuous.

The earliest Triassic deposits, the *Sherwood Sandstone Group* and *Helsby Sandstone (Keuper Sandstone)* are 1600 m thick in the Prees Borehole (Colter and Barr, 1975) and are thought (I. F. Smith, personal communication) to lap on to a buried feature to the east, where they thin appreciably (Figure 3). Because of faulting, a small exposure of Helsby Sandstone occurs south of Hawk Lake [574 300]; this comprises red, white and pale yellow sandstone with some disseminated barytes. In the Prees Borehole the *Tarporley Siltstones (Keuper Waterstones)*, which are not exposed in the district, consist of 200 m of alternating sandstones and mudstones. The overlying *Lower Keuper Marl*, which is exposed at the surface, is 240 m thick and consists of an upper laminated reddish brown and greenish grey member above less well laminated but dominantly reddish brown mudstones.

This formation is overlain by the *Northwich Halite (Lower Keuper Saliferous Beds)* which consists of 170 m of halite with several interbedded mudstones up to 4.0 m thick, usually overlain by mudstone breccias

Table 1 Stratigraphy

DRIFT	
Quaternary	Peat Alluvium Glacial Sand and Gravel Laminated Clay Till
SOLID	
Jurassic	Lias
Triassic	Penarth Group (Rhaetic) Blue Anchor Formation (Tea Green Marl) 'Upper Keuper Marl' Wilkesley Halite (Upper Keuper Saliferous Beds) Northwich Halite (Lower Keuper Saliferous Beds) 'Lower Keuper Marl' Helsby Sandstone Formation (Keuper Sandstone)

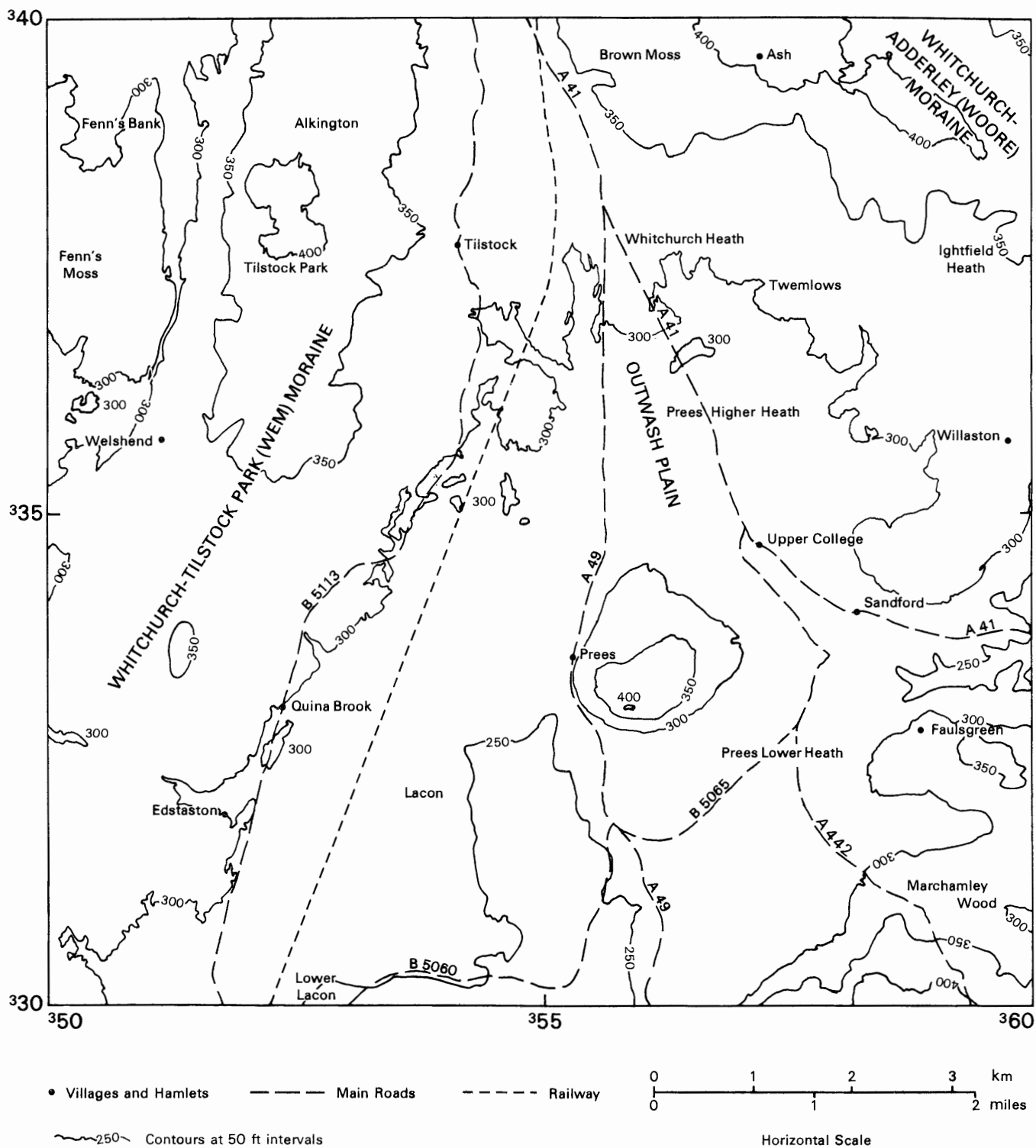


Figure 2 Locality map.

derived from collapsed mudstone bands (formerly within the dissolved halite) together with collapsed remnants of the Upper Keuper Marl. Four IMAU boreholes on the south-east side of the Wem fault are believed to have encountered such breccias with both porphyroblastic and 'chicken wire' gypsum, a common feature in salt-solution subsidence breccias.

The *Middle Keuper Marl*, which is not exposed because of faulting, is 230m thick in the Prees Borehole. It consists of structureless reddish brown mudstone with anhydrite nodules overlying a lower division with some laminated, partly greenish grey bands, interbedded with structureless mudstone. The

Wilkesley Halite (Upper Keuper Saliferous Beds) probably crops out in the extreme north-west of the district and consists of 290 m of halite with some mudstone partings much veined by halite.

The overlying *Upper Keuper Marl* comprises about 205 m of chocolate-brown and reddish brown structureless mudstones with a few thin greenish grey mudstones, and nodules and bands of anhydrite at many levels. The *Blue Anchor Formation (Tea Green Marl)* consists of 17 m of greyish green, partly calcareous, mudstones and siltstones. The *Penarth Group (Rhaetic)*, which is 13.4 m thick, comprises silty mudstones with some thin beds of sandstone and limestone.

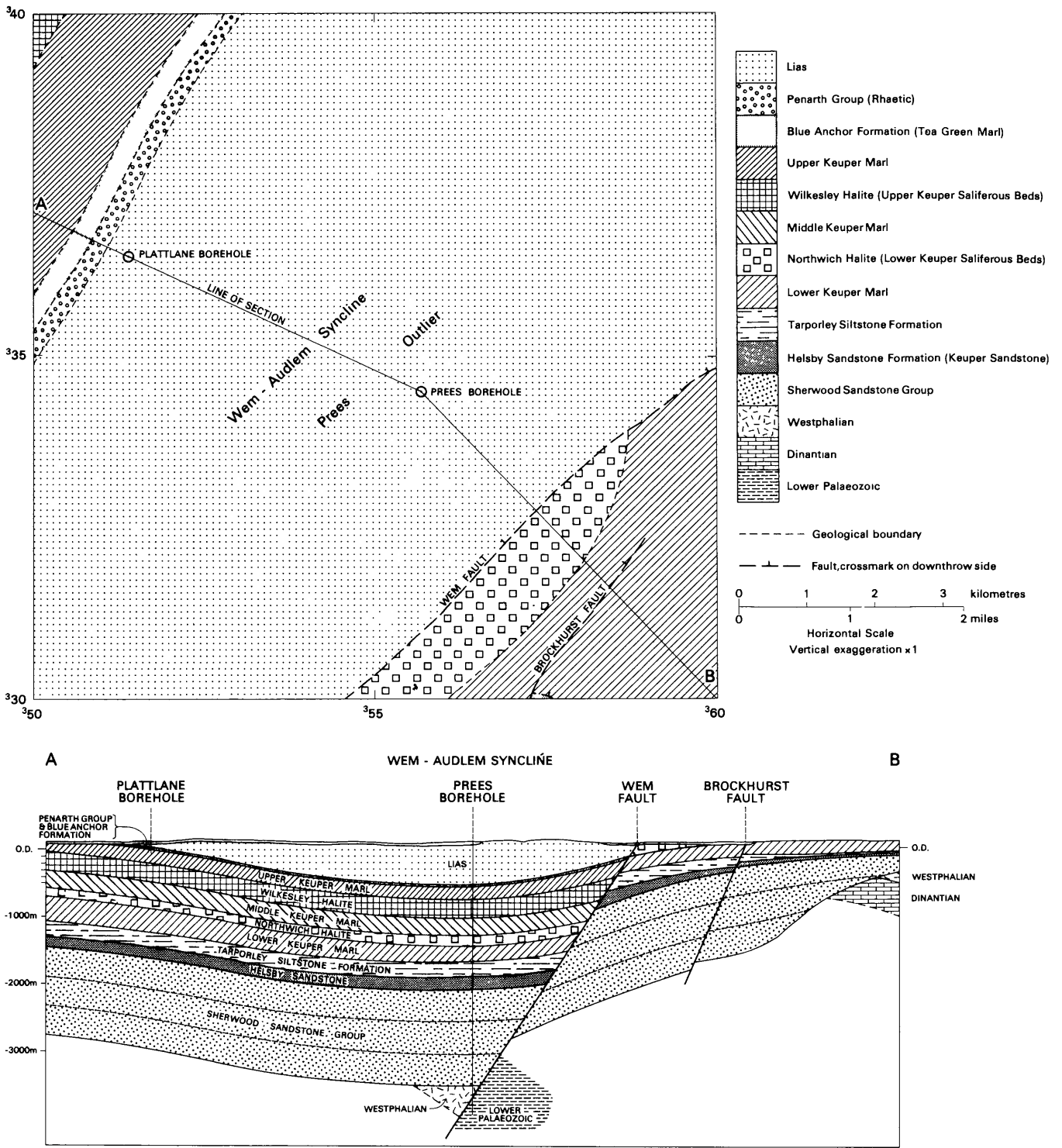


Figure 3 Solid geology

Jurassic

In the Prees Borehole (Figure 3), which was drilled for oil exploration, the *Lias* proved to be an unusually thick succession (594m) of Lower Lias, overlain at outcrop by 30m of Middle Lias. Ten IMAU boreholes proved the Lias, mainly north-east of Prees, but IMAU borehole SW 34 confirmed the presence of Lias in the drift-covered southern part of the Prees Outlier (Figure 3) as shown on the Wem (138) geological sheet. The Lias comprises mainly grey, fossiliferous mudstones, limestones, siltstones and fine-grained sandstones. IMAU borehole NW 27, while not reaching solid, contained abundant fragments of Lias in the lower part of the drift, and it is likely that this borehole lies within

the Lias outcrop. The base of the Lias has been amended compared with its position on published one-inch maps and this amendment accords with Dr A. A. Wilson's recent revision (unpublished) of the geology, established in Wych Brook [468 444], north of the Prees district.

DRIFT

Drift covers approximately ninety per cent of the district, and is thinnest in the south-east. Elsewhere, it is generally in excess of 25 m, the arbitrary maximum depth to which sand and gravel survey boreholes are taken. The thickest recorded sequence of drift deposits overlying bedrock is 51.8m at Upper Tilstock Park

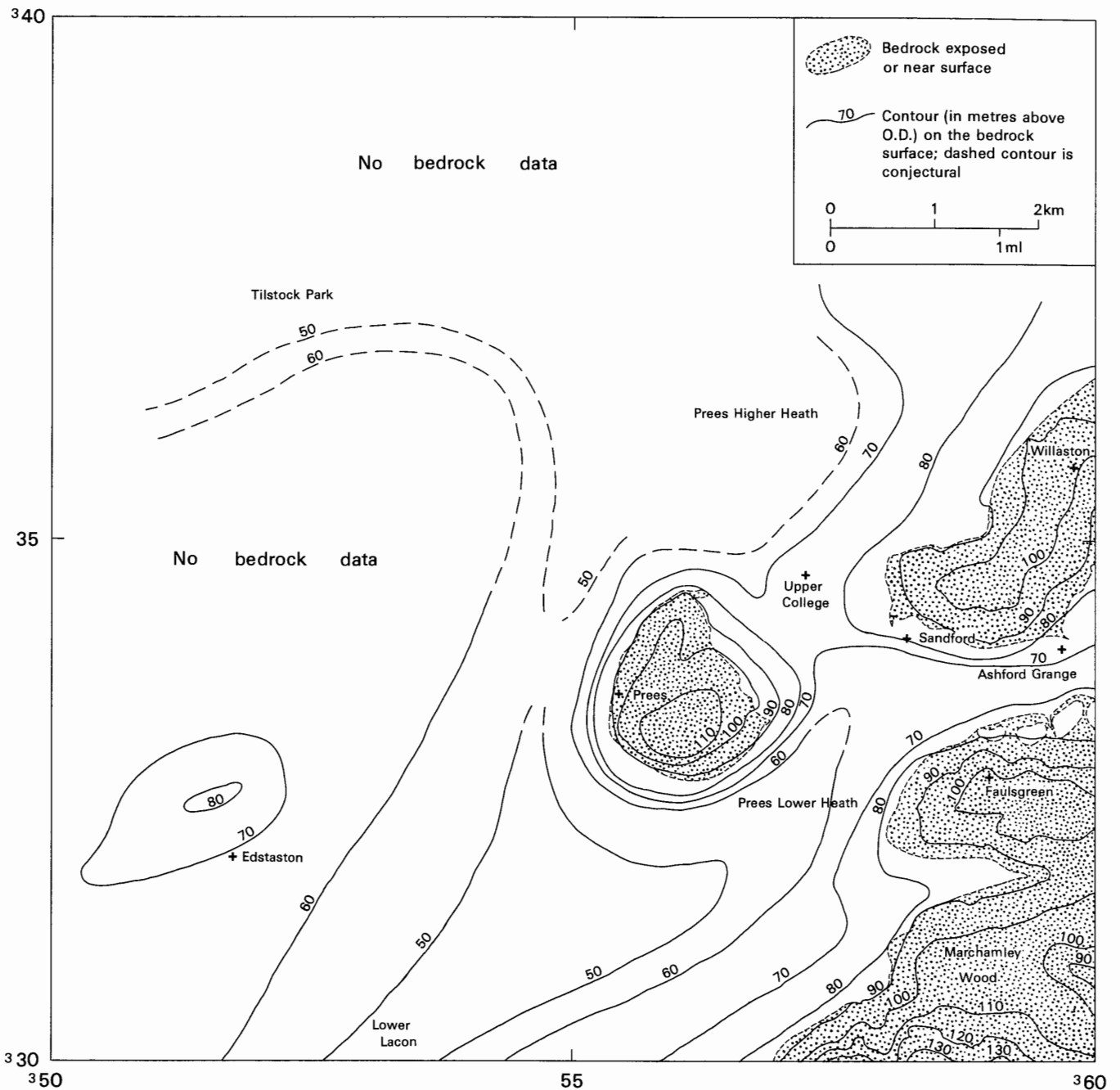


Figure 4 Contour map showing the form of the bedrock surface.

[519 365] and it is probably thicker than this in the far north of the district.

Because there are fewer data points where the drift thickens towards the north and west, the form of the bedrock surface (Figure 4) is best known in the southern half of the district. The ridge at Willaston and the hill at Prees are joined by a low col beneath Upper College (Figure 5, Section A) and all three features can be traced south-westwards to Edstaston (Figures 4 and 5, Section B) where the Lias rises beneath drift to approximately 80 m AOD. South-east of this line, drift infills a depression which trends and widens from north-east to south-west and is bounded on its south-east flank by the ridge in Lower Keuper Marl at Marchamley Wood. Although there is little information from north of Prees, evidence from the Whitchurch area (Poole and Whiteman, 1966, p. 110) suggests that the bedrock surface here may fall to about 35 m above OD.

The drift consists mainly of glacial deposits of the

Devensian glaciation when ice crossed the Irish Sea basin and moved into the district from the north-west. This direction is confirmed by the composition of the erratics generally found in the drift: these comprise Lower Palaeozoic sandstones, siltstones, mudstones, acid and basic lavas, tuffs and granites, all from the Lake District, Southern Scotland and North Wales; Carboniferous sandstones, mudstones, siltstones and limestones from Lancashire and North Wales, and mainly locally derived red Permo-Triassic sandstones, siltstones and mudstones.

The drift deposits also contain many comminuted marine shells brought down from the Irish Sea basin including *Turritella communis*, *Cerastoderma* and *Cardium* (D. C. Davies, Aberystwyth University, written communication). Because of its characteristic suite of erratics and shells, the drift is often referred to as 'Irish Sea drift'.

Morphologically the drift can be divided into three

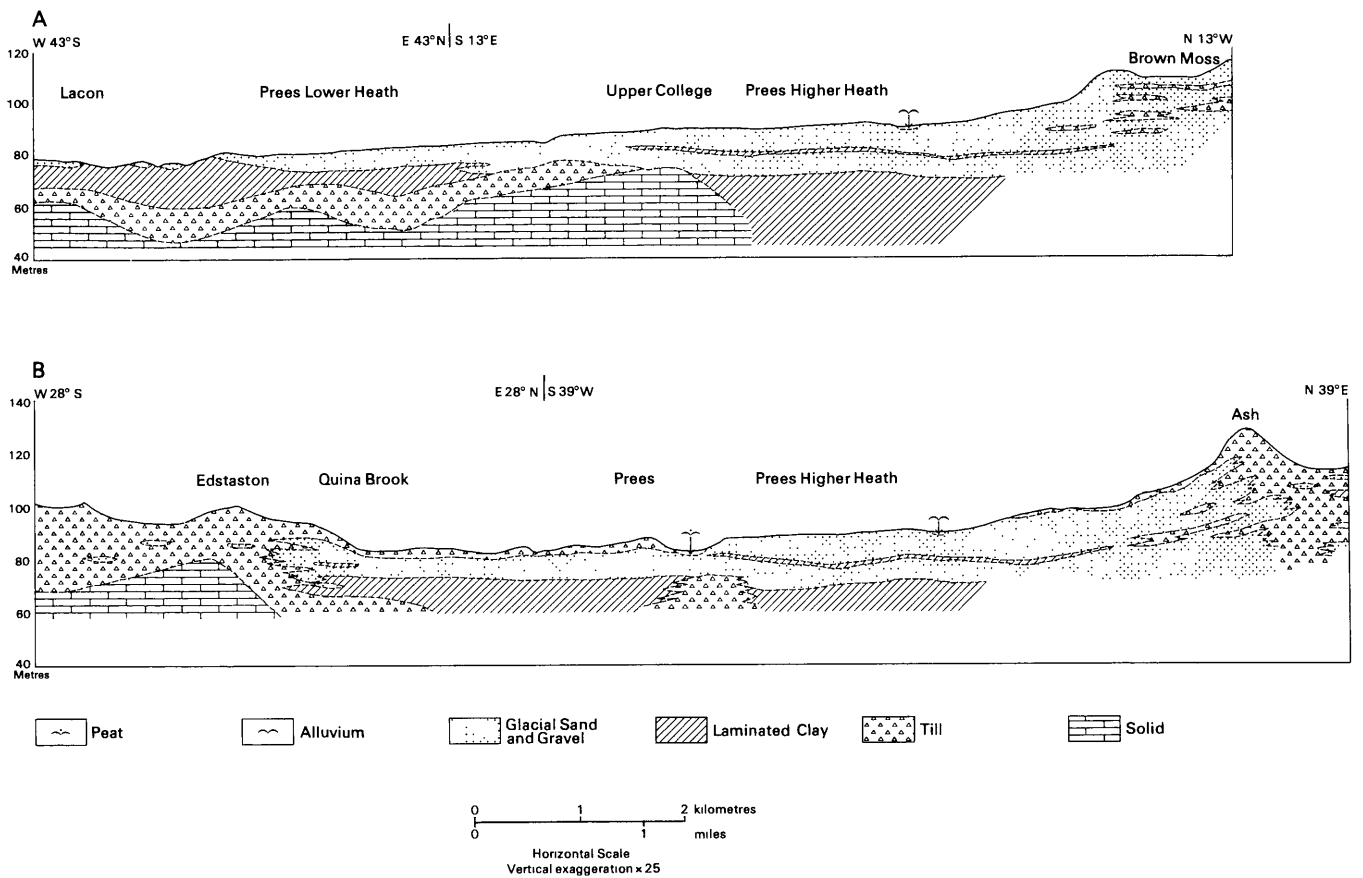


Figure 5 Schematic cross-sections across the district.

areas, namely the outwash plain of Prees Higher and Lower Heath in the central part of the district, which is situated between two morainic complexes. To the west is higher ground comprising the tills and glacial sand and gravel of the Whitchurch-Tilstock Park moraine (Poole and Whiteman, 1966) which continues southwards as the Wem moraine (Peake, 1981). In the north-east, the Whitchurch-Adderley moraine, which is also known as the Woore moraine, crosses the district at Ash (Figure 5, Section B).

Till This comprises generally greyish brown (5 YR 4/2) (Geological Society of America Rock-Color Chart Committee, 1975) to moderate brown (5 YR 3/4), massive to poorly laminated, sandy, stony clay. Erratics are usually up to 10 mm in diameter, although larger pebbles and cobbles are present; their sources have been referred to earlier. Tills located at depth and south of the Lias crop can contain a high proportion of Lias erratics.

The till may be relatively stoneless and laminated, and in part include lenses, laminae and bands over 1 m thick of sand, gravel, silt, sandy silt and silty clay. The till is generally firm to hard but it may be soft where the clay is plastic or has a high sand and silt content. Some of the till immediately overlying the bedrock in the south-west of the district is very hard. (The consistency of clay was measured in the field using a pocket penetrometer.)

Although surface exposures and the thicker sequences of till are confined largely to the moraines of the west and north-east, up to 10.9 m of till has been recorded underlying the glacial sand and gravel and laminated clay of much of Prees Lower Heath (Figure

5, Section A), and probably continues beneath similar deposits at Prees Higher Heath.

Within the morainic drift the relationship between till, glacial sand and gravel and laminated clay is complex, both vertically through the succession and laterally across the district. This complexity is particularly evident in the north-west (see description of Block A).

Laminated Clay As well as the minor laminated clays associated with and subordinate to till, an extensive deposit of laminated clay underlies Prees Higher and Prees Lower Heath and Lacon [540 310] in the south-central part of the district (Figure 5, Sections A and B). This laminated clay is generally brownish grey (5 YR 4/1), soft, plastic and generally stoneless, with some bands and laminae of fine sand and silt; these form a rhythmite sequence in part.

The laminated clay varies in thickness from 1.6 m to in excess of 23.1 m, the thicker sequences being found within the bedrock depression south of Prees (Figure 4) where the deposit thins to the east and west and finally disappears. Nowhere has laminated clay been seen to be directly on bedrock, but where the base of the laminated clay has been found, it generally lies on a very hard till overlying bedrock.

Beneath Upper College and Prees, borehole evidence suggests that the laminated clay may not be a continuous deposit between Prees Lower and Higher Heath because of a 'col' in the solid strata at Upper College and the proximity of morainic drift at Prees (see Figure 5).

The northward extent of the laminated clay at Prees Higher Heath is hidden by thick glacial sand and

gravel, and the form of the base of the deposit is not known even where the clays are at their thickest, which is in excess of 7.6 m in this area.

Within the overlying glacial sand and gravel is a younger laminated clay (Figure 5, Section A and B). It is between 0.1 and 1.6 m in recorded thickness and is generally moderate brown (5 YR 3/4) to greyish brown (5 YR 4/2), laminated, silty and stoneless. It may be partly plastic and/or massive and contains bands of fine sand and sandy silt. Laterally, this younger clay is restricted to the area beneath Prees Higher Heath.

Although laminated clay is not mapped at the surface in the district, borehole evidence suggests that some of the so-called till in the Lacon area is laminated clay and it is shown as such in Figure 5, Section A.

Glacial Sand and Gravel The glacial sand and gravel is divisible into two major types, namely that associated with the morainic drift of the west and north-east, and pro-glacial outwash deposits around and on Prees Higher and Lower Heath. The latter type also includes the glacial sand and gravel beneath the peat of Fenn's Moss.

Within the morainic drift, glacial sand and gravel ranges from small lenses and bodies of less than 0.5 m thick to fuller sequences up to 28 m thick, the latter often containing some beds of silt and clay, for example at Ash (Figure 5, Section B).

At the surface, the deposit varies from small outcrops such as those at Bank House [528 357] and Welshend [513 358] to the extensive spread around Tilstock and Alkington. However, in this area, IMAU borehole evidence suggests that the outcrop may be neither as continuous nor as uniform as shown on the geological map. Furthermore, other IMAU boreholes (for example NE 58) have proved glacial sand and gravel at the surface at localities hitherto mapped as till.

The deposit within the morainic drift comprises sand, 'clayey' sand, pebbly sand and 'clayey' pebbly sand with some more 'clayey' and gravelly material (for definitions of terms, see Appendix C).

The glacial sand and gravel of the outwash plain extends at surface from Brown Moss [560 397] in the north southwards through the heaths of Whitchurch and Prees to Lower Lacon (Figure 5, Section A). It is bounded on the west and north-east by the higher ground of morainic drift and in the south-east by solid strata (bedrock). The outwash plain also surrounds the hill of Lias at Prees. Its outcrop is generally two to three kilometres wide except in the south where it forms discrete outcrops in till, laminated clay and alluvium.

In the north, where the base has not been proved, the deposit is in excess of 25 m in thickness and contains some thin clays and silts. Farther south beneath Prees Higher Heath it is generally 14 to 17 m thick and lies on laminated clay, whereas at Lower Heath, it is less than

10 m thick and continues to thin southwards against laminated clay and the bedrock which eventually crops out at the surface.

In some areas, for example around Ightfield Heath [591 373] and Quina Brook [523 330], the outwash sand and gravel extends east and west beneath a cover of till (Figure 5, Section B).

These outwash deposits are generally coarser in the north and at the margins, where they consist of sandy gravel or pebbly sand though they may become sandier at depth. Farther south and towards the centre of the plain, the deposit is mainly of sand.

The composition of the glacial sand and gravel, the main sand and gravel resource of the district, is more fully described under Composition of the Sand and Gravel Deposits (below).

Alluvium Alluvium is generally confined to narrow belts along the streams and brooks draining Prees Heath, and small hollows in the morainic drift. However, around Soulton Brook in the Lacon area, there is an alluvial flat about a kilometre wide. Although sandy alluvium has been recorded (Poole and Whiteman, 1966, p. 94), peat and peaty silt are also common, as confirmed by IMAU boreholes SW 32 and SW 38, which encountered 0.7 m and 2.1 m, respectively, of peat and peaty silt.

Peat The smaller exposure of peat is associated with alluvium and surrounds the brook north of the Platt [554 347]. The other exposure is at Fenn's Moss, a large peat-filled depression between morainic drift, a part of which lies in the north-west of the district. IMAU borehole NW 34 drilled on the Moss encountered 2.5 m of peat with silty peat at the base, the whole lying on glacial sand and gravel which, with some till and laminated clay, probably underlies much of this area. It also seems likely that to the west, on the Welshampton sheet (SJ 43), the southern part of Fenn's Moss may also be underlain by glacial sand and gravel, although there is no borehole evidence in the Welshampton district to confirm this assumption (Institute of Geological Sciences, 1982). Peat was seen to be over 1.5 m thick along many drains, and thicknesses up to 7.6 m have been reported (Poole and Whiteman, 1966, p. 94).

COMPOSITION OF THE SAND AND GRAVEL DEPOSITS

Within the district, potentially workable sand and gravel is confined to the glacial sand and gravel. The mineral of this deposit has a mean grading of fines 7 per cent, sand 85 per cent and gravel 8 per cent, and ranges in composition from 'very clayey' and 'clayey' sand through sand, pebbly sand and sandy gravel to 'very clayey' gravel; of these, the last named is uncommon.

The gravel fraction is fine and coarse with some cobbles in places and comprises subangular to rounded,

Table 2 Physical and mechanical properties of the aggregate from representative boreholes

Borehole	Aggregate impact value	10% fines value (kN)	Relative density		Water absorption (% of dry mass)
			oven-dried basis	saturated and surface dried bases	
NE 42	22	250	2.6	2.6	1.3
NE 45	24	230	2.8	2.8	1.7

sandstones and siltstones of Lower Palaeozoic, Carboniferous and Permo-Triassic origin with acid tuffs and lavas, limestones and some mudstones (of similar origin to the sandstones), granites, dolerites, basalts, quartzites, quartz and rare cherts. The sand is fine- to medium-grained with some coarse, subangular to sub-rounded quartz with subordinate lithic grains of similar composition to the gravel, together with some coal and shell fragments.

