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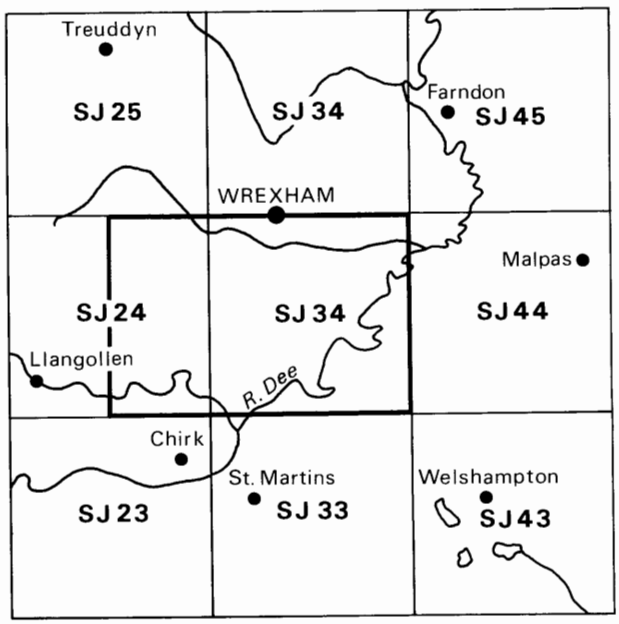
Mineral Assessment Report 106



The sand and gravel resources of the country south of Wrexham, Clwyd

Description of 1:25 000 sheet SJ 34 and parts of SJ 24

D. F. Ball

ISBN 0 11 884306 0*

HMSO

Institute of Geological Sciences

MINERAL ASSESSMENT REPORT 106

SJ34* South of Wrexham, Clwyd

ISBN 0 11 884306 0*

CORRECTIONS

Page ii, column 1 *Insert after existing text*
The asterisk on the cover indicates that part of a sheet adjacent to the one cited is described in this report.

Page ii, column 2, paragraph 3, line 9
For 1956 – 17 *read* 1956 – 57

Pages 7, 8 and 10, figures 4, 5 and 7
Insert in the caption for each figure
The continuous line represents the weighted mean grading of the block. Broken lines delimit the envelope within which the mean grading curves of the individual boreholes fall.

London Her Majesty's Stationery Office 1982

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 No. 13 and subsequent reports appear as Mineral Assessment Reports of the Institute.

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

Any enquiries concerning this report may be addressed to Head, Industrial Minerals Assessment Unit,
Institute of Geological Sciences,
Keyworth, Nottingham NG12 5GG.

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 resources of sand and gravel of 150 km^2 of country south of Wrexham, Clwyd, shown on the accompanying 1:25 000 resource map SJ 34 and part of SJ 24. The survey was conducted by Mr D. F. Ball, assisted by Mr K. A. McL. Adlam and Dr P. N. Dunkley. The work is based on six-inch scale geological surveys carried out by D. A. MacAlister, H. H. Thomas, C. B. Wedd and L. J. Willis in 1910-13 and by E. G. Poole and A. J. Whiteman in 1956-17, revised in part by D. J. Lowe, A. J. Reedman and R. J. Tappin in 1977-78.

Mr J. D. Burnell, ISO (Land Agent) negotiated access to land for drilling. The ready cooperation of land owners and tennants is gratefully acknowledged.

G. M. Brown
Director

Institute of Geological Sciences
Exhibition Road
London SW7 2DE

6 October 1981

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MAP

The sand and gravel resources of the area south of Wrexham, including cross-sections showing the relationships between Drift deposits **in pocket**

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The sand and gravel resources of the country south of Wrexham, Clwyd

Description of 1:25 000 sheet SJ 34 and part of SJ 24

D. F. BALL

SUMMARY

The geological maps of the Institute of Geological Sciences, pre-existing borehole information, and 70 boreholes drilled for the Industrial Minerals Assessment Unit form the basis of the assessment of the sand and gravel resources of the area south of Wrexham, Clwyd.

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 mineral-bearing ground is divided into four resource blocks, containing between 9.4 and 18.4 km^2 of 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 grading of the mineral 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 resource map.

Notes

Each borehole registered with the Institute is identified by a four-element code (e.g. SJ 24 NE 23). 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 the borehole is normally referred to by the last three elements alone (e.g. 24 NE 23).

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

Bibliographical reference

BALL, D.F. 1982. The sand and gravel resources of the country south of Wrexham, Clwyd. Description of 1:25 000 sheet SJ 34 and part of SJ 24. **Miner. Assess. Rep. Inst. Geol. Sci.,** No. 106.

Author

D. F. Ball, BSc
Institute of Geological Sciences, Keyworth, Nottingham NG12 5GG

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 a 0.063 mm (1/16 mm) mesh BS sieve) 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 body of mineral.

For the particular needs of assessing sand and gravel resources, a grain-size classification based on the geometric scale 1/16 mm, ¼ 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 1/16 mm and 4 mm respectively (see Appendix C).

The volume and other characteristics are assessed within resource blocks, each of which, ideally, contains

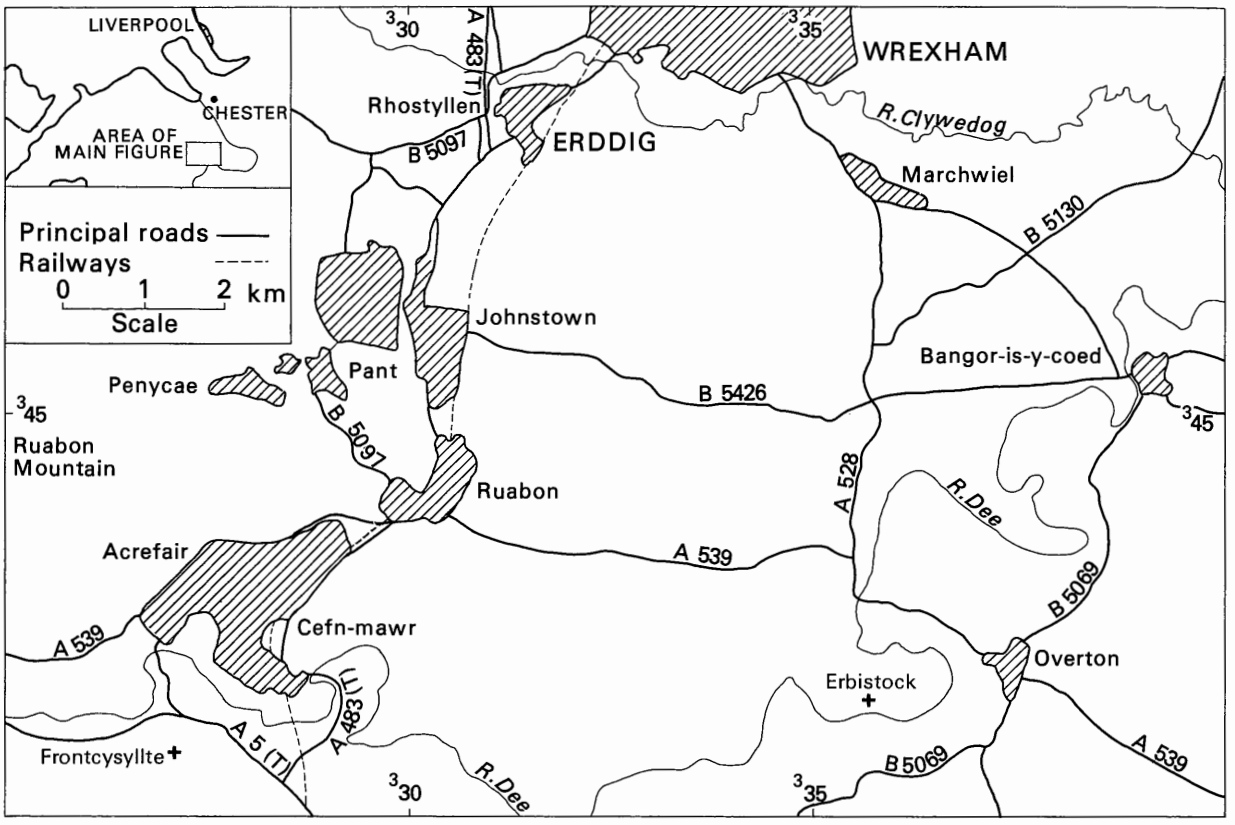


Figure 1 Outline map of the district shown on the resource sheet

approximately 10 km^2 of sand and gravel. No account is taken of any factors, for example roads, 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 covered in this report (Figure 1) lies about 30 km south of Liverpool and embraces the transition from the broad Cheshire plain in the east to the steep slopes of the Welsh hills to the west. The gentle westerly rise of the land assumes a steeper gradient beyond Ruabon and Rhosllanerchrugog, and an elevation of 460 m above OD is reached on Ruabon Mountain in the north-west. In the south-west, the River Dee has cut a deep valley into the hill-mass upstream from Cefn-mawr; downstream to Erbistock it flows through a narrow valley incised into the superficial deposits and, beyond, across a broad flood-plain developed at about 20 m OD.

An industrial belt stretching from Wrexham to Cefn-mawr includes Bersham Colliery together with numerous abandoned coal workings and a number of defunct clay pits. This contrasts with the predominantly rural character of the remainder of the district. There are no commercial sand and gravel workings.

GEOLOGY

The geological sequence is summarised in Table 1, in which deposits are listed, as far as possible, in order of increasing age. The relationships between the Drift deposits are shown in the horizontal sections on the resource sheet. The notes below are based largely on accounts given in the Wrexham memoir (Wedd and others, 1927 and 1928). Some geological features, notably the 'Wrexham Delta-Terrace', are more fully described in the mineral assessment report for the district to the north (Dunkley, 1981), and a review of the glacial history of this and adjacent areas investigated recently by the Industrial Minerals Assessment Unit will be published shortly (Wilson and others, in press).

Solid

Silurian Strata assigned to the Ludlow series crop out in the extreme south-west of the district and consist of dark grey mudstones and thin sandy beds.

Table 1 Geological sequence.

DRIFT	
Recent and **Pleistocene**	Peat
	Alluvium and Alluvial Fan
	River Terrace Deposits
	Late-Glacial Flood-Gravels
	Boulder Clay
	Glacial Sand and Gravel
	Glacial Silt
SOLID	
Permo-Triassic	
Carboniferous	Coal Measures - Upper, Middle and. Lower
	Millstone Grit 'Series'*
	Carboniferous Limestone 'Series'*
Silurian	Ludlow Series

* The term 'Series' is used as recommended by Holland and others (1978, p. 3).

Carboniferous Limestone 'Series' At Froncysyllte, 10 m or so of the White Limestone, comprising red clay and pale grey limestone, rests unconformably on Ludlow rocks. The overlying Upper Grey Limestone, about 90 m thick in this distict, is represented by a sequence of pale to dark grey limestone with intercalations of shale. The succeeding Sandy Limestone varies from about 50 m thick in the sout-west to 65 m in the north-west and comprises alternations of arenaceous limestone with calcareous sandstone, siltstone and mudstone. The lower part of the overlying Cefn-y-fedw Sandstone consists of about 180 m of massive, variably pebbly, calcareous, quartzose sandstone interbedded with mudstone, cherty siltstone and minor amounts of limestone.

Millstone Grit 'Series' The upper part of the Cefn-y-fedw Sandstone, attaining a maximum thickness of 190 m in the north of the district, is assigned to the Millstone Grit 'Series'. Lithologically it is similar to the lower part of the formation but it includes at the top the massive, pebbly, feldspathic Aqueduct Grit.

Coal Measures: Lower and Middle Coal Measures, averaging 300 m in thickness, contain most of the coal seams in the district and comprise a typical 'grey measures' sequence of mudstone with subordinate sandstone, siltstone and seatearth. The lowest 200 m of the Upper Coal Measures are similar and include a 35 m thick sandstone, the Cefn Rock. Overlying the grey measures is a sequence of 'red beds' more than 1000 m thick. The Ruabon Marl, believed to be the reddened equivalent of grey beds to the north, consists of red, purple and green marl. The succeeding Coed-yr-allt Beds consist of greenish white sandstone, partly calcareous, with a few marl bands; and the Erbistock Beds, lying unconformably above, comprise red, purple and brown sandstone with numerous marl bands.

Permo-Triassic The presence of a typical tri-partite Permo-Triassic sequence in the east and south-east of the district is inferred on evidence from adjacent areas. Though sandstone was once quarried north-east of Bangor-is-coed, elsewhere the rocks are completely concealed by thick drift and are only incompletely known from borehole records. They are about 800 m thick and probably consist mainly of red sandstone with, in the Bunter Pebble Beds, bands of conglomerate and pebbly sandstone.

Drift

The glacial drift of the district was deposited during the last, Devensian, glaciation and includes the products of 'Irish Sea' ice and local, Welsh ice. Although in detail the sequence is complex, it broadly conforms to the stratigraphy proposed by Wedd and Wills (Wedd and others, 1928) which, for the 'Irish Sea' deposits, they summarise as follows: Lower Boulder Clay, Sand and Gravel, Upper Boulder Clay and finally, Outwash deposits. However, there is some dispute over the relative age of some of the sand and gravel, notably that forming the 'Wrexham Delta-Terrace', the prominent feature on which Wrexham is built, and about the origin of the Upper Boulder Clay (Poole and Whiteman, 1961; Peake, 1961).

Boulder Clay The boulder clay of the district is most readily subdivided into two main types -the grey 'Welsh' boulder clay and the red to brown 'Irish Sea' boulder clay. The former is till deposited by the Welsh ice and contains erratics derived chiefly from local Carboniferous sandstone, mudstone and limestone, but also includes Welsh slate, greywacke and igneous rock. This till is best seen in the Ruabon-Rhostyllen area and on the slopes of Ruabon Mountain.

The 'Irish Sea' clay comprises both tills and, 'stoneless' clay. The till is largely stiff reddish brown stony clay containing erratics of mostly local origin but also including such far-travelled types as Eskdale granite and Lake District volcanic rocks. Fragments of marine shells are quite common. The matrix was derived from Permo-Triassic rocks and is usually sandy.

The 'stoneless' clay, generally included with the Upper Boulder Clay, occurs mainly east of Marchwiel and Overton. It is relatively soft and is partly silty and laminated. South-east of Wrexham it appears to interdigitate with the thick sands of the Wrexham Delta-Terrace and this, together with its mainly stoneless nature, led Wedd and Wills to conclude that it was formed in an extensive glacial lake that reached into Cheshire. However, Poole and Whiteman regard the clay as till laid down during an ice readvance. In the vicinity of Marchwiel the stoneless clay is underlain by stony till and westwards it gives place to this deposit at surface.

Glacial Sand and Gravel This deposit, the most important source of bulk aggregate in the district, is of common occurrence both at surface and beneath younger deposits. To the south of Wrexham, around Erddig, two units may be distinguished in the Wrexham Delta-Terrace. The lower consists of well-sorted sand, at least 21 m thick in places, which passes down into Glacial Silt. The latter consists of sandy silt and laminated silty clay; it has been proved in a number of boreholes and its principal outcrop in the district, near Kings Mills, has been delineated on the geological map. The upper unit of the Delta Terrace is a coarse gravel; its maximum proved thickness is 9.3 m, and it is less extensive than the sand unit. West of Erddig the pattern of gravel overlying sand and fining downwards into silt is replaced near Bersham by a more complex relationship involving several layers of till interbedded with sand and gravel.

From Rhostyllen to the Dee valley, drift infills a shallow trough cut into the Ruabon Marl. Sandy gravels, partly covered by till, extend more or less continuously along the length of this tract, varying in thickness from 1.6 m near the Hafod Red Brick Works [3080 4550] to 18.9 m at Ruabon. South and east of the Wrexham Delta-Terrace, boulder clay, in places exceeding 18 m thick, covers much of the ground. Sand crops out in the valley of Gyfelia Brook and in small isolated patches elsewhere, but the extent of the deposit beneath the boulder clay is uncertain. Again, the distribution of glacial sand and gravel beneath the fluvial deposits in the Dee valley is not fully known, although it has been proved in number of boreholes.

At Overton the geological map shows a large spread of 'Glacial Sand and Gravel'. Boreholes on the outcrop confirm the presence of sand and gravel, but generally show them to be overlain by reddish-brown, partly laminated clay. To the west of Overton, both north and south of the River Dee, sand and sandy gravel exhibit a complex relationship with reddish-brown stony till.