The results of several physical and mechanical tests carried out according to BS 812 (British Standards Institution, 1975) upon aggregates from two boreholes in the glacial sand and gravel are shown in Table 2.

THE MAP

The sand and gravel resource map is folded into the pocket at the end of this report. The base map is the Ordnance Survey 1:25 000 Outline Edition, on which the topography is shown by contours in grey, the geological data in black and the mineral resource information in shades of red.

Geological data The geological boundary lines, symbols shown are taken from the geological maps of this district, which was surveyed at a scale of 1:10 560. However, as a result of this assessment survey, amendments to the geological lines have been incorporated on the map. Borehole data, which include the stratigraphical relations, thicknesses and mean particle-size distribution of the sand and gravel samples collected during the assessment survey, are also shown.

The geological boundaries are the best interpretation of the information available at the time of survey. However, this assessment survey indicates that bodies of glacial sand and gravel and till may not be distributed exactly as indicated (for example, at IMAU boreholes NW 28 and NE 58). These factors are taken into account in assessing the resources. It is inevitable, particularly with drift deposits which change rapidly vertically and laterally, that further local irregularities or discrepancies will be revealed by future borings and excavations.

Mineral resource information For assessment purposes, the district is divided into resource blocks (see Appendix A) which, apart from block A, are subdivided into areas where mineral is 'exposed' and areas where mineral is present beneath overburden. Because of the complex drift relationships at the surface in the north-west of the district in the area of block A, these

two categories have not been differentiated, and a category embracing both 'exposed' mineral and mineral beneath overburden has been introduced. A fourth category covers areas where sand and gravel is absent or not potentially workable. The mineral is identified as 'exposed' where the overburden, commonly consisting only of soil and subsoil, averages less than 1.0 m in thickness. Areas where bedrock outcrops, where boreholes indicate absence of sand and gravel beneath cover, and where sand and gravel beneath cover is interpreted to be not potentially workable are uncoloured on the Map. In such areas it has been assumed that mineral is absent except in infrequent and relatively minor patches which can neither be outlined nor assessed quantitatively in the context of this survey.

Where possible, the limits of the different categories of deposits are based on the mapped geological boundaries. Where there is a transition from one category to another which is independent of the geological lines and which could not be accurately delineated during this survey, inferred boundaries have been inserted. Such boundaries are shown by a distinctive zigzag symbol. The symbol is intended to convey an approximate location within a likely zone of occurrence, rather than to represent the breadth of the zone, its size being limited only by cartographical considerations. For the purpose of measuring area the centre-line of the symbol is used.

RESULTS

The statistical results are summarised in Table 3. Fuller grading particulars are shown in Figures 6 to 12 and Tables 4 to 9; the cumulative grading curves are based on up to 11 data points.

For the six resource blocks, A to F, the accuracy of the results at the symmetrical 95 per cent probability level (that is, on average nineteen out of every twenty sets of limits constructed in this way contain the true value for the volume of mineral) varies between 12 and 42 per cent (Appendix B). However, the true values are more likely to be nearer the figures estimated than either of the limits. Moreover, it is probable that approximately the same percentage limits would apply for the estimate of volume of a very much smaller parcel of ground (say, 100 hectares) containing similar sand and gravel deposits if the results from the same number of sample points were used in the calculation. Thus, if closer limits are needed for the quotation of reserves of part of a block, it can be expected that data from more points will be required, even if the area is

Table 3 The sand and gravel resources of sheet SJ 53: statistical assessment

Block	Area		Mean thickness			Volume of sand and gravel			Mean grading percentage		
	Block	Mineral	Over- burden	Mineral	Waste between mineral	Limits at the 95% probability level		Fines -1/16 mm	Sand +1/16-4mm	Gravel +4 mm	
	km ²	km ²	m	m	m	m ³ × 10 ⁶ ± %	± m ³ × 10 ⁶				
A	18.7	16.5	2.3	6.6	2.5	109	27	29	10	79	11
B	11.2	11.2	0.5	16.4	0.8	184	12	22	4	87	9
C	11.2	9.1	1.6	13.0	2.3	118	42	50	7	85	8
D	23.6	10.5	5.5	9.1	1.0	96	16	15	7	86	7
E	21.1	10.7	0.8	3.3	0	35	35	12	9	82	9
F	14.2	9.3	0.5	6.8	0.4	63	26	16	6	90	4
A-F	100	67.3	1.9	8.9	1.3	605	15	91	7	85	8

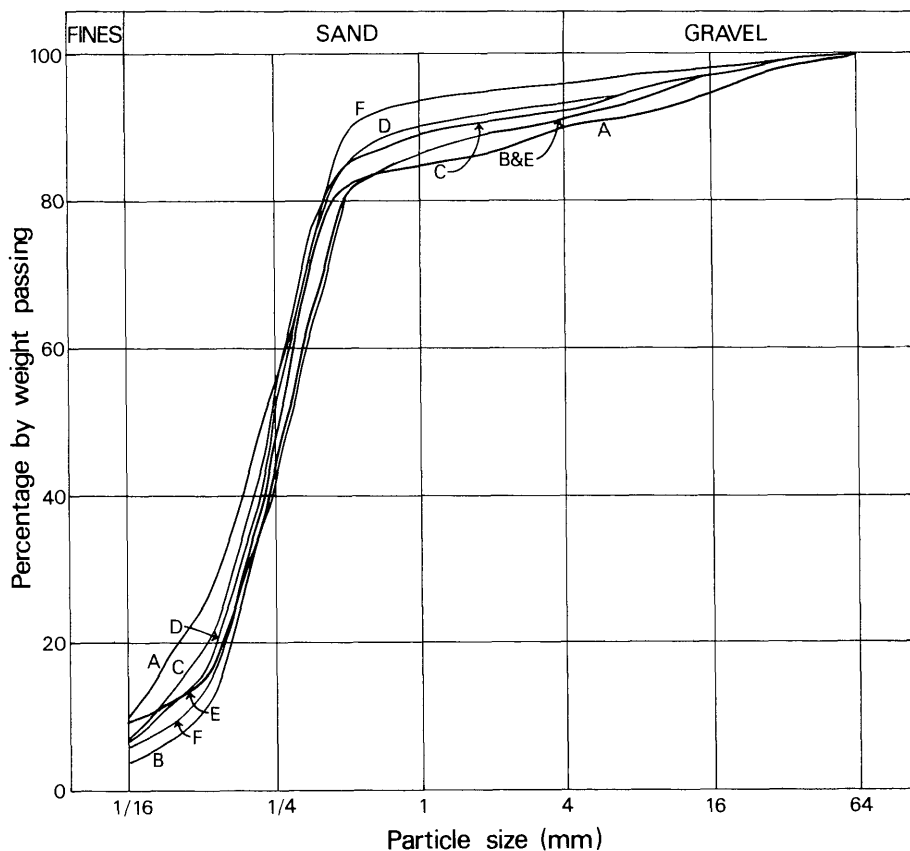


Figure 6 Mean particle-size distribution for the mineral in the resource blocks.

quite small. This point can be illustrated by considering the whole of the potentially workable sand and gravel on this sheet. The volume (605 million m³) can be estimated to limits of ± 15 per cent at the 95 per cent probability level, by a calculation based on the data from 72 sample points spread across the six resource blocks.

However, it must be emphasised that the quoted volume of sand and gravel bears no simple relationship to the amount that could be extracted in practice, as no allowance has been made in the calculations for any restraints (such as existing buildings and roads) on the use of land for mineral working.

NOTES ON THE RESOURCE BLOCKS

Bedrock crops out over about 10 per cent of the resource sheet area and this barren ground forms part of blocks E and F. Potentially workable sand and gravel is confined to the glacial sand and gravel, and the resource sheet area is divided into resource blocks, which primarily reflect the two major types of occurrence encountered in the district. Thus, blocks A, C and D comprise glacial sand and gravel mainly associated with morainic drift, whereas blocks B, E and F consist of glacial sand and gravel deposited as proglacial outwash around and on Prees Higher and Lower Heath. Blocks A, C and D generally have thicker sequences of overburden and waste between mineral than the other blocks.

Block A (Figure 7, Table 4)

Although much of this block is mapped as glacial sand and gravel, borehole information indicates that the outcrops are much more varied than the geological lines suggest. For example, of the nineteen boreholes sited within the mapped outcrops of glacial sand and

gravel, ten proved mineral at the surface, seven proved mineral beneath overburden and two proved no sand and gravel. Similarly some IMAU boreholes within the till, for example NE 58 and NW 38, proved that the till in places is very thin.

Because of the varied and complex drift geology, no attempt has been made to separate the exposed mineral from mineral beneath overburden and most of the block has been categorised as 'exposed mineral and continuous spreads of mineral beneath overburden, undifferentiated'. The exceptions are the areas of

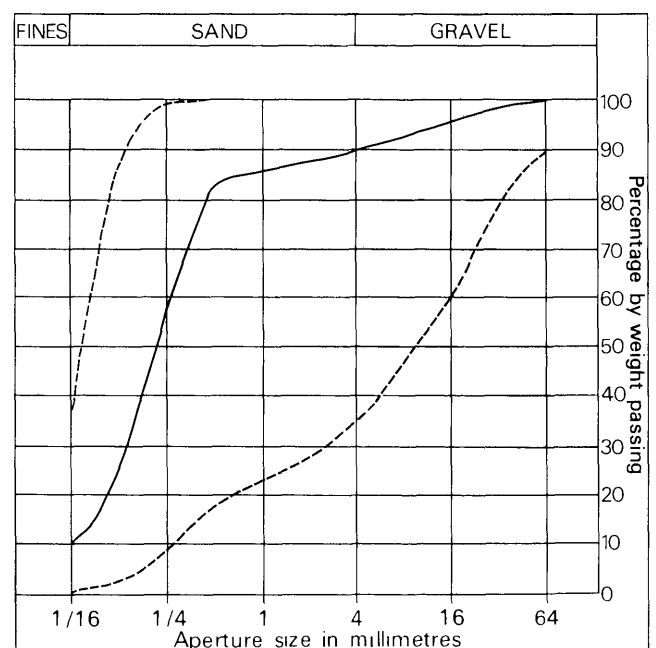


Figure 7 Grading characteristics of the mineral in block A.

Table 4 Block A: data from IMAU boreholes

Borehole	Recorded thickness (m)			Mean grading percentage						
	Mineral	Over-burden	Waste between mineral	Fines - $\frac{1}{16}$ mm	Fine sand + $\frac{1}{16}$ - $\frac{1}{4}$ mm	Medium sand + $\frac{1}{4}$ -1 mm	Coarse sand +1-4 mm	Fine gravel +4-16 mm	Coarse gravel +16-64 mm	Cobbly gravel +64 mm
NW 25	2.7	3.1		13	71	15	1			
NW 26	8.7	0.3	4.7	9	50	36	2	2	1	
NW 28	8.8	3.4	3.0	8	37	32	7	10	6	
NW 29	16.3	0.3	1.2	18	76	6				
NW 30	8.0	1.1	8.4	9	38	32	7	8	5	1
NW 31	3.4	0.6	0.9	28	51	15	2	2	2	
NW 32	3.6	8.5		14	45	25	3	6	7	
NW 34	13.0	2.5		7	66	26	1	trace		
NW 35	5.8	10.7	3.8	14	68	15	1	1	1	
NW 36	2.1	1.3		11	20	28	7	15	17	2
NW 37	8.9	0.2	4.9	12	20	29	8	16	15	trace
NW 38	3.7	0.8		4	45	50	1	trace		
NW 40	6.9	1.0		4	38	42	4	7	4	1
NW 41	3.0	0.5		7	28	27	7	14	13	4
NE 33	6.8	1.5	0.4	4	20	33	10	21	11	1
NE 39	12.7	1.8	9.7	12	42	32	4	6	3	1
NE 58	11.0	0.5	9.8	5	26	58	5	4	2	

overburden on mineral at Fenn's Moss and north of Fenn's Bank [50 39] and the barren ground around Alkington Hall [530 393].

The assessment of resources is based on 17 IMAU boreholes and 14 others, of which three proved no mineral. The area of barren ground cannot be delimited but the 'nil' values of these boreholes have been taken into account in assessing the resources.

The mineral varies from 'very clayey' sand through to 'very clayey' gravel, and the eastern half of the block generally contains a higher proportion of gravel than the western half, where thick sequences of 'clayey' sand and sand occur, for example at IMAU borehole NW 29. The mean grading of the mineral for the block as a whole is fines 10 per cent, sand 79 per cent and gravel 11 per cent, which classifies it as a 'clayey' pebbly sand.

The combined thicknesses of mineral within boreholes range from 2.1 m to 16.3 m and the overburden, where present, proved to be up to 10.7 m thick.

The estimated volume of mineral in the block is 109 million m³ ± 29 million m³.

Waste was encountered between beds of mineral in

16 boreholes and varied between 0.4 m and 9.7 m in thickness; the mean thickness is 2.5 m.

Block B (Figure 8, Table 5)

This block encompasses the northern part of the Prees outwash plain and mineral is generally exposed at the surface except where alluvium is found along the streams, and at Brown Moss and Ash near the northern margin of the block, where overburden may exceed 1.0 m, as proved for example, in IMAU borehole NE 35.

In the north of the block, the mineral contains more gravel than in the south and is generally a pebbly sand or sandy gravel, as for example at IMAU borehole NE 34. To the south the mineral is predominantly sand and the percentage of fines within the mineral is commonly less than 5. Combined mineral thicknesses vary from 3.3 m to greater than 23.0 m to give a mean of 16.4 m. Three IMAU boreholes and most of the other boreholes did not reach the base of the mineral in the northern part of the block.

The assessment is based on 10 IMAU boreholes and 13 others; waste between mineral was found in 15

Table 5 Block B: data from IMAU boreholes

Borehole	Recorded thickness (m)			Mean grading percentage						
	Mineral	Over-burden	Waste between mineral	Fines - $\frac{1}{16}$ mm	Fine sand + $\frac{1}{16}$ - $\frac{1}{4}$ mm	Medium sand + $\frac{1}{4}$ -1 mm	Coarse sand +1-4 mm	Fine gravel +4-16 mm	Coarse gravel +16-64 mm	Cobbly gravel +64 mm
NE 34	18.1+	0.3	2.6	6	17	35	11	15	14	2
NE 35	20.1	2.3	1.3	4	32	44	7	8	5	trace
NE 40	22.2+	0.3	2.5	7	36	39	6	7	5	
NE 44	20.2	0.3	0.9	4	44	42	3	4	3	trace
NE 45	23.0+	0.5	1.5	4	34	47	6	7	2	
NE 48	17.7	0.4	0.9	3	49	41	2	3	2	
NE 49	17.4	0.2	0.3	2	51	44	2	1		
NE 50	14.5	0.4	0.4	2	50	47	1	trace		
NE 53	18.6	0.4	1.0	3	43	49	3	2	trace	
NE 54	17.5	0.3	0.1	2	53	42	2	1	trace	

The + sign indicates that the full thickness of mineral was not proved in the borehole

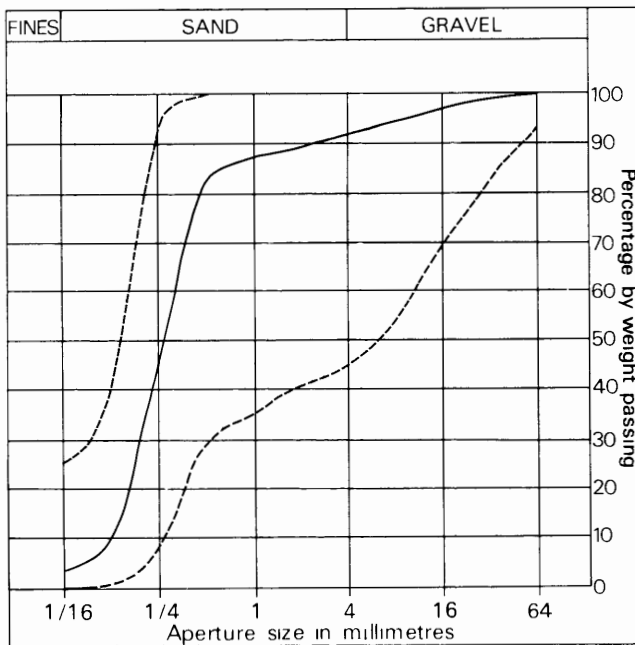


Figure 8 Grading characteristics of the mineral in block B.

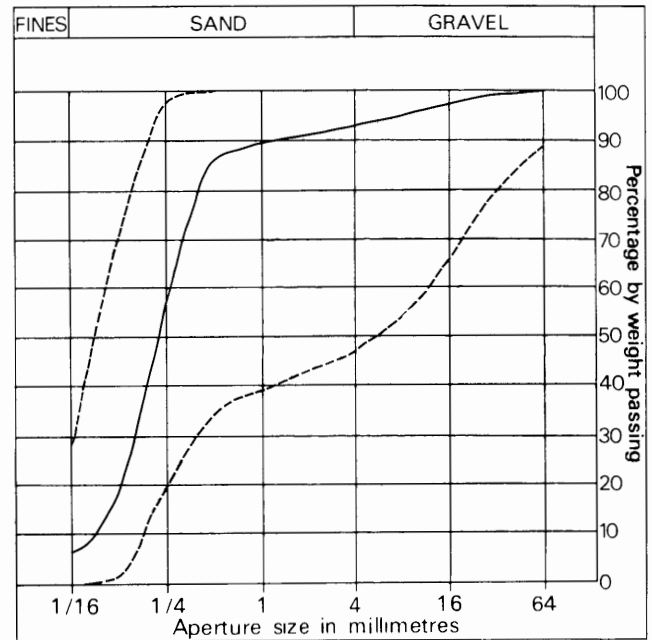


Figure 9 Grading characteristics of the mineral in block C.

boreholes and ranged from 0.1 m to 4.4 m in thickness, giving a mean of 0.8 m.

The estimated volume of mineral in the block is 184 million m³ ± 22 million m³.

Block C (Figure 9, Table 6)

This block comprises the moraine at Ash (Figure 5, Section B) and its associated deposits of till and glacial sand and gravel. The thickest deposits of mineral occur within the core of the moraine where up to 28 m of sand and gravel has been proved in borehole NE 26. The mineral thins southwards against bedrock (Figure 4) and here the lowest proven thickness was 3.7 m in IMAU borehole NE 56. The mean thickness of mineral for the block is 13.0 m.

The assessment is based on eight IMAU boreholes and 11 others; five of the IMAU boreholes contain sand or 'clayey' sand, whereas the other three (NE 41, NE 42 and NE 56) contain up to 25 per cent of gravel. The estimated volume is 118 million m³ ± 50 million m³.

Overburden, where present, ranges in recorded thickness between 0.3 m and 4.1 m, giving a calculated average of 1.6 m, but exceptionally IMAU borehole NE 36 on the moraine at Ash proved 11.0 m.

In the area of Twemlows [575 372] and Ightfield Heath [591 372], where till has been mapped overlying glacial sand and gravel, borehole data suggest (for example IMAU borehole NE 46) that mineral is exposed in some places. Conversely, in an area mapped as glacial sand and gravel, IMAU borehole NE 42 proved 2.0 m of overburden.

Waste bands between mineral were encountered in 14 boreholes used in the assessment and they ranged from 0.3 m to 11.0 m in thickness with a mean of 2.3 m.

Block D (Figure 10, Table 7)

The mineral-bearing ground is confined to the eastern margin of the block, except for a small outcrop of mineral at Welshend, which has also been assessed. Elsewhere, isolated occurrences of mineral have been proved (for example at IMAU boreholes NW 42 and SW 34 and another borehole NW 16), but these have been excluded from the assessment because of their modest thickness or apparently small extent in a predominantly clay terrain. The assessment is based on 11 IMAU boreholes and five others.

Within the mineral-bearing area, potentially workable sand and gravel crops out at Bank House

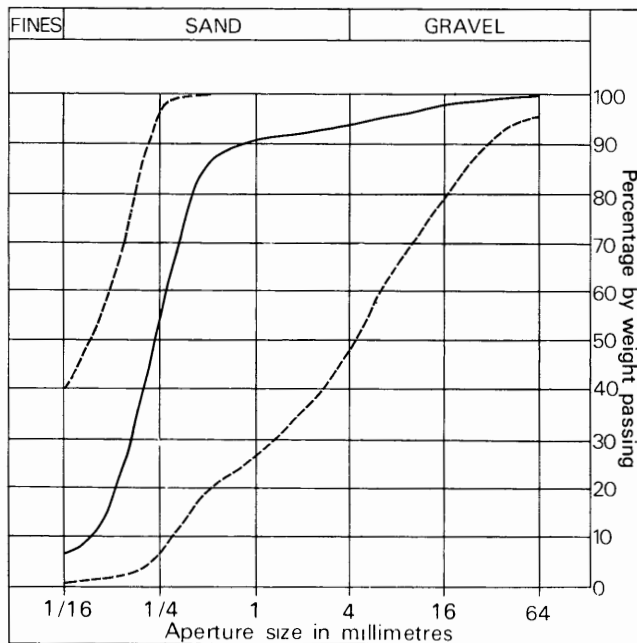
Table 6 Block C: data from IMAU boreholes

Borehole	Recorded thickness (m)			Mean grading percentage						
	Mineral	Overburden	Waste between mineral	Fines -1/16 mm	Fine sand +1/16-1/4 mm	Medium sand +1/4-1 mm	Coarse sand +1-4 mm	Fine gravel +4-16 mm	Coarse gravel +16-64 mm	Cobbly gravel +64 mm
NE 36	8.5	11.0		10	81	9				
NE 41	14.6+	3.1	3.8	6	25	36	8	13	10	2
NE 42	20.6+	2.0	2.1	9	34	38	6	8	5	trace
NE 46	23.0+	0.4	1.6	4	50	39	3	2	2	
NE 47	15.6+	1.8	8.6	9	58	31	1	1	trace	
NE 51	15.5	1.7	3.7	5	54	37	2	2		
NE 52	4.1	1.6		7	54	35	2	2		
NE 56	3.7	1.0		10	42	36	6	5	1	

The + sign indicates that the full thickness of mineral was not proved in the borehole

Table 7 Block D: data from IMAU boreholes

Borehole	Recorded thickness (m)			Mean grading percentage						
	Mineral	Overburden	Waste between mineral	Fines -1/16 mm	Fine sand +1/16-1/4 mm	Medium sand +1/4-1 mm	Coarse sand +1-4 mm	Fine gravel +4-16 mm	Coarse gravel +16-64 mm	Cobbly gravel +64 mm
NW 43	4.7	0.5		17	47	28	2	4	2	
NW 45	11.1	0.2	0.8	12	45	30	3	5	4	1
NW 46	10.4	3.5	5.1	4	43	46	3	2	2	
NW 47	13.3	8.0	1.0	4	47	40	4	4	1	
SW 25	8.7	8.3		8	44	46	1	1	trace	
SW 26	6.2	1.8	2.5	11	42	38	5	3	1	
SW 29	11.8	4.9	4.4	14	50	28	3	3	2	
SW 30	11.8	3.8		6	55	35	2	1	1	trace
SW 39	8.6	11.5	0.4	7	43	41	3	3	3	
SW 40	9.7	4.5	0.8	5	25	44	8	11	7	trace
SW 41	9.0	2.1	0.2	5	37	43	6	6	3	trace

**Figure 10** Grading characteristics of the mineral in block D.

[528 357], as proved by IMAU borehole NW45; elsewhere, however, the mineral lies beneath overburden, which ranges in recorded thickness from 2.1 m to

11.5 m with a mean for the block of 5.5 m.

The mineral is generally sand, pebbly sand or 'clayey' pebbly sand and ranges in recorded thickness from 2.0 m to 13.3 m with a mean of 9.1 m. The estimated volume of mineral in the block is 96 million m³ ± 15 million m³.

Waste partings between mineral were found in eight boreholes used in the assessment and their thickness ranged from 0.2 m to 5.1 m with a mean of 1.0 m.

Block E (Figure 11, Table 8)

This block lies at the southern end of the Prees Heath outwash plain. In its western half, exposed mineral is confined generally to several discrete outcrops lying on waste (Figure 5, Section B); by contrast, the eastern half is almost completely exposed mineral.

The assessment is based on 12 IMAU boreholes and three others. Six of the boreholes proved sand with 'clayey' and 'very clayey' sand; the others, except for SW38, are confined to the western and southern margin of the block and contain 'very clayey' pebbly sand through pebbly sand and sandy gravel to gravel. Mineral thicknesses recorded from boreholes range from 1.0 m to 7.2 m with a mean of 3.3 m. Waste partings between mineral were not encountered.

The estimated volume of mineral in the block is 35 million m³ ± 12 million m³.

The thicker sequences of overburden are confined to the alluvium associated with the two brooks that cross

Table 8 Block E: data from IMAU boreholes

Borehole	Recorded thickness (m)			Mean grading percentage						
	Mineral	Overburden	Waste between mineral	Fines -1/16 mm	Fine sand +1/16-1/4 mm	Medium sand +1/4-1 mm	Coarse sand +1-4 mm	Fine gravel +4-16 mm	Coarse gravel +16-64 mm	Cobbly gravel +64 mm
SW 32	7.2	1.3		14	38	45	2	1	trace	
SW 37	3.5	1.5		5	33	55	2	3	2	
SW 38	1.2	3.6		3	5	22	16	34	20	
SW 42	3.4	0.5		11	42	29	3	7	7	1
SW 43	1.9	0.2		20	55	24	1	trace		
SW 44	1.0	0.5		23	27	32	5	9	4	
SE 23	1.5	0.2		6	37	53	2	1	1	
SE 27	2.7	0.3		7	30	59	3	1		
SE 28	5.5	0.7		6	41	51	1	1	trace	
SE 29	3.5	0.3		9	41	46	1	2	1	
SE 31	4.2	0.3		8	19	38	11	16	8	
SE 32	3.9	1.1		5	14	51	10	16	4	

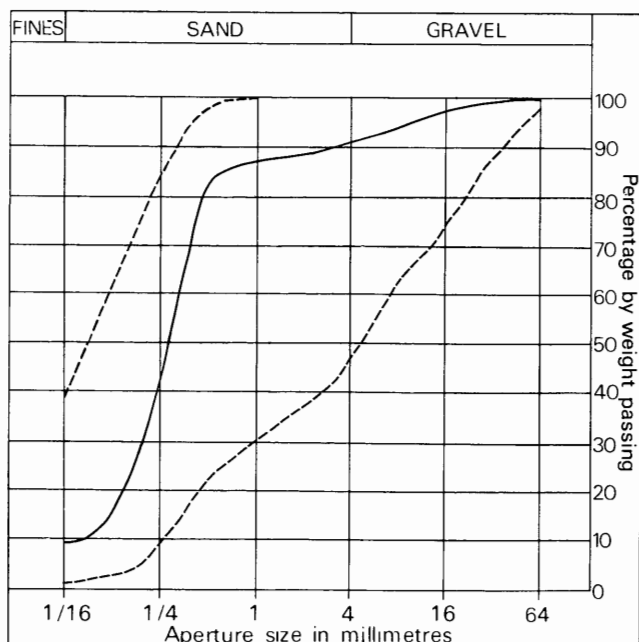


Figure 11 Grading characteristics of the mineral in block E.

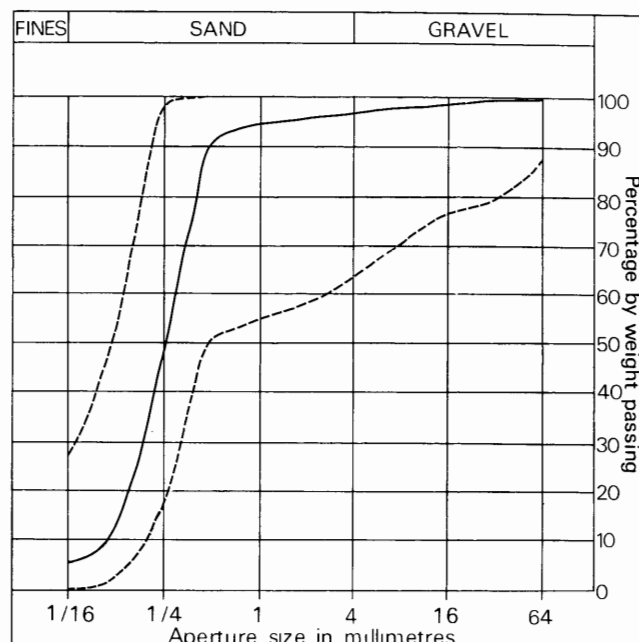


Figure 12 Grading characteristics of the mineral in block F.

the block; the thickest recorded overburden is 3.6 m in IMAU borehole SW38 and in only three other boreholes did it exceed 1.0 m.

An inferred boundary has been drawn along a part of the block's southern margin to accord with the adjoining Wem resource sheet (Cannell and Harries, 1981) where mineral is shown underlying till.

However, in the Prees district, no mineral underlies the till in this locality.

Block F (Figure 12, Table 9)

The central part of the Prees Heath outwash plain and its extension to the eastern margin of the district is covered by this block. Mineral, where present, is mainly exposed except along streams that cross the block where alluvial overburden up to 2.9 m thick has been recorded; elsewhere the overburden is less than 1.0 m thick and the mean for the block is 0.5 m.

The assessment is based on 11 IMAU boreholes and 14 others. The mineral consists primarily of sand and pebbly sand between 1.1 m and 13.6 m in recorded

thickness. It generally appears to thin towards the south and against the solid outcrops at Prees in the west and Faulsgreen and Sandford in the east. The mean thickness of mineral is 6.8 m.

Waste between mineral was encountered in five boreholes and ranged from 0.5 m to 1.6 m with a calculated mean thickness of 0.4 m.

The estimated volume of mineral in the block is 63 million m³ ± 16 million m³.

NOTES ON THE SAND AND GRAVEL WORKINGS IN THE DISTRICT

No large-scale workings exist in the district but there are several small, disused sand and gravel pits, three of which are detailed in Table 10. In addition, there are a number of other small pits, some of which are shown on the Ordnance Survey base map, and which were opened presumably to satisfy local demand.

Table 9 Block F: data from IMAU boreholes

Borehole	Recorded thickness (m)			Mean grading percentage						
	Mineral	Overburden	Waste between mineral	Fines -1/16 mm	Fine sand +1/16-1/4 mm	Medium sand +1/4-1 mm	Coarse sand +1-4 mm	Fine gravel +4-16 mm	Coarse gravel +16-64 mm	Cobbly gravel +64 mm
NE 55	9.5	0.8	1.1	2	61	35	1	1		
SE 15	11.2	0.4	1.2	12	43	42	2	1	trace	
SE 16	13.6	0.5	0.5	5	43	47	2	2	1	
SE 18	2.0	0.5		20	26	27	5	8	9	5
SE 19	10.1	0.5		6	27	59	4	3	1	
SE 20	5.9+	1.1		7	27	56	2	4	3	1
SE 21	4.4	1.4		4	34	53	2	2	5	
SE 22	8.3	0.3		3	36	51	3	4	3	
SE 24	4.1	0.6		7	43	47	1	1	1	
SE 25	6.9	0.2		3	33	58	3	2	1	
SE 26	8.5	0.8	1.6	5	55	38	1	1		

The + sign indicates that the full thickness of mineral was not proved in the borehole

Table 10 List of disused workings

Location	Grid reference	Principal deposit worked
Fenn's Bank	510 390	Glacial Sand and Gravel
Tilstock	5506 3792	Glacial Sand and Gravel
Bank House	5289 3567	Glacial Sand and Gravel

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APPENDIX A

FIELD AND LABORATORY PROCEDURES

Trial and error during initial studies of the complex and variable glacial deposits of East Anglia and Essex showed that an absolute minimum of five sample points evenly distributed across the sand and gravel are needed to provide a worthwhile statistical assessment, but that, where possible, there should be not less than ten. Sample points are any points for which adequate information exists about the nature and thickness of the deposit and may include boreholes other than those drilled during the survey and exposures. In particular, the cooperation of sand and gravel operators ensures that boreholes are not drilled where reliable information is already available; although this may be used in the calculations, it is held confidentially by the Institute and cannot be disclosed.

The mineral shown on each 1:25 000 sheet is divided into resource blocks. The arbitrary size selected, 10 km², is a compromise to meet the aims of the survey by providing sufficient sample points in each block. As far as possible the block boundaries are determined by geological boundaries so that, for example, glacial and river terrace gravels are separated. Otherwise division is by arbitrary lines, which may bear no relationship to the geology. Exceptionally, other schemes for subdividing the resource sheet area (for example, the use of 'resource sub-blocks') may be used where these are considered to be more appropriate.

A reconnaissance of the ground is carried out to record and sample any exposures, and inquiries are made to ascertain what borehole information is available. In addition, shallow trenches may be cut to investigate the grading of deposits, particularly in very coarse material, and to test the geology prior to commencing the drilling programme. Borehole sites are then selected to provide an even pattern of sample points at a density of approximately one per square kilometre. However, because broad trends are independently overlain by smaller scale characteristically random variations, it is unnecessary to adhere to a square grid pattern. Thus such factors as ease of access and the need to minimise disturbance to land and the public are taken into account in siting the holes; at the same time it is necessary to guard against the possibility that ease of access (that is, the positions of roads and farms) may reflect particular geological conditions, which may bias the drilling results.

The drilling machine employed should be capable of providing a continuous sample representative of all unconsolidated deposits, so that the in-situ grading can be determined, if necessary, to a depth of 30 m (100 ft) at a diameter of about 200 mm (8 in), beneath different types of overburden. It should be reliable, quiet, mobile and relatively small (so that it can be moved to sites of difficult access). Shell and auger rigs (sometimes referred to as 'percussion' rigs) have proved to be almost ideal.

The rigs are modified to enable deposits above the water table to be drilled 'dry', instead of with water added to facilitate the drilling, to minimise the amount of material drawn in from outside the limits of the hole. The samples thus obtained are representative of the in-situ grading, and satisfy one of the most important aims of the survey. Below the water-table the rigs are used conventionally, although this may result in the loss of some of the fines fraction and the pumping action of the bailer tends to draw unwanted material into the hole from the sides or the bottom.

A continuous series of bulk samples is taken throughout the sand and gravel. Ideally samples are composed exclusively of the whole of the material encountered in the borehole between stated depths. However, care is taken to discard, as far as possible, material which has caved or has been pumped from the bottom of the hole. A new sample is commenced whenever there is an appreciable lithological change within the deposit, or, ideally, at every 1 m (3.3 ft) depth. The samples, each weighing between 25 and 45 kg (55 and 100 lb), are despatched in heavy duty polythene bags to a laboratory for grading. The

grading procedure is based on British Standard 1377 (1975). Random checks on the accuracy of the grading are made in the Institute's laboratories.

Other methods of drilling and sampling are occasionally employed, for example the Minuteman power auger rig, and downhole tests such as U4 and SPT may be carried out. The Minuteman, which is small and portable, is normally used when access to land with shell rigs would be difficult to arrange and when information is requested quickly.

The auger tool comprises a continuous-'flight' 76-mm (3-inch) spiral auger; the use of this equipment, as with all 'open-hole' drilling methods, inevitably leads to the mixing and contamination of the sampled material. Thus, data relating to depth and composition cannot always be accurately determined.

All data, including mean grading analysis figures calculated for the total thickness of the mineral, are entered on standard record sheets, abbreviated copies of which are reproduced in Appendix E.

Detailed records may be consulted at the appropriate office of the Institute: the address is shown on page ii of this report, next to the preface.

APPENDIX B

STATISTICAL PROCEDURE

Statistical assessment

1 A statistical assessment is made of an area of mineral greater than 2 km², if there is a minimum of five evenly spaced boreholes in the resource block (for smaller areas see paragraph 12 below).

2 The simple methods used in the calculations are consistent with the amount of data provided by the survey (Hull, pp. 192–193 in Thurrell, 1981). Conventional symmetrical confidence limits are calculated for the 95 per cent probability level, that is, there is a 5 per cent or one in twenty chance of a result falling outside the stated limits.

3 The volume estimate (V) for the mineral in a given block is the product of the two variables, the sampled areas (A) and the mean thickness (\bar{l}_m) calculated from the individual thicknesses at the sample points. The standard deviations for these variables are related such that

$$S_A = \sqrt{S_A^2 + S_{\bar{l}_m}^2}. \quad [1]$$

4 The above relationship may be transposed such that

$$S_{\bar{l}_m} = S_A \sqrt{1 + S_A^2 / S_{\bar{l}_m}^2}. \quad [2]$$

From this it can be seen that as $S_A^2 / S_{\bar{l}_m}^2$ tends to 0, $S_{\bar{l}_m}$ tends to S_A .

If, therefore, the standard deviation for area is small with respect to that for mean thickness, the standard deviation for volume approximates to that for mean thickness.

5 Given that the number of approximately evenly spaced sample points in the sampled area is n , with mineral thickness measurements $l_{m_1}, l_{m_2}, \dots, l_{m_n}$, then the best estimate of mean thickness, \bar{l}_m , is given by

$$\bar{l}_m = (\sum(l_{m_1} + l_{m_2} \dots l_{m_n}) / n).$$

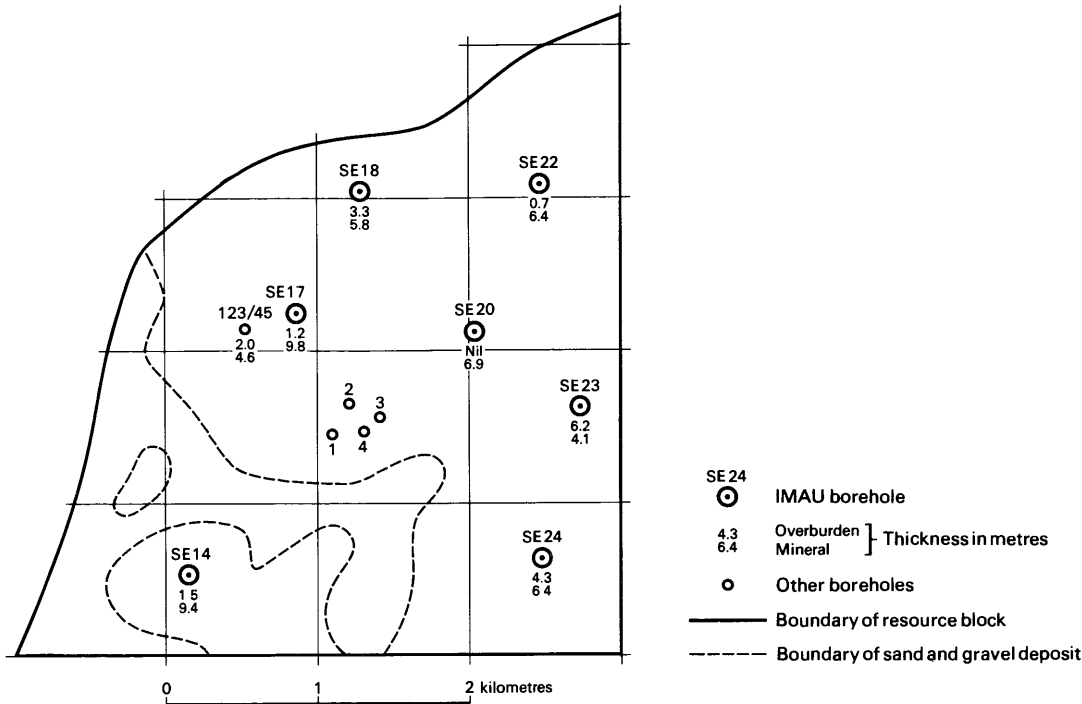
For groups of closely spaced boreholes a discretionary weighting factor may be applied to avoid bias (see note on weighting below). The standard deviation for mean thickness $S_{\bar{l}_m}$, expressed as a proportion of the mean thickness, is given by

$$S_{\bar{l}_m} = (1 / \bar{l}_m) \sqrt{[\sum(l_m - \bar{l}_m)^2 / (n - 1)]}$$

where l_m is any value in the series l_{m_1} to l_{m_n} .

6 The sampled area in each resource block is coloured pink on the map. Wherever possible, calculations relate to the mineral within mapped geological boundaries (which may not necessarily correspond to the limits of deposit). Where the area

Example of resource block assessment: map of fictitious block, calculation and results.



Block calculation 1:25 000 block: Fictitious

Area
 Block: 11.08 km²
 Mineral: 8.32 km²

Mean thickness
 Overburden: 2.5 m
 Mineral: 6.5 m

Volume
 Overburden: 21 million m³
 Mineral: 54 million m³

Confidence limits of the estimate of mineral volume at the 95 per cent probability level: ± 20 per cent
 That is, the volume of mineral (with 95 per cent probability): 54 ± 11 million m³

Thickness estimate (measurements in metres)
*l*_o = overburden thickness *l*_m = mineral thickness

Sample point	Weighting <i>w</i>	Overburden		Mineral		Remarks
		<i>l</i> _o	<i>wl</i> _o	<i>l</i> _m	<i>wl</i> _m	
SE 14	1	1.5	1.5	9.4	9.4	} IMAU boreholes
SE 18	1	3.3	3.3	5.8	5.8	
SE 20	1	nil	-	6.9	6.9	
SE 22	1	0.7	0.7	6.4	6.4	
SE 23	1	6.2	6.2	4.1	4.1	
SE 24	1	4.3	4.3	6.4	6.4	
SE 17	1/2	1.2	} 1.6	9.8	} 7.2	Hydrogeology Unit record
123/45	1/2	2.0		4.6		
1	1/4	2.7	} 2.6	7.3	} 5.8	Close group of four boreholes (commercial)
2	1/4	4.5		3.2		
3	1/4	0.4		6.8		
4	1/4	2.8		5.9		
Totals	Σ <i>w</i> = 8	Σ <i>wl</i> _o = 20.2		Σ <i>wl</i> _m = 52.0		
Means		$\overline{wl}_o = 2.5$		$\overline{wl}_m = 6.5$		

Calculation of confidence limits

<i>wl</i> _m	(<i>wl</i> _m - \overline{wl}_m)	(<i>wl</i> _m - \overline{wl}_m) ²
9.4	2.9	8.41
5.8	0.7	0.49
6.9	0.4	0.16
6.4	0.1	0.01
4.1	2.4	5.76
6.4	0.1	0.01
7.2	0.7	0.49
5.8	0.7	0.49

$$\Sigma(wl_m - \overline{wl}_m)^2 = 15.82$$

$$n = 8$$

$$t = 2.365$$

*L*_i is calculated as

$$1.05 (t/\overline{wl}_m) \sqrt{[\Sigma(wl_m - \overline{wl}_m)^2 / n(n-1)] \times 100}$$

$$= 1.05 \times (2.365/6.5) \sqrt{[15.82 / (8 \times 7)] \times 100}$$

$$= 20.3$$

$$\approx 20 \text{ per cent.}$$

is not defined by a mapped boundary, that is, where the boundary is inferred, a distinctive symbol is used. Experience suggests that the errors in determining area are usually small relative to those in thickness. The relationship $S_A/S_{\bar{t}_m} \leq \frac{1}{3}$ is assumed in all cases. It follows from equation [2] that

$$S_{\bar{t}_m} \leq S_r \leq 1.05 S_{\bar{t}_m} \quad [3]$$

7 The limits on the estimate of mean thickness of mineral,

$L_{\bar{t}_m}$, may be expressed in absolute units

$\pm (t/\sqrt{n}) \times S_{\bar{t}_m}$ or as a percentage

$\pm (t/\sqrt{n}) \times S_{\bar{t}_m} \times (100/\bar{t}_m)$ per cent, where t is Student's t at the 95 per cent probability level for $(n - 1)$ degrees of freedom, evaluated by reference to statistical tables. (In applying Student's t it is assumed that the measurements are distributed normally).

8 Values of t at the 95 per cent probability level for values of n up to 20 are as follows:

n	t	n	t
1	infinity	11	2.228
2	12.706	12	2.201
3	4.303	13	2.179
4	3.182	14	2.160
5	2.776	15	2.145
6	2.571	16	2.131
7	2.447	17	2.120
8	2.365	18	2.110
9	2.306	19	2.101
10	2.262	20	2.093

(from Table 12, *Biometrika Tables for Statisticians*, Volume 1, Second Edition, Cambridge University Press, 1962). When n is greater than 20, 1.96 is used (the value of t when n is infinity).

9 In calculating confidence limits for volume, L_v , the following inequality corresponding to equation [3] is applied: $L_{\bar{t}_m} \leq L_v \leq 1.05 L_{\bar{t}_m}$.

10 In summary, for values of n between 5 and 20, L_v is calculated as

$$[(1.05 \times t)/\bar{t}_m] \times [\sqrt{\sum(l_m - \bar{t}_m)^2/n(n-1)}] \times 100$$

per cent, and when n is greater than 20, as

$$[(1.05 \times 1.96)/\bar{t}_m] \times [\sqrt{\sum(l_m - \bar{t}_m)^2/n(n-1)}] \times 100$$

per cent (weighting factors may be included: see paragraph 15).

11 The application of this procedure to a fictitious area is illustrated in the diagram which accompanies this Appendix.

Inferred assessment

12 If the sampled area of mineral in a resource block is between 0.25 km² and 2 km² an assessment is inferred, based on geological and topographical information usually supported by the data from one or two boreholes. The volume of mineral is calculated as the product of the area, measured from field data, and the estimated thickness. Confidence limits are not calculated.

13 In some cases a resource block may include an area left uncoloured on the map, within which mineral (as defined) is interpreted to be generally absent. If there is reason to believe that some mineral may be present, an inferred assessment may be made.

14 No assessment is attempted for an isolated area of mineral less than 0.25 km².

15 *Note on weighting* The thickness of a deposit at any point may be governed solely by the position of the point in relation to a broad trend. However, most sand and gravel deposits also exhibit a random pattern of local, and sometimes considerable, variation in thickness. Thus the distribution of sample points need be only approximately regular and in estimating the mean thickness only simple weighting is necessary. In practice, equal weighting can often be applied to thicknesses at all sample points. If, however, there is a distinctly unequal distribution of points, bias is avoided by

dividing the sampled area into broad zones, to each of which a value roughly proportional to its area is assigned. This value is then shared between the data points within the zone as the weighting factor.

APPENDIX C

CLASSIFICATION AND DESCRIPTION OF SAND AND GRAVEL

For the purposes of assessing resources of sand and gravel a classification should take account of economically important characteristics of the deposit, in particular the absolute content of fines and the ratio of sand to gravel.

The terminology commonly used by geologists when describing sedimentary rocks (Wentworth, 1922) is not entirely satisfactory for this purpose. For example, Wentworth proposed that a deposit should be described as a 'gravelly sand' when it contains more sand than gravel and there is at least 10 per cent of gravel, provided that there is less than 10 per cent of material finer than sand (less than $\frac{1}{16}$ mm) and coarser than pebbles (more than 64 mm in diameter). Because deposits containing more than 10 per cent fines are not embraced by this system a modified binary classification based on Willman (1942) has been adopted.

When the fines content exceeds 40 per cent the material is not considered to be potentially workable and falls outside the definition of mineral. Deposits which contain 40 per cent fines or less are classified primarily on the ratio of sand to gravel but qualified in the light of the fines content, as follows: less than 10 per cent fines—no qualification; 10 per cent or more but less than 20 per cent fines—'clayey'; 20 to 40 per cent fines—'very clayey'.

The term 'clay' (as written, with single quote marks) is used to describe all material passing $\frac{1}{16}$ mm. Thus it has no mineralogical significance and includes particles falling within the size range of silt. The normal meaning applies to the term clay where it does not appear in single quotation marks.

The ratio of sand to gravel defines the boundaries between sand, pebbly sand, sandy gravel and gravel (at 19:1, 3:1 and 1:1).

Thus it is possible to classify the mineral into one of twelve descriptive categories (illustrated at the end of this appendix). The procedure is as follows:

- 1 Classify according to ratio of sand to gravel.
- 2 Describe fines.

For example, a deposit grading 11 per cent gravel, 70 per cent sand and 19 per cent fines is classified as 'clayey' pebbly sand. This short description is included in the borehole log (see the note on lithological description in Appendix D).

Many differing proposals exist for the classification of the grain size of sediments (Atterberg, 1905; Udden, 1914; Wentworth, 1922; Wentworth, 1935; Allen, 1936; Twenhofel, 1937; Lane and others, 1947). As Archer (1970a, b) has emphasised, there is a pressing need for a simple metric scale acceptable to both scientific and engineering interests, for which the class limit sizes correspond closely with certain marked changes in the natural properties of mineral particles. For example, there is an important change in the degree of cohesion between particles at about the $\frac{1}{16}$ -mm size, which approximates to the generally accepted boundary between silt and sand. These and other requirements are met by a system based on Udden's geometric scale and a simplified form of Wentworth's terminology, which is used in this report, and which appears in the table at the end of this appendix.

The fairly wide intervals in the scale are consistent with the general level of accuracy of the qualitative assessments of the resource blocks. Three sizes of sand are recognised, fine ($+\frac{1}{16} - \frac{1}{4}$ mm), medium ($+\frac{1}{4} - 1$ mm) and coarse ($+1 - 4$ mm). The boundary at 16 mm distinguishes a range of finer gravel ($+4 - 16$ mm), often characterised by abundance of worn tough pebbles of vein quartz, from larger pebbles often of notably different materials.

The boundary at 64 mm distinguishes pebbles from cobbles. The term 'gravel' is used loosely to denote both pebble-sized and cobble-sized material.

The size distribution of borehole samples is determined by sieve analysis, which is presented by the laboratory as logarithmic cumulative curves (see, for example, British Standard 1377: 1975). In this report the grading is tabulated on the borehole record sheets (Appendix E), the intercepts corresponding with the simple geometric scale $\frac{1}{16}$ mm, $\frac{1}{4}$ mm, 1 mm, 4 mm, 16 mm and so on as required. Original sample grading curves are available for reference at the appropriate office of the Institute.

Each bulk sample is described subjectively by a geologist at the borehole site. Subsequently, the descriptive categories of the mineral for each borehole are modified according to the results obtained from the mean particle size analysis of the samples.

The relative proportions of the rock types present in the gravel fraction are indicated by the use of the words 'and' or 'with'. For example, 'flint and quartz' indicates very approximate equal proportions with neither constituent accounting for less than about 25 per cent of the whole; 'flint with quartz' indicates that flint is dominant and quartz, the principal accessory rock type, comprises 5 to 25 per cent of the whole. Where the accessory material accounts for less than 5 per cent of the whole, but is still readily apparent, the phrase 'with some' has been used. Rare constituents are referred to as 'trace'.

The terms used in the field to describe the degree of rounding of particles, which is concerned with the sharpness of the edges and corners of a clastic fragment and not the shape (after Pettijohn, 1975), are as follows.

Angular: showing little or no evidence of wear; sharp edges and corners.

Subangular: showing definite effects of wear. Fragments still have their original form but edges and corners begin to be rounded off.

Subrounded: showing considerable wear. The edges and corners are rounded off to smooth curves. Original grain shape is still distinct.

Rounded: original faces almost completely destroyed, but some comparatively flat surfaces may still remain. All original edges and corners have been smoothed off to rather broad curves. Original shape is still apparent.

Well-rounded: no original faces, edges or corners left. The entire surface consists of broad curves; flat areas are absent. The original shape is suggested by the present form of the grain.

Classification of gravel, sand and fines

Size limits	Grain size description	Qualification	Primary classification
64 mm –	Cobble		
16 mm –	Pebble	Coarse	Gravel
4 mm –		Fine	
1 mm –		Coarse	
$\frac{1}{4}$ mm –	Sand	Medium	Sand
$\frac{1}{16}$ mm –		Fine	
	Fines (silt and clay)		Fines

- I Gravel
- II 'Clayey' gravel
- III 'Very clayey' gravel
- IV Sandy gravel
- V 'Clayey' sandy gravel
- VI 'Very clayey' sandy gravel
- VII Pebbly sand
- VIII 'Clayey' pebbly sand
- IX 'Very clayey' pebbly sand
- X Sand
- XI 'Clayey' sand
- XII 'Very clayey' sand

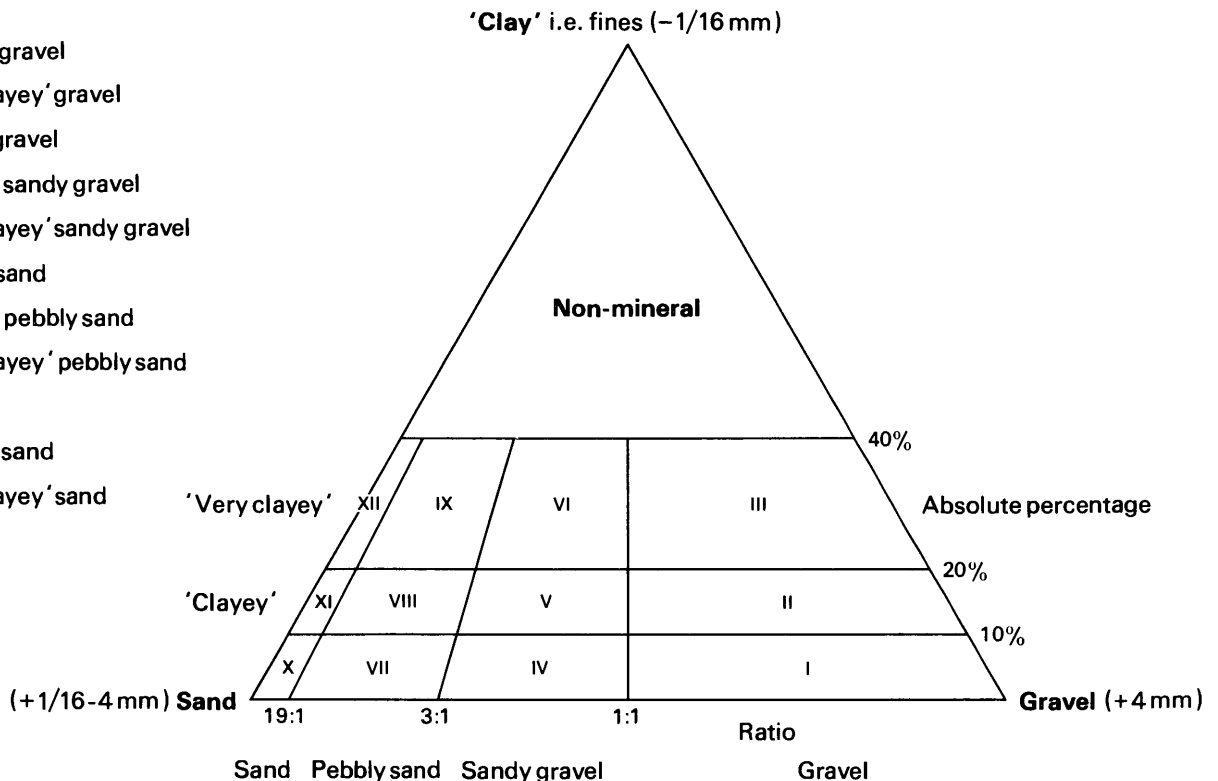


Diagram showing the descriptive categories used in the classification of sand and gravel

APPENDIX D
EXPLANATION OF THE BOREHOLE RECORDS Annotated example

SJ 53 NW 30 5156 3791 Brickwalls Farm¹

Block A

Surface level² +96.2 m
 Water struck³ at +85.0 m
 203 mm percussion⁴
 May 1981

Overburden⁵ 1.1 m
 Mineral 1.4 m
 Waste 5.6 m
 Mineral 2.1 m
 Waste 2.8 m
 Mineral 4.5 m
 Waste 2.6 m +⁶

LOG

<i>Geological classification</i>	<i>Lithology</i> ⁷	<i>Thickness</i> m	<i>Depth</i> m
	Soil	0.3	0.3
Till	Clay, moderate brown ⁸ , sandy, stony and weathered	0.8	1.1
Glacial Sand and Gravel	a 'Clayey' sand, moderate brown, fine with medium subangular to subrounded, quartz, with lithic grains; some fine pebbles	1.4	2.5
Till	Clay, moderate brown, stony, very sandy and softer to 5.0 m; rare shell fragments	5.6	8.1
Glacial Sand and Gravel	b 'Clayey' pebbly sand Gravel: fine and coarse, subangular to subrounded, Palaeozoic (A) and red (D) sandstones with acid volcanics (E), limestones (C) and some quartzites (H), quartz (I), plutonics (G), chert (J) and basic volcanics (F) Sand: fine and medium with coarse, quartz with lithic grains as in gravel Fines: 0.1 m of brown laminated silt at 9.2 m	2.1	10.2
Till	Clay, moderate brown, very sandy in part	1.0	11.2
Glacial Sand and Gravel	Silt, moderate brown, fine quartz	1.8	13.0
	c Pebbly sand Gravel: fine and coarse with some cobbles, Palaeozoic and red sandstones with acid volcanics, limestones and some quartzites, quartz, plutonics and chert Sand: fine and medium with coarse, quartz with lithic grains as in gravel	4.5	17.5
Till	Clay, moderate brown, hard, stony with sandy texture and some shell fragments	2.6+	20.1

GRADING⁹

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Gravel						
					- $\frac{1}{16}$	+ $\frac{1}{16}$ - $\frac{1}{4}$	+ $\frac{1}{4}$ -1	+1-4	+4-16	+16-64	+64 (mm)
a	15	81	4	1.1-2.5	15	51	26	4	4	0	0
b	16	63	21	8.1-9.1	10	41	39	5	3	2	0
				9.1-9.2	Clay parting, assumed to comprise 100% fines						
				9.2-10.2	14	21	16	9	20	17	3
				Mean	16	30	26	7	11	9	1
c	5	80	15	13.0-14.0	3	25	44	11	11	6	0
				14.0-15.0	2	21	29	13	17	10	8
				15.0-16.0	5	49	34	5	3	4	0
				16.0-17.5	7	51	36	3	2	1	0
				Mean	5	37	36	7	8	5	2
a + b + c	9	77	14	Mean	9	38	32	7	8	5	1

COMPOSITION¹⁰

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
13.0–15.0	52		6	24	12	trace	1	3	1	1

The numbered paragraphs below correspond with the annotations given on the specimen record above.