Towards the western margin of the district, sand and gravel is found on the slopes of Ruabon Mountain between 180 and 300 m OD. It occurs both as prominent mounds surrounded by till and interbedded with stony tills.

Late-Glacial Flood Gravels These occur as high-level terraces in the Dee valley upstream from the Cefn-Mawr railway viaduct. They are over 10 m thick in places and consist of sand and gravel, composed almost entirely of dark grey Silurian siltstone and greywacke, with interbedded finely laminated clay.

River Terrace Deposits In the Dee valley, terraces form extensive features about 10-15 m above the floodplain. A lower, but nevertheless conspicuous terrace is present about 8 m above the floodplain and there are even lower, poorly developed, terraces which in places merge imperceptibly with the alluvium. The terraces are generally formed by well-rounded coarse gravel which may be up to 5 m thick, although three boreholes (34 NE 23, 27 and 34 SE 5) on a high terrace

found pebbly clay, tentatively classified as 'Boulder Clay', at the surface; possibly the terrace is in part a cut feature rather than constructional.

The River Clywedog has a similar suite of terraces but they are less well developed. They are formed from gravel similar to that of the Dee terraces.

Alluvium and Alluvial Fan In the higher reaches of the Dee, alluvium has a relatively restricted development but downstream from Overton Bridge there is an extensive alluvial flat at about 6 m above the low summer level of the river. It is composed mainly of silt with sporadic seams of gravel. Narrow ribbons of alluvium also border the River Clywedog and numerous minor streams. A small alluvial fan has been recognised in a small valley east of Bangor-is-coed.

Peat Although peat is known to cover much of the upland area, it has been delineated only on the eastern slopes of Ruabon Mountain.

COMPOSITION OF THE SAND AND GRAVEL DEPOSITS

Detailed grading data and lithological analyses of the gravel fractions accompany the borehole logs in Appendix E; they are summarised below. A number of mechanical and physical properties have been determined for samples of gravel representative of the deposits described, as well as for three of the rock types present. The tests were made in accordance with BS 812 (British Standards Institution, 1975) and gravel in the 10 to 14 mm range was used throughout. The results are given in Table 2.

Glacial Sand and Gravel These deposits account for about 70 per cent by volume of the potentially workable sand and gravel in the district. On the basis of grading they can be divided into two groups - the gravels and sandy gravels, which predominate in the western part of the district, and sands and pebbly sands, restricted mainly to the northern and eastern areas. The former have proved thicknesses up to 18 m (borehole 34 SW 13), and their mean grading is fines 6 per cent, sand 43 per cent and gravel 51 per cent. The sands and pebbly sands have a maximum proved thickness of 21.4 m (borehole 34 NE 19) and a mean grading of fines 12 per cent, sand 83 per cent and gravel 5 per cent. Between Marchwiel and Wrexham, sandy gravel, proved to be up to 9.3 m in thickness, overlies the sands and pebbly sands, as shown in boreholes 34 NW 38 and 41 and NE 20.

Quartzite is the most common component of the gravel at all but eight borehole sites and, together with sandstone, limestone and Lower Palaeozoic rocks accounts for over 80 per cent of the fraction on average. Igneous rock pebbles, including volcanic and granitic rocks, account for more than 20 per cent of the gravel fraction at only four borehole sites. The sand is mostly medium-grained subrounded to subangular quartz, but the coarse fraction consists mainly of quartzite and sandstone; coal is present in conspicuous but minor amounts.

Late-Glacial Flood Gravels The Flood Gravels occur as high terraces in the vicinity of Froncysyllte. Their mean grading is fines 8 per cent, sand 34 per cent and gravel 58 per cent, and proved thicknesses range up to 10.6 m (borehole 24 SE 22). Silurian greywacke with some igneous rock and quartzite accounts for virtually the whole of this deposit, in both the sand and the gravel fractions.

River Terrace Deposits These deposits are, in general, much coarser than the Glacial Sand and Gravel, their mean grading being fines 4 per cent, sand 36 per cent and gravel 60 per cent. They are all associated with the River Dee or its tributary, the River Clywedog, and occur in a number of terraces. Proved thicknesses range up to 7.0 m (borehole 34 SE 18).

The gravel fraction is normally composed of roughly equal amounts of rounded quartzite, siltstone and igneous material, but upstream from Froncysyllte greywacke accounts for at least 74 per cent of the total. Sand is mostly medium- to fine-grained subrounded quartz but quartzite and siltstone are common in the coarse fraction.

Table 2 Mechanical and physical properties.

Geological classification	Source borehole	Flakiness Index	Elongation Index	Relative Density on oven-dried basis	Water Abosorption %	10 % Fines Value kN	Aggregate Impact Value
Glacial Sand and Gravel	34 SW 13	31	20	2.52	2.5	170	
Glacial Sand and Gravel	34 NW 35	16	12			190	25
Glacial Sand and Gravel	24 SE 20	21	20	2.49	2.5	180	
Glacial Sand and Gravel	24 SE 21	27	16			120	25
Late-Glacial Flood Gravels	24 SE 22	17	34				22
Late-Glacial Flood Gravels	24 SE 26	24	20			200	18
River Terrace	24 SE 24	45	24			200	
River Terrace	24 SE 23	17	19				16
Quartzite		19	11			230	25
Igneous rocks		11	19				15
Siltstone		42	30			190	23

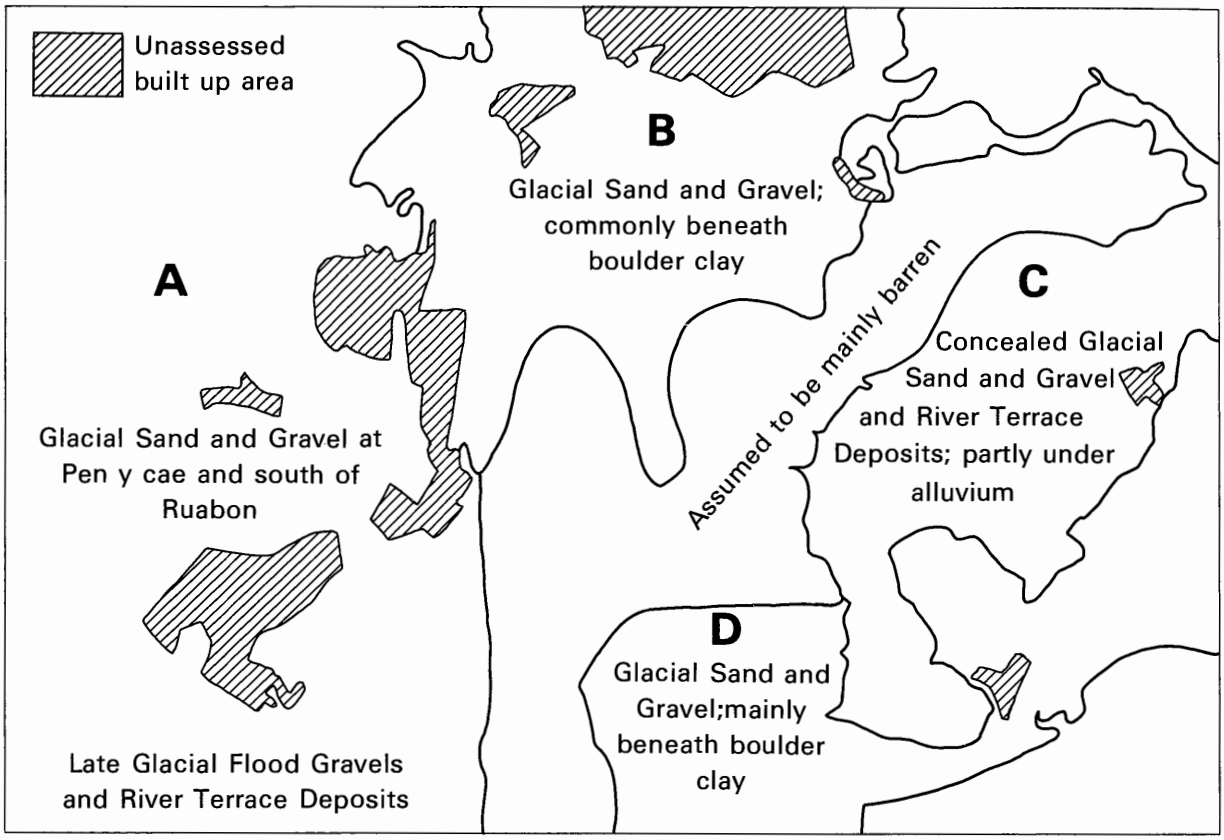


Figure 2 Diagram showing the relationship between the sand and gravel deposits and the resource blocks.

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 in grey, on which the geological data are shown in black and the mineral resource information in shades of red.

Geological data The geological boundary lines are taken from the geological maps of the district, which was surveyed on the 1:10 560 scale in 1910-13 and 1956-57 and partially revised in more recent years.

The geological boundaries represent the best available interpretation of the information available at the time of the geological survey. However, it is inevitable, particularly with respect to the superficial deposits, that local irregularities and discrepancies will be revealed as new evidence from boreholes and excavations becomes available. Where necessary, these have been taken into account in the assessment of resources.

Borehole data, which include the stratigraphic relations, thicknesses and mean particle size distributions of the sand and gravel samples collected during the assessment survey, are also shown on the map.

Mineral resource information The mineral-bearing ground is divided into resource blocks (see Appendix A and Figure 2). Within a resource block the mineral is subdivided into areas where it is exposed, that is where the overburden averages less than 1 m in thickness, and areas where it is present in continuous, or almost continuous, spreads beneath overburden.

Areas where bedrock crops out, 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; where appropriate, the relevant criterion is noted. In such cases it has been assumed that mineral is absent except in infrequent and relatively minor patches that can neither be outlined nor assessed quantitatively in the context of this survey. Areas of unassessed sand and gravel, for example in built-up areas, are indicated by a red stipple.

The area of the mineral-bearing ground is measured, where possible, from the mapped geological boundary lines. Inferred boundaries have been inserted to delimit areas where sand and gravel beneath cover is interpreted to be not potentially workable or absent. Such boundaries (for which a distinctive zigzag symbol is used) are drawn primarily for the purpose of volume estimation. The symbol is intended to indicate an approximate location within a likely zone of occurrence rather than to represent the breadth of the zone, its size being determined only by cartographic considerations. For the purpose of measuring areas the centre line of the symbol is used.

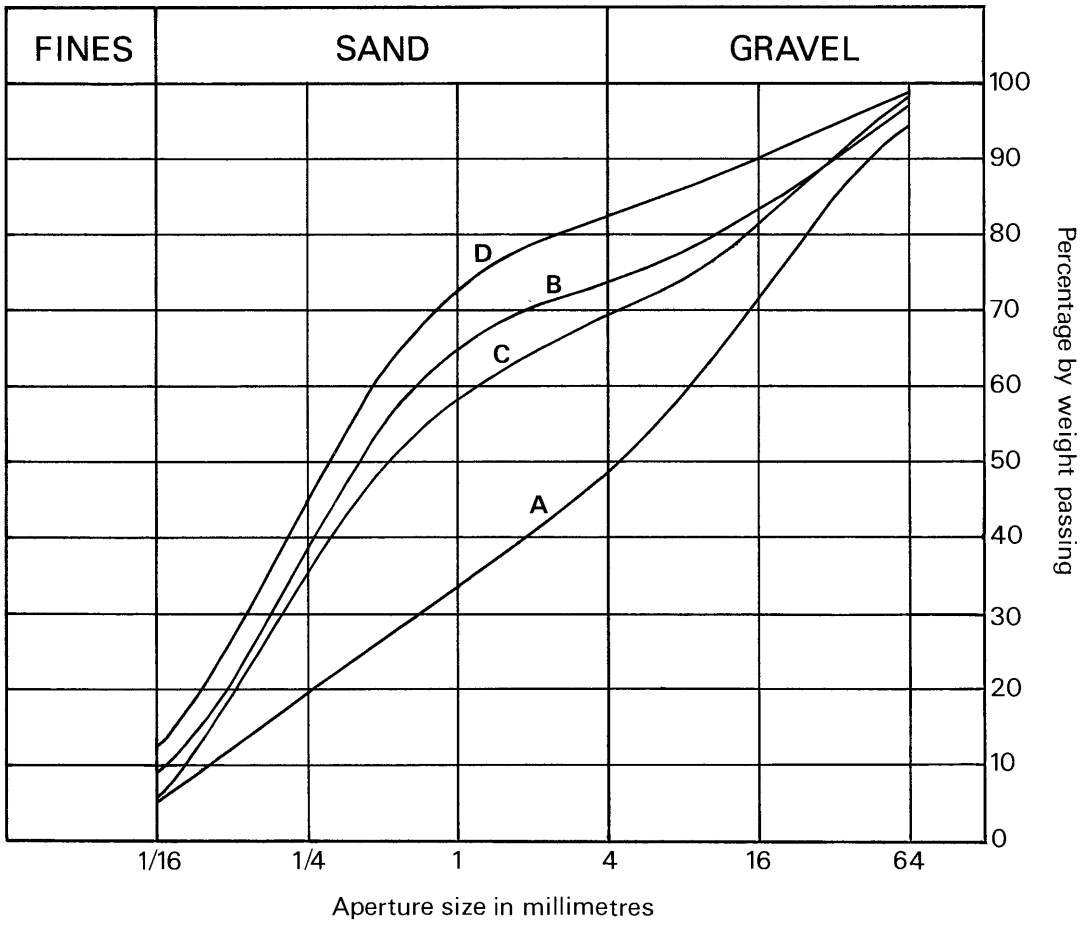
RESULTS

The statistical results are summarised in Table 3. Fuller grading particulars are shown in Tables 4 to 7 and Figures 3 to 7.

For the four blocks, the accuracy of the results at the two-sided 95 per cent confidence level varies between 39 per cent and 50 per cent. However, the true volumes are more likely to be nearer the figure estimated than either of the limits. Moreover, it is probably that roughly the same percentage limit would apply for the statistical estimate of mineral volume within a very much smaller parcel of ground 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 quotation of reserves, data from more sample points would be required, even if the area were quite small. This point can be illustrated by considering the whole of the potentially workable sand and gravel on the resource sheet. The total volume (406 million m^3) can be

Table 3 The sand and gravel resources of the district.

Resource block and sub-division	Area		Mean thickness			Volume of sand and gravel			Mean grading percentage		
	Block	Mineral	Over-burden	Mineral	Waste		Limits at the 95% probability level		Fines $-\frac{1}{16}$ mm	Sand $+\frac{1}{16}-4$ mm	Gravel +4 mm
	km^2	km^2	m	m	m	$m^3 \times 10^6$	± %	± $m^3 \times 10^6$			
A	51.6	9.4	2.3	7.0	1.0	66	39	26	7	42	51
B	20.2	18.4	2.0	8.6	1.5	158	41	65	10	65	25
C											
Fluvial	18.4	16.1	1.4	2.9		47	44	21	5	34	61
Glacial		6.5		8.4	0.4	55	71	39	8	80	12
Combined		17.9	2.4	5.7	0.4	102	51	52	7	59	34
D	17.8	14.5	3.2	5.5	0.8	80	48	38	12	71	17
A to D	108.0	60.2	2.4	6.7	0.9	406	21	85	9	61	30



Block	Percentage by weight						
	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1-4	+4-16	+16-64	+64 mm
A	7	12	15	15	20	26	5
B	10	31	27	7	10	14	1
C	7	25	25	9	14	17	3
D	12	31	33	7	8	8	1

Figure 3 Mean particle-size distributions for the mineral in the resource blocks

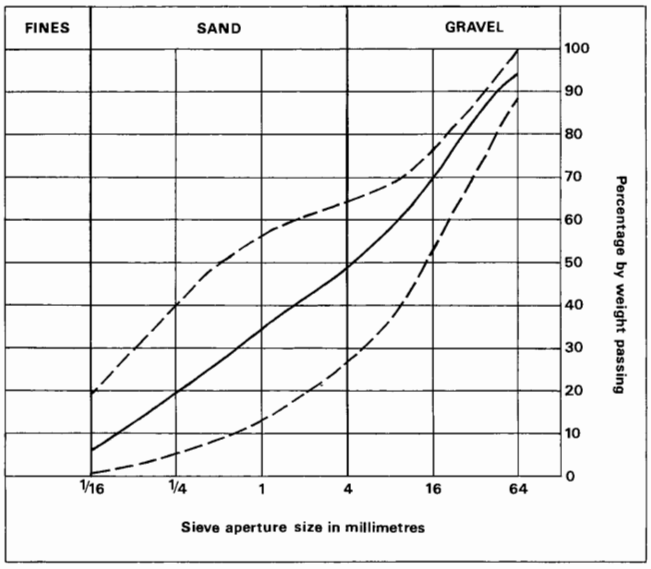


Figure 4 Grading characteristics of the mineral in block A.

estimated to limits of ± 21 per cent at the 95 per cent confidence level by a calculation based on the data from all sample points spread across the four resource blocks. However, it must again be emphasised that the quoted volume of mineral has no simple relationship with the amount that could be extracted in practice, because apart from the exlusion of the urban areas, no allowance has been made in the calculations for any restraints (such as existing buildings and roads) on the use of the land for mineral working.

NOTES ON THE RESOURCE BLOCKS

Block A (Table 4, Figure 4)

Slightly less than one-fifth of the area of this block is inferred to be mineral-bearing; it has been assessed on the data from 13 IMAU boreholes and three others.

Glacial Sand and Gravel in the Pen-y-Cae area occurs in irregular mounds partially concealed beneath till deposits. Its extent, therefore, is largely a matter of conjecture. Boreholes in this area have proved up to 13.4 m of mineral with a gravel content generally exceeding 36 per cent, although borehole 24 NE 21 was barren. In the vicinity of Ruabon, Glacial Sand and Gravel occurs as channel-fill partly concealed by till and is again of uncertain extent. Proved mineral thicknesses range up to 18.9 m, with the gravel content exceeding 42 per cent in the three IMAU boreholes. In the block as a whole the Glacial Sand and Gravel has an estimated mean thickness of 7.4 m, a mean grading of 7 per cent fines, 44 per cent sand and 49 per cent gravel and an estimated volume of about 46 million m^3.

The fluvial deposits in the Dee valley, including the Late-Glacial Flood Gravels, have been investigated by five IMAU boreholes which proved up to 10.6 m of mineral. Three of these boreholes, however, failed to reach the base of the deposit and so the mean thickness is likely to be greater than the estimated 6.2 m. The volume of this fluvial mineral is of the order of 20 million m^3. The mean grading is 6 per cent fines, 37 per cent sand and 57 per cent gravel. The Late-Glacial Flood Gravels have a slightly higher fines content than the river terrace deposits.

Total volume of mineral in the block is estimated as 66 million m^3 ±39 per cent and its mean grading is 7 per cent fines, 42 per cent sand and 51 per cent gravel.

Overburden concealing Glacial Sand and Gravel is generally a stiff, red or grey stony till and may be up to 8.7 m thick. That overlying fluvial mineral is soft alluvial silt proved to be up to 1.5 m thick.

East of Ruabon, the water table is about 3.5 m below ground level within a proven thickness of 18.5 m of sandy gravel (borehole 34 SW 13). Southwards, the Glacial Sand and Gravel appears to be unsaturated. The river deposits and Late-Glacial Flood Gravels of the Dee are, apart fom those in the flood-plain, generally above the water table.

Block B (Table 5, Figure 5)

The assessed mineral in this block, which includes the southern part of the 'Wrexham Delta-Terrace', consists

Table 4 Block A: data from IMAU boreholes.

Borehole	Recorded thickness (m)			Mean grading percentage						
	Mineral	Over-burden	Waste*	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	Cobbles +64 mm
River Terrace Deposits										
24 SE 23	8.8	1.2	3.3	3	4	17	21	22	26	7
24 SE 24	3.9+	0.8		4	4	23	15	20	29	5
Late-Glacial Flood Gravels										
24 SE 22	10.6+	0.2		8	4	12	18	22	27	9
24 SE 25	1.7	1.5		9	6	10	15	25	35	0
24 SE 26	6.0+	1.5	3.5	6	3	12	20	24	30	5
Glacial Sand and Gravel										
24 NE 20	2.4	2.8		1	3	9	14	25	39	9
24 NE 22	3.9	3.9		8	26	21	8	18	19	0
24 NE 23	7.4	2.5	7.5	14	26	17	7	13	19	4
24 SE 20	13.4	0.2		5	16	16	17	24	19	3
24 SE 21	7.1	7.3		2	3	10	22	27	33	3
24 SE 27	3.0	0.6	0.4	19	15	13	11	15	16	11
34 SW 13	18.5	0.4	0.4	6	17	15	11	18	30	3
34 SW 14	4.6	0.5		12	10	15	13	20	27	3

Borehole 24 NE 21 proved no mineral

* Between mineral beds

\+ Indicates base of mineral not reached

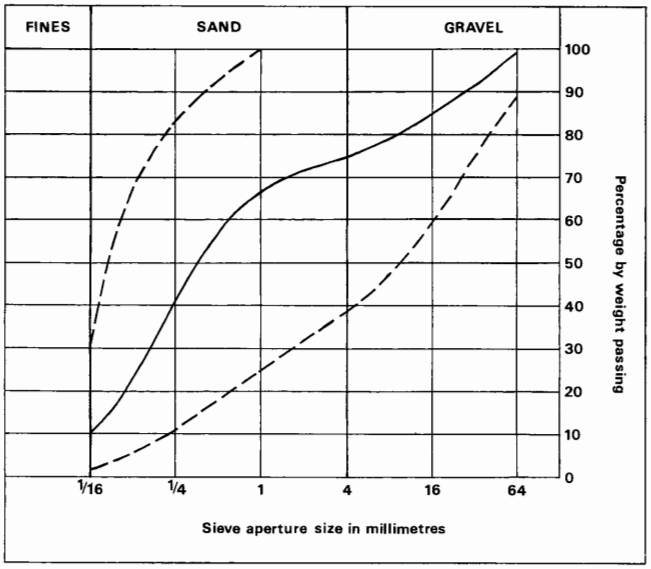


Figure 5 Grading characteristics of the mineral in block B.

entirely of Glacial Sand and Gravel; small areas of terrace deposits in the Clywedog valley are excluded. 'Exposed' mineral accounts for about 8 km^2 of the total; the remainder lies beneath overburden and is of uncertain extent.

In the western part of the block the mineral is predominantly gravelly and around Rhostyllen it is interbedded with stony till. To the east, between Erddig and Marchwiel, three boreholes show gravel 5.3 to 9.3 m thick resting on 3.0 to 8.7 m of 'clayey' sand. In the south-eastern part of the block and to the north in the Cefn Park area, gravel is absent and mainly 'clayey' sands are found.

Proved thicknesses of mineral range up to 21.4 m (borehole 34 NE 19) but are generally less than 14 m and have a mean of 8.6 m. The estimated volume of mineral in the block is 158 million m^3 ±41 per cent and its mean grading is 10 per cent fines, 65 per cent sand and 25 per cent gravel.

Overburden has a mean proved thickness of 2.0 m but since the borehole sites are biased towards 'exposed' sand and gravel this is probably an underestimate.

The majority of the mineral, including the thick deposits of sand in the Cefn Park area, lie above the water table. South-west of Marchwiel and along the southern boundary of the block, the water table is about 3 to 4 m below ground level.

Block C (Table 6, Figure 6)

The mineral in this block consists of river terrace deposits and Glacial Sand and Gravel. The former include deposits of the River Dee downstream from Erbistock and of the lower Clywedog valley; in places they overlie the Glacial Sand and Gravel.

Eight of the IMAU boreholes drilled in this block proved Glacial Sand and Gravel which ranged up to 20.2 m in thickness (borehole 34 NE 27) but two boreholes were abandoned before reaching the prescribed depth. Although a high proportion of gravel is present locally, the mineral is predominantly of sand and its mean grading is 8 per cent fines, 80 per cent sand and 12 per cent gravel. The estimated mean thickness of glacial mineral, where it is thought to be present, is 8.4 m and its volume is of the order of 55 million m^3.

Terrace and alluvial deposits have been investigated by 18 IMAU boreholes and two others. Three boreholes sited on the highest Dee terrace did not encounter fluvial deposits, indicating that they have a patchy distribution at this level. A fourth borehole on the terrace east of Erbistock proved sand and gravel too thin and too deeply buried to be regarded as mineral. No attempt has been made to delimit the area of barren ground, but the results of these boreholes have been taken into account in assessing the resources. Elsewhere, fluvial mineral has been proved up to 7.0 m thick. Gravel content generally lies between 49 per cent and 81 per cent, but in borehole 34 NE 29 it was as low as 11 per cent. The mean grading is 5 per cent fines, 34 per cent sand and 61 per cent gravel. The mean proved thickness of fluvial mineral is 2.9 m and the estimated volume 47 million m^3.

Glacial and fluvial mineral combined have a mean recorded thickness of 5.7 m, an estimated volume of 102 million m^3 ±51 per cent and a mean grading of 7 per cent fines, 59 per cent sand and 34 per cent gravel.

Table 5 Block B: data from IMAU boreholes.

Borehole	Recorded thickness (m)			Mean grading percentage						
	Mineral	Overburden	Waste*	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	Cobbles +64 mm
34 NW 29	1.8	0.3	2.0	6	7	13	16	21	26	11
34 NW 30	9.8	8.5	3.7	2	8	25	19	22	24	0
34 NW 31	5.5	3.2	4.3	6	8	11	13	22	36	4
34 NW 32	7.1	0.7	2.4	9	16	22	13	20	20	0
34 NW 33	Absent									
34 NW 34	1.6	5.0		3	11	18	11	12	45	0
34 NW 35	5.0	3.5		5	12	12	12	23	36	0
34 NW 36	7.0	0.5	5.0	Data incomplete						
34 NW 38	12.0	0.5		8	25	24	6	11	23	3
34 NW 39	11.3+	3.2		6	48	44	1	1	trace	0
34 NW 41	18.0	1.0		9	21	30	9	11	17	3
34 NW 42	7.8	0.2		31	51	15	1	1	1	0
34 NW 43	5.9	0.5		9	53	36	2	trace	0	0
34 NE 19	21.4†	0.5	3.1	15	46	38	1	0	0	0
34 NE 20	12.7	0.5	0.3	11	45	18	7	8	8	3
34 SW 17	Absent									

* Between mineral beds
\+ Indicates base of mineral not reached
† Indicates base of deposit not reached

Table 6 Block C: data from IMAU boreholes.

Borehole	Recorded thickness (m)			Mean grading percentage						
	Mineral	Over-burden	Waste*	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	Cobbles +64 mm
River Terrace Deposits										
34 NE 24	5.0	0.3		3	4	10	14	28	41	0
34 NE 28	4.0	3.2		2	3	14	19	29	33	0
34 NE 29	2.3	1.5		22	32	2	2	2	8	1
34 NE 30	1.8	2.2		1	2	6	10	32	49	0
34 NE 31	4.9	2.7		2	6	14	14	26	37	1
34 SE 6	6.8	2.1		5	6	19	13	25	31	1
34 SE 7	2.6	0.3		19	10	12	10	23	26	0
34 SE 8	5.2	0.5		11	5	14	12	16	30	12
34 SE 11	4.2	1.4		4	3	11	13	23	34	12
34 SE 13	1.4+	2.1		3	8	0	16	25	48	0
34 SE 14	4.7	1.0		4	3	9	15	26	31	12
34 SE 18	7.0	1.0		3	6	19	14	25	26	7
Glacial Sand and Gravel										
34 NE 24	9.5			21	55	21	1	1	1	0
34 NE 27	20.2†	4.8		4	34	45	8	6	3	0
34 NE 28	7.4+			3	39	46	3	3	6	0
34 NE 33	4.0	12.0		12	76	12	0	0	0	0
34 SE 5	5.4	2.8	0.9	5	6	10	16	26	27	10
34 SE 6	1.4			33	66	1	0	0	0	0
34 SE 18	10.7+		1.8	6	39	40	6	6	3	0
Total mineral										
34 NE 21	Absent									
34 NE 23	Absent									
34 NE 24	14.5	0.3	2.2	14	38	18	5	11	14	0
34 NE 27	20.2†	4.8		4	34	45	8	6	3	0
34 NE 28	11.4	3.2	1.9	3	26	35	8	12	16	0
34 NE 29	2.3	1.5		22	32	33	2	2	8	1
34 NE 30	1.8	2.2		1	2	6	10	32	49	0
34 NE 31	4.9	2.7		2	6	14	14	26	37	1
34 NE 32	Absent									
34 NE 33	4.0	12.0		12	76	12	0	0	0	0
34 SE 5	5.4	2.8	0.9	5	6	10	16	26	27	10
34 SE 6	8.2	2.1	1.7	10	16	16	11	21	25	1
34 SE 7	2.6	0.3		19	10	12	10	23	26	0
34 SE 8	5.2	0.5		11	5	14	12	16	30	12
34 SE 9	Absent									
34 SE 11	4.2	1.4		4	3	11	13	23	34	12
34 SE 13	1.4+	2.1		3	8	0	16	25	48	0
34 SE 14	4.7	1.0		4	3	9	15	26	31	12
34 SE 18	17.7+	1.0	1.8	4	26	33	9	13	12	3

* Between mineral beds
\+ Indicates base of mineral not reached
† Indicates base of deposit not reached

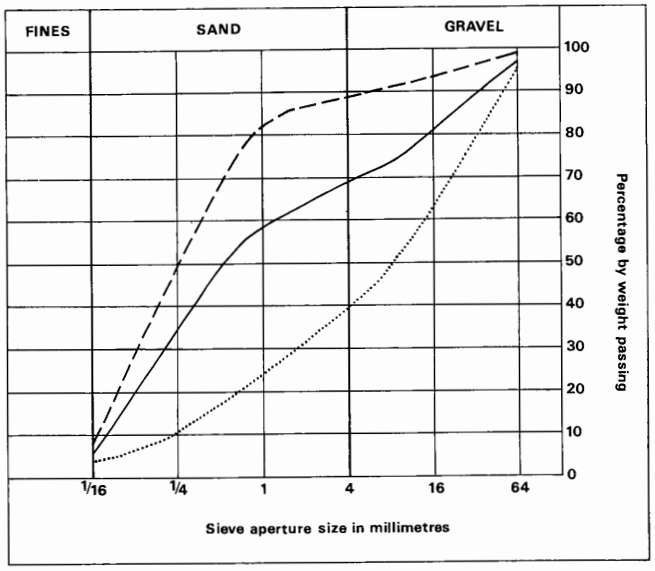


Figure 6 The mean grading of the mineral deposits in block C.

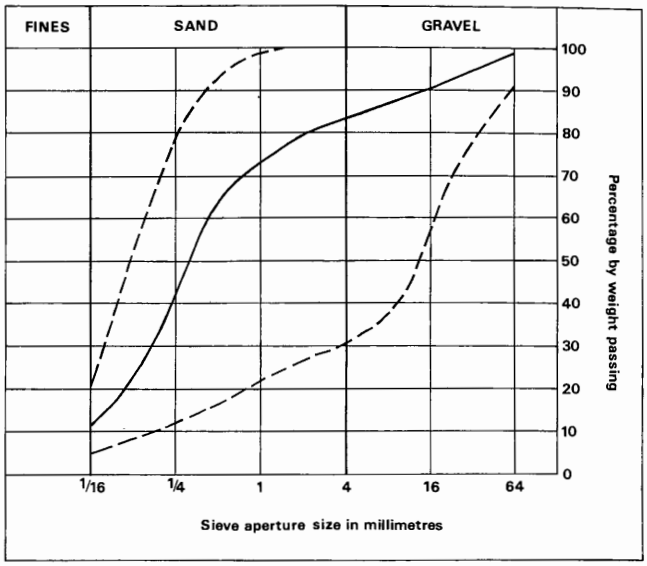


Figure 7 Grading characteristics of the mineral in block D

Overburden has a mean proved thickness of 2.4 m and consists mainly of silts. Most of the mineral lies below the water table which is on average about 2 m below ground level.

Block D (Table 7, Figure 7)
The assessed mineral in this block consists entirely of Glacial Sand and Gravel; several minor terraces in the Dee valley are of limited extent and are therefore not included in the assessment. Much of the sand and gravel is concealed beneath overburden and its extent is a matter of conjecture.