1 Location

The position of the borehole is generally referred to the nearest named locality on the 1:25 000 base map and the resource block in which the borehole lies is stated.

2 Surface level

The surface level at the borehole site is given in metres above Ordnance Datum.

3 Groundwater conditions

If groundwater was present, the level at which it was encountered or the level at which it stood on the completion of drilling is normally given (in metres relative to Ordnance Datum).

4 Type of drill and date of drilling

All boreholes were drilled by a shell and auger rig using 203 mm and/or 152 mm casing. The month and year of completion of drilling are stated.

5 Overburden, Mineral, Waste and Bedrock

Mineral is sand and gravel which, as part of a deposit, falls within the arbitrary definition of potentially workable material (see p. 1). Bedrock is the 'formation', 'country rock' or 'rock head' below which potentially workable sand and gravel will not be found. Waste is any material other than bedrock or mineral. Where waste occurs between the surface and mineral it is classified as overburden.

6 The plus sign (+) indicates that the base of the deposit was not reached during drilling.

7 Lithological description

When sand and gravel is recorded a general description based on the grading characteristics (for details see Appendix C) is followed by more detailed particulars of the gravel and/or sand fractions. Where more than one mineral horizon is recognised each is designated by a letter, e.g. **a**, **b**, etc. The description of other deposits is based on visual examination in the field.

8 Colour

The colour name has been deduced by reference to a modified system based on the Rock-Color Chart (Geological Society of America Rock-Color Chart Committee, 1975). A numerical designation, in brackets, may follow the colour name in some parts of the report.

9 Grading data

A continuous series of bulk samples is taken throughout the thickness of sand and gravel. A new sample is commenced whenever there is appreciable lithological change or at every 1 m of depth.

For each bulk sample the percentages of fines ($-\frac{1}{8}$ mm), fine sand ($+\frac{1}{8}-\frac{1}{4}$ mm), medium sand ($+\frac{1}{4}-1$ mm), coarse sand ($+1-4$ mm), fine gravel ($+4-16$ mm), coarse gravel ($+16-64$ mm), and cobble gravel ($+64$ mm) are stated.

The mean grading of groups of samples making up an identified mineral horizon is also given in detail and in summary. Where more than one horizon is recognised the mean grading for the whole of the mineral in the borehole may be given. Where necessary, in calculating mean gradings,

data for individual samples are weighted by the thickness represented. If, exceptionally, grading results are not available for a sample, an attempt may be made to estimate the grading by comparing the grading and field descriptions of adjacent samples with the sample in question. Such estimates are shown in square brackets.

Fully representative sampling of sand and gravel is difficult to achieve, particularly where groundwater levels are high. Comparison between boreholes and adjacent exposures commonly suggests that in borehole samples the proportion of sand may be higher and the proportion of fines and coarse gravel may be lower.

10 Composition

Samples of +8-mm gravel were analysed from selected boreholes. The categories recognised were:

- A Palaeozoic sandstones of Carboniferous and Lower Palaeozoic origin.
- B Palaeozoic siltstones and mudstones of Carboniferous and Lower Palaeozoic origin.
- C Limestones and calcareous mudstones.
- D Red sandstones and siltstones, mainly from the Permo-Trias.
- E Acid volcanics of tuff and porphyritic lavas.
- F Basic volcanics, primarily basalts with some dolerites.
- G Plutonics, mainly granites and microgranites.
- H Quartzites.
- I Quartz.
- J Chert with rare jaspers and unconsolidated mudstones and siltstones.

APPENDIX E

INDUSTRIAL MINERALS ASSESSMENT UNIT BOREHOLE RECORDS

SJ 53 NW 25 5050 3973 Fenn's Bank

Block A

Surface level +86.0 m
Water struck at +82.9 m
203 mm percussion
May 1981

Overburden 3.1 m
Mineral 2.7 m
Waste 15.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Till	Clay, light grey, plastic and stoneless to 1.6 m, sandy in part, then moderate brown, firmer and very sandy with some stones	3.0	3.1
Glacial Sand and Gravel	'Clayey' sand, reddish brown, fine with medium, subangular to rounded, quartz with some lithic grains including coal	2.7	5.8
Till	Clay, greyish red to moderate brown, sandy, mainly stony and firm but soft, silty and very sandy in part and from 8.9 m to 11.0 m	15.7 +	21.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
13	87	0	3.1 - 5.8	13	71	15	1	0	0	0

SJ 53 NW 26 5178 3983 Blackoe Farm

Block A

Surface level +86.8
Water struck at +79.3 m
203 mm percussion
April 1981

Overburden 0.3 m
Mineral 1.0 m
Waste 3.7 m
Mineral 1.5 m
Waste 1.0 m
Mineral 6.2 m
Waste 8.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	a 'Clayey' sand, fine and medium, subangular to rounded, quartz with lithic grains and rare shell fragments; some fine pebbles	1.0	1.3
	Clay, soft and sandy	3.7	5.0
	b 'Clayey' sand, as above	1.5	6.5
Till	Clay, greyish red to dark reddish brown, sandy, silty; stony in part	1.0	7.5
Glacial Sand and Gravel	c Sand, 'clayey' with some pebbles below 11.2 m; fine and medium, subrounded, quartz with some lithic grains and rare shell fragments	6.2	13.7
Till	Clay, reddish, sandy, stony and soft, some grey laminae in part, firmer at base	8.3 +	22.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	16	81	3	0.3 - 1.3	16	41	37	3	3	0	0
b	12	85	3	5.0 - 6.5	12	51	33	1	3	0	0
c	7	90	3	7.5 - 9.5	6	45	46	2	1	0	0
				9.5 - 11.2	5	50	43	1	1	0	0
				11.2 - 13.7	10	55	26	2	2	5	0
				Mean	7	51	37	2	1	2	0
a + b + c	9	88	3	Mean	9	50	36	2	2	1	0

SJ 53 NW 27 5304 3976 Chain House

Block A

Surface level +115.7 m
 Water seeping
 203 mm percussion
 April 1981

Waste 21.0m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Till	Soil	0.3	0.3
	Clay, brownish grey to greyish brown, sandy, stony and firm but very sandy and softer in part; below 17.0m olive grey to greyish red, hard and with many Lias clasts	20.7+	21.0

Surface level +100.8 m
 Water struck at +99.1 m
 203 mm and 152 mm percussion
 May 1981

Overburden 3.4 m
 Mineral 2.1 m
 Waste 0.5 m
 Mineral 4.6 m
 Waste 2.5 m
 Mineral 2.1 m
 Waste 7.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.7	0.7
Glacial Sand and Gravel	Clay, greyish yellow to greyish red, very sandy, silty and micaceous, few fine pebbles, leached and weathered. 'Very clayey' sandy gravel with thin clay bands from 1.9m to base	2.0	2.7
Till	Clay, greyish red, stony with a sandy texture	0.7	3.4
Glacial Sand and Gravel	a Pebbly sand Gravel: fine and coarse, subangular to rounded, Palaeozoic (A) and red sandstones (D) with acid volcanics (E) limestones (C), plutonics (G) and some quartzites (H), quartz (I), basic volcanics (F) and chert (J) Sand: medium and fine with coarse, quartz with lithic grains as in gravel and some shell fragments	2.1	5.5
Till	Clay, greyish red, sandy, few clasts	0.5	6.0
Glacial Sand and Gravel	b Pebbly sand, 'clayey' to 8.0 m Gravel: fine and coarse, subangular to rounded, Palaeozoic sandstones (A) with acid volcanics (E), limestones (C), red sandstones (D), and some quartz (I), quartzites (H), plutonics (G), chert (J) and basic volcanics (F), rare Palaeozoic mudstones and siltstones (B) Sand: fine and medium with coarse, quartz with lithic grains as in gravel and some shell fragments, coal and mica Fines: reddish brown, thin clay bands	4.6	10.6
Till	Clay, greyish brown, stony with very sandy texture, some laminae and thin bands of sand	2.5	13.1
Glacial Sand and Gravel	c 'Clayey' pebbly sand Gravel: fine and coarse, subangular to subrounded, composition as gravel at 10.6 m Sand: fine and medium, subangular to subrounded, quartz with lithic grains as in gravel and some shell fragments and coal Fines: some thin bands of greyish brown till to 14.1 m	2.1	15.2
Till	Clay, moderate brown to greyish brown, mainly massive and stony with a sandy texture, but poorly laminated and generally stoneless in part; 0.5 m of pebbly sand at 17.6 m	5.7	20.9
Laminated Clay	Silt and clay, moderate brown to pale brown, laminated, clayey silt, sandy silt, silty clay and plastic clay, generally stoneless; silts are slightly micaceous and sandy silt massive in part	1.5	22.4
Till	Clay, moderate brown to greyish brown, massive, stony with slightly sandy texture	0.6+	23.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
N	25	51	24	1.9 - 2.7	25	30	19	2	9	15	0
a	4	73	23	3.4 - 4.4	4	22	30	9	20	15	0
				4.4 - 5.5	4	28	45	12	10	1	0
				Mean	4	25	37	11	15	8	0
b	9	73	18	6.0 - 7.0	21	37	24	4	9	5	0
				7.0 - 8.0	12	33	32	5	8	10	0
				8.0 - 9.0	3	30	34	9	16	8	0
				9.0 - 10.6	3	33	36	10	11	7	0
				Mean	9	34	32	7	11	7	0
c	12	82	6	13.1 - 14.1	18	49	20	5	8	0	0
				14.1 - 15.2	6	53	34	3	1	3	0
				Mean	12	51	27	4	4	2	0
N	9	77	14	17.1 - 17.6	9	35	30	12	13	1	0
a + b + c	8	76	16	Mean	8	37	32	7	10	6	0

N means non-mineral

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
3.4 - 5.5	39		11	25	12	1	6	3	2	1
6.0 - 10.6	51	trace	8	13	17	1	3	2	3	2

Surface level +102.2
 Water struck at +97.7 m
 203 mm and 152 mm percussion
 May 1981

Overburden 0.3 m
 Mineral 14.9 m
 Waste 1.2 m
 Mineral 1.4 m
 Waste 5.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	a 'Clayey' sand, 'very clayey' in part Sand: fine with medium, subrounded, quartz with some lithic grains and rare coal and mica Fines: thin laminae and bands of greyish red plastic clay	14.9	15.2
Laminated Clay	Clay, greyish red, plastic, stoneless and micaceous, laminated and sandy in parts	1.2	16.4
Glacial Sand and Gravel	b 'Very clayey' sand, fine, composition as sand at 15.2 m	1.4	17.8
Laminated Clay	Clay, moderate brown, silty, laminated and stoneless; plastic at top, massive in part	5.4 +	23.2

GRADING

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>									
	Fines	Sand	Gravel		Fines			Sand				Gravel		
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm			
a	17	83	0	0.3 - 1.3	13	79	8	0	0	0	0	0		
				1.3 - 2.3	7	75	18	0	0	0	0	0		
				2.3 - 4.5	6	77	17	0	0	0	0	0		
				4.5 - 6.5	29	66	5	0	0	0	0	0		
				6.5 - 8.5	10	84	6	0	0	0	0	0		
				8.5 - 10.5	23	73	4	0	0	0	0	0		
				10.5 - 12.5	15	83	2	0	0	0	0	0		
				12.5 - 15.2	24	75	1	0	0	0	0	0		
				Mean	17	76	7	0	0	0	0	0		
b	33	67	0	16.4 - 17.8	33	66	1	0	0	0	0	0		
a + b	18	82	0	Mean	18	76	6	0	0	0	0	0		

Surface level +96.2 m
 Water struck at +85.0 m
 203 m percussion
 May 1981

Overburden 1.1 m
 Mineral 1.4 m
 Waste 5.6 m
 Mineral 2.1 m
 Waste 2.8 m
 Mineral 4.5 m
 Waste 2.6 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, moderate brown, sandy, stony and weathered	0.8	1.1
Glacial Sand and Gravel	a 'Clayey' sand, moderate brown, fine with medium, subangular to subrounded, quartz with lithic grains; some fine pebbles	1.4	2.5
Till	Clay, moderate brown, stony, very sandy and softer to 5.0 m; rare shell fragments	5.6	8.1
Glacial Sand and Gravel	'Clayey' pebbly sand Gravel: fine and coarse, subangular to subrounded, Palaeozoic (A) and red (D) sandstones with acid volcanics (E), limestones (C) and some quartzites (H), quartz (I), plutonics (G), chert (J) and basic volcanics (F) Sand: fine and medium with coarse, quartz with lithic grains as in gravel Fines: 0.1 m of brown laminated silt at 9.2 m	2.1	10.2
Till	Clay, moderate brown, very sandy in part	1.0	11.2
Glacial Sand and Gravel	Silt, moderate brown, fine quartz	1.8	13.0
	c Pebbly sand Gravel: fine and coarse with some cobbles, Palaeozoic and red sandstones with acid volcanics, limestones and some quartzites, quartz, plutonics and chert Sand: fine and medium with coarse, quartz with lithic grains as in gravel	4.5	17.5
Till	Clay, moderate brown, hard, stony with sandy texture and some shell fragments	2.6+	20.1

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines			Sand			
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	15	81	4	1.1 - 2.5	15	51	26	4	4	0	0
b	16	63	21	8.1 - 9.1	10	41	39	5	3	2	0
				9.1 - 9.2	Clay parting, assumed to comprise 100% fines						
				9.2 - 10.2	14	21	16	9	20	17	3
				Mean	16	30	26	7	11	9	1
c	5	80	15	13.0 - 14.0	3	25	44	11	11	6	0
				14.0 - 15.0	2	21	29	13	17	10	8
				15.0 - 16.0	5	49	34	5	3	4	0
				16.0 - 17.5	7	51	36	3	2	1	0
				Mean	5	37	36	7	8	5	2
a + b + c	9	77	14	Mean	9	38	32	7	8	5	1

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
13.0 - 15.0	52		6	24	12	trace	1	3	1	1

Surface level +126.2 m
 Water struck at +124.4 m
 203 mm percussion
 May 1981

Overburden 0.6 m
 Mineral 1.1 m
 Waste 0.9 m
 Mineral 2.3 m
 Waste 15.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial Sand and Gravel	Sandy silt, light brown to moderate reddish brown, fine and medium, quartz with lithic grains	0.4	0.6
	a 'Very clayey' sand, some fine pebbles Sand: fine with medium and some coarse, quartz with lithic grains and some shell fragments Fines: light brown with thin bands of moderate reddish brown sandy silt	1.1	1.7
	Clayey sandy silt, light brown, fine, micaceous quartz	0.9	2.6
	b 'Very clayey' pebbly sand Gravel: fine and coarse, subangular to subrounded, Palaeozoic sandstones and siltstones with red sandstones, acid volcanics and some limestones, quartzites, quartz and plutonics Sand: fine with medium and some coarse, subangular to subrounded, quartz with lithic grains as in gravel, some shell fragments, slightly micaceous Fines: light brown, some thin silt and clay bands	2.3	4.9
Till	Clay, generally greyish brown, mainly massive and stony with a sandy texture but thin bands and laminae of sand in part; 0.2 m of olive grey, laminated, plastic and relatively stoneless clay at 6.9 m	15.1 +	20.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
						- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64
a	24	74	2	0.6 - 1.7	24	50	22	2	2	0	0
b	29	66	5	2.6 - 3.6	35	53	9	1	2	0	0
				3.6 - 4.9	25	50	15	2	2	6	0
				Mean	29	52	12	2	2	3	0
a + b	28	68	4	Mean	28	51	15	2	2	2	0

Surface level +115.7 m
 Water seeping
 203 mm percussion
 April 1981

Overburden 8.5 m
 Mineral 3.6 m
 Waste 10.9 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.7	0.7
Glacial Sand and Gravel	Clay, reddish brown, very sandy, weathered at top, soft with some clasts below 2.0 m; 0.8 m of 'clayey' pebbly sand at 2.0 m	3.6	4.3
	'Very clayey' pebbly sand	1.0	5.3
	Clay, greyish red, silty, stoneless	1.2	6.5
	Pebbly sand	1.5	8.0
	Clay, greyish red, silty, stoneless	0.5	8.5
	'Clayey' pebbly sand, 'very clayey' in upper half	3.6	12.1
	Gravel: fine and coarse, Palaeozoic sandstones and siltstones with red sandstones, acid volcanics and some limestones, quartzites, quartz and plutonics		
	Sand: fine with medium, quartz with lithic grains as in gravel		
Till	Clay, moderate brown, mainly massive and stony with sandy lenses but below 14.0 m softer and less stony with some silty laminated clay bands	10.9+	23.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines			Gravel			
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
N	19	74	7	1.2-2.0	19	44	26	4	5	2	0
N	21	69	10	4.3-5.3	21	38	28	3	4	6	0
N	5	88	7	6.5-8.0	5	53	33	2	2	5	0
	14	73	13	8.5-10.5	21	41	20	2	6	10	0
				10.5-12.1	6	49	32	4	6	3	0
				Mean	14	45	25	3	6	7	0

N means non-mineral

Surface level +106.0 m
 Water struck at +101.9 m
 203 mm percussion
 May 1981

Waste 20.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Till	Soil Clay, moderate brown to greyish brown, massive and stony with a sandy texture, some laminae of sand and silt in part; 0.6 m of 'clayey' sandy gravel at 5.5 m and 1.1 m of pebbly sand at 13.8 m	0.5 19.5+	0.5 20.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines		Sand		Gravel		
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
N	19	46	35	4.9 - 5.5	19	23	18	5	14	19	2
N	8	72	20	12.7 - 13.8	8	35	31	6	11	9	0

N means non-mineral

Surface level +92.6 m
 Water struck at +92.4 m
 152 mm percussion
 April 1981

Overburden 2.5 m
 Mineral 13.0 m
 Waste 5.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Peat	Peat, silty at base	2.5	2.5
Glacial Sand and Gravel	Sand, 'very clayey' at base: fine with medium, quartz with lithic grains, some organic debris at top; scattered fine pebbles, thin band of plastic silty clay at 10.5 m Clay, greyish red, very sandy and silty, few pebbles, soft but harder and stoneless below 19.8 m	13.0 5.0+	15.5 20.5

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages					
	Fines	Sand	Gravel		Fines		Sand		Gravel	
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64
7	93	trace	2.5 - 3.5	4	80	15	1	0	0	0
			3.5 - 4.5	4	75	20	0	1	0	0
			4.5 - 5.5	2	87	11	0	0	0	0
			5.5 - 6.5	3	69	28	0	0	0	0
			6.5 - 7.5	3	69	28	0	0	0	0
			7.5 - 8.5	1	40	59	0	0	0	0
			8.5 - 9.5	1	28	67	2	2	0	0
			9.5 - 10.5	2	56	39	2	1	0	0
			10.5 - 13.5	7	72	20	1	0	0	0
			13.5 - 15.5	23	70	7	0	0	0	0
			Mean	7	66	26	1	trace	0	0

Surface level + 115.7 m
 Water struck at + 113.1 m
 203 mm percussion
 May 1981

Overburden 10.7 m
 Mineral 4.0 m
 Waste 3.8 m
 Mineral 1.8 m
 Waste 3.9 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.7	0.7
Till	Clay, moderate brown to brownish grey, massive and stony with a sandy texture and some shell fragments; 0.1 m of 'very clayey' sandy gravel at 2.7 m and a pebbly layer at 6.4 m	6.7	7.4
Laminated Clay	Clay, brownish grey, plastic, laminated and contorted, generally stoneless with few pebbles	0.4	7.8
Glacial Sand and Gravel	Sandy gravel	0.3	8.1
Till	Clay, greyish brown, mainly massive and stony with a sandy texture but laminated, hard and less stony from 10.0 m to base	2.6	10.7
Glacial Sand and Gravel	a 'Clayey' sand, some fine pebbles at top Sand: fine with medium, subangular to subrounded, quartz with lithic grains and some shell fragments and coal Fines: pale brown, laminated, micaceous silt in part below 12.7 m	4.0	14.7
Till	Clay, greyish brown to brownish grey, mainly massive and stony with a sandy texture but with some bands of sand and silt and softer in part; 0.2 m of 'very clayey' sand at 15.4 m	3.8	18.5
Glacial Sand and Gravel	b 'Clayey' sand, pebbly at top: fine with medium, subangular to subrounded, quartz with lithic grains and some shell fragments	1.8	20.3
Till	Clay, moderate brown to greyish brown, massive and stony with a sandy texture and few shell fragments, some lenses and laminae of sand; 0.5 m of 'clayey' pebbly sand at 21.7 m	3.9+	24.2

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		percentages						
					Fines	Sand			Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm	
a	16	83	1	10.7 - 11.7	8	59	27	3	3	0	0
				11.7 - 12.7	9	77	13	1	0	0	0
				12.7 - 14.7	23	72	4	1	0	0	0
				Mean	16	69	12	2	1	0	0
b	11	85	4	18.5 - 20.3	11	61	23	1	2	2	0
a + b	14	84	2	Mean	14	68	15	1	1	1	0

Surface level +106.7 m
 Water struck at +104.4 m
 203 mm percussion
 February 1981

Overburden 1.3 m
 Mineral 2.1 m
 Waste 17.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, sandy, gravelly and weathered	0.9	1.3
Glacial Sand and Gravel	'Clayey' sandy gravel Gravel: fine and coarse with some cobbles, subangular to rounded, Palaeozoic sandstones and siltstones with acid volcanics, red sandstones, quartzites, quartz, plutonics and basic volcanics Sand: fine and medium with coarse, quartz with lithic grains as in gravel	2.1	3.4
Till	Clay, greyish red to moderate brown, massive stony and sandy; 1.3 m of 'clayey' pebbly sand at 18.0m	17.8+	21.2

GRADING

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
	Fines	Sand	Gravel		Fines			Sand			
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
	11	55	34	1.3 - 2.3	9	17	25	7	18	22	2
				2.3 - 3.4	13	22	31	7	12	13	2
				Mean	11	20	28	7	15	17	2
N	11	71	18	16.7 - 17.7	12	11	48	17	10	2	0
				17.7 - 18.0	6	13	31	12	13	20	5
				Mean	11	11	44	16	11	6	1

N means non-mineral

Surface level +99.2 m
 Water struck at +97.2 m
 203 mm percussion
 February 1981

Overburden 0.2 m
 Mineral 5.2 m
 Waste 3.0 m
 Mineral 1.4 m
 Waste 1.9 m
 Mineral 2.3 m
 Waste 8.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial Sand and Gravel	a Sandy gravel, 'clayey at top Gravel: fine and coarse, subangular to subrounded, Palaeozoic sandstone (A) with acid volcanics (E), red sandstones and siltstones (D), quartzites (H) and some quartz (I), plutonics (G), chert (J), limestone (C) and Palaeozoic siltstones (B) Sand: medium with fine and coarse, subangular to subrounded, quartz with lithic grains as in gravel; thin stoneless clays in part from 4.2 m to base	5.2	5.4
Till	Clay, greyish brown to moderate brown, massive, stony with sandy texture; some shell fragments	3.0	8.4
Glacial Sand and Gravel	b 'Clayey' pebbly sand Gravel: fine and coarse, composition as gravel at 5.4 m Sand: fine and medium with some coarse, quartz with lithic grains as in gravel	1.4	9.8
Till	Clay, greyish brown, massive, stony with sandy texture and some shell fragments	1.9	11.7
Glacial Sand and Gravel	c 'Very clayey' gravel Gravel: fine and coarse with some cobbles at top, composition as gravel above Sand: fine to coarse, quartz with lithic grains as in gravel Fines: 0.4 m of greyish brown till at 12.7 m	2.3	14.0
Till	Clay, greyish brown, massive, stony, sandy and hard; bands of sand and gravel in part	8.0+	22.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages								
	Fines	Sand	Gravel		Fines			Sand				Gravel	
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm		
a	7	62	31	0.2 - 1.2	14	24	36	8	11	7	0		
				1.2 - 2.2	9	20	42	7	10	12	0		
				2.2 - 3.2	2	10	24	11	26	27	0		
				3.2 - 4.2	3	13	34	11	20	19	0		
				4.2 - 5.4	5	23	37	9	15	11	0		
			Mean	7	18	35	9	16	15	0			
b	13	72	15	8.4 - 9.8	13	38	29	5	8	7	0		
c	23	33	44	11.7 - 12.3	5	5	13	12	25	33	7		
				12.3 - 12.7	Clay parting, assumed to comprise 100% fines								
				12.7 - 14.0	8	18	19	9	23	23	0		
			Mean	23	11	14	8	20	22	2			
a + b + c	12	57	31	Mean	12	20	29	8	16	15	trace		

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in +8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
0.2 - 5.4	59	2	1	12	14		2	5	3	2

Surface level +93.8 m
 Water level +92.8 m
 203 mm percussion
 February 1981

Overburden 0.8 m
 Mineral 3.7 m
 Waste 15.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.8	0.8
Glacial Sand and Gravel	Sand, fine and medium, rounded to well rounded, quartz with lithic grains and some coal and mica	3.7	4.5
Laminated Clay and Till	Clay, dark reddish brown to moderate red, micaceous, silty and generally stoneless, laminated in part, some stony bands below 19.0 m	15.5+	20.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
4	96	trace	0.8 - 2.8	2	43	54	1	0	0	0
			2.8 - 4.5	7	47	44	1	1	0	0
			Mean	4	45	50	1	trace	0	0

Surface level +96.7 m
 Water struck at +95.7 m
 203 mm percussion
 February 1981

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, greyish brown to moderate brown, mainly massive and stony with a sandy texture, but some bands and laminae of pebbly sand, and gravel	17.6+	18.0

Surface level + 111.6m
 Water struck at + 110.6 m
 203 mm percussion
 February 1981

Overburden 1.0m
 Mineral 6.9m
 Waste 14.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Till	Clay, weathered, sandy with few pebbles	0.9	1.0
Glacial Sand and Gravel	Pebbly sand, sandier in upper half Gravel: fine and coarse, some cobbles at base, rounded to subrounded, Palaeozoic sandstones (A) with acid volcanics (E), limestones (C), red sandstones (D), quartz (I) and some quartzites (H), plutonics (G), basic volcanics (F), siltstones (B) and chert (J) Sand: fine and medium with some coarse, rounded to subrounded, quartz with lithic grains as in gravel	6.9	7.9
Till	Clay, greyish brown, massive and stony with sandy texture, but thin bands of sandy gravel at 9.7 m and poorly laminated in part	14.1 +	22.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines			Gravel			
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
4	84	12	1.0 - 2.0	11	34	45	3	2	5	0
			2.0 - 3.0	3	42	48	2	4	1	0
			3.0 - 4.0	5	44	47	2	1	1	0
			4.0 - 5.0	3	44	46	2	3	2	0
			5.0 - 6.0	3	42	34	3	10	8	0
			6.0 - 7.1	2	32	36	6	15	9	0
			7.1 - 7.9	3	30	39	10	12	1	5
			Mean	4	38	42	4	7	4	1

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
5.0 - 7.9	51	1	11	9	17	1	1	3	5	1

Surface level +95.2 m
 Water seeping
 203 mm percussion
 February 1981

Overburden 0.5 m
 Mineral 3.0 m
 Waste 16.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil	0.5	0.5
	Sandy gravel, 'clayey' and cobbly at top Gravel: fine and coarse with some cobbles, rounded to subrounded, Palaeozoic sandstones with acid volcanics, red sandstones, and some plutonics, limestone and quartz Sand: fine and medium with some coarse, quartz with lithic grains as in gravel	3.0	3.5
Till	Clay, greyish red to greyish brown, mainly massive and stony with a sandy texture, and some shell fragments; some thin bands of sand as well as 0.5 m of pebbly sand at 10.5 m and 1.4 m at 12.7 m	16.5 +	20.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines		Sand			Gravel	
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
	7	62	31	0.5 - 1.5	10	18	22	6	14	10	11
				1.5 - 2.5	5	37	37	6	8	7	0
				2.5 - 3.5	5	28	26	8	20	13	0
				Mean	7	28	27	7	14	13	4
N	4	83	13	11.3 - 12.7	4	39	37	7	11	2	0

N means non-mineral

Surface level +96.6 m
 Water level +82.6 m
 203 mm percussion
 May 1981

Overburden 0.5 m
 Mineral 3.0 m
 Waste 17.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil	0.5	0.5
	Sand, fine with medium, subangular to rounded, quartz with lithic grains	3.0	3.5
Till	Clay, greyish red to greyish brown, mainly massive, very sandy and silty, soft to firm, with some stones, but laminated in part and some bands of sand and gravel including 1.0 m of 'very clayey' pebbly sand at 8.9 m; harder below 19.3 m	17.5 +	21.0