In the extreme west of the block, mineral comprises gravel and sandy gravel but between here and Overton 1 to 2 m of sandy gravel overlies sand, and east of Overton only 'clayey' to 'very clayey' sand is present. Proved thicknesses of mineral range up to 15.2 m (NCB borehole 34 SW 7) and have a mean of 5.5 m. The estimated volume of mineral is 80 million m^3 ±48 per cent and its mean grading is 12 per cent fines, 71 per cent sand and 17 per cent gravel.

The geological map shows Glacial Sand and Gravel at the surface over much of the area but most IMAU boreholes found clay more than a metre thick overlying the sand and gravel. Mineral is therefore shown as beneath overburden on the resource map. The overburden varies in composition from stiff, stony, red clay in the eastern part of the block to softer, sandy clay north and east of Overton; its thickness ranges up to 7.3 m.

North of the River Dee, IMAU boreholes found water levels between 1 m and 12 m below the surface and the major part of the mineral lies above the water table. South of the Dee, much of the sand and gravel is dry but around Overton glacial sands at depths greater than 5 m below surface are water-bearing.

Table 7 Block D: data from IMAU boreholes.

Borehole	Recorded thickness (m)			Mean grading percentage						
	Mineral	Over-burden	Waste*	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	Cobbles +64 mm
34 SW 18	3.1	0.5		5	7	10	8	28	34	8
34 SW 19	2.3	3.1		7	17	31	9	13	23	0
34 SW 21	5.3	4.3	1.3	Data incomplete						
34 SW 22	8.2	5.3		7	21	41	12	11	7	1
34 SW 23	5.0	0.3	2.2	21	30	8	7	13	21	0
34 SE 10	4.1	3.8		8	25	43	9	11	4	0
34 SE 12	Absent									
34 SE 15	2.0	1.0		20	21	36	12	8	3	0
34 SE 16	2.2	4.0		22	39	33	4	2	trace	0
34 SE 17	7.9	3.0	1.5	7	22	53	8	7	3	0
34 SE 20	7.4	7.3		15	52	32	1	0	0	0

* Between mineral beds

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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 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. The blocks are drawn provisionally before drilling begins.

A reconnaissance of the ground is carried out to record any exposures and inquiries are made to ascertain what borehole information is available. 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.

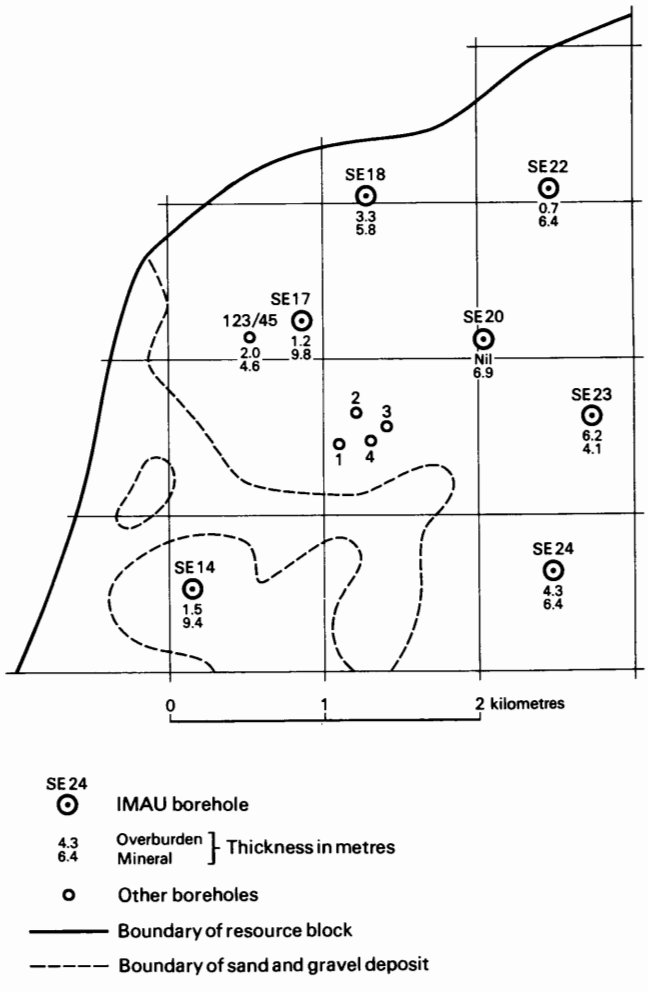
The drilling machine employed should be capable of providing a continuous sample representative of all unconsolidated deposits, so that the in-situ grading can be determined, if necessary, to a depth of 30 m (100 ft) at a diameter of about 200 mm (8 in), beneath different types of overburden. It should be reliable, quiet, mobile and relatively small (so that it can be moved to sites of difficult access). Shell and auger rigs 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 sand and gravel, or 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 B.S. 1337 (British Standards Institution, 1967). Random checks of the accuracy of the grading are made in the Institute's laboratories.

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 offices of the Institute, upon application to the Head, Industrial Minerals Assessment Unit.



Example of resource block assessment: map of a fictitious block

APPENDIX B

STATISTICAL PROCEDURE

Statistical assessment

1 A statistical assessment is made of an area of mineral greater than 2 km^2, if there are at least 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, 1981). Conventional symmetrical confidence limits are calculated for the 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.

3 The volume estimate (V) for the mineral in a given block is the product of 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

$$S_V = \sqrt{(S_A^2 + S_{\bar{l}_m}^2)} \qquad [1]$$

4 The above relationship may be transposed such that

$$S_V = S_{\bar{l}_m} \sqrt{(1 + S_A^2 / S_{\bar{l}_m}^2)} \qquad [2]$$

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

If, therefore, the standard deviation for area is small with respect to that for 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 $l_{m_1}, l_{m_2}, \ldots l_{m_n}$, then the best estimate of mean thickness, $\bar{l}_m$, is given by

$$\Sigma\ (l_{m_1} + l_{m_2} \ldots l_{m_n}) / n .$$

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

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

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 a deposit). Where the area 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 small relative to those in thickness. The relationship $S_A / S_{\bar{l}_m} \leq 0.\dot{3}$ is assumed in all cases. It follows from Equation [2] that

$$S_{\bar{l}_m} \leq S_V \leq 1.05\ S_{\bar{l}_m} \qquad [3]$$

7 The limits on the estimate of mean thickness of mineral, $L_{\bar{l}_m}$, may be expressed in absolute units $\pm (t/\sqrt{n}) \times S_{\bar{l}_m}$ or as a percentage $\pm (t/\sqrt{n}) \times S_{\bar{l}_m} \times (100/\bar{l}_m)$ 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 in *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:

$$L_{\bar{l}_m} \leq L_V \leq 1.05\, L_{\bar{l}_m}.$$

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

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

per cent,

and when n is greater than 20, as

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

per cent.

11 The application of this procedure to a fictitious area is illustrated in the accompanying Figure and example of a block calculation.

Inferred assessment

12 If the sampled area of mineral in a resource block is between 0.25 km^2 and 2 km^2, an assessment is inferred on the basis of 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 km^2.

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 needs to 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 with the zone as the weighting factor.

Block calculation

Scale: 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 w	Overburden l_o	Overburden wl_o	Mineral l_m	Mineral wl_m	Remarks
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	½	1.2	1.6	9.8	7.2	Hydrogeology Unit record
123/45	½	2.0		4.6		
1	¼	2.7	2.6	7.3	5.8	Close group of four boreholes (commercial)
2	¼	4.5		3.2		
3	¼	0.4		6.8		
4	¼	2.8		5.9		
Totals	$\Sigma w = 8$	$\Sigma wl_o = 20.2$		$\Sigma wl_m = 52.0$		
Means		$\overline{wl}_o = 2.5$		$\overline{wl}_m = 6.5$		

Calculation of confidence limits

wl_m	$\lvert(wl_m - \overline{wl}_m)\rvert$	$(wl_m - \overline{wl}_m)^2$
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_V is calculated as

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

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

$= 20.3$

$\simeq 20$ per cent.

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 (< $\frac{1}{16}$ mm) and coarser than pebbles (> 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 considered to be not 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 (see the accompanying Figure). The procedure is as follows:

1 Classify according to the ratio of sand to gravel.
2 Describe the 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 Appendix D)

Many differing proposals have been made 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 (see the accompanying table), which is used in the Report.

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 Standards Institution, 1967). 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. Being based on visual examination, the description of the grading is inexact, the accuracy depending on the experience of the observer. The descriptions recorded are modified, as necessary, when the laboratory results become available.

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 roughly 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 constitutents 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, 1957), 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: not 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
	Cobble		
64 mm			
		Coarse	Gravel
16 mm	Pebble		
		Fine	
4 mm			
		Coarse	
1 mm			
	Sand	Medium	Sand
$\frac{1}{4}$ mm			
		Fine	
$\frac{1}{16}$ mm			
	Fines (silt and clay)		Fines

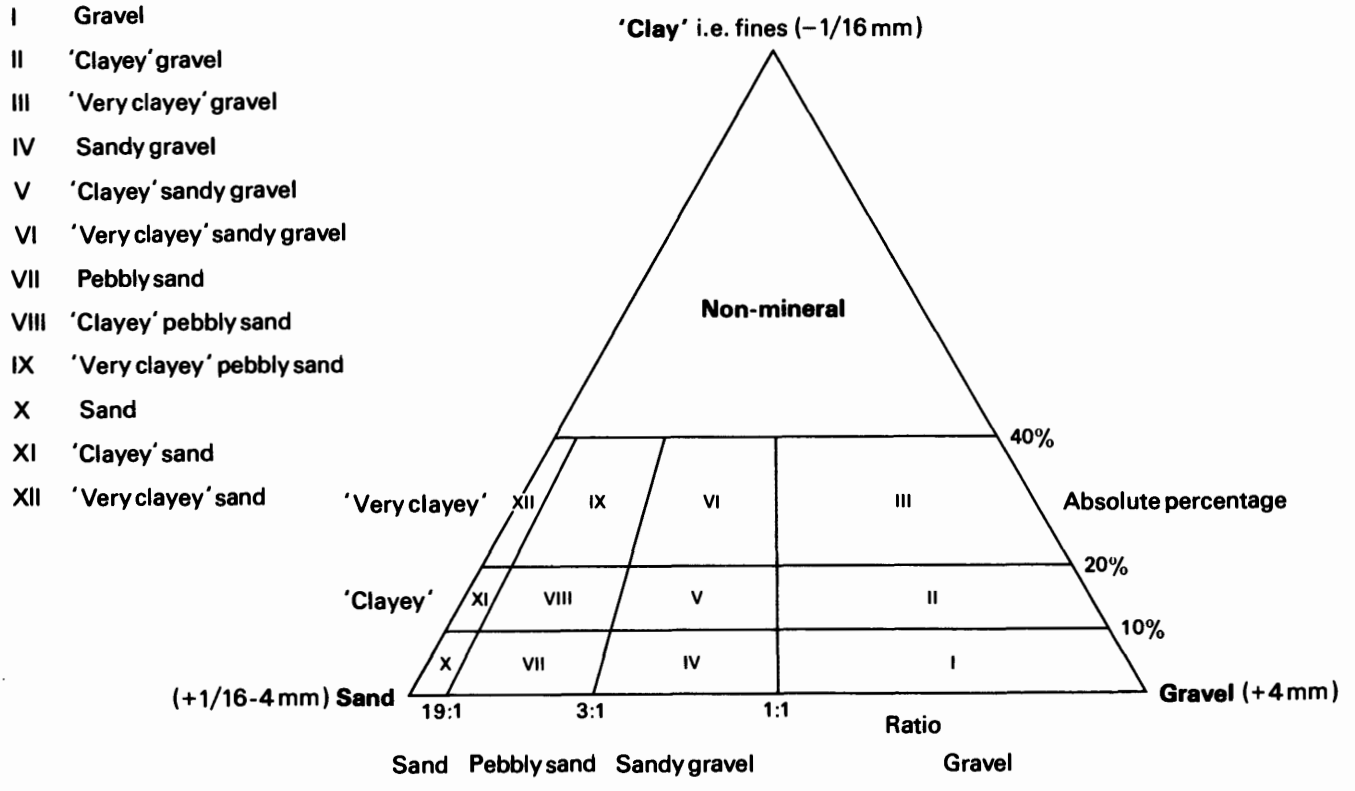


Diagram showing the descriptive categories used in the classification of sand and gravel

APPENDIX D
EXPLANATION OF THE BOREHOLE RECORDS

Annotated fictitious example

CK 66 NW 5 **6191 6962** **Northfields**[1] **Block B**

Surface level (+49.7 m) + 163 ft[2]
Water struck at +45.9 m[3]
October 1977[4]

Overburden [5] 2.8 m
Mineral 5.4 m
Waste 1.1 m
Mineral 1.4 m
Bedrock 0.7 m+[6]

LOG

Geological classification	Lithology[7]	Thickness m	Depth m
	Soil	0.2	0.2
Alluvium	Clay, silty, dark brown	2.6	2.8
River Terrace Deposits	**a** Gravel Gravel: fine to coarse, with cobbles towards base, angular to rounded, flint and limestone with ironstone and some quartz and chalk Sand: medium with coarse and some fine, quartz and limestone	5.4	8.2
Boulder Clay	Clay, sandy and pebbly, red-brown	1.1	9.3
Glacial Sand and Gravel	**b** Sand, 'clayey' in part: fine, subangular to rounded, quartz with some coal	1.4	10.7
Lias	Mudstone, blue-grey, fossiliferous	0.7+	11.4

GRADING[8]

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	5	46	49	2.8-3.8	20	14	62	2	2		
				3.8-4.8	2	2	12	18	42	24	
				4.8-5.8	1	3	24	13	35	24	
				5.8-6.8	0	4	21	20	26	29	
				6.8-8.2	4	3	23	10	23	30	7
				Mean	5	5	28	13	25	22	2
b	5	95	0	9.3-10.3	3	73	23	1			
				10.3-10.7	9	85	5	1			
				Mean	5	77	17	1			
a+b	5	56	39	Mean	5	20	26	10	20	17	2

COMPOSITION[9]

Depth below surface (m)	percentages by weight in gravel fraction				
	Flint	Limestone	Quartz	Chalk	Ironstone
3.8-4.8	41	50	5	1	3
4.8-5.8	39	45	3	5	8
5.8-6.8	45	42	2	5	6
6.8-8.2	19	61	6	3	11
Mean	35	51	4	3	7

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

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
Unless otherwise stated the borehole was drilled by a shell and auger rig using 152 or 203 mm diameter 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 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 ($-\frac{1}{16}$ 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) and cobble gravel (+64 mm) are stated.

The mean gradings of groups of samples making up an identified mineral horizon are 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. In calculating mean gradings, data for individual samples are weighted by the thickness represented.

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 corase gravel may be lower.