GRADING

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
	Fines	Sand	Gravel		Fines			Gravel			
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
6	94	0	0.5 - 2.5	6	70	24	0	0	0	0	
			2.5 - 3.5	6	76	18	0	0	0	0	
			Mean	6	72	22	0	0	0	0	
N	25	61	14	7.9 - 8.9	25	38	20	3	5	9	0

N means non-mineral

SJ 53 NW 43 5155 3587 Sandy Bank

Block D

Surface level +104.8 m
Water level +103.8 m
203 mm percussion
January 1981

Overburden 0.5 m
Mineral 4.7 m
Waste 15.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Peat	Sandy peat, layers of fine sand and peaty silt	0.2	0.5
Glacial Sand and Gravel	'Clayey' pebbly sand Gravel: fine and coarse, subrounded to rounded, Palaeozoic sandstones and acid volcanics with quartz, basic volcanics, plutonics and some red sandstones, mudstones, quartzites and limestone Sand: fine and medium with some coarse, angular to rounded, quartz with lithic grains as in gravel Fines: thin brown silt layers	4.7	5.2
Till	Clay, moderate brown to greyish red, massive, stony, sandy in part	15.8 +	21.0

GRADING

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>					
	Fines	Sand	Gravel		Fines			Gravel		
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64
17	77	6	0.5 - 2.0	13	51	25	3	6	2	0
			2.0 - 3.0	14	48	35	1	1	1	0
			3.0 - 5.2	22	44	26	2	4	2	0
			Mean	17	47	28	2	4	2	0

Surface level + 107.8 m
 Water seeping
 203 mm percussion
 January 1981

Waste 22.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, moderate brown to greyish red, mainly massive, stony and sandy but laminated in part towards base; very sandy and pebbly at top	21.7+	22.0

Surface level + 114.4 m
 Water struck at + 106.4 m
 203 mm percussion
 February 1981

Overburden 1.2 m
 Mineral 6.8 m
 Waste 0.8 m
 Mineral 4.3 m
 Waste 14.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial Sand and Gravel	a 'Clayey' pebbly sand Gravel: fine and coarse, cobbles in part, Palaeozoic sandstones (A) with acid volcanics (E) and some red sandstones (D), chert (J), quartzites (H), plutonics (G), and rare quartz (I), limestones (C), and basic volcanics (F) Sand: fine and medium, subangular to subrounded, quartz with lithic grains as in gravel	6.8	7.0
Till	Clay, moderate brown, massive, stony with a sandy texture, some shell fragments	0.8	7.8
Glacial Sand and Gravel	b Pebbly sand, some thin clay bands Gravel: fine and coarse, subangular to subrounded, Palaeozoic sandstones (A) red sandstones (D) and acid volcanics (E) with limestones (C) plutonics (G) quartzites (H) and some quartz (I) chert (J) mudstones (B) and basic volcanics (F) Sand: fine and medium with some coarse, quartz with lithic grains as in gravel	4.3	12.1
Till	Clay, greyish brown, mainly massive, stony with a sandy texture but laminated in part and 0.2 m of 'clayey' gravel at 18.9 m	14.8+	26.9

Note This borehole was drilled on the floor of a small sand and gravel pit. The top 2.1 m of this log comprises a section sampled from the top of the borehole to the top of the pit face adjacent to the borehole. Surface level recorded is for the top of the pit face

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	14	80	6	0.2-2.1	23	40	27	3	5	2	0
				2.1-3.1	12	42	26	3	9	4	4
				3.1-4.1	8	55	35	1	1	0	0
				4.1-5.1	5	41	47	1	0	1	5
				5.1-6.1	6	78	16	0	0	0	0
				6.1-7.0	22	63	11	1	1	2	0
			Mean	14	51	27	2	3	2	1	
b	9	74	17	7.8-8.8	14	26	37	9	11	3	0
				8.8-9.8	7	40	35	4	5	9	0
				9.8-10.8	8	36	33	3	9	11	0
				10.8-12.1	9	37	29	5	11	9	0
				Mean	9	36	33	5	9	8	0
a + b	12	78	10	Mean	12	45	30	3	5	4	1

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
2.1-3.1	75		trace	1	12		1	1	trace	10
7.8-12.1	38	1	9	19	14	1	7	5	4	2

Surface level +91.4 m
 Water level +86.4 m
 203 mm percussion
 February 1981

Overburden 3.5 m
 Mineral 1.0 m
 Waste 5.1 m
 Mineral 9.4 m
 Waste 6.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, moderate brown, weathered at top, massive, stony and sandy	3.3	3.5
Glacial Sand and Gravel	a 'Clayey' pebbly sand Gravel: fine and coarse, angular to rounded, Palaeozoic sandstones with acid and basic volcanics, quartzites, limestones and some plutonics Sand: fine and medium with some coarse, quartz with lithic grains as in gravel	1.0	4.5
Till	Clay, moderate brown, mainly massive and stony with a sandy texture but some bands of sand and gravel including 0.5 m at 6.8 m and 0.2 m at 8.3 m	5.1	9.6
Glacial Sand and Gravel	b Sand, pebbly in part: fine and medium with some coarse, quartz with lithic grains including some coal and shell fragments; thin clay band at 17.6 m	9.4	19.0
Till	Clay, greyish red to greyish brown, mainly massive and stony with a sandy texture but softer and laminated in part, hard at base	6.0+	25.0

GRADING

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
	Fines	Sand	Gravel		Fines		Sand			Gravel	
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	16	74	10	3.5 - 4.5	16	43	27	4	5	5	0
b	2	94	4	9.6 - 10.6	3	55	37	1	1	3	0
				10.6 - 12.6	1	53	40	2	1	3	0
				12.6 - 14.6	2	62	35	1	0	0	0
				14.6 - 15.6	1	38	52	4	3	2	0
				15.6 - 17.6	2	22	59	8	5	4	0
				17.6 - 19.0	5	26	66	2	1	0	0
			Mean	2	43	48	3	2	2	0	
a + b	4	92	4	Mean	4	43	46	3	2	2	0

Surface level +95.9m
 Water struck at +92.9m and +84.9m
 203 mm and 152 mm percussion
 February 1981

Overburden 8.0m
 Mineral 1.6m
 Waste 1.0m
 Mineral 11.7m
 Waste 2.3m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	'Very clayey' pebbly sand, leached and oxidised	0.8	1.1
Till	Clay, moderate brown to greyish brown, mainly massive, stony and very sandy with shell fragments but some bands of sand and pebbly sand in part	6.9	8.0
Glacial Sand and Gravel	a Sand with some pebbles: fine and medium with some coarse, quartz with lithic grains and some coal and shell fragments	1.6	9.6
	Clay and sand, bands 2cms to 10cms thick of till and fine quartz sand	1.0	10.6
	b Pebbly sand, sandier in part, 'clayey' at top	11.7	22.3
	Gravel: fine with some coarse, Palaeozoic sandstones with acid volcanics, red sandstones, quartzites and some limestones, plutonics, quartz and mudstones		
	Sand: fine and medium with some coarse, subangular to subrounded, quartz with lithic grains as in gravel and some coal and shell fragments		
	Fines: greyish brown laminated sandy silt in part to 12.6m		
	Clayey silt, greyish brown, stoneless, banded and laminated with some sand	0.4	22.7
Till	Clay, moderate brown to greyish brown, stony and massive, some clasts of Lias mudstone at base	1.9+	24.6

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
N	20	67	13	0.3 - 1.1	20	41	22	4	8	5	0
a	5	92	3	8.0 - 9.6	5	53	35	4	2	1	0
b	4	90	6	10.6 - 11.6	13	75	10	1	1	0	0
				11.6 - 12.6	11	62	18	2	4	3	0
				12.6 - 13.6	6	58	29	3	3	1	0
				13.6 - 14.6	4	70	24	1	1	0	0
				14.6 - 15.6	3	56	40	1	0	0	0
				15.6 - 17.6	2	44	50	2	2	0	0
				17.6 - 19.6	1	24	67	5	3	0	0
				19.6 - 22.3	1	29	45	8	13	4	0
			Mean	4	45	41	4	5	1	0	
a + b	4	91	5	Mean	4	47	40	4	4	1	0

N means non-mineral

Surface level +96.2 m
 Water struck at +96.2 m
 203 mm percussion
 February 1981

Overburden 1.5 m
 Mineral 1.9 m
 Waste 0.4 m
 Mineral 4.9 m
 Waste 10.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Made ground	1.5	1.5
	a Gravel Gravel: fine and coarse, subrounded to rounded, Palaeozoic sandstones, acid volcanics and quartzites with mudstones, red sandstones and some plutonics, quartz and chert Sand: medium and coarse with fine, quartz with lithic grains as in gravel and some shell fragments	1.9	3.4
Till	Clay, greyish brown, sandy and stony	0.4	3.8
Glacial Sand and Gravel	b Sandy gravel, cobbles at top, clay band at 6.5 m Gravel: fine and coarse with some cobbles, composition as gravel at 3.4 m Sand: fine and medium with coarse, quartz with lithic grains as in gravel and some shell fragments	4.9	8.7
	Till	Clay, greyish brown, sandy and stony but below 11.0m alternates with beds and bands of brownish grey, soft, stoneless silty clay	10.3
Glacial Sand and Gravel	Sand, fine and medium, quartz with lithic grains <i>Borehole abandoned due to rising sand</i>	0.1+	19.1

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines		Sand			Gravel	
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	3	46	51	1.5 - 2.5	3	7	34	14	21	21	0
				2.5 - 3.4	3	6	15	13	35	28	0
				Mean	3	7	25	14	27	24	0
b	4	71	25	3.8 - 5.0	3	32	34	7	13	6	0
				5.0 - 6.5	2	23	45	6	19	5	0
				6.5 - 7.5	3	13	41	14	21	8	0
				7.5 - 8.7	8	29	28	10	20	5	0
Mean	4	25	37	9	18	6	1				
a + b	4	63	33	Mean	4	20	33	10	21	11	1

SJ 53 NE 34

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
0.3 - 3.6	61	1	trace	5	16	trace	4	5	6	2
4.5 - 11.0	52	trace	6	14	16	trace	4	5	2	1
14.7 - 17.7	58	1	7	2	17		5	6	3	1
18.7 - 21.0	54	1	9	6	12	trace	5	9	1	3

Surface level +106.6m
 Water level +94.3 m
 203 mm and 152 mm percussion
 April 1981

Overburden 0.3 m
 Mineral 3.3 m
 Waste 0.9 m
 Mineral 6.5 m
 Waste 1.7 m
 Mineral 8.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.3	0.3
Glacial Sand and Gravel	a Pebbly sand Gravel: fine and coarse, subangular to rounded, Palaeozoic sandstones (A) with acid volcanics (E), quartz (I), quartzites (H), plutonics (G), red sandstones and siltstones (D), and some chert (J) and siltstones (B); rare basic volcanics (F) and limestones (C) Sand: medium and fine with coarse, quartz with lithic grains as in gravel	3.3	3.6
Till	Clay, greyish red, sandy and stony	0.9	4.5
Glacial Sand and Gravel	b Sandy gravel, 'clayey' at top Gravel: fine and coarse with some cobbles, composition as in gravel above but with limestones Sand: fine to coarse, quartz with lithic grains as in gravel and some shell fragments	6.5	11.0
Till	Clay, dark reddish brown to greyish brown, hard and stony to 11.5 m then silty, relatively stoneless and laminated in part; shell fragments	1.7	12.7
Glacial Sand and Gravel	c Sandy gravel Gravel: fine and coarse with some cobbles, composition as in gravel at 11.0 m Sand: medium with fine and coarse, quartz with lithic grains as in gravel and some shell fragments	8.3+	21.0

Borehole abandoned—cobbles jamming casing

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines		Sand			Gravel	
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	7	73	20	0.3 - 1.5	8	29	37	6	13	7	0
				1.5 - 2.5	7	22	39	7	16	9	0
				2.5 - 3.6	6	30	42	6	7	9	0
				Mean	7	27	40	6	12	8	0
b	9	49	42	4.5 - 5.5	16	27	25	8	9	10	5
				5.5 - 6.5	10	9	20	10	21	23	7
				6.5 - 7.5	8	9	29	9	19	26	0
				7.5 - 8.1	10	11	23	14	17	20	5
				8.1 - 9.1	5	19	22	9	22	23	0
				9.1 - 10.1	6	15	36	12	18	13	0
				10.1 - 11.0	6	11	24	7	24	25	3
Mean	9	15	24	10	19	20	3				
c	3	70	27	12.7 - 13.7	6	38	48	4	4	0	0
				13.7 - 14.7	2	20	36	12	16	14	0
				14.7 - 15.7	2	6	41	19	10	15	7
				15.7 - 16.7	3	7	37	16	21	16	0
				16.7 - 17.7	2	8	36	20	23	11	0
				17.7 - 18.7	3	16	68	10	3	0	0
				18.7 - 19.7	2	22	42	10	10	14	0
				19.7 - 21.0	2	10	23	15	24	23	3
Mean	3	16	41	13	14	12	1				
a + b + c	6	63	31	Mean	6	17	35	11	15	14	2

Surface level + 109.3 m
 Water struck at + 94.3 m
 203 mm and 152 mm percussion
 April 1981

Overburden 2.3 m
 Mineral 11.2 m
 Waste 1.3 m
 Mineral 8.9 m
 Waste 1.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	'Clayey' gravelly sand and clay bound sandy gravel with very sandy stony clay at base	2.0	2.3
	a Pebbly sand, 'clayey' at top	11.2	13.5
	Gravel: fine and coarse, with cobbles near top, subrounded to rounded, Palaeozoic sandstones with quartzites, acid volcanics, plutonics and some limestone and red sandstone		
	Sand: fine and medium with coarse, subangular to subrounded, quartz with lithic grains as in gravel and some shell fragments		
Till	Clay, dark reddish brown, massive and stony with a sandy texture	1.3	14.8
Glacial Sand and Gravel	b Pebbly sand	5.8	20.6
	Gravel: fine with some coarse, composition as gravel above		
	Sand: fine and medium with coarse, composition as sand above		
	c Sand, fine and medium with coarse, quartz with lithic grains including some shell fragments and coal; some fine pebbles	3.1	23.7
	Silt, sandy silt and sand: pale brown and light brown, mainly massive and banded but some laminae in part, fine and medium quartz sand to base	1.3 +	25.0

GRADING

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
	Fines	Sand	Gravel		Fines			Gravel			
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	6	73	21	2.3 - 3.6	17	34	37	5	5	2	0
				3.6 - 4.6	9	19	27	9	18	13	5
				4.6 - 5.2	8	10	19	15	24	19	5
				5.2 - 6.2	6	26	48	8	9	3	0
				6.2 - 7.2	4	22	44	11	14	5	0
				7.2 - 8.2	3	30	41	5	12	9	0
				8.2 - 9.2	3	37	49	4	3	4	0
				9.2 - 10.2	3	35	41	6	13	2	0
				10.2 - 11.2	4	21	34	9	15	17	0
				11.2 - 12.2	3	30	43	6	12	6	0
				12.2 - 13.5	5	22	37	11	13	12	0
				Mean	6	27	38	8	12	8	1
b	3	91	6	14.8 - 15.8	7	31	53	5	4	0	0
				15.8 - 16.8	2	35	51	5	7	0	0
				16.8 - 17.8	2	32	53	4	6	3	0
				17.8 - 18.8	1	30	55	8	4	2	0
				18.8 - 19.8	2	38	43	10	6	1	0
				19.8 - 20.6	1	24	63	6	4	2	0
				Mean	3	32	53	6	5	1	0
c	2	96	2	20.6 - 21.6	3	66	29	1	1	0	0
				21.6 - 22.6	2	43	45	7	3	0	0
				22.6 - 23.7	2	45	44	7	2	0	0
				Mean	2	52	39	5	2	0	0
a + b + c	4	83	13	Mean	4	32	44	7	8	5	trace

SJ 53 NE 36 5752 3990 Greenfields

Block C

Surface level + 128.8 m
 Water level not recorded
 203 mm percussion
 January 1981

Overburden 11.0 m
 Mineral 8.5 m
 Waste 2.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, dark reddish brown to greyish red, massive and stony, with bands of 'very clayey' sand from 9.5 m to base	10.7	11.0
Glacial Sand and Gravel	'Clayey' sand, sand in lower half: fine with medium, quartz with lithic grains, some thin bands of clay	8.5	19.5
Till	Clay, greyish red, massive and stony but sandy at top and some micaceous sand laminae to base	2.0+	21.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines		Sand			Gravel	
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
10	90	0	11.0 - 12.5	14	73	13	0	0	0	0
			12.5 - 14.0	14	82	4	0	0	0	0
			14.0 - 19.5	8	82	10	0	0	0	0
			Mean	10	81	9	0	0	0	0

SJ 53 NE 37 5871 3917 Ash Fields

Block C

Surface level + 128.5 m
 Water struck at + 110.1 m
 203 mm percussion
 May 1981

Waste 21.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Till	Clay moderate brown, mainly massive and stony with some shell fragments but some bands of sand and silt in part	18.4	18.4
Glacial Sand and Gravel	Sandy silt, fine quartz, slightly micaceous, mainly massive but some laminae in part; 0.5 m of till at 19.2 m	2.6+	21.0

Surface level + 114.3 m
 Water struck at + 111.8 m
 203 mm percussion
 April 1981

Waste 18.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Till	Soil	0.3	0.3
	Clay, moderate brown to brownish grey, mainly massive and stony with some shell fragments but laminated, plastic and generally stoneless in part and from 2.1 m to 4.1 m and 8.3 m to 11.6 m; also includes some thin bands and laminae of sand	17.7 +	18.0

Surface level + 98.7 m
 Water level + 84.4 m
 203 mm percussion
 January 1981

Overburden 1.8 m
 Mineral 2.5 m
 Waste 0.5 m
 Mineral 1.6 m
 Waste 7.8 m
 Mineral 1.0 m
 Waste 1.4 m
 Mineral 7.6 m
 Waste 0.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil	0.5	0.5
	'Very clayey' pebbly sand to 1.3 m underlain by a moderate reddish brown sandy clay	1.3	1.8
Glacial Sand and Gravel	a 'Clayey' pebbly sand	2.5	4.3
	Gravel: fine and coarse with cobbles, Palaeozoic sandstones with red sandstones, acid volcanics, quartzites, plutonics, and some limestones and siltstones		
	Sand: fine and medium with some coarse, quartz with lithic grains as in gravel Fines: moderate brown, silty		
Till	Clay, greyish brown, massive and stony	0.5	4.8
Glacial Sand and Gravel	b 'Very clayey' pebbly sand	1.6	6.4
Glacial Sand and Gravel	Gravel: fine with some coarse, composition as in gravel above		
	Sand: fine and medium, quartz with lithic grains as in gravel		
Till	Clay, greyish red to dark reddish brown, mainly massive and stony but sandy and silty in part	7.8	14.2
Glacial Sand and Gravel	c Gravel	1.0	15.2
Glacial Sand and Gravel	Gravel: fine and coarse with some cobbles, composition as in gravel above		
	Sand: fine to coarse, quartz with lithic grains as in gravel and some coal		
Till	Clay, as at 14.2 m	1.4	16.6
Glacial Sand and Gravel	a Sand, pebbly at top: fine and medium, quartz with lithic grains and some shell fragments	7.6	24.2
	Silt, sandy, laminated and micaceous, some pebbles	0.8 +	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
N	36	58	6	0.5 - 1.3	36	33	24	1	4	2	0
a	19	65	16	1.8 - 2.8	20	26	26	4	7	9	8
				2.8 - 4.3	19	37	30	4	5	5	0
				Mean	19	33	28	4	6	7	3
b	26	68	6	4.8 - 6.4	26	38	27	3	5	1	0
c	5	46	49	14.2 - 15.2	5	16	17	13	26	19	4
d	8	89	3	16.6 - 17.6	8	57	24	2	6	3	0
				17.6 - 19.6	4	60	33	2	1	0	0
				19.6 - 24.2	9	45	39	3	4	0	0
				Mean	8	51	35	3	3	trace	0
a - d	12	78	10	Mean	12	42	32	4	6	3	1

N means non mineral

Surface level +99.7 m
 Water struck at +92.5 m
 203 mm and 152 mm percussion
 January 1981

Overburden 0.3 m
 Mineral 9.7 m
 Waste 1.0 m
 Mineral 7.6 m
 Waste 1.5 m
 Mineral 4.9 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	a 'Clayey' pebbly sand, 'very clayey' in part Gravel: fine and coarse, angular to rounded, Palaeozoic sandstones, acid volcanics, quartzites with siltstones, red sandstones, plutonics and quartz Sand: fine and medium with some coarse, quartz with lithic grains as in gravel including some coal, mica and shell fragments	4.7	5.0
	b Sandy gravel, composition as above	5.0	10.0
Till	Clay, dark reddish brown to greyish red, massive and stony	1.0	11.0
Glacial Sand and Gravel	c Pebbly sand, sand in lower half Gravel: fine with some coarse, composition as in gravels above Sand: fine and medium with some coarse, composition as in sands above	7.6	18.6
Till	Silty clay, pale red to greyish red, very sandy with some stones	1.5	20.1
Glacial Sand and Gravel	d Sand, pebbly in upper half: fine with medium and some coarse, quartz with lithic grains including some coal, mica and shell fragments	4.9+	25.0

GRADING

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
	Fines	Sand	Gravel		Fines				Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	19	70	11	0.3 - 1.5	13	26	39	7	8	7	0
				1.5 - 2.5	20	28	40	6	2	4	0
				2.5 - 3.8	26	41	26	2	3	2	0
				3.8 - 5.0	16	28	30	5	12	9	0
				Mean	19	31	34	5	6	5	0
b	4	71	25	5.0 - 7.0	8	35	49	3	4	1	0
				7.0 - 8.5	2	12	25	6	24	31	0
				8.5 - 10.0	1	15	50	12	14	8	0
				Mean	4	22	42	7	13	12	0
c	3	88	9	11.0 - 13.0	2	16	60	12	8	2	0
				13.0 - 15.0	1	38	26	17	15	3	0
				15.0 - 17.0	2	23	69	4	0	2	0
				17.0 - 18.6	7	54	35	1	3	0	0
				Mean	3	32	47	9	7	2	0
d	6	91	3	20.1 - 23.1	7	48	36	5	3	1	0
				23.1 - 25.0	5	80	14	1	0	0	0
				Mean	6	61	27	3	2	1	0
a - d	7	81	12	Mean	7	36	39	6	7	5	0

Surface level + 104.7 m
 Water struck at + 95.2 m
 203 mm percussion
 March 1981

Overburden 3.1 m
 Mineral 13.1 m
 Waste 3.8 m
 Mineral 1.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, moderate brown to dark reddish brown, massive, stony and silty, very sandy at top	2.7	3.1
Glacial Sand and Gravel	a 'Clayey' gravel Gravel: fine and coarse with cobbles, Palaeozoic sandstones (A), acid volcanics (E) with limestones (C), quartzites (H) and some red sandstones and siltstones (D), plutonics (G), quartz (I), chert (J) and rare Palaeozoic siltstones and mudstones (B) Sand: fine to coarse, quartz with lithic grains as in gravel Fines: 0.1 m of till at 4.4 m	2.3	5.4
	b Pebbly sand Gravel: fine and coarse, cobbles in part, composition as gravel above but more red sandstones (D) and less acid volcanics (E) though some basic volcanics (F) Sand: fine and medium with some coarse, quartz with lithic grains as in gravel and some coal and shell fragments	10.8	16.2
Till	Clay, moderate brown, massive, sandy with some stones; 0.8 m of sand at 19.0 m	3.8	20.0
Glacial Sand and Gravel	c Sand with some fine pebbles: fine and medium, quartz with lithic grains and some shell fragments	1.5 +	21.5

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel								
					Fines	Sand			Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm	
a	13	40	47	3.1 - 4.3	10	12	17	8	18	23	12
				4.3 - 4.4	Clay parting, assumed to comprise 100% fines						
				4.4 - 5.4	8	11	25	10	22	20	4
				Mean	13	11	20	9	19	20	8
b	5	72	23	5.4 - 6.4	6	25	49	7	11	2	0
				6.4 - 7.4	6	22	45	9	10	8	0
				7.4 - 8.4	8	23	42	8	9	10	0
				8.4 - 9.4	10	17	33	12	16	12	0
				9.4 - 10.4	11	12	23	11	17	19	7
				10.4 - 11.4	3	16	26	13	20	21	1
				11.4 - 12.4	3	19	38	11	17	12	0
				12.4 - 13.4	2	36	45	6	8	3	0
				13.4 - 14.4	2	40	45	5	6	2	0
				14.4 - 16.2	4	38	34	10	12	2	0
Mean	5	26	37	9	13	9	1				
c	3	94	3	20.0 - 21.5	3	42	49	3	3	0	0
a + b + c	6	69	25	Mean	6	25	36	8	13	10	2

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
3.1 – 4.3	43	trace	10	3	33		2	6	2	1
5.4 – 9.4	43	trace	6	18	16	1	6	6	3	1
9.4 – 13.4	56	1	10	7	12	1	5	3	2	3

SJ 53 NE 42 5917 3822 The Townsend

Block C

Surface level + 111.4 m
 Water struck at + 94.9 m
 203 mm and 152 mm percussion
 April 1981

Overburden 2.0
 Mineral 11.2
 Waste 1.1
 Mineral 7.3
 Waste 1.0
 Mineral 2.1 +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial Sand and Gravel on Till	'Clayey' pebbly sand to 1.2 m underlain by a moderate brown, massive, stony clay	1.6	2.0
Glacial Sand and Gravel	a 'Clayey' sand with some pebbles, 'very clayey' in part Sand: fine and medium with some coarse, angular to subrounded, quartz with lithic grains and some shell fragments Fines: light brown, laminated and banded silt	7.7	9.7
	b Sandy gravel Gravel: fine and coarse with some cobbles, subangular to rounded, Palaeozoic sandstones (A), with acid volcanics (E), red sandstones and siltstones (D), limestones (C), quartzites (H) and some plutonics (G), quartz (I), chert (J), basic volcanics (F) and Palaeozoic siltstones and mudstones (B) Sand: fine to coarse, subangular to subrounded, quartz with lithic grains as in gravel	3.5	13.2
Till	Clay, moderate brown, massive and stony	1.1	14.3
Glacial Sand and Gravel	c Pebbly sand Gravel: fine with some coarse, composition as in gravel above Sand: fine and medium with some coarse, quartz with lithic grains as in gravel and some shell fragments and coal	7.3	21.6
Till	Clay, greyish brown to moderate brown, hard, massive and stony with some shell fragments; at base band of pale brown, mainly massive silt	1.0	22.6
Glacial Sand and Gravel	d 'Clayey' sandy gravel Gravel: fine and coarse, composition as in gravels above Sand: fine and medium with coarse, quartz with lithic grains and some shell fragments Fines: 0.2 m of moderate brown till at 23.3 m and a thin band of pale brown silt at 24.0 m	2.1 +	24.7

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages							
	Fines	Sand	Gravel		Fines				Gravel			
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm	
N	19	66	15	0.4 - 1.2	19	28	32	6	5	8	2	
a	12	85	3	2.0 - 3.0	9	46	35	4	6	0	0	
				3.0 - 4.0	16	41	39	2	2	0	0	
				4.0 - 5.0	23	39	35	2	1	0	0	
				5.0 - 6.0	22	42	32	2	2	0	0	
				6.0 - 7.0	7	39	47	2	2	3	0	
				7.0 - 8.0	5	39	49	4	3	0	0	
				8.0 - 9.7	6	47	43	2	2	0	0	
Mean	12	42	40	3	3	trace	0					
b	9	50	41	9.7 - 10.7	8	17	23	10	20	19	3	
				10.7 - 11.7	10	15	21	13	22	15	4	
				11.7 - 12.7	8	14	24	12	22	20	0	
				12.7 - 13.2	8	14	27	15	21	11	4	
				Mean	9	15	23	12	21	17	3	
c	5	89	6	14.3 - 15.3	7	26	49	9	9	0	0	
				15.3 - 16.3	9	25	52	9	5	0	0	
				16.3 - 17.3	4	24	58	6	5	3	0	
				17.3 - 18.3	5	43	48	3	1	0	0	
				18.3 - 19.3	4	48	46	1	1	0	0	
				19.3 - 20.3	4	48	40	2	5	1	0	
				20.3 - 21.6	3	49	34	5	8	1	0	
				Mean	5	38	46	5	5	1	0	
d	15	50	35	22.6 - 23.1	7	30	30	7	15	11	0	
				23.1 - 23.3	Clay parting, assumed to comprise 100% fines							
				23.3 - 24.7	5	21	21	9	19	25	0	
				Mean	15	21	21	8	16	19	0	
a - d	9	78	13	Mean	9	34	38	6	8	5	trace	

N means non-mineral

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
9.7 - 13.2	52	1	9	7	17	1	4	5	2	2