9 Composition
Details of the composition of selected gravel samples or groups of samples may be given.

APPENDIX E

INDUSTRIAL MINERALS ASSESSMENT UNIT BOREHOLE RECORDS

SJ 24 NE 20 **2745 4854** **Plas-yn-Fron, Esclusam Above** **Block A**

Surface level +253.7 m
Water struck at +248.4 m
Shell and auger 203 mm and 152 mm diameter
April 1978

Overburden	2.8 m
Mineral	2.4 m
Waste	4.1 m
Bedrock	2.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, clayey	0.2	0.2
Boulder Clay	Clay, stiff, light brown, sandy, with quartzite	2.6	2.8
Glacial Sand and Gravel	Gravel Gravel: coarse with fine, and in lower part, cobbles, subangular to subrounded, quartzite and siltstone, with some sandstone and igneous rock Sand: mainly coarse and medium, subrounded	2.4	5.2
Boulder Clay	Clay, sandy, stiff, red-brown and grey, stony, with traces of coal	4.1	9.3
Millstone Grit	Mudstone, dark grey	2.8+	12.1

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
1	26	73	2.8-3.8	1	4	8	15	31	41	0
			3.8-5.2	1	3	9	14	20	37	16
			Mean	1	3	9	14	25	39	9

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
2.8-5.2	40	7	0	45	8	trace	0

SJ 24 NE 21 **2648 4692** **Pant-Glas, Penycae** **Block A**

Surface level +293.3 m
Water struck at +281.3 m
Shell and auger 203 mm diameter
March 1978

Waste	17.7 m
Bedrock	1.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy, clayey	0.2	0.2
Boulder Clay	Clay, sandy, stiff, red-brown, with quartzite, buff sandstone, limestone and igneous erratics	17.5	17.7
Millstone Grit	Sandstone, buff, micaceous	1.1+	18.8

SJ 24 NE 22 **2653 4616** **Dryll, Penycae** **Block A**

Surface level +296.0 m
Water struck at 285.2 m
Shell and auger 203 mm diameter
March 1978

Overburden	3.9 m
Mineral	3.9 m
Waste	12.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey, sandy	0.3	0.3
Boulder Clay	Clay, soft, brown to dark brown, sandy, with small subrounded pebbles	3.6	3.9
Glacial Sand and Gravel	Sandy gravel Gravel: coarse and fine, subrounded to subangular, quartzite, siltstone and sandstone, with some igneous rock Sand: mainly fine with medium, subrounded; traces of coal	3.9	7.8
Boulder Clay	Clay, dark brown, with small pebbles of quartzite and coal fragments	12.8+	20.6

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
8	55	37	3.9-4.9	9	5	33	9	18	26	0
			4.9-6.1	11	44	18	4	11	12	0
			6.1-7.2	8	25	16	10	22	19	0
			7.2-7.8	1	24	18	11	22	24	0
			Mean	8	26	21	8	18	19	0

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
3.9-7.8	33	25	3	33	6	trace	0

SJ 24 NE 23 **2712 4510** **Plasuchaf, Penycae** **Block A**

Surface level +219.8 m
Water struck at +212.8 m
Shell and auger 203 mm diameter
March 1978

Overburden	2.5 m
Mineral	1.1 m
Waste	0.4 m
Mineral	3.4 m
Waste	7.1 m
Mineral	2.9 m
Waste	2.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy, clayey	0.2	0.2
Boulder Clay	Clay, brown and grey, sandy, pebbly and some cobbles of quartzite	2.3	2.5

Glacial Sand and Gravel	**a** 'Very clayey' pebbly sand with cobbles at base, 0.4 m silty clay at 4.0 m Gravel: mainly coarse subangular to subrounded, siltstone with quartzite, sandstone and igneous rock Sand: fine to medium, coarse at base, subangular	4.9	7.4
Boulder Clay	Clay, sandy, stiff, grey, with pebbles of quartzite and traces of coal	7.1	14.5
Glacial Sand and Gravel	**b** Gravel, with rare clayey layers Gravel: coarse to fine with cobbles in lower part, angular to subrounded, igneous rock, sandstone, quartzite and siltstone Sand: coarse to fine, subrounded	2.9	17.4
Boulder Clay	Clay, sandy, stiff, red-brown, with pebbles of quartzite and siltstone and traces of coal	2.6+	20.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
a	20	57	23	2.5-3.6	25	44	23	4	2	2	0
				3.6-4.0	Clayband						
				4.0-5.0	29	42	17	3	5	4	0
				5.0-6.0	21	36	31	4	6	2	0
				6.0-7.4	6	13	10	8	13	40	10
				Mean	20	33	19	5	7	13	3
b	4	36	60	14.5-16.0	5	17	16	12	27	23	0
				16.0-17.4	3	11	8	8	21	36	13
				Mean	4	14	12	10	24	30	6
a+b	14	50	36	Mean	14	26	17	7	13	19	4

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	6.0-7.4	21	13	11	52	1	2	0
b	14.5-17.4	15	25	4	24	32	2	0

SJ 24 SE 20 **2796 4492** **Plas-Isaf, Penycae** **Block A**

Surface level +190.0 m
Water struck at +178.8 m
Shell and auger 203 mm diameter
March 1978

Overburden	0.2 m
Mineral	13.4 m
Waste	5.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, stony	0.2	0.2
Glacial Sand and Gravel	Sandy gravel Gravel: coarse to fine with cobbles from 4.2 m to 6.0 m, subangular to subrounded, quartzite, with limestone below 1 m, and some greywacke Sand: coarse to fine, mostly subrounded quartzite in coarser fractions and clear quartz in medium and fine; traces of coal	13.4	13.6
Boulder Clay	Clay, soft, grey, becoming sandy with depth; coal fragments	5.8+	19.4

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
5	49	46	0.2-1.2	9	24	13	14	19	21	0
			1.2-2.2	7	21	16	8	18	30	0
			2.2-3.2	19	53	17	4	5	2	0
			3.2-3.6	17	48	17	6	8	4	0
			3.6-4.2	3	11	12	15	21	38	0
			4.2-6.0	1	4	12	23	22	12	26
			6.0-7.0	2	7	17	26	37	11	0
			7.0-8.0	1	8	16	22	31	22	0
			8.0-9.0	1	5	11	24	32	27	0
			9.0-10.0	2	12	20	23	28	15	0
			10.0-11.0	1	6	16	18	28	31	0
			11.0-13.6	5	20	21	12	23	19	0
			Mean	5	16	16	17	24	19	3

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
0.2-1.2	78	11	0	3	7	1	0
1.2-2.2	74	2	20	4	trace	trace	0
2.2-4.2	41	1	42	4	12	trace	0
4.2-8.0	66	trace	24	9	1	trace	0
8.0-10.0	46	7	35	11	1	trace	0
10.0-13.6	41	trace	33	24	2	trace	0

SJ 24 SE 21 **2699 4449** **Cross Street, Cefn** **Block A**

Surface level +222.2 m
Water struck at +217.5 m
Shell and auger 203 mm diameter
March 1978

Overburden	7.3 m
Mineral	7.1 m
Waste	3.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown	0.3	0.3
Boulder Clay	Clay, stiff, brown, becoming grey at base, with quartzite and coal fragments	7.0	7.3
Glacial Sand and Gravel	Gravel: Gravel: coarse to fine, mostly subrounded, quartzite, sandstone, limestone and siltstone Sand: mainly coarse, subangular to subrounded	7.1	14.4
Boulder Clay	Clay, stiff, grey; many quartzite cobbles	3.7+	18.1

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
2	35	63	7.3-8.3	0	1	3	9	28	59	0
			8.3-9.3	3	3	11	33	39	11	0
			9.3-10.3	3	4	8	23	31	31	0
			10.3-11.3	4	5	19	32	23	17	0
			11.3-12.3	1	5	9	17	19	29	20
			12.3-13.3	5	1	9	17	26	42	0
			13.3-14.4	1	3	11	22	26	37	0
			Mean	2	3	10	22	27	33	3

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
7.3-14.4	25	22	27	26	trace	0	0

SJ 24 SE 22 **2550 4161** **Bryn-Ceirch, Llangollen Rural** **Block A**

Surface level +104.0 m
Water not encountered
Shell and auger 203 mm diameter
March 1978

Overburden 0.2 m
Mineral 10.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, stoney	0.2	0.2
Late-Glacial Flood Gravels	Gravel, 'very clayey' between 7.2 m and 8.2 m Gravel: coarse to fine and some cobbles, angular to subrounded, greywacke with some sandstone and traces of limestone and quartz Sand: mainly medium and coarse, mostly greywacke	10.6+	10.8

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
8	34	58	0.2-1.2	4	5	10	15	24	42	0
			1.2-2.2	15	5	10	14	18	20	18
			2.2-3.2	8	5	20	15	24	28	0
			3.2-4.2	2	3	9	10	17	33	26
			4.2-5.2	4	3	10	23	27	33	0
			5.2-6.2	4	1	10	29	29	19	8
			6.2-7.2	3	2	12	21	22	18	22
			7.2-8.2	37	3	15	21	11	12	1
			8.2-9.2	4	5	13	17	23	28	10
			9.2-10.2	6	5	13	17	26	33	0
			10.2-10.8	5	3	10	17	27	27	11
			Mean	8	4	12	18	22	27	9

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
0.2-10.8	0	3	trace	97	0	trace	0

SJ 24 SE 23 **2652 4151** **Plas-yn-Pentre, Llangollen Rural** **Block A**

Surface level +65.6 m
Water struck at +63.2 m
Shell and auger 203 mm diameter
March 1978

Overburden	1.2 m
Mineral	2.3 m
Waste	1.4 m
Mineral	1.6 m
Waste	1.9 m
Mineral	4.9 m
Bedrock	0.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil and made ground	0.6	0.6
River Terrace Deposits	Clay, soft, buff-brown	0.6	1.2
	a Gravel Gravel: coarse to fine with cobbles, mostly subangular, greywacke with igneous rock Sand: mainly medium with coarse, subangular	2.3	3.5
	Clay, soft, red-brown, silty	1.4	4.9
	b Gravel Gravel: coarse to fine with some cobbles, subangular, greywacke with some quartzite Sand: coarse to medium, subangular, greywacke	1.6	6.5
	Clay, soft, red-brown	1.9	8.4
	c Sandy gravel Gravel: coarse to fine, subangular greywacke Sand: coarse to medium, greywacke	4.9	13.3
Ludlow	Siltstone, dark grey	0.1+	13.4

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	5	31	64	1.2-1.9	9	7	19	14	20	24	7
				1.9-2.5	4	7	12	11	20	41	5
				2.5-3.5	2	3	9	14	22	29	21
				Mean	5	5	13	13	21	30	13
b	3	38	59	4.9-5.9	4	2	12	25	27	27	3
				5.9-6.5	2	1	9	26	18	31	13
				Mean	3	2	11	25	24	28	7
c	3	49	48	8.4-9.4	0	0	25	18	19	25	13
				9.4-10.4	4	8	32	25	16	15	0
				10.4-11.4	3	5	17	18	19	32	6
				11.4-12.4	3	3	13	30	31	20	0
				12.4-13.3	4	5	17	28	26	20	0
				Mean	3	4	21	24	22	22	4
a+b+c	3	42	55	Mean	3	4	17	21	22	26	7

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	1.2-3.5	4	trace	0	68	28	trace	0
b	4.9-13.3	4	0	trace	96	0	trace	0

SJ 24 SE 24 **2728 4152** **Ty-Isaf, Llangollen Rural** **Block A**

Surface level +67.3 m
Water not encountered
Shell and auger 203 mm diameter
March 1978

Overburden 0.8 m
Mineral 3.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
River Terrace Deposits	Soil, stony, on soft brown clay	0.8	0.8
	Gravel Gravel: coarse to fine, with cobbles in lower part, subangular greywacke Sand: coarse to medium, subrounded to subangular greywacke	3.9+	4.7
	Borehole abandoned due to obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
4	42	54	0.8-1.6	6	5	48	15	15	11	0
			1.6-2.1	6	8	26	14	20	26	0
			2.1-3.1	1	3	13	13	21	37	12
			3.1-4.7	5	4	15	17	21	34	4
			Mean	4	4	23	15	20	29	5

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
0.8-4.7	18	trace	1	74	8	trace	0

SJ 24 SE 25 **2826 4152** **Ty-Mawr, Cefn** **Block A**

Surface level +81.1 m
Water struck at +78.3 m
Shell and auger 203 mm diameter
March 1978

Overburden	1.5 m
Mineral	1.7 m
Waste	12.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.4	0.4
Late-Glacial Flood Gravels	Clay, stiff, brown, with greywacke pebbles	1.1	1.5
	Gravel, 'clayey' between 2.5 m and 2.8 m Gravel: coarse to fine, subangular, greywacke with some igneous rock Sand: coarse to fine, subangular to subrounded, greywacke, with quartz	1.7	3.2
Boulder Clay	Clay, becoming stiff with depth, red-brown, stony, with silty laminated layers	12.1+	15.3
	Borehole abandoned due to obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
9	31	60	1.5-2.5	9	6	9	13	24	39	0
			2.5-2.8	15	9	8	13	31	24	0
			2.8-3.2	3	4	14	22	25	32	0
			Mean	9	6	10	15	25	35	0

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
1.5-3.2	4	1	0	87	7	1	0

SJ 24 SE 26 **2794 4079** **Offas Cottages, Chirk** **Block A**

Surface level +113.8 m
Water not encountered
Shell and auger 203 mm diameter
March 1978

Overburden	1.5 m
Mineral	3.1 m
Waste	2.2 m
Mineral	1.2 m
Waste	1.3 m
Mineral	1.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, stony	0.6	0.6
	Clay, stiff, light brown, stony	0.9	1.5

Late-Glacial Flood Gravels	**a** Gravel, 'very clayey' at top Gravel: coarse to fine, with cobbles between 1.5 m and 3.5 m, subangular, greywacke with some igneous rock Sand: coarse to medium, subangular greywacke	3.1	4.6
	Clay, silty, soft, brown; rare pebbles	2.2	6.8
	b Gravel Gravel: coarse with fine and some cobbles, subangular greywacke with rounded igneous rocks Sand: coarse to medium, subangular greywacke	1.2	8.0
	Clay, silty, brown, stony	1.3	9.3
	c Gravel Gravel: coarse with fine, subangular, greywacke with quartzite and igneous rock Sand: coarse with medium, subangular greywacke and rounded quartz	1.7+	11.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	9	39	52	1.5-2.5	20	4	10	17	21	22	6
				2.5-3.5	6	4	8	18	24	28	12
				3.5-4.6	2	7	19	27	24	21	0
				Mean	9	5	13	21	23	23	6
b	5	33	62	6.8-8.0	5	3	12	18	23	27	12
c	2	31	67	9.3-11.0	2	1	11	19	25	42	0
a+b+c+	6	35	59	Mean	6	3	12	20	24	30	5

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	1.5-4.6	1	trace	0	91	8	trace	0
b	6.8-8.0	2	trace	1	81	16	trace	0
c	9.3-11.0	18	0	1	77	1	3	0

SJ 24 SE 27 **2996 4212** **Darland Wood, Ruabon** **Block A**

Surface level +102.8 m
Water struck at +93.8 m
Shell and auger203 mm diameter
March 1978

Overburden	0.6 m
Mineral	1.5 m
Waste	0.4 m
Mineral	1.5 m
Waste	7.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, stony	0.6	0.6
Glacial Sand and Gravel	**a** Gravel Gravel: coarse with fine and cobbles, subangular to subrounded, quartzite and sandstone with some siltstone and igneous rock Sand: coarse to fine, subrounded, quartzite and quartz	1.5	2.1

	Clay, soft, red-brown, stony	0.4	2.5
	b 'Very clayey' sandy gravel Gravel: fine to coarse, subrounded quartzite Sand: fine with coarse and medium	1.5	4.0
Boulder Clay	Clay, stiff, red-brown, calcareous, with quartzite, sandstone and grey limestone pebbles	7.8+	11.8

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	5	32	63	0.6-1.6	5	10	11	11	17	24	22
				1.6-2.1	6	10	10	11	18	23	22
				Mean	5	10	11	11	17	24	22
b	30	48	22	2.5-4.0	30	21	15	12	13	9	0
a+b	19	39	42	Mean	19	15	13	11	15	16	11

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	0.6-2.1	51	32	0	14	3	trace	0

SJ 24 SE 28 **2579 4429** **Cae-Merddyn, Cefn** **Block A**

Surface level +284.4 m
Water struck at +281.8 m
Shell and auger 203 mm diameter
April 1978

Waste	9.5 m
Bedrock	1.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, stony	0.1	0.1
Boulder clay	Clay, becoming stiff with depth, red-brown above 2.0 m, grey below; quartzite and siltstone pebbles	9.4	9.5
? Millstone Grit	Shale, dark grey, weathered in upper part	1.6+	11.1

SJ 34 NW 29 **3011 4939** **Caeau Bridge, Esclusham below** **Block B**

Surface level +121.2 m
Water struck at +108.7 m
Shell and auger 203 mm and 152 mm diameter
January 1978

Overburden	0.3 m
Mineral	1.1 m
Waste	2.0 m
Mineral	0.7 m
Waste	12.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, stony, clayey	0.3	0.3
Glacial Sand and Gravel	**a** Gravel Gravel: coarse and fine, with cobbles, subrounded to subangular, quartzite, sandstone, siltstone and igneous rock Sand: coarse and medium, subrounded	1.1	1.4
Boulder Clay	Clay, stiff, red-brown, stony; traces of coal	2.0	3.4
Glacial Sand and Gravel	**b** Gravel Gravel: coarse to fine, subrounded, quartzite, sandstone siltstone and igneous rock Sand: coarse to fine, subrounded	0.7	4.1
Boulder Clay	Clay, becoming stiff at 11 m, red-brown with patches of grey, with quartzite and sandstone fragments	12.9+	17.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	6	34	60	0.3-1.4	6	6	12	16	20	22	18
b	6	39	55	3.4-4.1	6	9	15	15	23	32	0
a+b	6	36	58	Mean	6	7	13	16	21	26	11