SJ 53 NE 43 5981 3888 Ightfield Hall

Block C

Surface level + 112.3 m
Water not encountered
203 mm percussion
March 1981

Waste 20.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Till	Soil Clay, moderate brown to greyish brown; massive and stony to 5.0m then slightly plastic, poorly laminated in part; thin 'very clayey' sand at 5.0m	0.3 12.2	0.3 12.5
Laminated Clay	Clay, brownish grey to greyish brown, laminated, generally stoneless	7.5+	20.0

Surface level +91.5 m
 Water struck at +89.0 m
 203 mm and 152 mm percussion
 February 1981

Overburden 0.3 m
 Mineral 12.6 m
 Waste 0.9 m
 Mineral 7.6 m
 Waste 3.6 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	a Sand with some pebbles: fine and medium, subangular to subrounded, quartz with lithic grains	2.8	3.1
	b Sandy gravel Gravel: fine and coarse with some cobbles at top and base, subangular to rounded, Palaeozoic sandstones, acid volcanics, red sandstones, siltstones, quartzites, limestones with some plutonics, quartz, basic volcanics and chert Sand: medium with fine and coarse, quartz with lithic grains as in gravel	5.0	8.1
	c Sand with some pebbles: fine and medium, quartz with lithic grains and some shell fragments	4.8	12.9
Laminated Clay	Clay, greyish brown to moderate brown, laminated and silty but plastic and clayier in part; stoneless	0.9	13.8
Glacial Sand and Gravel	d Sand, 'very clayey' and pebbly at base: fine and medium, quartz with lithic grains and some shell fragments and coal	7.6	21.4
Laminated Clay	Clay, brownish grey, laminated, plastic; rhythmic in part with bands and laminae of silt and sand	3.6 +	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines				Gravel		
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	3	96	1	0.3 - 1.3	6	48	42	2	2	0	0
				1.3 - 3.1	2	41	55	1	1	0	0
				Mean	3	43	52	1	1	0	0
b	1	71	28	3.1 - 4.1	3	16	24	9	24	23	1
				4.1 - 5.1	2	45	43	5	3	2	0
				5.1 - 6.1	1	21	44	8	12	14	0
				6.1 - 7.1	1	17	51	10	11	10	0
				7.1 - 8.1	0	11	39	13	19	15	3
				Mean	1	22	40	9	14	13	1
c	5	93	2	8.1 - 9.1	3	35	53	4	5	0	0
				9.1 - 10.1	2	41	51	3	3	0	0
				10.1 - 11.1	2	50	45	2	1	0	0
				11.1 - 12.9	9	53	37	1	0	0	0
				Mean	5	46	45	2	2	0	0
d	4	96	0	13.8 - 14.8	3	68	29	0	0	0	0
				14.8 - 15.8	3	59	38	0	0	0	0
				15.8 - 17.8	1	37	61	1	0	0	0
				17.8 - 19.8	3	62	34	1	0	0	0
				19.8 - 20.9	5	80	14	1	0	0	0
				20.9 - 21.4	28	35	25	4	6	2	0
				Mean	4	58	37	1	trace	trace	0
a - d	4	89	7	Mean	4	44	42	3	4	3	trace

Surface level +97.5 m
 Water struck at +93.7 m
 203 mm and 152 mm percussion
 March 1981

Overburden 0.5 m
 Mineral 18.2 m
 Waste 1.5 m
 Mineral 4.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial Sand and Gravel	<p>a Pebbly sand, 'clayey' in part Gravel: fine and coarse, subangular to subrounded, Palaeozoic sandstones (A), with red sandstones and siltstones (D), acid volcanics (E), plutonics (G), quartzites (H), and some quartz (I), siltstones (B), basic volcanics (F), and chert (J) Sand: medium with fine and coarse, quartz with lithic grains and some shell fragments Fines: thin bands of moderate reddish brown till</p>	3.0	3.5
	<p>b Sand with some pebbles, 'clayey' at top: fine and medium, quartz with lithic grains and some shell fragments and coal</p>	6.0	9.5
	<p>c Pebbly sand with 0.1 m of till at 12.9 m Gravel: fine with coarse, subangular to subrounded, composition as gravel above but with less red sandstones and siltstones (D) and the addition of limestones (C) and Palaeozoic siltstones and mudstones (B) Sand: fine and medium with coarse, quartz with lithic grains and shell fragments and coal</p>	9.2	18.7
Laminated Clay	Clay, greyish brown, laminated, plastic and stoneless with bands of fine 'clayey' sand	1.5	20.2
Glacial Sand and Gravel	d Sand, some pebbles in upper half: fine and medium, quartz with lithic grains and coal and some shell fragments	4.8+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines				Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	8	77	15	0.5 - 1.5	8	28	48	5	8	3	0
				1.5 - 2.5	10	22	42	6	11	9	0
				2.5 - 3.5	7	22	47	8	9	7	0
				Mean	8	24	47	6	9	6	0
b	5	92	3	3.5 - 4.5	15	33	41	4	7	0	0
				4.5 - 5.5	6	49	40	2	3	0	0
				5.5 - 6.5	4	54	38	2	2	0	0
				6.5 - 7.5	2	38	48	6	5	1	0
				7.5 - 8.5	2	42	54	1	1	0	0
				8.5 - 9.5	4	30	61	4	1	0	0
Mean	5	41	48	3	3	trace	0				
c	4	80	16	9.5 - 10.5	2	23	53	8	11	3	0
				10.5 - 11.5	1	15	55	8	11	10	0
				11.5 - 12.8	2	10	46	17	21	4	0
				12.8 - 12.9	Clay parting, assumed to comprise 100% fines						
				12.9 - 13.9	3	13	34	14	27	9	0
				13.9 - 14.9	2	35	44	7	7	5	0
				14.9 - 15.9	2	22	61	10	5	0	0
				15.9 - 16.9	4	43	36	7	10	0	0
				16.9 - 17.9	4	41	48	5	2	0	0
				17.9 - 18.7	5	34	42	6	7	6	0
				Mean	4	25	46	9	12	4	0
d	2	97	1	20.2 - 21.2	5	54	38	2	1	0	0
				21.2 - 22.2	2	41	52	2	3	0	0
				22.2 - 23.2	1	30	67	1	1	0	0
				23.2 - 24.2	2	59	39	0	0	0	0
				24.2 - 25.0	1	65	34	0	0	0	0
				Mean	2	50	46	1	1	0	0
a - d	4	87	9	Mean	4	34	47	6	7	2	0

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
2.5 - 3.5	53	1		17	13	1	6	5	3	1
9.5 - 12.8	43	6	5	12	13	1	5	8	6	1
12.9 - 14.9	53	3	7	5	11	1	6	8	5	1

Surface level +96.4 m
 Water struck at +90.4 m
 203 mm and 152 mm percussion
 March 1981

Overburden 0.4 m
 Mineral 17.3 m
 Waste 1.6 m
 Mineral 5.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial Sand and Gravel	a Sandy gravel, 'clayey' in lower half Gravel: fine and coarse, angular to subrounded, Palaeozoic sandstones, acid volcanics with red sandstones and siltstones, quartzites and some quartz, limestones, plutonics, basic volcanics and cherts Sand: fine and medium with some coarse, quartz with lithic grains as in gravel and some shell fragments Fines: thin bands of very sandy and stony till	2.5	2.9
	b Sand, some pebbles at top and base: quartz with lithic grains and some shell fragments and coal	6.0	8.9
	c Pebbly sand Gravel: fine with some coarse, composition as gravel above Sand: fine and medium with some coarse, quartz with lithic grains and some shell fragments and coal	5.0	13.9
	d Sand, fine and medium, quartz with lithic grains and some shell fragments and coal	3.8	17.7
Laminated Clay	Clay, greyish brown, laminated and plastic with some bands of massive silty clay	1.6	19.3
Glacial Sand and Gravel	e Sand, fine with medium, quartz with lithic grains and some shell fragments and coal; some thin bands and laminae of laminated clay	5.7+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines		Sand			Gravel	
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	9	68	23	0.4-1.4	6	27	42	5	9	11	0
				1.4-2.4	10	20	37	5	10	18	0
				2.4-2.9	11	30	36	7	10	6	0
				Mean	9	25	38	5	10	13	0
b	3	96	1	2.9-3.9	3	58	35	1	1	2	0
				3.9-4.9	3	47	45	3	2	0	0
				4.9-5.9	5	60	33	2	0	0	0
				5.9-6.9	4	69	26	1	0	0	0
				6.9-7.9	2	50	44	3	1	0	0
				7.9-8.9	4	50	39	4	3	0	0
Mean	3	57	37	2	1	trace	0				
c	2	92	6	8.9-9.9	2	31	57	5	5	0	0
				9.9-10.9	2	34	55	3	5	1	0
				10.9-11.9	2	28	58	5	6	1	0
				11.9-12.9	1	33	59	5	2	0	0
				12.9-13.9	3	30	47	11	7	2	0
Mean	2	31	55	6	5	1	0				
d	4	96	0	13.9-14.9	2	55	41	2	0	0	0
				14.9-15.9	2	57	41	0	0	0	0
				15.9-16.9	4	61	34	1	0	0	0
				16.9-17.7	8	63	28	1	0	0	0
Mean	4	59	36	1	0	0	0				
e	5	95	0	19.3-20.3	6	62	32	0	0	0	0
				20.3-21.3	6	66	28	0	0	0	0
				21.3-22.3	4	67	29	0	0	0	0
				22.3-23.3	6	69	25	0	0	0	0
				23.3-25.0	5	67	28	0	0	0	0
Mean	5	67	28	0	0	0	0				
a-e	4	92	4	Mean	4	50	39	3	2	2	0

Surface level +104.5 m
 Water struck at +91.1 m
 203 mm and 152 mm percussion
 April 1981

Overburden 1.8 m
 Mineral 2.4 m
 Waste 3.7 m
 Mineral 2.3 m
 Waste 1.1 m
 Mineral 7.8 m
 Waste 3.5 m
 Mineral 1.2 m
 Waste 0.3 m
 Mineral 1.9 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, moderate brown, mainly massive and stony with a sandy texture but some thin laminae and bands of sand	1.5	1.8
Glacial Sand and Gravel	a 'Clayey' sand with some pebbles Sand: fine and medium, quartz with lithic grains and some shell fragments Fines: bands of pale brown silt to 2.8 m	2.4	4.2
	Silt, pale brown to light brown, finely laminated with clay and massive bands with sand	0.4	4.6
Till	Clay, moderate brown, mainly massive and stony but poorly laminated and silty at top and bands and laminae of sand to base	3.3	7.9
Glacial Sand and Gravel	b 'Clayey' sand Sand: fine with some medium, quartz with some lithic grains; oxidised and reduced at base Fines: bands of pale brown silt	2.3	10.2
Till	Clay, moderate brown, mainly massive and stony with some shell fragments but some bands and laminae at base	1.1	11.3
Glacial Sand and Gravel	c Sand, 'very clayey' at top: fine and medium, quartz with lithic grains and some shell fragments	7.8	19.1
	Clayey silt, moderate brown to greyish red, mainly massive and stoneless	3.5	22.6
	d 'Clayey' sand with some pebbles: fine with medium, quartz with lithic grains and some shell fragments	1.2	23.8
Laminated Clay	Clay and silt, moderate brown, laminated and stoneless	0.3	24.1
Glacial Sand and Gravel	e Sand, composition as at 23.8 m	1.9+	26.0

GRADING

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	14	84	2	1.8 - 2.8	27	38	31	2	2	0	0
				2.8 - 4.2	5	41	50	2	0	2	0
				Mean	14	40	42	2	1	1	0
b	13	87	0	7.9 - 8.9	18	78	4	0	0	0	0
				8.9 - 10.2	9	84	6	1	0	0	0
				Mean	13	81	5	1	0	0	0
c	6	94	0	11.3 - 12.3	24	73	2	1	0	0	0
				12.3 - 13.3	6	86	8	0	0	0	0
				13.3 - 14.3	3	84	13	0	0	0	0
				14.3 - 15.3	3	46	51	0	0	0	0
				15.3 - 16.3	1	25	72	1	1	0	0
				16.3 - 17.3	1	29	69	1	0	0	0
				17.3 - 18.3	3	43	53	1	0	0	0
				18.3 - 19.1	3	44	52	0	1	0	0
Mean	6	53	40	1	trace	0	0				
d	10	86	4	22.6 - 23.8	10	67	19	0	4	0	0
e	9	90	1	24.1 - 26.0	9	66	24	0	1	0	0
a - e	9	90	1	Mean	9	58	31	1	1	trace	0

Surface level +89.3 m
 Water struck at +87.8 m
 203 mm and 152 mm percussion
 February 1981

Overburden 0.4 m
 Mineral 11.3 m
 Waste 0.9 m
 Mineral 6.4 m
 Waste 6.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial Sand and Gravel	a Pebbly sand Gravel: fine and coarse, subangular to subrounded, Palaeozoic sandstones (A) with red sandstones and siltstones (D), acid volcanics (E), quartzites (H), and some plutonics (G), siltstones (B), quartz (I) and chert (J) Sand: fine and medium with some coarse, quartz with lithic grains as in gravel and some shell fragments and coal	5.2	5.6
Laminated Clay	b Sand with some pebbles: fine and medium, composition as sand above Clay, greyish brown to moderate brown, laminated and plastic, silty in part; rare stones	6.1 0.9	11.7 12.6
Glacial Sand and Gravel	c Sand, 'clayey' at top: fine and medium, composition as sand above; rare pebbles, thin silt band at 16.6m	6.4	19.0
Laminated Clay	Clay, brownish grey, laminated, plastic and stoneless but rhythmic below 21.0m with laminae and bands of silt, sand and clay	6.0+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	3	83	14	0.4 - 1.4	4	51	42	2	1	0	0
				1.4 - 2.4	4	42	35	3	9	7	0
				2.4 - 3.6	3	29	32	8	14	14	0
				3.6 - 4.6	1	41	47	4	5	2	0
				4.6 - 5.6	1	26	54	4	10	5	0
				Mean	3	37	42	4	8	6	0
b	1	98	1	5.6 - 6.6	3	33	56	4	4	0	0
				6.6 - 7.6	2	48	48	1	1	0	0
				7.6 - 8.6	2	50	46	1	1	0	0
				8.6 - 9.6	1	51	46	1	1	0	0
				9.6 - 11.7	0	67	32	0	1	0	0
				Mean	1	54	43	1	1	0	0
c	5	94	1	12.6 - 13.6	14	44	40	2	0	0	0
				13.6 - 14.6	5	52	42	0	1	0	0
				14.6 - 16.6	4	81	14	1	0	0	0
				16.6 - 19.0	3	38	56	2	1	0	0
				Mean	5	55	38	1	1	0	0
				a + b + c	3	92	5	Mean	3	49	41

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in +8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
1.4 - 3.6	47	3		16	15		3	13	2	1

Surface level +90.1 m
 Water struck at +87.9 m
 203 mm and 152 mm percussion
 March 1981

Overburden 0.2m
 Mineral 9.4 m
 Waste 0.3 m
 Mineral 8.0 m
 Waste 7.6 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial Sand and Gravel	a Sand with some pebbles: fine and medium, quartz with lithic grains	9.4	9.6
Laminated Clay?	Clay, pale brown, silty and stoneless	0.3	9.9
Glacial Sand and Gravel	b Sand, fine and medium, quartz with lithic grains and some shell fragments	8.0	17.9
Laminated Clay	Clay, brownish grey, laminated and plastic, some bands of silt and sand at top and rhythmic below 21.4 m with silt and sand laminae; 0.5 m of sand at base	7.6+	25.5

GRADING

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
	Fines	Sand	Gravel		Fines			Gravel			
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	2	96	2	0.2-1.2	2	42	50	2	4	0	0
				1.2-2.2	5	38	51	3	3	0	0
				2.2-3.2	4	28	62	4	2	0	0
				3.2-4.2	1	23	66	6	4	0	0
				4.2-5.2	1	42	55	2	0	0	0
				5.2-6.2	1	40	55	3	1	0	0
				6.2-7.2	1	46	48	1	4	0	0
				7.2-8.2	3	63	33	1	0	0	0
				8.2-9.6	2	75	23	0	0	0	0
				Mean	2	45	49	2	2	0	0
b	2	98	0	9.9-10.9	7	62	30	1	0	0	0
				10.9-11.9	1	57	42	0	0	0	0
				11.9-12.9	1	54	45	0	0	0	0
				12.9-13.9	1	47	51	1	0	0	0
				13.9-14.9	2	83	15	0	0	0	0
				14.9-15.9	0	91	9	0	0	0	0
				15.9-16.9	1	42	51	3	3	0	0
				16.9-17.9	0	27	67	5	1	0	0
				Mean	2	58	39	1	trace	0	0
N	3	95	2	25.0-25.5	3	8	80	7	2	0	0
a + b	2	97	1	Mean	2	51	44	2	1	0	0

N means non-mineral

Surface level +88.2m
 Water struck at +86.2m
 203 mm and 152 mm percussion
 March 1981

Overburden 0.4m
 Mineral 8.1m
 Waste 0.4m
 Mineral 6.4m
 Waste 8.7m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial Sand and Gravel	a Sand, fine and medium, quartz with lithic grains and some coal	8.1	8.5
Laminated Clay	Clay, pale brown, silty, poorly laminated and stoneless	0.4	8.9
Glacial Sand and Gravel	b Sand, fine and medium, composition as sand above	6.4	15.3
	Silt, pale brown, soft, micaceous with fine quartz and some shell fragments	1.5	16.8
Laminated Clay	Clay, brownish grey, mainly laminated and stoneless but massive and silty to 17.8m	7.2+	24.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines			Gravel			
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	2	97	1	0.4 - 1.4	0	33	64	2	1	0	0
				1.4 - 2.4	2	31	64	2	1	0	0
				2.4 - 3.4	2	32	63	2	1	0	0
				3.4 - 4.5	0	31	64	3	2	0	0
				4.5 - 5.5	1	27	69	2	1	0	0
				5.5 - 6.5	3	63	33	1	0	0	0
				6.5 - 7.5	1	63	35	1	0	0	0
				7.5 - 8.5	7	67	26	0	0	0	0
			Mean	2	43	52	2	1	0	0	
b	1	99	0	8.9 - 10.2	0	63	37	0	0	0	0
				10.2 - 12.0	2	75	23	0	0	0	0
				12.0 - 15.3	1	47	52	0	0	0	0
				Mean	1	58	41	0	0	0	0
a + b	2	98	0	Mean	2	50	47	1	trace	0	0

Surface level +97.9 m
 Water struck at +94.3 m
 203 mm and 152 mm percussion
 March 1981

Overburden 1.7 m
 Mineral 5.6 m
 Waste 2.7 m
 Mineral 6.7 m
 Waste 1.0 m
 Mineral 3.2 m
 Bedrock 0.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, moderate reddish brown, weathered with some stones	1.4	1.7
Glacial Sand and Gravel	a Sand with some pebbles, 'clayey' to base: fine and medium with some coarse, quartz with lithic grains	5.6	7.3
Till	Clay, greyish red to dark reddish brown, massive, stony and silty, sandy in part	2.7	10.0
Glacial Sand and Gravel	b Sand, some pebbles to base: fine and medium, quartz with lithic grains and some shell fragments and coal	6.7	16.7
Laminated Clay	Clay, greyish red, poorly laminated, micaceous and stoneless	1.0	17.7
Glacial Sand and Gravel	c Sand, 'clayey' in upper half: fine with medium, composition as sand at 16.7 m	3.2	20.9
Lias	Limestone with thin till at top: greyish black with greyish green calcareous mudstone	0.4 +	21.3

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages									
	Fines	Sand	Gravel		Fines			Sand				Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm			
a	7	90	3	1.7 - 3.7	5	48	39	3	5	0	0			
				3.7 - 5.7	4	42	47	4	3	0	0			
				5.7 - 7.3	13	61	24	1	1	0	0			
				Mean	7	49	38	3	3	0	0			
b	1	98	1	10.0 - 11.5	3	55	37	4	1	0	0			
				11.5 - 13.0	1	62	35	2	0	0	0			
				13.0 - 14.5	0	53	46	0	1	0	0			
				14.5 - 16.7	1	42	54	0	3	0	0			
				Mean	1	53	44	1	1	0	0			
c	7	93	0	17.7 - 19.7	10	77	13	0	0	0	0			
				19.7 - 20.9	3	60	36	1	0	0	0			
				Mean	7	71	22	trace	0	0	0			
a + b + c	5	93	2	Mean	5	54	37	2	2	0	0			

Surface level +97.4 m
 Water struck at +92.6 m and +90.4 m
 203 mm percussion
 March 1981

Overburden 1.6 m
 Mineral 4.1 m
 Waste 1.6 m
 Bedrock 1.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Till	Clay, moderate brown, massive and stony, some thin bands of sand	1.0	1.6
Glacial Sand and Gravel	Sand, pebbly at base: fine and medium, quartz with lithic grains and rare shell fragments	4.1	5.7
Laminated Clay	Clay, moderate brown, plastic and stoneless	0.4	6.1
Till on Glacial Sand and Gravel	Clay, moderate brown to greyish brown, massive and stony with 0.3 m of 'clayey' sandy gravel at base	1.2	7.3
Lias	Mudstone, medium grey, weathered to 8.6 m	1.5+	8.8

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm	
7	91	2	1.6-2.6	8	60	30	0	2	0	0	
			2.6-3.6	6	56	36	2	0	0	0	
			3.6-4.6	8	59	31	1	1	0	0	
			4.6-5.7	7	42	41	5	5	0	0	
			Mean	7	54	35	2	2	0	0	
N	14	64	22	7.0-7.3	14	8	42	14	19	3	0

N means non-mineral

Surface level +89.4 m
 Water level +85.2 m
 203 mm and 152 mm percussion
 March 1981

Overburden 0.4 m
 Mineral 7.1 m
 Waste 1.0 m
 Mineral 11.5 m
 Waste 2.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial Sand and Gravel	a Sand, fine and medium, quartz with lithic grains and some shell fragments and coal	7.1	7.5
Laminated Clay	Clay, moderate brown, laminated and stoneless with some bands and laminae of micaceous silt; plastic in part	1.0	8.5
Glacial Sand and Gravel	b Sand, as sand above	8.0	16.5
	c Pebbly sand with 0.1 m of silt at 18.9 m Gravel: fine, subangular to subrounded, Palaeozoic sandstones and siltstones, acid volcanics, red sandstones, and quartzites with quartz, limestone and plutonics Sand: medium with fine and coarse, quartz with lithic grains as in gravel and some shell fragments and coal	3.5	20.0
Laminated Clay	Clay, brownish grey to greyish brown, laminated, plastic, rhythmic in part with laminae of silt and sand	2.0+	22.0

GRADING

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
	Fines	Sand	Gravel		Fines				Gravel		
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	2	97	1	0.4 - 1.4	2	45	47	4	1	1	0
				1.4 - 2.4	3	63	31	1	2	0	0
				2.4 - 3.4	3	44	49	2	2	0	0
				3.4 - 4.4	0	41	55	1	3	0	0
				4.4 - 5.4	0	61	38	1	0	0	0
				5.4 - 6.4	1	58	39	2	0	0	0
				6.4 - 7.5	3	75	22	0	0	0	0
				Mean	2	55	40	2	1	trace	0
b	2	98	0	8.5 - 9.5	7	71	21	1	0	0	0
				9.5 - 10.5	1	59	40	0	0	0	0
				10.5 - 11.5	1	50	49	0	0	0	0
				11.5 - 12.5	3	42	54	1	0	0	0
				12.5 - 13.5	0	45	52	2	1	0	0
				13.5 - 14.5	0	31	66	2	1	0	0
				14.5 - 16.5	2	19	78	1	0	0	0
				Mean	2	42	55	1	trace	0	0
c	6	88	6	16.5 - 17.5	1	17	62	13	6	1	0
				17.5 - 18.8	2	13	63	15	7	0	0
				18.8 - 18.9	Clay parting, assumed to comprise 100% fines						
				18.9 - 20.0	6	31	47	12	4	0	0
				Mean	6	19	56	13	6	trace	0
a + b + c	3	95	2	Mean	3	43	49	3	2	trace	0

Surface level + 88.8 m
 Water struck at + 86.5 m
 203 mm and 152 mm percussion
 March 1981

Overburden 0.3 m
 Mineral 8.7 m
 Waste 0.1 m
 Mineral 8.8 m
 Waste 7.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	a Sand, with some pebbles: fine and medium, quartz with lithic grains and some shell fragments and coal	8.7	9.0
Laminated Clay	Clay, moderate brown, laminated, sandy and silty	0.1	9.1
Glacial Sand and Gravel	b Sand, fine with medium, composition as sand above, but coal more prevalent; thin laminated clay at 11.2 m	8.8	17.9
Laminated Clay	Clay, brownish grey to greyish red, laminated and stoneless, rhythmic below 23.5 m with silt laminae	7.1 +	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines		Sand			Gravel	
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	2	96	2	0.3 - 1.5	6	31	55	5	3	0	0
				1.5 - 2.5	3	28	62	5	2	0	0
				2.5 - 3.5	1	33	60	3	2	1	0
				3.5 - 4.5	1	21	67	6	4	1	0
				4.5 - 6.5	1	52	43	1	3	0	0
				6.5 - 9.0	2	53	44	1	0	0	0
			Mean	2	41	52	3	2	trace	0	
b	2	98	0	9.1 - 11.0	4	53	42	1	0	0	0
				11.0 - 12.0	1	60	38	1	0	0	0
				12.0 - 14.0	0	78	22	0	0	0	0
				14.0 - 16.0	1	75	24	0	0	0	0
				16.0 - 17.9	3	53	42	1	1	0	0
				Mean	2	64	33	1	trace	0	0
a + b	2	97	1	Mean	2	53	42	2	1	trace	0

Surface level +86.2 m
 Water struck at +84.2 m
 203 mm percussion
 March 1981

Overburden 0.8 m
 Mineral 2.5 m
 Waste 1.1 m
 Mineral 7.0 m
 Waste 0.1 m
 Bedrock 0.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.8	0.8
Glacial Sand and Gravel	a Sand with some pebbles: medium with fine, quartz with lithic grains and rare shell fragments and coal	2.5	3.3
Laminated Clay	Clay, dark reddish brown to greyish red, stoneless and micaceous	1.1	4.4
Glacial Sand and Gravel	b Sand, fine with medium, composition as in sand above	7.0	11.4
Till	Clay, dark reddish brown, sandy and stony	0.1	11.5
Lias	Limestone	0.5+	12.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages									
	Fines	Sand	Gravel		Fines			Sand				Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm			
a	2	95	3	0.8 - 3.3	2	27	66	2	3	0	0			
b	2	98	0	4.4 - 6.4	6	74	20	0	0	0	0			
				6.4 - 8.4	2	72	26	0	0	0				
				8.4 - 11.4	0	74	26	0	0	0				
				Mean	2	74	24	0	0	0				
a + b	2	97	1	Mean	2	61	35	1	1	0	0			

Surface level +93.1 m
 Water struck at +89.1 m
 203 mm percussion
 April 1981

Overburden 1.0 m
 Mineral 3.7 m
 Waste 4.0 m
 Bedrock 0.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Till	Clay, moderate brown, massive and stony, weathered	0.5	1.0
Glacial Sand and Gravel	'Clayey' pebbly sand, gravel to base Gravel: fine with coarse, angular to subrounded, Palaeozoic sandstones (A) and acid volcanics (E) with red sandstones and siltstones (D), plutonics (G), quartzites (H) and some quartz (I), and chert (J), rare basic volcanics (F) and Palaeozoic siltstones and mudstones (B) Sand: fine and medium with coarse, subangular to subrounded, quartz with lithic grains as in gravel with some shell fragments Fines: thin moderate brown laminated clays	3.7	4.7
Laminated Clay	Clay, moderate brown to light brown, some stones to 5.0 m then plastic and stoneless;	0.7	5.4
Glacial Sand and Gravel	Sand and silt, 'clayey' sand interbedded with moderate to pale brown laminated silt and clay	2.3	7.7
Till	Clay, greyish brown, massive and stony with a sandy texture	1.0	8.7
Lias	Limestone and mudstone	0.5+	9.2

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
10	84	6	1.0-2.0	12	70	17	1	0	0	0
			2.0-3.0	9	49	39	2	1	0	0
			3.0-4.0	9	28	55	5	3	0	0
			4.0-4.7	11	12	32	18	22	5	0
			Mean	10	42	36	6	5	1	0

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
4.0-4.7	46	trace	0	13	24	trace	7	5	3	2

Surface level +101.8 m
 Water not encountered
 203 mm percussion
 March 1981

Waste 0.3 m
 Bedrock 3.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Lias	Limestone and mudstone, dark to olive grey, fossiliferous; soft and weathered to 2.7 m	3.2+	3.5

Surface level +96.9 m
 Water struck at +95.1 m
 203 mm and 152 mm percussion
 November 1981

Overburden 0.5 m
 Mineral 1.3 m
 Waste 9.8 m
 Mineral 9.7 m
 Waste 2.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial Sand and Gravel and Till	'Very clayey' pebbly sand to 0.4 m with a moderate reddish brown very sandy, silty and stony clay to base	0.3	0.5
Glacial Sand and Gravel	a 'Clayey' sandy gravel Gravel: fine and coarse, subrounded, Palaeozoic sandstones and siltstones with acid volcanics, quartzites, red sandstones, quartz, plutonics and some limestones Sand: medium with fine and coarse, subrounded, quartz with lithics as in gravel Fines: moderate brown to moderate reddish brown	1.3	1.8
Till	Clay, moderate brown, mainly massive and stony but some bands of sand in part, also laminated and stoneless at 8.0m; 0.7 m of sandy gravel with thin clays at 5.2m	9.8	11.6
Glacial Sand and Gravel	b Sand with some pebbles, thin till at 13.5 m: medium with fine and some coarse, quartz with lithic grains and some shell fragments Clay, moderate brown to dark yellowish brown, silty, laminated at top, mainly massive	9.7	21.3
Till	Clay, moderate brown to moderate reddish brown, silty, mainly massive and stony with a sandy texture but poorly laminated in part	0.7 1.6+	22.0 23.6

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines				Gravel		
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	16	57	27	0.5 - 1.8	16	12	38	7	13	14	0
b	4	92	4	11.6 - 12.6	5	13	74	6	2	0	0
				12.6 - 13.6	14	13	62	7	2	0	
				13.6 - 16.5	3	39	52	4	2	0	
				16.5 - 20.0	2	35	63	0	0	0	
				20.0 - 21.3	3	6	53	18	16	4	0
			Mean	4	28	59	5	3	1	0	
a + b	5	89	6	Mean	5	26	58	5	4	2	0

SJ 53 SW 23 5106 3422 Bostock Hall

Block D

Surface level +102.5 m
 Water seeping
 203 mm percussion
 February 1981

Waste 20.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Till	Soil Clay, dark reddish brown to greyish brown, mainly massive and stony but very sandy in part; thin gravel band at 16.0 m	0.2 19.8 +	0.2 20.0

SJ 53 SW 24 5216 3438 Brook House

Block D

Surface level +96.3 m
 Water struck at +94.1 m
 203 mm percussion
 January 1981

Waste 18.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Till	Soil Clay, greyish brown to greyish red, mainly massive and stony but plastic and also laminated in part, many thin bands of 'clayey' sand from 6.0 m to 8.8 m and 0.6 m of gravel at 2.8 m	0.4 17.6 +	0.4 18.0

GRADING

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
N	12	42	46	2.2 - 2.8	12	17	17	8	21	24	1

N means non-mineral

Surface level +91.1 m
 Water struck at +87.7 m and +83.3 m
 203 mm and 152 mm percussion
 January 1981

Overburden 8.3 m
 Mineral 8.7 m
 Waste 8.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, greyish brown, massive and stony with a sandy texture and 0.6 m of 'very clayey' sand at 6.8 m and sand from 7.8 m to 8.0 m	8.0	8.3
Glacial Sand and Gravel	Sand with 0.2 m of interbedded silts and clays at 16.2 m: fine and medium, quartz with lithic grains; some pebbles	8.7	17.0
Till	Clay, brownish grey, laminated to massive, some stones and 0.4 m of 'clayey' sand at base	1.7	18.7
Laminated Clay	Clay, brownish grey, plastic and generally stoneless, with silt and bands of 'clayey' sand to 19.8 m	2.6	21.3
Till	Clay, greyish brown, massive to poorly laminated, stony, some thin laminae of sand	3.7+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
N	33	64	3	6.2 - 6.8	33	39	22	3	2	1	0
	8	91	1	8.3 - 9.3	6	47	42	2	1	2	0
				9.3 - 10.3	4	63	32	1	0	0	0
				10.3 - 11.3	7	60	32	1	0	0	0
				11.3 - 12.3	14	25	58	2	1	0	0
				12.3 - 14.3	1	31	67	1	0	0	0
				14.3 - 16.0	4	51	45	0	0	0	0
				16.0 - 16.2	Clay parting, assumed to comprise 100% fines						
				16.2 - 17.0	10	46	36	3	4	1	0
				Mean	8	44	46	1	1	trace	0
N	13	86	1	18.3 - 18.7	13	37	47	2	1	0	0

N means non-mineral

Surface level + 83.5 m
 Water struck at + 80.4 m
 203 mm percussion
 December 1980

Overburden 1.8 m
 Mineral 1.3 m
 Waste 2.5 m
 Mineral 4.9 m
 Waste 12.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, reddish brown, massive and laminated, stony and weathered	1.4	1.8
Glacial Sand and Gravel	a 'Very clayey' pebbly sand Gravel: fine with coarse, Palaeozoic sandstones and siltstones, acid volcanics with quartzites, quartz and limestones Sand: fine with medium and some coarse, quartz with lithic grains as in gravel and some shell fragments Fines: reddish brown	1.3	3.1
Till	Clay, very sandy and silty, stony: poor recovery	2.5	5.6
Glacial Sand and Gravel	b Sand with some pebbles: fine and medium with some coarse, quartz with lithic grains and some shell fragments and coal	4.9	10.5
Laminated Clay	Clay, pale brown, plastic, micaceous and silty, rare sandy patches, some fine pebbles in part	12.0+	22.5

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines		Sand			Gravel	
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	22	74	4	1.8 - 3.1	22	41	29	4	3	1	0
b	8	88	4	5.6 - 7.0	4	35	45	7	7	2	0
				7.0 - 10.5	10	46	38	4	2	0	0
				Mean	8	43	40	5	3	1	0
a + b	11	85	4	Mean	11	42	38	5	3	1	0

Surface level +97.8 m
 Water struck at +83.0 m and +80.0 m
 203 mm percussion
 February 1981

Waste 21.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Till	Soil	0.2	0.2
	Clay, moderate brown to greyish brown, mainly massive and stony with a sandy texture and some shell fragments but some laminae and bands of silt and sand and gravel; 1.3 m of sandy gravel at 16.1 m and pebbly sand from 17.8 m to 19.8 m	21.0+	21.2

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
N	8	64	28	14.8 - 16.1	8	19	35	10	18	10	0
N	5	84	11	17.8 - 18.8	4	17	62	11	5	1	0
				18.8 - 19.8	5	17	52	10	5	11	0
				Mean	5	17	57	10	5	6	0

N means non-mineral

Surface level +107.9 m
 Water struck at +101.4 m
 203 mm percussion
 February 1981

Waste 18.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Till	Soil	0.2	0.2
	Clay, moderate brown, massive and stony, sandy texture, some thin sand laminae in part	17.8+	18.0

Surface level +92.8 m
 Water struck at +85.2 m and +83.3 m
 203 mm and 152 mm percussion
 January 1981

Overburden 4.9 m
 Mineral 2.8 m
 Waste 1.8 m
 Mineral 6.6 m
 Waste 2.6 m
 Mineral 2.4 m
 Waste 3.9 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, moderate brown, massive and stony, sandy texture with some sand lenses and smears	4.7	4.9
Glacial Sand and Gravel	a 'Clayey' pebbly sand Gravel: fine and coarse, subangular to subrounded, Palaeozoic sandstones (A) with acid volcanics (E), and some limestones (C), red sandstones and siltstones (D), quartzites (H) and rare plutonics (G), quartz (I), chert (J) and Palaeozoic siltstones (B) Sand: fine and medium with some coarse, subangular to subrounded, quartz with lithic grains as in gravel Fines: thin bands of sandy till	2.8	7.7
Till	Clay, moderate brown, massive and stony, very sandy texture	1.8	9.5
Glacial Sand and Gravel	b Sand with some pebbles and 0.1 m of clay at 15.7 m: fine with medium, quartz with lithics as in gravel and coal	6.6	16.1
Till	Clay, brownish grey, massive and stony, but also well laminated in part with sand and silt laminae	2.6	18.7
Glacial Sand and Gravel	c 'Very clayey' sand with some pebbles at base Sand: fine with medium, quartz with lithic grains Fines: olive grey sandy silt bands	2.4	21.1
Till	Clay, greyish brown, stony, laminated and massive	2.5	23.6
Laminated Clay	Silt, sand and clay: bands and laminae of micaceous sand and silt, and plastic clay	1.4 +	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	17	70	13	4.9 - 6.1	16	37	31	5	5	6	0
				6.1 - 7.7	17	35	29	5	6	8	0
				Mean	17	35	30	5	6	7	0
b	5	91	4	9.5 - 10.5	3	55	41	0	1	0	0
				10.5 - 11.5	1	41	53	1	4	0	0
				11.5 - 12.5	6	54	30	3	4	3	0
				12.5 - 13.5	5	90	4	1	0	0	0
				13.5 - 14.5	3	91	6	0	0	0	0
				14.5 - 15.6	1	57	32	4	4	2	0
				15.6 - 15.7	Clay parting, assumed to comprise 100% fines						
				15.7 - 16.1	5	20	50	11	9	5	0
			Mean	5	60	29	2	3	1	0	
c	35	64	1	18.7 - 19.7	40	38	20	2	0	0	0
				19.7 - 21.1	32	41	24	2	1	0	0
				Mean	35	40	22	2	1	0	0
a + b + c	14	81	5	Mean	14	50	28	3	3	2	0

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
4.9 - 7.7	70	trace	6	6	13		trace	4	trace	trace

Surface level +89.7 m
 Water struck at +83.4 m
 203 mm and 152 mm percussion
 January 1981

Overburden 3.8 m
 Mineral 11.8 m
 Waste 7.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, moderate reddish brown, massive with some stones, sandy texture and some lenses and laminae of sand; 0.6 m of 'very clayey' pebbly sand at 2.0m	3.5	3.8
Glacial Sand and Gravel	Sand, with 0.1 m of silt at 11.7 m and 14.2 m, pebbly at base: fine and medium, quartz with lithic grains	11.8	15.6
Laminated Clay on Glacial Sand and Gravel	Silt and clay, pale brown to brownish grey, massive, banded and laminated silt with laminae of micaceous sand and plastic clay, rhythmic in part; 0.6 m of gravel at base	3.8	19.4
Till	Clay, greyish brown to greyish red, massive and stony but with 0.6 m of massive to laminated silt and clay at 21.6 m	3.6+	23.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
						- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64
N	27	59	14	1.4 - 2.0	27	34	21	4	9	5	0
	6	92	2	3.8 - 4.8	7	71	21	1	0	0	0
				4.8 - 5.8	7	43	45	3	2	0	0
				5.8 - 6.8	3	39	57	1	0	0	0
				6.8 - 8.8	3	61	35	1	0	0	0
				8.8 - 11.6	2	76	22	0	0	0	0
				11.6 - 11.7	Clay parting, assumed to comprise 100% fines						
				11.7 - 12.7	3	56	40	1	0	0	0
				12.7 - 14.1	2	49	43	3	3	0	0
				14.1 - 14.2	Clay parting, assumed to comprise 100% fines						
				14.2 - 15.6	11	27	39	7	7	7	2
				Mean	6	55	35	2	1	1	trace
N	5	35	60	18.8 - 19.4	5	6	18	11	32	27	1

N means non-mineral

Surface level +76.5 m
 Water struck at +67.1 m
 203 mm percussion
 January 1981

Waste 18.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Laminated Clay	Clay, brownish grey to greyish brown, laminated and generally stoneless, plastic; rhythmic below 8.3 m with laminae of sand and silt	9.1	9.4
Till	Clay, greyish brown, mainly massive and very stony but poorly laminated and sandy in part	1.0	10.4
Laminated Clay	Clay, brownish grey, poorly laminated with some stones	7.6+	18.0

Surface level +79.9 m
 Water struck at +77.3 m
 203 mm percussion
 December 1980

Overburden 1.3 m
 Mineral 7.2 m
 Waste 14.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Peat	Peat, sandy towards base	0.7	1.3
Glacial Sand and Gravel	'Clayey' sand Sand: fine and medium, quartz with lithic grains including some coal Fines: mainly moderate brown but peaty at top and thin laminated clay at 3.6 m	7.2	8.5
Laminated Clay	Clay, brownish grey, laminated and plastic, some laminae of micaceous silt, rare stones	14.5+	23.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
14	85	1	1.3-2.3	16	33	45	4	2	0	0
			2.3-3.3	38	43	16	1	1	1	0
			3.3-4.3	16	55	27	1	1	0	0
			4.3-5.3	6	37	55	1	1	0	0
			5.3-6.3	12	34	51	2	1	0	0
			6.3-8.5	5	32	59	1	2	1	0
			Mean	14	38	45	2	1	trace	0

Surface level +98.1 m
 Water struck at c. +89.1 m
 203 mm percussion
 November 1980

Waste 18.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Till	Soil Clay, greyish red with greyish brown, stony, mainly massive but laminated in part below 14.8 m, some thin sands, and 0.4 m of 'very clayey' pebbly sand at 14.8 m and 'very clayey' sandy gravel from 16.7 m to 17.0 m	0.2 17.8 +	0.2 18.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
25	71	4	14.4 - 14.8	25	47	22	2	2	2	0
33	48	19	16.7 - 17.0	33	19	24	5	9	10	0

Surface level +96.6 m
 Water struck at +96.1 m
 203 mm percussion
 February 1981

Overburden 0.5 m
 Mineral 1.2 m
 Waste 15.2 m
 Bedrock 1.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Till	Soil	0.1	0.1
Glacial Sand and Gravel	Clay, pale grey, weathered 'Clayey' sandy gravel Gravel: fine and coarse with cobbles, subangular to rounded, acid volcanics (E), and Palaeozoic sandstones (A) and siltstones (B) with red sandstones and siltstones (D) and some quartz (I), plutonics (F), and quartzites (H), rare chert (J) Sand: fine and medium with some coarse, quartz with lithic grains as in gravel	0.4 1.2	0.5 1.7
Till	Clay, moderate brown to brownish grey, massive and stony, rare thin sands	15.2	16.9
Lias	Mudstone, medium grey	1.1 +	18.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
13	57	30	0.5 - 1.7	13	25	25	7	15	10	5

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
0.5-1.7	32	9		5	50		1	1	2	trace

SJ 53 SW 35 5346 3254 Lacon Farm Block E

Surface level +79.5 m Waste 20.0m +
 Water struck at +65.9 m
 203 mm percussion
 January 1981

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Laminated Clay	Clay, brownish grey, laminated, mainly plastic but harder in part, rhythmic with sand and silt laminae below 13.0m; rare stones	13.3	13.6
Till	Clay, moderate reddish brown to greyish brown, massive and stony, sandy texture; thin gravel at top	0.7	14.3
Laminated Clay	Clay, brownish grey, laminated and plastic with some stones	5.7+	20.0

SJ 53 SW 36 5116 3161 Ryebank Farm Block D

Surface level +95.1 m Waste 23.5 m +
 Water struck at +92.1 m
 203 mm percussion
 November 1980

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, greyish brown, mainly massive and stony with a sandy texture, but laminated in part with bands and laminae of sand and silt including 0.8 m of 'very clayey' pebbly sand at 1.9 m, 1.5 m of 'clayey' sandy gravel at 10.3 m and 'clayey' pebbly sand from 14.4 m to 15.2 m	17.0	17.4
Glacial Sand and Gravel	Sandy gravel Gravel: fine and coarse, subangular to rounded, Palaeozoic sandstones and siltstones, and acid volcanics with some quartzites, plutonics, limestones and basic volcanics Sand: medium with fine and coarse, quartz with lithics as in gravel	2.4	19.8
Till	Clay, greyish brown, massive and stony with 0.8 m of sand at 21.7 m and pebbly sand from 23.1 m to base	3.7+	23.5

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
N	24	71	5	1.1 - 1.9	24	37	32	2	2	3	0
N	13	51	36	8.8 - 10.3	13	24	24	3	6	30	0
N	11	79	10	14.4 - 15.2	11	28	47	4	8	2	0
N	4	50	46	17.4 - 18.0	8	15	27	30	18	2	0
				18.0 - 19.0	4	7	17	14	28	30	0
				19.0 - 19.8	2	13	29	6	8	42	0
				Mean	4	11	24	15	19	27	0
N	5	93	2	20.9 - 21.7	5	69	21	3	1	1	0
N	4	76	20	23.1 - 23.5	4	12	42	22	19	1	0

N means non-mineral

SJ 53 SW 37 5355 3175 Upper Lacon Firm

Block E

Surface level +79.4 m
 Water struck at +77.7 m
 203 mm percussion
 January 1981

Overburden 1.5 m
 Mineral 3.5 m
 Waste 16.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	'Very clayey' pebbly sand	0.4	0.7
Till	Clay, leached and oxidised, stony, mainly massive but some laminae	0.8	1.5
Glacial Sand and Gravel	Pebbly sand Gravel: fine and coarse, subangular to subrounded, Palaeozoic sandstones, siltstones and acid volcanics with basic volcanics, quartzites and limestones and some red sandstones and plutonics Sand: medium and fine, quartz with lithic grains as in gravel	3.5	5.0
Laminated Clay on Glacial Sand and Gravel	Clay, pale brown, plastic in part, laminated with light olive grey silt; 0.4 m of sandy gravel at base	2.1	7.1
Laminated clay	Clay, brownish grey, plastic, mainly stoneless or with rare stones but stony at top to 7.9 m, some silty and sandy laminal in part	13.9+	21.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
N	34	54	12	0.3 - 0.7	34	31	20	3	5	7	0
N	5	90	5	1.5 - 2.5	6	38	53	1	2	0	0
				2.5 - 3.5	3	33	59	2	2	1	0
				3.5 - 5.0	5	30	55	2	4	4	0
				Mean	5	33	55	2	3	2	0
N	6	52	42	6.7 - 7.1	6	23	22	7	26	16	0

N means non-mineral

Surface level + 73.3 m
 Water struck at + 69.7 m
 203 mm percussion
 December 1980

Overburden 3.6 m
 Mineral 1.2 m
 Waste 15.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	1.5	1.5
Peat	Peat and peaty silt, medium dark grey, some shell fragments	2.1	3.6
Glacial Sand and Gravel	Gravel Gravel: fine and coarse, subangular to rounded, Palaeozoic sandstones (A), and acid volcanics (E) with limestones (C), quartzites (H) and some red sandstones and siltstones (D), basic volcanics (F), plutonics (G), quartz (I), siltstones (B) and chert (J) Sand: medium and coarse with fine, quartz with lithic grains as in gravel	1.2	4.8
Laminated Clay	Clay, brownish grey to olive grey, soft, silty, rare stones, mainly poorly laminated but well laminated in part with silt and sand laminae	15.7 +	20.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
3	43	54	3.6 - 4.8	3	5	22	16	34	20	0

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
3.6 - 4.8	41	2	9	4	25	4	4	7	3	1

Surface level +93.9 m
 Water level +86.9 m
 203 mm and 152 mm percussion
 November 1980

Overburden 11.5 m
 Mineral 1.7 m
 Waste 0.3 m
 Mineral 5.5 m
 Waste 0.1 m
 Mineral 1.4 m
 Waste 3.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Till	Clay, dusky red to dark reddish brown, mainly massive and stony with some shell fragments but some sand lenses and laminae; 0.5 m of pebbly sand at 8.5 m	11.0	11.5
Glacial Sand and Gravel	a 'Clayey' pebbly sand Gravel: fine and coarse, subangular to rounded, Palaeozoic sandstones and siltstones, with acid volcanics and some quartzites, quartz, plutonics, limestones and red sandstones Sand: fine and medium, quartz with lithic grains as in gravel	1.7	13.2
	Clay, greyish red, sandy	0.3	13.5
	b Sand, fine and medium, quartz with lithic grains and some shell fragments	5.5	19.0
Laminated Clay	Clay, dark reddish brown, poorly laminated	0.1	19.1
Glacial Sand and Gravel	c Pebbly sand Gravel: fine and coarse, angular to rounded, composition as gravel at 13.2 m Sand: medium with fine and coarse, quartz with lithic grains as in gravel	1.4	20.5
Till	Clay, greyish red, stony with some lenses of sand and silt	3.5 +	24.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	10	82	8	11.5 - 13.2	10	33	47	2	4	4	0
b	7	92	1	13.5 - 15.5	4	49	43	3	1	0	0
				15.5 - 17.5	10	57	31	1	0	1	0
				17.5 - 19.0	6	60	32	1	1	0	0
				Mean	7	54	36	2	1	trace	0
c	3	76	21	19.1 - 20.5	3	12	53	11	10	11	0
a + b + c	7	87	6	Mean	7	43	41	3	3	3	0

Surface level + 88.1 m
 Water struck at c. + 82.1 m
 203 mm and 152 mm percussion
 November 1980

Overburden 4.5 m
 Mineral 8.4 m
 Waste 0.8 m
 Mineral 1.3 m
 Waste 10.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, reddish brown to pale brown, sandy and stony, mainly massive but some laminae and bands of sand and gravel	4.2	4.5
Glacial Sand and Gravel	a Pebbly sand, sand in upper half Gravel: fine and coarse, Palaeozoic sandstones (A) and siltstones (B) with red sandstones and siltstones (D), acid volcanics (E), limestones (C), quartz (I), quartzites (H) and some basic volcanics (F), plutonics (G) and chert (J) Sand: medium and fine, quartz with lithic grains as in gravel and some coal	6.1	10.6
	b Gravel Gravel: fine and coarse with some cobbles, composition as gravel above Sand: medium and coarse with fine, quartz with lithic grains as in gravel and some coal	2.3	12.9
Till	Clay, reddish brown, massive and stony	0.8	13.7
Glacial Sand and Gravel	c Pebbly sand Gravel: fine, composition as above Sand: medium with fine and coarse, composition as above	1.3	15.0
Laminated Clay	Clay, greyish brown to greyish red, laminated; sandy and silty below 16.5 m, some stones in part	10.0+	25.0

GRADING

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
	Fines	Sand	Gravel		Fines			Gravel			
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	5	89	6	4.5 - 6.5	6	37	52	2	0	3	0
				6.5 - 8.2	4	44	51	0	1	0	0
				8.2 - 9.2	9	30	36	6	12	7	0
				9.2 - 10.6	2	12	75	3	4	4	0
				Mean	5	32	55	2	3	3	0
b	3	45	52	10.6 - 11.6	3	3	25	19	28	20	2
				11.6 - 12.9	3	10	13	21	35	18	0
				Mean	3	7	18	20	32	19	1
c	7	82	11	13.7 - 15.0	7	21	50	11	10	1	0
a + b + c	5	77	18	Mean	5	25	44	8	11	7	trace

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction										
	A	B	C	D	E	F	G	H	I	J	
10.6 - 12.9	42	15	6	9	7	4	3	5	6	3	

Surface level +83.8 m
 Water struck at +79.8 m
 203 mm percussion
 November 1981

Overburden 2.1 m
 Mineral 1.4 m
 Waste 0.2 m
 Mineral 7.6 m
 Waste 10.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, moderate reddish brown, massive and stony; thin band of sand at 1.6m	1.8	2.1
Glacial Sand and Gravel	a Pebbly sand, 'clayey' at top Gravel: fine and coarse, subangular to subrounded, Palaeozoic sandstones and siltstones with acid volcanics, quartzites, red sandstones and some limestone and plutonics Sand: medium with fine, quartz with lithic grains as in gravel	1.4	3.5
Till	Clay, greyish red, massive and stony	0.2	3.7
Glacial Sand and Gravel	b Pebbly sand, sand in lower half Gravel: fine and coarse with some cobbles at top, composition as gravel at 3.5 m Sand: fine and medium, quartz with lithic grains as in gravel	5.8	9.5
	c Pebbly sand Gravel: fine with coarse, composition as above Sand: medium with fine and coarse, composition as above	1.8	11.3
Till	Clay, greyish brown, massive to laminated, stony, bands of silt in part	10.7+	22.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines				Gravel		
					- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	8	79	13	2.1 - 2.4	15	13	34	5	16	17	0
				2.4 - 3.5	6	28	56	3	4	3	0
				Mean	8	25	51	3	7	6	0
b	5	90	5	3.7 - 4.5	12	19	42	5	9	10	3
				4.5 - 5.5	9	50	35	3	2	1	0
				5.5 - 6.5	2	11	75	7	4	1	0
				6.5 - 7.5	3	54	40	2	1	0	0
				7.5 - 8.5	4	88	8	0	0	0	0
				8.5 - 9.5	3	51	37	8	1	0	0
				Mean	5	47	39	4	3	2	trace
c	3	76	21	9.5 - 10.5	1	13	50	12	19	5	0
				10.5 - 11.3	6	18	43	15	13	5	0
				Mean	3	15	48	13	16	5	0
a + b + c	5	86	9	Mean	5	37	43	6	6	3	trace

Surface level +77.4 m
 Water struck at +74.7 m and +52.4 m
 203 mm percussion
 January 1981

Overburden 0.5 m
 Mineral 3.4 m
 Waste 23.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial Sand and Gravel	'Clayey' pebbly sand Gravel: fine and coarse with some cobbles at base, subangular to subrounded, Palaeozoic sandstones and siltstones, and acid volcanics with red sandstones, quartzites, quartz, limestones and some plutonics and chert Sand: fine and medium, quartz with lithic grains as in gravel	3.4	3.9
Laminated Clay	Clay, brownish grey, laminated and plastic, generally stoneless, some laminae of micaceous silt and sand, rhythmic in part	23.1 +	27.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
11	74	15	0.5 - 1.5	20	39	31	3	4	3	0
			1.5 - 3.1	8	53	33	2	3	1	0
			3.1 - 3.9	6	24	19	7	17	24	3
			Mean	11	42	29	3	7	7	1

Surface level +78.4 m
 Water struck at +66.1 m and +53.6 m
 203 mm percussion
 November 1980

Overburden 0.2 m
 Mineral 1.9 m
 Waste 22.9 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial Sand and Gravel	'Very clayey' sand, fine with medium, quartz with lithic grains, some silty laminae in part	1.9	2.1
Laminated Clay	Clay, pale brown to greyish brown, mainly laminated and plastic but more massive in part with some stones; rhythmic with silt and sand laminae below 22.1 m	22.9 +	25.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
20	80	trace	0.2 - 1.2	20	54	25	1	0	0	0
			1.2 - 2.1	19	57	22	1	1	0	0
			Mean	20	55	24	1	trace	0	0

Surface level +77.7 m
 Water level +69.2 m
 203 mm percussion
 November 1980

Overburden 0.5 m
 Mineral 1.0 m
 Waste 14.1 m
 Bedrock 2.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial Sand and Gravel	'Very clayey' pebbly sand Gravel: fine and coarse, Palaeozoic sandstones and siltstones, and acid volcanics with red sandstones, quartzites, quartz, limestones and some plutonics and chert Sand: fine and medium with some coarse, quartz with lithic grains as in gravel	1.0	1.5
Laminated Clay	Clay, greyish red to moderate red, laminated in part, some sandy laminae and stones	8.0	9.5
Till	Clay, brownish grey, mainly massive, some stones	6.1	15.6
Northwich Halite	Mudstone, brown, green in part	2.4+	18.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
23	64	13	0.5 - 1.5	23	27	32	5	9	4	0

Surface level +87.8 m
 Water struck at +83.7 m
 203 mm percussion
 December 1980

Overburden 0.4 m
 Mineral 1.4 m
 Waste 1.1 m
 Mineral 2.5 m
 Waste 0.1 m
 Mineral 7.3 m
 Waste 12.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial Sand and Gravel	a 'Very clayey' pebbly sand Gravel: fine with coarse, Palaeozoic sandstones and siltstones with acid volcanics, red sandstones, quartzites, quartz, limestones and some plutonics and chert Sand: fine and medium with some coarse, quartz with lithic grains as in gravel Fines: moderate reddish brown	1.4	1.8
	Sandy clayey silt, moderate reddish brown, bands of sand, silt and clay up to 10 mm thick	1.1	2.9
	b 'Clayey' sand, fine and medium, quartz with lithic grains	2.5	5.4
Laminated Clay	Clay, light brown, laminae of silty clay	0.1	5.5
Glacial Sand and Gravel	c 'Clayey' sand, pebbly in lower half: fine and medium, quartz with lithic grains and some coal; thin silts and clays to base	7.3	12.8
Till	Clay, moderate brown to greyish red, mainly massive and stony but some laminae at top	12.3 +	25.1

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages							
	Fines	Sand	Gravel		Fines				Gravel			
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm	
a	21	75	4	0.4 - 1.8	21	41	30	4	3	1	0	
b	10	90	0	2.9 - 3.9	16	18	65	1	0	0	0	
				3.9 - 5.4	6	70	24	0	0	0		
				Mean	10	50	40	trace	0	0	0	
c	11	88	1	5.5 - 6.5	7	55	37	1	0	0	0	
				6.5 - 7.5	6	55	38	1	0	0		
				7.5 - 8.5	2	35	62	0	1	0		
				8.5 - 9.5	9	14	71	3	3	0		
				9.5 - 10.5	4	35	56	3	2	0		
				10.5 - 12.8	23	45	30	1	1	0		
Mean	11	41	46	1	1	0	0					
a + b + c	12	87	1	Mean	12	43	42	2	1	trace	0	