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	0.3-1.4	53	14	0	22	11	0	0
b	3.4-4.1	35	31	6	16	12	trace	0

SJ 34 NW 30 **3055 4851** **Bryn-Tirion, Esclusham Below** **Block B**

Surface level +113.5 m
Water struck at +105.0 m
Shell and auger 203 mm and 152 mm diameter
January 1978

Overburden	8.5 m
Mineral	5.8 m
Waste	3.7 m
Mineral	4.0 m
Waste	2.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, clayey, stony	0.2	0.2
Boulder Clay	Clay, stiff, yellow-brown to 3.9 m, grey below; pebbles of sandstone, limestone, quartzite and siltstone and traces of coal	8.3	8.5
Glacial Sand and Gravel	**a** Sandy gravel Gravel: coarse and fine, angular to subrounded, quartzite, sandstone and siltstone with traces of coal Sand: medium and coarse, subangular to subrounded	5.8	14.3
Boulder Clay	Clay, stiff, red-brown, with quartzite, quartz and igneous rock pebbles and traces of coal	3.7	18.0
Glacial Sand and Gravel	**b** Gravel, with 0.1 m stony clay at 20.3 m Gravel: coarse to fine, subangular to subrounded, siltstone, sandstone, quartzite, igneous rock and limestone Sand: coarse to fine, subangular to subrounded	4.0	22.0
Boulder Clay	Clay, sandy, stiff, red-brown, with traces of coal, becoming stony in lower metre	2.0+	24.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	2	58	40	8.5-9.5	2	5	26	29	23	15	0
				9.5-10.5	2	6	18	20	24	30	0
				10.5-11.5	5	15	25	20	18	17	0
				11.5-12.5	2	3	46	20	19	10	0
				12.5-13.5	1	2	48	20	23	6	0
				13.5-14.3	1	3	24	13	20	39	0
				Mean	2	6	31	21	21	19	0
b	3	44	53	18.0-19.0	4	10	13	17	30	26	0
				19.0-20.0	1	12	19	25	23	20	0
				20.0-21.0	3	12	16	10	18	41	0
				21.0-22.0	2	11	14	15	22	36	0
				Mean	3	11	16	17	23	30	0
a+b	2	52	46	Mean	2	8	25	19	22	24	0

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	8.5-11.5	21	21	13	24	17	4	0
	11.5-14.3	32	25	11	7	21	4	0
b	18.0-20.0	13	16	8	45	17	1	0
	20.0-22.0	35	18	3	28	15	1	0

SJ 34 NW 31 **3023 4789** **Pentre-Bychan, Esclusham Below** **Block B**

Surface level +121.2 m
Water struck at +118.0 m
Shell and auger 203 mm diameter
April 1978

Overburden	3.2 m
Mineral	0.9 m
Waste	0.9 m
Mineral	2.3 m
Waste	2.4 m
Mineral	1.2 m
Waste	1.0 m
Mineral	1.1 m
Waste	4.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, stony	0.4	0.4
Boulder Clay	Clay, soft, yellow-brown, with quartzite and sandstone pebbles and traces of coal	2.8	3.2
Glacial Sand and Gravel	**a** Gravel Gravel: mainly coarse, subrounded, quartzite, limestone and siltstone Sand: mainly fine and medium, mostly subangular, quartzite and quartz	0.9	4.1
Boulder Clay	Clay, stiff, grey-brown, stony with sandy lenses	0.9	5.0
Glacial Sand and Gravel	**b** Gravel Gravel: coarse to fine with cobbles in lower part, subrounded to subangular, quartzite Sand: mainly coarse and medium, subangular, quartzite, sandstone and quartz, with traces of coal	2.3	7.3
Boulder Clay	Clay, stiff, grey, stony	2.4	9.7
Glacial Sand and Gravel	**c** 'Very clayey' sandy gravel Gravel: coarse to fine, subangular, sandstone, quartzite and limestone Sand: coarse to fine, subangular, quartzite and sandstone with mostly clear quartz in finer fractions	1.2	10.9
Boulder clay	Clay, stiff, grey, stony	1.0	11.9
Glacial Sand and Gravel	**d** Gravel Gravel: coarse to fine, subangular, quartzite Sand: coarse to medium, quartzite with quartz in finer fractions	1.1	13.0
Boulder Clay	Clay, stiff, red-brown, becoming grey with depth, stony, calcareous	4.7+	17.7

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
a	5	29	66	3.2-4.1	5	12	12	5	15	51	0
b	1	26	73	5.0-6.0	2	2	9	24	31	32	0
				6.0-7.3	1	6	6	8	19	42	18
				Mean	1	4	7	15	24	39	10
c	20	45	35	9.7-10.9	20	16	16	13	17	18	0
d	1	33	66	11.9-13.0	1	5	13	15	28	38	0
a-d	6	32	62	Mean	6	8	11	13	22	36	4

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	3.2-13.0	37	11	32	14	6	trace	0

SJ 34 NW 32 **3177 4950** **Fawnog Farm, Bersham** **Block B**

Surface level +95.4 m
Water struck at +91.3 m
Shell and auger 203 mm diameter
January 1978

Overburden	0.7 m
Mineral	1.8 m
Waste	0.3 m
Mineral	3.3 m
Waste	2.1 m
Mineral	2.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, stony, sandy	0.7	0.7
Glacial Sand and Gravel	**a** Clayey sandy gravel, with 0.3 m stony clay at 2.5 m Gravel: coarse and fine, subangular to subrounded, quartzite sandstone and siltstone Sand: medium to fine, subangular to rounded, quartzite and quartz	5.4	6.1
Boulder Clay	Clay, grey and red-brown, with cobbles and smaller stones of quartzite, sandstone and igneous rock	2.1	8.2
Glacial Sand and Gravel	**b** Gravel, sandy in lower part Gravel: coarse and fine in upper metre, fine below, subrounded, quartzite, sandstone and siltstone with igneous rock and limestone Sand: coarse and medium, subangular; traces of coal	2.0+	10.2

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	12	50	38	0.7-1.7	6	8	12	12	28	34	0
				1.7-2.5	6	9	14	8	26	37	0
				2.5-2.8	Clay Band						
				2.8-4.0	20	18	16	8	21	17	0
				4.0-5.1	9	29	33	7	8	14	0
				5.1-6.1	15	37	28	5	9	6	0
				Mean	12	21	21	8	18	20	0
b	2	54	44	8.2-9.2	1	3	15	21	27	33	0
				9.2-10.2	2	2	37	32	25	2	0
				Mean	2	3	26	25	26	18	0
a+b	9	51	40	Mean	9	16	22	13	20	20	0

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	0.7-2.5	58	23	1	15	3	0	0
	3.0-6.1	25	28	6	32	8	1	0
b	8.2-10.2	25	24	9	32	10	trace	0

SJ 34 NW 33 **3142 4790** **Plas Ground Farm, Esclusham Below** **Block B**

Surface level +103.0 m
Water not encountered
Shell and auger 203 mm diameter
January 1978

Waste 6.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.4	0.4
Boulder Clay	Clay, stiff, red-brown with some grey intercalations; scattered stones; silty sandy layers below 1.6 m	4.8	5.2
Glacial Sand and Gravel	Gravel Gravel: coarse to fine, subrounded, quartzite, igneous rock and sandstone with limestone Sand: coarse and medium	0.8+	6.0
	Borehole abandoned due to rock obstruction		

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
5.2-6.0	33	19	10	11	25	2	0

SJ 34 NW 34 **3115 4547** **New Hall, Ruabon** **Block B**

Surface level +105.8 m
Water struck at +91.8 m
Shell and auger 203 mm and 152 mm diameter
February 1978

Overburden 5.0 m
Mineral 1.6 m
Waste 8.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, clayey	0.4	0.4
Boulder Clay	Clay, stiff, red-brown, slightly stony with subrounded quartzite fragments and traces of coal, becoming sandy below 2.9 m	4.6	5.0
Glacial Sand and Grave;	Gravel Gravel: mainly coarse with fine, subrounded quarzite and igneous rocks Sand: medium with coarse and fine	1.6	6.6
Ruabon Marl	Clay, stiff, varying from red-brown to blue-green, calcareous	8.3+	14.9

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
3	40	57	5.0-6.6	3	11	18	11	12	45	0

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
5.0-6.6	53	4	trace	9	33	1	0

SJ 34 NW 35 **3233 4894** **Manor Farm, Erddis** **Block B**

Surface level +88.5 m
Water struck at +68.7 m
Shell and auger 203 mm and 152 mm diameter
December 1977

Overburden	3.5 m
Mineral	5.0 m
Waste	13.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, stony	0.3	0.3
Boulder Clay	Clay, soft, orange-red, stony, sandy; some rounded sandstone cobbles	3.2	3.5
Glacial Sand and Gravel	Gravel, sandy in top metre Gravel: coarse to fine, subrounded, limestone and quartzite with siltstone and sandstone Sand: coarse to fine, subangular, quartzite and quartz, with traces of coal	5.0	8.5
Boulder Clay	Clay, soft in upper part, stiff below, brown and grey, very stony in top metre with subangular quartzite and limestone erratics	11.3	19.8
Glacial Sand and Gravel	Sand, brown, with traces of coal	2.2+	22.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
5	36	59	3.5-5.5	7	15	12	12	22	32	0
			5.5-6.5	7	14	15	12	22	30	0
			6.5-7.5	2	5	7	11	21	54	0
			7.5-8.5	4	9	13	12	30	32	0
			Mean	5	12	12	12	23	36	0

SJ 34 NW 36 **3213 4773** **Plas Grono, Esclusham Below** **Block B**

Surface level +89.2 m
Water struck at +77.1 m
Shell and auger 203 mm and 152 mm diameter
December 1977

Overburden	0.5 m
Mineral	4.7 m
Waste	5.0 m
Mineral	2.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, stony	0.5	0.5
Glacial Sand and Gravel	**a** Gravel, sandy and 'clayey' near top and base Gravel: coarse to fine, rounded to subrounded, quartzite with sandstone and siltstone Sand: coarse to fine, subangular, quartzite and quartz with traces of coal	4.7	5.2
Glacial Silt	Clay, soft, grey-green, with silty laminations	5.0	10.2
Glacial Sand and Gravel	**b** 'Clayey' gravel Gravel: coarse to fine, subrounded quartzite and quartz Sand: coarse to medium, quartzite and quartz with traces of coal	2.3+	12.5
	Borehole abandoned due to rock obstruction		

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	9	40	51	0.5-1.5	13	14	21	7	29	16	0
				1.5-2.5	5	9	20	7	23	36	0
				2.5-3.5	3	7	12	6	19	53	0
				3.5-5.2	13	18	19	12	22	16	0
				Mean	9	13	18	9	23	28	0

b No data available

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
0.5-5.2	50	20	5	17	7	1	0

SJ 34 NW 37 **3190 4574** **One Oak Cottages, Ruabon** **Block B**

Surface level +95.4 m
Water struck at +87.5 m rising to +92 m
Shell and auger 203 mm and 152 mm diameter
February 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, clayey	0.3	0.3
Boulder Clay	Clay, soft, becoming stiff with depth, interbedded dark red-brown and grey, calcareous, with limestone cobbles, subrounded quartzite pebbles and traces of coal	7.8	8.1
Glacial Silt	Silt, grey, sandy	1.8	9.9
Glacial Sand and Gravel	Sandy gravel: mostly subangular quartzite and limestone pebbles with coarse to medium sand	0.4	10.3
Boulder clay	Clay, stiff, grey with subangular quartzite and limestone erratics	3.4	13.7
Glacial Sand and Gravel	Sandy gravel, on pebbly sand Gravel: coarse to fine, subrounded quartzite with limestone Sand: coarse to medium	2.4	16.1
Boulder Clay	Clay, stiff, mainly red-brown but grey and silty at base, with quartzite and sandstone pebbles, traces of limestone	1.9+	18.0

SJ 34 NW 38 **3365 4819** **New Sontley, Marchwiel** **Block B**

Surface level +88.6 m
Water not encountered
Shell and auger 203 mm and 152 mm
November 1978

Overburden 0.5 m
Mineral 12.0 m
Waste 10.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, stony	0.5	0.5
Glacial Sand and Gravel	**a** Gravel. partly sandy, 'clayey' at base Gravel: mainly coarse, well-rounded to subrounded, quartzite with sandstone, siltstone and limestone Sand: medium with coarse and fine, subrounded; traces of coal	9.0	9.5
	b 'Clayey' sand, light brown; mainly fine, rare silty layers	3.0	12.5
Glacial Silt	Clay, stiff, dark brown, laminated	10.5+	23.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	6	45	49	0.5-1.5	9	9	45	8	11	18	0
				1.5-2.5	4	6	22	8	23	37	0
				2.5-3.5	4	4	21	8	20	31	12
				3.5-4.5	2	5	16	7	17	53	0
				4.5-5.5	6	7	30	14	16	27	0
				5.5-6.5	3	7	33	12	20	25	0
				6.5-7.5	2	7	19	8	10	38	16
				7.5-8.5	5	34	14	3	6	38	0
				8.5-9.5	17	51	7	1	4	7	13
				Mean	6	14	23	8	14	30	5
b	14	86	0	9.5-12.5	14	61	25	0	0	0	0
a+b	8	55	37	0.5-12.5	8	25	24	6	11	23	3

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	0.5-4.5	47	22	6	14	9	2	trace
	4.5-9.5	38	11	35	6	8	2	0

SJ 34 NW 39 **3302 4657** **Old Sontley Farm, Marchwiel** **Block B**

Surface level +74.7 m
Water struck at +70.9 m
Shell and auger 203 mm diameter
February 1978

Overburden 3.2 m
Mineral 11.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey, slightly stony	0.6	0.6
Boulder Clay	Clay, soft, red-brown, slightly sandy, rare stones	2.6	3.2
Glacial Sand and Gravel	Sand, brown, with some pebbles in upper part: medium to fine, subrounded; traces of coal	11.3+	14.5

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
	6	93	1	3.2-4.2	13	40	42	3	2	0	0
				4.2-5.2	4	35	44	5	9	3	0
				5.2-6.2	5	40	46	4	4	1	0
				6.2-7.2	3	48	48	0	0	1	0
				7.2-8.2	2	46	51	1	0	0	0
				8.2-9.2	5	37	58	0	0	0	0
				9.2-10.2	10	52	36	1	1	0	0
				10.2-11.2	4	44	52	0	0	0	0
				11.2-12.2	6	49	44	1	0	0	0
				12.2-13.2	5	51	43	1	0	0	0
				13.2-14.0	7	50	42	1	0	0	0
				14.0-14.5	20	71	9	0	0	0	0
				Mean	6	48	44	1	1	trace	0

SJ 34 NW 40 **3380 4598** **The Grove, Marchwiel** **Block B**

Surface level +83.5 m
Water not encountered
Shell and auger 203 mm diameter
February 1978

Waste	18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey, rare stones	0.4	0.4
Boulder Clay	Clay, stiff, slightly sandy, red-brown, rare stones	17.6+	18.0

SJ 34 NW 41 **3426 4877** **Bryn-y-cabanau, Marchwiel** **Block B**

Surface level +82.3 m
Water struck at +63.3 m
Shell and auger 203 mm and 152 mm diameter
November 1977

Overburden	1.0 m
Mineral	18.0 m
Waste	6.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, stony	0.3	0.3
	Clay, stiff, orange-red, with rounded stones - mainly quartzite	0.7	1.0
Glacial Sand and Gravel	**a** Gravel Gravel: coarse to fine, with cobbles in parts, well- rounded to subrounded, quartzite, limestone and igneous rock Sand: mainly medium and coarse, rounded to subangular: traces of coal	9.3	10.3
	b 'Clayey' sand, with pebbles in parts, light brown: medium to fine, up to 50% quartzite in coarser fractions, mostly clear quartz in finer grades; traces of coal	8.7	19.0
Glacial Silt	Clay, stiff, brown, silty	6.0+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	4	38	58	1.0-2.0	7	10	15	9	25	34	0
				2.0-3.0	5	9	18	10	26	32	0
				3.0-4.0	2	6	15	8	15	19	35
				4.0-5.0	2	4	5	9	19	49	12
				5.0-6.0	3	3	7	17	22	48	0
				6.0-7.0	2	5	11	26	20	36	0
				7.0-8.0	2	4	11	24	18	28	13
				8.0-9.0	4	6	23	20	21	26	0
				9.0-10.3	11	18	30	12	17	12	0
				Mean	4	8	15	15	20	32	6
b	14	83	3	10.3-11.3	8	31	56	2	2	1	0
				11.3-13.3	11	28	49	5	3	4	0
				13.3-15.3	11	31	49	3	5	1	0
				15.3-17.3	23	49	27	1	0	0	0
				17.3-19.0	14	36	50	0	0	0	0
				Mean	14	35	46	2	2	1	0
a+b	9	60	31	1.0-19.0	9	21	30	9	11	17	3

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	1.0-3.0	88	trace	0	1	9	2	0
	3.0-5.0	53	1	42	1	3	trace	0
	5.0-7.0	44	6	45	trace	4	1	0
	7.0-9.0	33	3	51	2	9	1	0
	9.0-10.3	55	2	22	3	13	2	3

SJ 34 NW 42 **3400 4744** **Marchwiel Hall, Marchwiel** **Block B**

Surface level +72.7 m
Water struck at +69.7 m
Shell and auger 203 mm and 152 mm diameter
November 1977

Overburden 0.2 m
Mineral 7.8 m
Waste 14.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.2	0.2
Glacial Sand and Gravel	'Very clayey' sand, light brown: mainly fine, subrounded; traces of coal	7.8	8.0
Boulder clay	Clay, silty, stiff, red, with small pebbles and coal fragments	14.0+	22.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
	31	67	2	0.2-2.0	20	56	23	1	0	0	0
				2.0-3.4	35	45	20	0	0	0	0
				3.4-6.0	33	49	12	1	2	3	0
				6.0-8.0	35	57	7	1	0	0	0
				Mean	31	51	15	1	1	1	0

SJ 34 NW 43 **3491 4683** **Wood house, Marchwiel** **Block B**

Surface level +61.3 m
Water struck at +58.3 m
Shell and auger 203 mm and 152 mm diameter
November 1977

Overburden	0.5 m
Mineral	5.9 m
Waste	11.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.5	0.5
Glacial Sand and Gravel	Sand, light brown, clayey in top metre: subangular to subrounded; traces of coal	5.9	6.4
Boulder Clay	Clay, silty, stiff, dark brown, pebbles rare in upper 4 metres, common below	11.6+	18.0
	Borehole abandoned due to obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
9	91	0	0.5-1.5	13	55	31	1	0	0	0
			1.5-2.5	9	59	32	0	0	0	0
			2.5-4.0	9	63	28	0	0	0	0
			4.0-5.5	7	50	40	3	0	0	0
			5.5-6.4	6	37	51	5	1	0	0
			Mean	9	53	36	2	trace	0	0

SJ 34 NE 19 **3567 4963** **Cefn Park, Abenbury** **Block B**

Surface level +79.0 m
Water not encountered
Shell and auger 203 mm and 152 mm diameter
November 1977

Overburden	0.5 m
Mineral	3.7 m
Waste	1.1 m
Mineral	10.7 m
Waste	2.0 m
Mineral	7.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.5	0.5
Glacial Sand and Gravel	**a** Sand, 'very clayey' in upper 1.5 m, light brown: medium to fine, subrounded to well-rounded, clear quartz with traces of coal	3.7	4.2
Glacial Silt	Silt, sandy, soft, dark brown	1.1	5.3
Glacial Sand and Gravel	**b** 'Clayey' to 'very clayey' sand, light brown: fine with medium, rounded quartz with traces of coal	10.7	16.0
Boulder clay	Clay, silty, dark brown, stiff and pebbly and with layers of fine sand	2.0	18.0
Glacial Sand and Gravel	**c** 'Clayey' sand, buff: fine grained, subrounded to rounded, clear quartz with traces of coal	7.0+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	10	90	0	0.5-1.5	20	58	19	3	0	0	0
				1.5-2.5	9	50	41	0	0	0	0
				2.5-4.2	4	34	62	0	0	0	0
				Mean	10	44	45	1	0	0	0
b	15	85	0	5.3-8.0	20	52	28	0	0	0	0
				8.0-10.0	21	41	37	1	0	0	0
				10.0-12.0	9	50	40	1	0	0	0
				12.0-14.0	10	48	40	2	0	0	0
				14.0-16.0	14	66	20	0	0	0	0
				Mean	15	51	33	1	0	0	0
c	17	83	0	18.0-20.0	14	41	45	0	0	0	0
				20.0-22.0	25	71	4	0	0	0	0
				22.0-24.0	16	8	76	0	0	0	0
				24.0-25.0	9	51	40	0	0	0	0
				Mean	17	42	41	0	0	0	0
a+b+c	15	85	0	Mean	15	46	38	1	0	0	0

SJ 34 NE 20 **3508 4836** **Bryn-y-Gros, Marchwiel** **Block B**

Surface level +79.4 m
Water struck at +73.5 m
Shell and auger 203 mm and 152 mm diameter
November 1977

Overburden	0.5 m
Mineral	3.1 m
Waste	0.3 m
Mineral	9.6 m
Waste	7.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.5	0.5
Glacial Sand and Gravel	**a** Gravel, part sandy, with 0.3 m stony clay at 3.6 m Gravel: coarse to fine, with cobbles below 3.6 m, subangular to subrounded, quartzite with some igneous rock, sandstone, limestone and siltstone Sand: medium to coarse, subangular to subrounded; traces of coal	5.3	5.8
	b 'Clayey' sand: fine, mostly subrounded clear quartz; traces of coal	7.7	13.5
Glacial Silt	Clay, silty, dark brown, finely laminated, scattered red sandstone fragments	7.5+	21.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
a	5	47	48	0.5-1.5	6	10	24	25	21	14	0
				1.5-2.5	5	8	15	17	30	25	0
				2.5-3.6	8	15	41	11	15	10	0
				3.6-3.9	Clay band						
				3.9-4.9	3	6	17	15	17	15	27
				4.9-5.8	2	5	18	11	23	33	8
				Mean	5	9	22	16	21	19	8
b	16	84	0	5.8-7.0	10	76	12	2	0	0	0
				7.0-9.0	5	76	19	0	0	0	0
				9.0-11.0	12	67	21	0	0	0	0
				11.0-13.5	30	65	5	0	0	0	0
				Mean	16	70	14	trace	0	0	0
a+b	11	70	19	0.5-13.5	11	45	18	7	8	8	3

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	0.5-3.6	66	6	6	11	11	1	0
	3.6-5.8	59	7	9	7	17	1	trace

SJ 34 NE 21 **3654 4865** **The Five Fords, Abenbury** **Block C**

Surface level +36.2 m
Water not encountered
Shell and auger 152 mm diameter
September 1977

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, loamy	0.4	0.4
Boulder clay	Clay, soft, dark brown; few laminations, some small stones	17.6+	18.0

SJ 34 NE 22 **3675 4750** **The Hollies, Marchwiel** **Block C**

Surface level +47.2 m
Water not encountered
Shell and auger 152 mm diameter
September 1977

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.3	0.3
Boulder Clay	Clay, stiff to 4.0 m, soft below, dark brown; few pebbles below 16 m	17.7+	18.0

SJ 34 NE 23 **3661 4541** **Waters Lane Cottages, Sesswick** **Block C**

Surface level +32.6 m
Water struck at +30.5 m
Shell and auger 152 mm diameter
September 1977

Waste	16.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey, stony	0.4	0.4
Boulder Clay	Clay, silty, stiff, red-brown, with coarse quartzite and igneous pebbles and few cobbles	4.5	4.9
Glacial Sand and Gravel	'Clayey' sand, light brown: medium	0.8	5.7
Boulder Clay	Clay, stiff, red-brown, stony	10.3+	16.0

SJ 34 NE 24 **3732 4556** **Gerwynfechan, Sesswick** **Block C**

Surface level +17.2 m
Water struck at +14.0 m
Shell and auger 152 mm diameter
September 1977

Overburden	0.3 m
Mineral	5.0 m
Waste	2.2 m
Mineral	9.5 m
Waste	2.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, very sandy	0.3	0.3
River Terrace Deposits	**a** Gravel Gravel: coarse to fine, subrounded, grey mudstone and greywacke with quartzite and igneous rock Sand: coarse, mostly subangular quartzite with minor quartz and sandstone; medium quartz and quartzite	5.0	5.3
	Clay, silty and sandy, soft, red-brown	2.2	7.5
Glacial Sand and Gravel	**b** Sand, 'very clayey' to 13.0 m; mainly fine	9.5	17.0
Boulder Clay	Clay, very sandy, mainly soft, red-brown, coal fragments	2.2+	19.2

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	3	28	69	0.3-1.3	1	0	4	11	25	59	0
				1.3-2.3	3	5	15	23	25	29	0
				2.3-3.3	4	4	12	15	29	36	0
				3.3-4.3	3	1	11	15	33	37	0
				4.3-5.3	2	10	10	7	30	41	0
				Mean	3	4	10	14	28	41	0
b	21	77	2	7.5-13.0	30	44	22	1	2	1	0
				13.0-14.0	8	62	29	1	0	0	0
				14.0-15.0	8	74	17	1	0	0	0
				15.0-17.0	7	75	18	0	0	0	0
				Mean	21	55	21	1	1	1	0
a+b	14	61	25	Mean	14	38	18	5	11	14	0

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	0.3-2.3	25	1	0	51	19	4	trace
	2.3-5.3	36	1	0	45	15	3	0

SJ 34 NE 25 **3860 4943** **Redwither, Abenbury** **Block C**

Surface level +28.8 m
Water not encountered
Shell and auger 152 mm diameter
September 1977

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	1.0	1.0
Boulder Clay	Clay, silty, dark brown, soft to 6 m stiff below; scattered stones	17.0+	18.0

SJ 34 NE 26 **3872 4775** **Talwrn Sesswick** **Block C**

Surface level +33.7 m
Water not encountered
Shell and auger 152 mm diameter
September 1977

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, clayey	0.3	0.3
Boulder Clay	Clay, slightly silty, red-brown; scattered small red sandstone pebbles, few sandy lenses	17.7+	18.0

SJ 34 NE 27 **3827 4664** **Porthwgan Sesswick** **Block C**

Surface level +27.5 m
Water struck at +21.5 m
Shell and auger 152 mm diameter
September 1977

Overburden 4.8 m
Mineral 20.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.3	0.3
Boulder Clay	Clay, stiff, red-brown; quartzite and sandstone pebbles to 3 m, stoneless below	4.5	4.8
Glacial Sand and Gravel	**a** Sand, 'clayey' at top, light brown: fine to medium, subrounded, clear quartz with traces of coal and quartzite; thin silty clay at base	7.0	11.8
	b 'Pebbly' sand, with sandy gravel to 14.0 m Gravel: mainly fine, subrounded, quartzite with igneous rock, sandstone and siltstone Sand: mainly medium, subrounded to rounded	13.2+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	8	91	1	4.8-5.8	17	74	7	2	0	0	0
				5.8-6.8	11	42	47	0	0	0	0
				6.8-7.8	2	42	55	1	0	0	0
				7.8-9.8	9	41	48	1	1	0	0
				9.8-11.8	5	71	22	1	1	0	0
				Mean	8	54	36	1	1	0	0
b	2	85	13	11.8-13.0	1	7	27	26	29	10	0
				13.0-14.0	1	4	24	23	32	16	0
				14.0-15.0	2	27	32	18	11	10	0
				15.0-16.0	3	51	42	2	2	0	0
				16.0-17.0	3	40	44	3	6	4	0
				17.0-18.0	3	36	56	2	2	1	0
				18.0-20.0	2	21	58	13	4	2	0
				20.0-22.0	3	21	66	9	1	0	0
				22.0-25.0	3	21	60	8	5	3	0
				Mean	2	24	50	11	9	4	0
a+b	4	87	9	4.8-25.0	4	34	45	8	6	3	0

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	7.8-11.8	99	0	0	0	0	0	0
b	11.8-14.0	46	11	1	9	26	6	1
	14.0-15.0	40	1	0	9	45	5	trace
	15.0-25.0	22	9	24	14	29	2	trace

SJ 34 NE 28 **3840 4538** **Bangor Bridge, Sesswick** **Block C**

Surface level +15.4 m
Water struck at +13.5 m
Shell and auger 152 mm diameter
September 1977

Overburden	3.2 m
Mineral	4.0 m
Waste	1.9 m
Mineral	7.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, loamy	0.3	0.3
Alluvium	Clay, sandy, soft, grey-brown; many coal fragments	2.9	3.2
River Terrace Deposits	**a** Gravel Gravel: coarse to fine, subrounded to rounded, siltstone with quartzite and igneous rock Sand: coarse to medium, subangular siltstone and quartz	4.0	7.2
Boulder Clay	Clay, grey, stony - mostly quartzite pebbles (recovered as slurry)	1.9	9.1
Glacial Sand and Gravel	**b** Gravel on pebbly sand Gravel: mainly coarse to fine, subangular, igneous rock, quartzite and other sediments Sand: medium with fine, subangular, siltstone and quartz	2.0	11.1
	c Sand: medium to fine, rounded to well-rounded, with angular coal fragments	5.4+	16.5

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	2	36	62	3.2-4.2	2	2	11	15	32	38	0
				4.2-5.2	2	2	20	23	20	33	0
				5.2-6.2	3	4	15	23	35	20	0
				6.2-7.2	1	3	9	15	29	43	0
				Mean	2	3	14	19	29	33	0
b	2	64	34	9.1-10.1	1	15	27	4	15	38	0
				10.1-11.1	2	28	50	5	5	10	0
				Mean	2	22	37	5	10	24	0
c	3	97	0	11.1-13.0	2	37	58	2	1	0	0
				13.0-15.0	6	52	39	3	0	0	0
				15.0-16.5	2	46	51	1	0	0	0
				Mean	3	45	50	2	trace	0	0
b+c	3	88	9	9.1-16.5	3	39	46	3	3	6	0
a+b+c	3	69	28	Mean	3	26	35	8	12	16	0

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	3.2-5.2	31	trace	0	55	11	3	0
	5.2-7.2	18	3	0	54	22	3	0
b	9.1-11.1	24	5	0	24	47	trace	0

SJ 34 NE 29 **3965 4827** **Pickhill Bridge, Isycoed** **Block C**

Surface level +15.2 m
Water struck at +14.2 m
Shell and auger 152 mm diameter
September 1977

Overburden	1.5 m
Mineral	2.3 m
Waste	16.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, silty	0.5	0.5
Alluvium	Silt, sandy, yellow-grey, becoming brown with depth: many coal fragments	1.0	1.5
River Terrace Deposits	'Clayey' to 'very clayey' sand with thin gravel at base Gravel: coarse, subangular to rounded, quartzite with some igneous rock, sandstone and other sediments Sand: medium and fine	2.3	3.8
? Glacial Silt	Clay, silty, grey-brown, with pale brown sandy laminae; few scattered small pebbles	16.2+	20.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm	
22	67	11	1.5-2.5	16	32	47	3	2	0	0	
			2.5-3.5	32	40	25	1	1	1	0	
			3.5-3.8	5	9	15	5	4	56	6	
			Mean	22	32	33	2	2	8	1	

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
1.5-3.8	90	2	0	2	5	trace	1

SJ 34 NE 30 **3968 4753** **Pickhill Farm, Sesswick** **Block C**

Surface level +19.5 m
Water not encountered
Shell and auger 152 mm diameter
September 1977