Surface level +89.5 m
 Water struck at +85.7 m
 203 mm percussion
 November 1980

Overburden 0.5 m
 Mineral 6.3 m
 Waste 0.5 m
 Mineral 7.3 m
 Bedrock 1.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial Sand and Gravel	a Pebbly sand Gravel: fine and coarse, subangular to rounded, Palaeozoic sandstones (A) with red sandstones and siltstones (D), acid volcanics (E), quartzites (H) and some plutonics (G), quartz (I) and chert (J), rare siltstones (B) Sand: fine and medium with some coarse, quartz with lithic grains as in gravel	2.0	2.5
	b Sand with some pebbles: fine and medium, quartz with lithic grains	4.3	6.8
Laminated Clay	Clay, greyish brown to moderate brown, laminated and stoneless, silty laminae	0.5	7.3
Glacial Sand and Gravel	c Sand, pebbly at base: fine and medium, quartz with lithics and some coal	7.3	14.6
Lias	Mudstone, medium dark grey	1.4+	16.0

GRADING

	Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
	Fines	Sand	Gravel		Fines			Gravel			
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	7	79	14	0.5 - 1.5	6	31	40	6	10	7	0
				1.5 - 2.5	7	28	49	6	8	2	0
				Mean	7	30	43	6	9	5	0
b	5	93	2	2.5 - 3.5	4	39	52	2	3	0	0
				3.5 - 4.5	4	39	49	4	3	1	0
				4.5 - 5.5	5	59	35	0	1	0	0
				5.5 - 6.8	5	60	34	1	0	0	0
				Mean	5	49	42	2	2	trace	0
c	4	95	1	7.3 - 8.3	12	49	38	1	0	0	0
				8.3 - 9.3	2	31	66	0	1	0	0
				9.3 - 10.3	0	39	60	1	0	0	0
				10.3 - 11.3	3	32	63	1	0	1	0
				11.3 - 13.3	4	55	40	1	0	0	0
				13.3 - 14.6	3	38	52	1	1	5	0
				Mean	4	43	51	1	trace	1	0
a + b + c	5	92	3	Mean	5	43	47	2	2	1	0

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in +8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
0.5 - 2.5	52	trace		15	21		3	7	1	1

Surface level +98.5 m
 Water not encountered
 203 mm percussion
 April 1981

Waste 0.3 m
 Bedrock 4.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Lias	Soil Calcareous mudstone and limestone, medium grey, with belemnites and bivalves, weathered to 3.2 m	0.3 4.7+	0.3 5.0

Surface level +92.0 m
 Water struck at +91.2 m
 203 mm percussion
 December 1980

Overburden 0.5 m
 Mineral 2.0 m
 Bedrock 2.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil 'Very clayey' sandy gravel Gravel: fine, coarse and cobbles, subangular to subrounded, Palaeozoic sandstones (A), acid volcanics (E), red sandstones and siltstones (D), chert (J), plutonics (G) and some quartzites (H), quartz (I) and basic volcanics (F), rare Palaeozoic siltstones (B) Sand: fine and medium with some coarse, quartz with lithics as in gravel Fines: dark reddish brown to pale yellowish brown	0.5 2.0	0.5 2.5
Lias	Mudstone, medium dark grey, weathered to 3.8 m	2.0+	4.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages							
Fines	Sand	Gravel		Fines		Sand			Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm	
20	58	22	0.5 - 1.5	18	30	37	6	6	3	0	
			1.5 - 2.5	21	22	21	3	9	14	10	
			Mean	20	26	27	5	8	9	5	

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
1.5 - 2.5	33	trace		16	24	1	7	4	1	14

Surface level +87.9 m
 Water struck at +81.8 m
 203 mm percussion
 November 1980

Overburden 0.5 m
 Mineral 10.1 m
 Waste 10.0 m
 Bedrock 1.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial Sand and Gravel	Sand, pebbly in part: medium with fine and some coarse, quartz with lithic grains and rare coal	10.1	10.6
Till	Clay, greyish red to greyish brown, mainly massive and stony with some shell fragments but some laminated silt in part	10.0	20.6
Lias	Mudstone, grey to black	1.4+	22.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
6	90	4	0.5 - 1.5	6	21	58	9	5	1	0
			1.5 - 2.5	6	28	60	3	3	0	0
			2.5 - 3.5	27	21	46	2	2	2	0
			3.5 - 5.3	4	24	68	2	2	0	0
			5.3 - 6.3	8	17	57	9	8	1	0
			6.3 - 7.3	4	37	51	3	5	0	0
			7.3 - 8.3	3	34	60	2	1	0	0
			8.3 - 9.3	2	19	76	1	1	1	0
			9.3 - 10.6	1	42	52	3	1	1	0
			Mean	6	27	59	4	3	1	0

Surface level +82.6 m
 Water struck at +80.2 m
 203 mm percussion
 November 1980

Overburden 1.1 m
 Mineral 5.9 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil	0.3	0.3
	Sandy silt, light to pale brown, laminated	0.8	1.1
	Pebbly sand, 'clayey' in part Gravel: fine and coarse, with cobbles at base, Palaeozoic sandstones and siltstones, acid volcanics, basic volcanics, quartzites with some limestones, red sandstones and quartz Sand: medium with fine, quartz with lithics as in gravel and some coal	5.9+	7.0

Borehole abandoned because of limestone boulder obstruction

Note This borehole is not displayed on the face of the accompanying map because it is adjacent to borehole SE 21

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
7	85	8	1.1 - 2.1	14	29	46	2	4	5	0
			2.1 - 3.1	3	37	57	1	2	0	0
			3.1 - 4.1	3	14	71	3	5	4	0
			4.1 - 5.1	16	20	59	2	2	1	0
			5.1 - 6.4	2	33	57	1	4	3	0
			6.4 - 7.0	6	27	21	9	13	11	13
			Mean	7	27	56	2	4	3	1

Surface level + 82.4 m
 Water struck at + 80.0 m
 203 mm percussion
 December 1981

Overburden 1.4 m
 Mineral 4.4 m
 Waste 12.4 m
 Bedrock 1.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil	0.4	0.4
	Sandy silt	1.0	1.4
	Pebbly sand Gravel: fine and coarse, subangular to subrounded, Palaeozoic sandstones and siltstones, acid volcanics, quartzites and basic volcanics with some limestones, red sandstones and quartz Sand: medium and fine, quartz with lithic grains as in gravel and some coal	4.4	5.8
Till	Clay, dark yellowish brown to brownish grey, mainly massive and stony but poor laminae in part and 0.5 m of laminated silt at 17.1 m and thinner bands of silt at top	12.4	18.2
Lower Keuper Marl	Mudstone, moderate reddish brown with some greenish grey fisheyes and lenses	1.8 +	20.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
4	89	7	1.4 - 3.4	5	41	46	3	2	3	0
			3.4 - 5.8	3	29	58	2	2	6	0
			Mean	4	34	53	2	2	5	0

Surface level + 82.6 m
 Water level + 78.6 m
 203 mm percussion
 November 1980

Overburden 0.3 m
 Mineral 8.3 m
 Waste 5.0 m
 Bedrock 2.9 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	Pebbly sand Gravel: fine and coarse, subangular to subrounded, Palaeozoic sandstones (A), acid volcanics (E) with quartz (I), red sandstones (D) chert (J) and some basic volcanics (F), plutonics (G) and quartzites (H) Sand: medium and fine, quartz with lithic grains as in gravel	8.3	8.6
	Silt, greyish red, laminated	0.5	9.1
Till	Clay, greyish red to brownish grey, mainly massive and stony but silty at top	4.5	13.6
Lower Keuper Marl	Mudstone, reddish brown with green fisheyes	2.9+	16.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
3	90	7	0.3 - 1.3	7	43	46	1	2	1	0
			1.3 - 2.0	5	71	22	0	1	1	0
			2.0 - 3.0	4	32	53	4	3	4	0
			3.0 - 4.0	2	57	34	2	1	4	0
			4.0 - 5.0	3	26	50	8	9	4	0
			5.0 - 6.4	1	26	59	2	7	5	0
			6.4 - 8.0	3	26	66	2	2	1	0
			8.0 - 8.6	3	26	66	2	2	1	0
			Mean	3	36	51	3	4	3	0

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
4.0 - 6.4	41	trace		7	30	3	2	2	10	5

Surface level +75.6 m
 Water struck at +73.9 m
 203 mm percussion
 December 1980

Overburden 0.2 m
 Mineral 1.5 m
 Waste 23.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial Sand and Gravel	Sand, some pebbles: medium and fine, quartz with lithic grains	1.5	1.7
Laminated Clay	Clay and silt, brownish grey to pale brown, mainly laminated but unlaminated in part with some stones	18.3	20.0
Till	Clay, dark reddish brown, very sandy, massive with some stones	5.0+	25.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
6	92	2	0.2-1.7	6	37	53	2	1	1	0

Surface level +79.9 m
 Water struck at +77.9 m
 203 mm percussion
 December 1980

Overburden 0.6 m
 Mineral 4.1 m
 Waste 16.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Glacial Sand and Gravel	Sand, some pebbles: fine and medium, quartz with lithic grains and some coal	4.1	4.7
Laminated Clay	Silt, brownish grey to greyish red, clayey and micaceous, laminated in part; some stones below 14.0 m	11.3	16.0
Glacial Sand and Gravel	Sandy silt, reddish brown, fine quartz with lithic grains, micaceous	5.0+	21.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
7	91	2	0.6-1.6	11	38	47	1	1	2	0
			1.6-3.2	4	35	60	1	0	0	0
			3.2-4.7	7	56	33	1	1	2	0
			Mean	7	43	47	1	1	1	0

Surface level +82.6 m
 Water struck at +80.6 m
 203 mm percussion
 December 1980

Overburden 0.2 m
 Mineral 6.9 m
 Waste 19.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial Sand and Gravel	Sand, pebbly in part: medium and fine, quartz with lithic grains	6.9	7.1
Laminated Clay	Clay, greyish brown, laminated, generally stoneless, plastic below 10.6 m, rhythmic in part with silt, sand and clay laminae	12.2	19.3
Till	Clay, greyish brown to greyish red, mainly massive, stony and hard but sandy at top and some silt and sand laminae in part	7.2+	26.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
3	94	3	0.2-1.2	4	35	59	1	1	0	0
			1.2-2.2	3	31	62	1	2	1	0
			2.2-3.2	1	39	52	3	2	3	0
			3.2-4.2	2	47	49	1	1	0	0
			4.2-5.2	3	35	58	3	1	0	0
			5.2-6.2	3	24	63	6	4	0	0
			6.2-7.1	7	17	72	3	1	0	0
			Mean	3	33	58	3	2	1	0

Surface level +83.5 m
 Water struck at +82.4 m
 203 mm percussion
 April 1981

Overburden 0.8 m
 Mineral 5.2 m
 Waste 1.6 m
 Mineral 3.3 m
 Waste 9.5 m
 Bedrock 0.6 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.8	0.8
Glacial Sand and Gravel	a Sand, pebbly in part: medium and fine, quartz with lithic grains and some shell fragments	5.2	6.0
	Silt, pale to light brown, generally massive with thin bands of fine sand	0.6	6.6
Laminated Clay	Clay, moderate brown to brownish grey, laminated, slightly plastic, rare stones	1.0	7.6
Glacial Sand and Gravel	b Sand, 'clayey' to base: fine with some medium, quartz with lithic grains and rare shell fragments	3.3	10.9
Laminated Clay	Clay and silt, brownish grey, rhythmic, laminae of plastic clay, micaceous silt and sandy silt	1.6	12.5
Till	Clay, greyish brown to brownish grey, mainly massive and stony with a sandy texture and some shell fragments but siltier and redder below 18.7 m	7.9	20.4
Northwich Halite	Mudstone, moderate reddish brown, some gypsiferous streaks towards base	0.6+	21.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines		Sand			Gravel	
					- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
a	3	95	2	0.8-1.8	6	36	56	1	1	0	0
				1.8-2.8	1	47	50	1	1	0	0
				2.8-3.8	2	32	64	2	0	0	0
				3.8-4.8	2	22	69	2	5	0	0
				4.8-6.0	2	42	53	2	1	0	0
			Mean	3	36	57	2	2	0	0	
b	9	91	0	7.6-8.6	8	78	13	1	0	0	0
				8.6-9.6	6	91	3	0	0	0	0
				9.6-10.9	12	85	2	1	0	0	0
				Mean	9	84	6	1	0	0	0
a + b	5	94	1	Mean	5	55	38	1	1	0	0

Surface level +76.2 m
 Water struck at +75.1 m, +62.6 and +48.4 m
 203 mm percussion
 April 1981

Overburden 0.3 m
 Mineral 2.7 m
 Waste 24.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	Sand, 'clayey' at top, pebbly at base: medium and fine, quartz with lithic grains and some coal	2.7	3.0
Laminated Clay	Clay, brownish grey to olive green, laminated, plastic and generally stoneless, rhythmic below 12.6 m; some laminae of sandy till at 6.6 m	13.9	16.9
Till	Clay, greyish brown to brownish grey, mainly massive and stony with a sandy texture and some shell fragments, but poorly laminated and some thin bands of sand in part	10.9 +	27.8

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
7	92	1	0.3 - 1.3	10	14	70	4	2	0	0
			1.3 - 2.8	5	43	52	0	0	0	0
			2.8 - 3.0	7	15	51	20	7	0	0
			Mean	7	30	59	3	1	0	0

Surface level +79.9 m
 Water struck at +78.2 m
 203 mm percussion
 November 1980

Overburden 0.7 m
 Mineral 5.5 m
 Waste 13.9 m
 Bedrock 1.9 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.7	0.7
Glacial Sand and Gravel	Sand, 'clayey' in part: medium and fine, quartz with lithic grains and some coal	5.5	6.2
Laminated Clay	Clay, greyish red to brownish grey, silty, laminated in part, rare stones; sandy silt from 9.8 m to base	5.3	11.5
Till	Clay, greyish red to brownish grey, massive, stony and sandy	8.6	20.1
Northwich Halite	Mudstone, reddish brown to pale greenish grey, gypsiferous	1.9+	22.0

GRADING

Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
Fines	Sand	Gravel		Fines		Sand		Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
6	93	1	0.7 - 1.7	6	30	60	2	1	1	0
			1.7 - 2.7	16	37	45	1	1	0	0
			2.7 - 3.7	3	44	51	1	1	0	0
			3.7 - 4.7	4	42	50	2	1	1	0
			4.7 - 6.2	3	50	45	1	1	0	0
			Mean	6	41	51	1	1	trace	0

SJ 53 SE 29 5768 3184 The Pines

Block E

Surface level + 80.7 m
 Water struck at + 79.6 m
 203 mm percussion
 December 1980

Overburden 0.3 m
 Mineral 3.5 m
 Bedrock 2.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	Sand, pebbly in part, 'clayey' at top: fine and medium, quartz with lithic grains and some coal	3.5	3.8
Northwich Halite	Mudstone, moderate reddish brown and greenish grey, with nodules and laminae of fibrous gypsum	2.2 +	6.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines		Sand		Gravel		
				- 1/6	+ 1/6 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
9	88	3	0.3 - 1.3	11	49	39	1	0	0	0
			1.3 - 2.3	7	36	44	2	6	5	0
			2.3 - 3.8	9	39	51	0	1	0	0
			Mean	9	41	46	1	2	1	0

SJ 53 SE 30 5873 3166 Vale Farm

Block E

Surface level + 88.3 m
 Water not encountered
 203 mm percussion
 December 1980

Waste 2.8 m
 Bedrock 1.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Till and Glacial Sand and Gravel	Clay, greyish red, sandy and stony with 0.6 m of sand at top	2.3	2.8
Lower Keuper Marl	Mudstone, reddish brown with green siltstone and fisheyes	1.2 +	4.0

Surface level + 83.6 m
 Water struck at + 82.4 m
 203 mm percussion
 December 1980

Overburden 0.3 m
 Mineral 4.2 m
 Bedrock 1.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	Sandy gravel Gravel: fine and coarse, subangular to subrounded, Palaeozoic sandstones (A) with acid volcanics (E) and some red sandstones and siltstones (D), quartz (I), mudstones (B), quartzites (H), chert (J), plutonics (G), and basic volcanics (F), and rare limestones (C) Sand: medium with fine and coarse, quartz with lithic grains as in gravel	4.2	4.5
Lower Keuper Marl	Mudstone, moderate reddish brown, some greenish grey lenses	1.5 +	6.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
8	68	24	0.3 - 1.3	22	34	32	3	4	5	0
			1.3 - 2.3	8	24	43	6	11	8	0
			2.3 - 3.3	2	9	41	16	23	9	0
			3.3 - 4.5	3	9	36	17	24	11	0
			Mean	8	19	38	11	16	8	0

COMPOSITION

The rock types are named in the log above and in Appendix D

Depth below surface (m)	Percentage by weight in + 8 mm fraction									
	A	B	C	D	E	F	G	H	I	J
1.3 - 2.3	59	5		3	21	trace	2	3	4	3
3.3 - 4.5	63	4	trace	5	12	1	3	3	6	3

Surface level + 82.9 m
 Water level + 82.1 m
 203 mm percussion
 December 1980

Overburden 1.1 m
 Mineral 3.9 m
 Waste 7.3 m
 Bedrock 1.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	Sandy clay, leached and weathered	0.8	1.1
	Pebbly sand Gravel: fine with coarse, Palaeozoic sandstones, siltstones and acid volcanics with quartzites, quartz, limestones, plutonics and rare chert Sand: medium with fine and coarse, quartz with lithic grains as in gravel and some coal and mica	3.9	5.0
Till	Clay, dark reddish brown to dusky yellowish brown, massive and stony but soft and sandy at top	7.3	12.3
Lower Keuper Marl	Mudstone, reddish with green siltstones and fisheyes	1.2 +	13.5

GRADING

Mean for deposit <i>percentages</i>			Depth below surface (m)	<i>percentages</i>						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				- 1/16	+ 1/16 - 1/4	+ 1/4 - 1	+ 1 - 4	+ 4 - 16	+ 16 - 64	+ 64 mm
5	75	20	1.1 - 2.1	9	18	53	7	10	3	0
			2.1 - 3.1	3	7	58	13	16	3	0
			3.1 - 4.1	4	10	56	13	13	4	0
			4.1 - 5.0	6	23	28	8	27	8	0
			Mean	5	14	51	10	16	4	0

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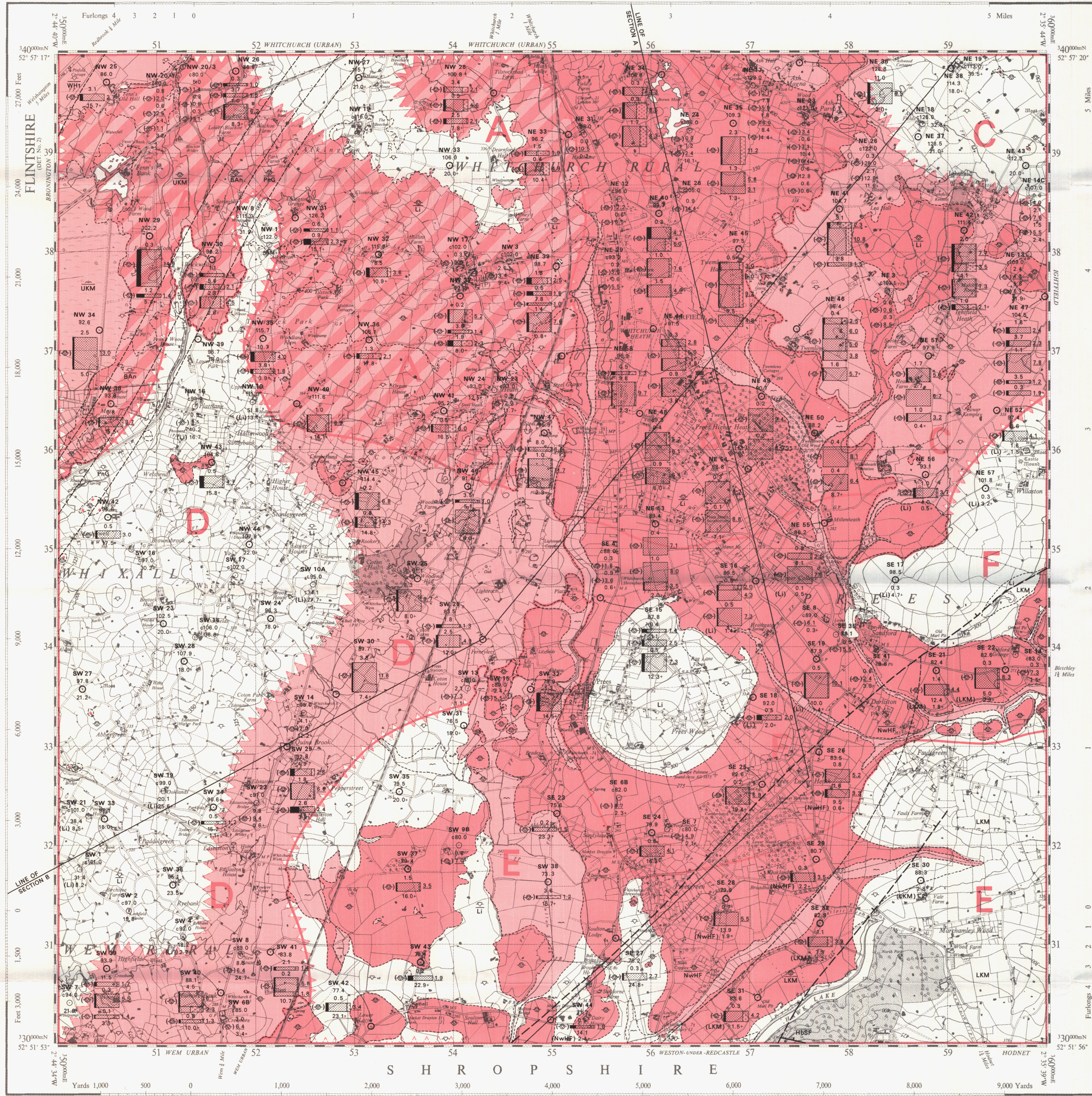
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Scale 1:25 000 or about 2 1/2 Inches to 1 Mile

ORDNANCE SURVEY
SHEET SJ53
PROVISIONAL EDITION

134

EXPLANATION OF SYMBOLS AND ABBREVIATIONS



- DRIFT**
- Peat P-1
 - Alluvium - silt, peat and clay with some sand and gravel A-77
 - Glacial Sand and Gravel - sand, some 'clayey' to 'very clayey', with gravel and partings of silt and clay
 - Till - mainly massive and stony clay, but laminated, and relatively stoneless in part, some beds of silt, sand and gravel

QUATERNARY
GS-86
TL-20

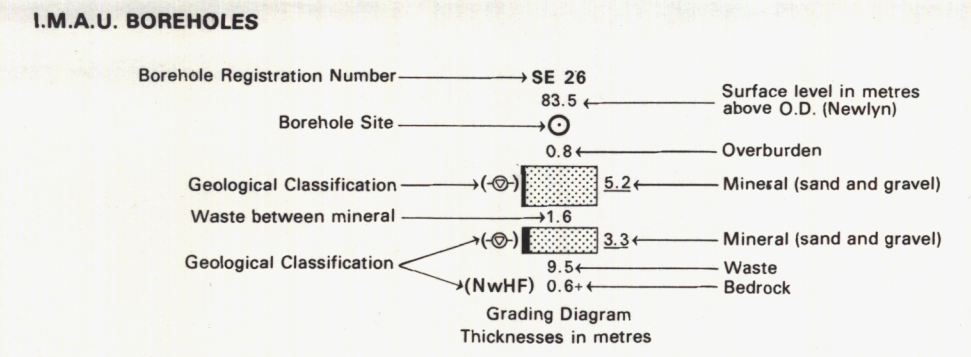
- SOLID**
- LI Lias - fossiliferous mudstones, limestones, siltstones and fine grained sandstones
 - PnG Penarth Group (Rhaetic) - silty mudstones with thin beds of sandstone and limestone
 - BAn Blue Anchor Formation (Tea Green Marl) - greyish green mudstones and siltstones
 - UKM Upper Keuper Marl - chocolate brown and reddish brown structureless mudstones with anhydrite nodules
 - Wht Wilkesley Halite (Upper Keuper Saliferous Beds) - halite with mudstone partings
 - NwHF Northwich Halite (Lower Keuper Saliferous Beds) - halite with mudstone partings
 - LKM Lower Keuper Marl - laminated reddish brown and greenish grey mudstones overlying less well laminated reddish brown mudstones
 - HBSF Helaby Sandstone Formation (Keuper Sandstone) - red, white and pale yellow sandstones with some disseminated barytes in part

JURASSIC AND TRIASSIC

Made Ground MG-2

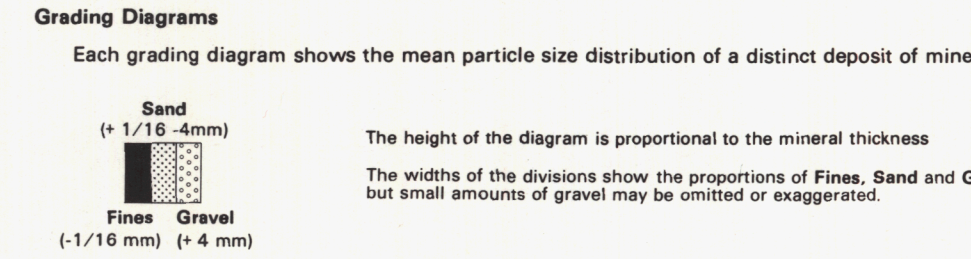
- BOUNDARY LINES**
- Geological boundary, Drift
 - Geological boundary, Solid
 - - - Fault, crossmark indicates downthrow side
 - Resource Block boundary
 - Inferred boundary between recognised categories of deposits
 - Broken lines denote uncertainty

- BOREHOLE DATA**
- SITE LOCATIONS**
- Industrial Minerals Assessment Unit (I.M.A.U.) Boreholes
 - Other Boreholes



Note:
(i) Figures underlined denote thicknesses used in the assessment of resources
(ii) The + sign indicates that the base of the deposit was not reached
(iii) The Geological Classification is given only for mineral and bedrock

Borehole Registration Number
Each I.M.A.U. borehole is identified by a Registration Number, e.g. SE26. The letters refer to the quarter sheet and the figures to the I.G.S. serial numbers for that quarter. The unique designation for borehole SE26 is SJ53SE26



OTHER BOREHOLES
The layout of information is the same as for I.M.A.U. boreholes although data available may not be as comprehensive. They are registered in the same series.

- CATEGORIES OF DEPOSITS**
- Exposed mineral CAT-E6
 - Exposed mineral, and continuous or almost continuous spreads of mineral beneath overburden, undifferentiated. CAT-E11
 - Continuous or almost continuous spreads of mineral beneath overburden. CAT-C1
 - Sand and gravel either not potentially workable (see Report) or absent. CAT-A2
 - Sand and gravel not assessed. CAT-N1

RESOURCE BLOCKS
For the purpose of assessment, the mineral is divided into Resource Blocks (see Report). Each is designated by a letter.

HORIZONTAL SECTIONS
Horizontal sections showing the general relations of the drift deposits along the lines shown, constitute Fig. 5 of the Report.

Detailed records may be consulted on application to the Head, Industrial Minerals Assessment Unit, Institute of Geological Sciences, Nicker Hill, Keyworth, Nottingham, NG12 5GG.

SJ 44	SJ 54	SJ 64
	122	123
SJ 43	SJ 53	SJ 63
SJ 42	SJ 52	SJ 62
	138	139

Diagram showing relation of the National Grid 1:25,000 sheets with the One-Inch Geological Sheets 122, 123, 138 and 139.

Geological lines from six-inch surveys by R.W. Peacock in 1919-21 (southern half) and by A.J. Whiteman in 1955-57 (northern half). T.C. Cantrell, J.V. Stephens and B.J. Taylor, District Geologists. Amendments to solid geology by A.A. Wilson and to drift geology by J.W.C. James, 1982. Included in One-Inch Geological Sheets 122 and 138. Sand and Gravel Survey by J.W.C. James and J.H. Lovell in 1980-81. P.G. Thorneil, Head, Industrial Minerals Assessment Unit. 1:25,000 Sand and Gravel Resource Sheet published 1983. G.M. Brown, F.R.S. Director, Institute of Geological Sciences.

Data quoted for an individual borehole refer strictly to that site; reliable conclusions cannot be drawn about the thickness and grading elsewhere in the deposit, particularly in material as variable as sand and gravel. However, estimates of the volume and mean grading of the mineral as a whole in each Resource Block are given in the Report.