Overburden	2.2 m
Mineral	1.8 m
Waste	15.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, loamy	0.3	0.3
River Terrace Deposits	Clay, silty and sandy, soft, grey-brown	1.9	2.2
	Gravel Gravel: coarse to fine, subangular to subrounded quartzite, igneous rock and siltstone with some quartz and sandstone Sand: coarse to medium, subangular to subrounded	1.8	4.0
Boulder clay	Clay, silty, soft, dark brown, vaguely laminated, calcareous; scattered pebbles, some red sand lenses	15.5+	19.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
1	18	81	2.2-3.2	1	2	8	11	36	42	0
			3.2-4.0	1	1	3	9	28	58	0
			Mean	1	2	6	10	32	49	0

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
2.2-4.0	40	2	0	28	25	5	0

SJ 34 NE 31 **3927 4671** **Pickhill Old Hall, Sesswick** **Block C**

Surface level +14.0 m
Water struck at +13.3 m
Shell and auger 152 mm diameter
September 1977

Overburden	2.7 m
Mineral	4.9 m
Waste	14.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, clayey	0.3	0.3
Alluvium	Clay, silty, soft, dark brown	2.4	2.7
River Terrace Deposits	Gravel Gravel: coarse to fine, subrounded, quartzite, siltstone and igneous rock with some sandstone Sand: coarse and medium, angular to rounded	4.9	7.6
Boulder clay	Clay, silty, dark red-brown, laminated, becoming stiff with depth; scattered small pebbles	14.4+	22.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
2	34	64	2.7-3.7	2	3	9	12	30	44	0
			3.7-4.7	2	2	12	15	24	45	0
			4.7-5.7	1	4	13	12	31	33	6
			5.7-6.7	3	11	19	15	27	25	0
			6.7-7.6	2	8	20	14	18	38	0
			Mean	2	6	14	14	26	37	1

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
2.7-3.7	44	2	0	31	21	2	trace
3.7-5.7	22	9	0	42	23	4	trace
5.7-7.6	40	2	0	29	28	1	trace

SJ 34 NE 32 **3941 4565** **The Mount, Bangor** **Block C**

Surface level +14.6 m
Water struck at +13.1 m
Shell and auger 203 mm diameter
November 1977

Waste	3.4 m
Bedrock	0.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, clayey	0.3	0.3
River Terrace Deposits	Silt, sandy, dark brown, with patches of dark red sand and few pebbles	3.1	3.4
Permo-Triassic	Sandstone, dark red, with buff layers, well-cemented, medium-grained	0.4+	3.8

SJ 34 NE 33 **3724 4672** **Kiln Inn, Sesswick** **Block C**

Surface level +41.9 m
Water not encountered
Shell and auger 152 mm diameter
April 1978

Overburden	12.0 m
Mineral	4.0 m
Waste	2.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, clayey	0.3	0.3
Boulder Clay	Clay, stiff, red-brown, calcareous: few, mostly small, soft siltstone and coal pebbles and white shells	11.7	12.0
Glacial Sand and Gravel	'Clayey' sand, light brown: fine, few coal fragments; clayey bands	4.0	16.0
Boulder Clay	Clay, stiff, slightly friable, dark red, calcareous; abundant red sandstone and quartzite pebbles and coal fragments	2.0+	18.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
12	88	0	12.0-14.0	8	71	21	0	0	0	0
			14.0-16.0	16	81	3	0	0	0	0
			Mean	12	76	12	0	0	0	0

SJ 34 SW 13 **3065 4392** **Maes-y-llan, Ruabon** **Block A**

Surface level +112.3 m
Water struck at +108.7 m
Shell and auger 203 mm diameter
March 1978

Overburden 0.4 m
Mineral* 18.9 m
Bedrock 0.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, stony	0.4	0.4
Glacial Sand and Gravel	Gravel, with thin pebbly clay bands at 8.5 m, 9.5 m and 11.8 m and 'clayey' sand and sandy gravel at base Gravel: mainly coarse, with cobbles at 4.5 m and 15.0 m; subangular quartzite with limestone, igneous rock and sandstone Sand: coarse to fine, subangular to subrounded	18.9	19.3
Ruabon Marl	Marl, red	0.8+	20.1

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
6	43	51	0.4-1.4	4	7	16	12	24	37	0
			1.4-3.5	5	9	14	11	23	38	0
			3.5-4.5	0	3	7	15	21	37	17
			4.5-6.0	1	4	12	16	27	40	0
			6.0-7.0	2	6	14	18	29	31	0
			7.0-8.5	2	5	7	13	24	49	0
			8.5-8.6	Clay band						
			8.6-9.5	0	6	8	9	17	60	0
			9.5-9.7	Clay band						
			9.7-10.5	7	16	22	13	22	20	0
			10.5-11.8	2	13	20	10	30	25	0
			11.8-11.9	Clay band						
			11.9-12.6	9	8	17	16	32	18	0
			12.6-13.5	8	3	18	22	15	34	0
			13.5-15.0	1	5	10	8	9	38	29
			15.0-17.3	14	63	20	3	0	0	0
			17.3-19.3	14	33	20	5	4	24	0
			Mean	6	17	15	11	18	30	3

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
0.4-1.4	83	6	0	9	2	trace	0
1.4-3.5	71	4	0	16	9	0	0
3.5-6.0	76	3	1	16	3	1	0
6.0-8.5	40	3	29	20	8	trace	0
8.5-9.5	33	27	26	13	1	trace	0
9.5-11.8	27	10	15	31	16	1	0
11.8-15.0	28	28	12	23	9	trace	0

* Includes 0.4 m Waste

SJ 34 SW 14 **0313 4322** **James's Farm, Ruabon** **Block A**

Surface level +110.5 m
Water not encountered
Shell and auger 203 mm diameter
March 1978

Overburden	0.5 m
Mineral	4.6 m
Waste	1.4 m
Bedrock	4.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown	0.5	0.5
Glacial Sand and Gravel	'Clayey' gravel Gravel: coarse and fine with cobbles at base, subangular to subrounded, quartzite with siltstone, sandstone and igneous rock Sand: fine to coarse	4.6	5.1
Boulder Clay	Clay, stiff, red-brown; subangular quartzite pebbles and scattered subangular limestone cobbles, grey silty sand laminae between 6.4 m and 6.5 m, traces of coal	1.4	6.5
Ruabon Marl	Marl, red-brown	4.1+	10.6

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
12	38	50	0.5-1.5	10	11	9	10	19	41	0
			1.5-2.5	18	16	18	11	22	15	0
			2.5-3.5	9	7	18	19	23	24	0
			3.5-4.5	7	7	17	14	20	35	0
			4.5-5.1	16	11	13	8	14	17	21
			Mean	12	10	15	13	20	27	3

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
0.5-4.5	48	16	6	23	7	trace	0
4.5-5.1	58	17	2	15	8	0	0

SJ 34 SW 15 **3210 4001** **Coed-deoedd-uchaf, Ruabon** **Block D**

Surface level +39.4 m
Water not encountered
Shell and auger 203 mm diameter
March 1978

Waste 1.9 m
Bedrock 1.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, red-brown, pebbly	0.3	0.3
Alluvium	Clay, soft, red-brown; scattered subrounded to subangular quartzite and sandstone pebbles, traces of coal	1.6	1.9
Ruabon Marl	Marl, bright red-brown	1.1+	3.0

SJ 34 SW 16 **3171 4218** **Rhos-y-Madoc Farm, Ruabon** **Block A**

Surface level +116.2 m
Water struck at 111.1 m
Shell and auger 203 mm diameter
February 1978

Waste 8.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown	0.3	0.3
Boulder Clay	Clay, stiff, sandy, red-buff; scattered subrounded quartzite and sandstone pebbles	5.2	5.5
Glacial Sand and Gravel	Sandy gravel Gravel: coarse to fine, subrounded to subangular, quartzite, sandstone and limestone Sand: medium to coarse	0.6	6.1
Boulder clay	Clay, stiff, dark brown to red-brown; quartzite, siltstone and sandstone pebbles	2.5+	8.6
	Borehole abandoned due to obstruction		

SJ 34 SW 17 **3270 4425** **Crymbal Farm, Ruabon** **Block B**

Surface level +99.6 m
Water struck at +92.9 m
Shell and auger 203 mm diameter
February 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, stony	0.3	0.3
Boulder clay	Clay, silty, red-brown with pockets of light grey; subrounded quartzite and sandstone pebbles	8.2	8.5

Glacial Sand and Gravel	Sandy gravel Gravel: coarse to fine, subrounded quartzite, subangular limestone, siltstone and igneous rock	1.1	9.6
Boulder clay	Clay, brown-grey, stony	1.2	10.8
Glacial Sand and Gravel	'Very clayey' sandy gravel Gravel: coarse with cobbles, subangular quartzite with limestone	1.8	12.6
Boulder Clay	Clay, silty, red-brown, with quartz and quartzite pebbles	5.4+	18.0

SJ 34 SW 18 **3285 4231** **Bryn Farm, Ruabon** **Block D**

Surface level +95.7 m
Water struck at +95.4 m
Shell and auger 203 mm diameter
March 1978

Overburden	0.5 m
Mineral	3.1 m
Waste	14.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown	0.5	0.5
Glacial Sand and Gravel	Gravel, 'clayey' in top 0.6 m Gravel: coarse to fine with cobbles at base, subangular to subrounded, sandstone with quartzite, siltstone and igneous rock Sand: coarse to fine, subrounded to subangular	3.1	3.6
Boulder clay	Clay, sandy, stiff, dark red: quartzite and siltstone pebbles	11.6	15.2
Glacial Sand and Gravel	Sand and sandy gravel, Gravel: fine, subrounded quartzite Sand: medium, subrounded	1.3	16.5
Boulder clay	Clay, stiff, red: cobbles of limestone	1.2+	17.7
	Borehole abandoned due to rock obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
5	25	70	0.5-1.1	11	13	10	9	25	32	0
			1.1-1.8	6	8	13	8	30	35	0
			1.8-2.8	3	5	10	11	37	34	0
			2.8-3.6	2	4	7	5	16	34	32
			Mean	5	7	10	8	28	34	8

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
0.5-3.6	20	42	2	20	14	2	0

SJ 34 SW 19 **3260 4128** **Pen-y-lan Farm, Ruabon** **Block D**

Surface level +94.0 m
Water struck at +90.4 m
Shell and auger 203 mm and 152 mm diameter
February 1978

Overburden	3.1 m
Mineral	2.3 m
Waste	14.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, stony	0.8	0.8
Boulder Clay	Clay, stiff, red-brown, with subrounded quartzite and igneous pebbles: becoming sandy and more stony with depth	2.3	3.1
Glacial Sand and Gravel	Gravel and sandy gravel Gravel: coarse with fine, subrounded quartzite, with sandstone siltstone, igneous rock and some limestone Sand: mainly medium	2.3	5.4
Boulder Clay	Clay, stiff, red-brown, with quartzite, red sandstone and limestone pebbles	14.7+	20.1

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
7	57	36	3.1-3.6	2	8	16	10	14	50	0
			3.6-4.6	10	22	37	8	15	8	0
			4.6-5.4	6	17	31	9	11	26	0
			Mean	7	17	31	9	13	23	0

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
3.1-5.4	43	23	5	19	10	trace	0

SJ 34 SW 20 **3365 4308** **Plas-Goulbourn, Erbistock** **Block D**

Surface level +96.1 m
Water not encountered
Shell and auger 203 mm diameter
February 1978

Waste	18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.2	0.2
Boulder Clay	Clay, silty, stiff, light to dark brown; bands of silty sand at 10 m and 15 m; sandstone and quartz pebbles	17.8+	18.0

SJ 34 SW 21 **3346 4134** **Graig, Ruabon** **Block D**

Surface level +92.2 m
Water struck at +84.2 m
Shell and auger 203 mm diameter
February 1978

Overburden	4.3 m
Mineral	1.1 m
Waste	1.3 m
Mineral	4.2 m
Waste	10.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown	0.3	0.3
Boulder clay	Clay, stiff, red-brown, with subrounded quartzite pebbles and small fragments of coal	4.0	4.3
Glacial Sand and Gravel	**a** Sandy gravel Gravel: coarse with fine, subrounded red sandstone and quartzite with traces of coal Sand: medium to coarse, subangular to subrounded	1.1	5.4
Boulder Clay	Clay, sandy, stiff, dark red, with angular fragments of turquoise marl, and red sandstone; traces of coal	1.3	6.7
Glacial Sand and Gravel	**b** 'Clayey' sand, mainly fine with medium; some pebbles	4.2	10.9
Glacial Silt	Sandy clayey silt, grey	2.0	12.9
Boulder Clay	Clay, sandy and silty, soft, red-brown; subrounded quartzite and quartz pebbles	8.1+	21.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	No data available										
b	17	81	2	6.7-8.9	18	64	15	1	2	0	0
				8.9-10.9	15	61	22	0	1	1	0
				Mean	17	62	18	1	2	trace	0

SJ 34 SW 22 **3482 4183** **Caennican Cottage, Erbistock** **Block D**

Surface level +78.7 m
Water struck at +66.7 m
Shell and auger 203 mm diameter
February 1978

Overburden	5.3 m
Mineral	8.2 m
Waste	7.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, clayey	0.5	0.5
Boulder Clay	Clay, soft in upper part, becoming stiff with depth, red-brown, laminated below 1.5 m	4.8	5.3

Glacial Sand and Gravel	'Pebbly' sand, with 0.3 m sandy clay at 7.7 m Gravel: fine to coarse, subrounded to subangular, quartzite with sandstone, limestone siltstone and igneous rock Sand: medium to fine with some coarse, subangular	8.2	13.5
Boulder Clay	Clay, sandy, soft in top metre, becoming stiff below, dark red, stony	7.1+	20.6

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
7	74	19	5.3-6.3	10	29	30	10	16	5	0
			6.3-7.3	6	12	24	11	21	16	10
			7.3-8.3	10	35	46	6	2	1	0
			8.3-9.3	12	11	35	13	11	18	0
			9.3-11.3	6	22	52	10	7	3	0
			11.3-13.5	5	17	41	19	13	5	0
			Mean	7	21	41	12	11	7	1

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
5.3-13.5	36	22	14	14	12	2	0

SJ 34 SW 23 **3446 4083** **Sodylt Hall** **Block D**

Surface level +75.8 m
Water struck at +73 m
Shell and auger 203 mm and 152 mm diameter
November 1977

Overburden	0.3 m
Mineral	3.0 m
Waste	2.2 m
Mineral	2.0 m
Waste	7.5 m
Bedrock	0.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, stony	0.3	0.3
Glacial Sand and Gravel	**a** Gravel with 'very clayey' pebbly sand at base Gravel: coarse to fine, subangular to subrounded, grey mudstone with quartzite and quartz Sand: coarse to medium in top 1 m, fine below, subangular quartz Fines: bands of coal fragments and silt	3.0	3.3
Boulder Clay	Clay, soft, dark red, silty and sandy, with quartzite pebbles	2.2	5.5
Glacial Sand and Gravel	**b** 'Very clayey' pebbly sand Gravel: coarse to fine, subangular, quartzite and siltstone with limestone, igneous rock, sandstone and quartz Sand: mainly fine, subangular to subrounded Fines: thin clayey bands	2.0	7.5
Boulder Clay	Clay, stiff, dark red, with quartzite, quartz, sandstone and igneous pebbles	7.5	15.0
Erbistock Beds	Sandstone, dark red, well-cemented	0.3+	15.3

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	17	38	45	0.3-1.3	4	6	12	13	22	43	0
				1.3-2.3	9	22	2	8	21	38	0
				2.3-3.3	39	46	1	3	6	5	0
				Mean	17	25	5	8	16	29	0
b	28	54	18	5.5-6.5	25	32	16	6	11	10	0
				6.5-7.5	30	45	8	3	4	10	0
				Mean	28	37	12	5	8	10	0
a+b	21	45	34	Mean	21	30	8	7	13	21	0

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	0.3-3.3	27	2	0	40	9	22	0
b	5.5-7.5	24	10	14	27	17	8	0

SJ 34 SE 5 **3544 4462** **Erbistock** **Block C**

Surface level +36.1 m
Water struck at +33.0 m
Shell and auger 152 mm diameter
September 1977

Overburden	2.8 m
Mineral	2.4 m
Waste	0.9 m
Mineral	3.0 m
Waste	4.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.3	0.3
Boulder Clay	Clay, sandy, stiff, grey, with quartzite, quartz and greywacke fragments	2.5	2.8
Glacial Sand and Gravel	**a** Gravel Gravel: coarse to fine, cobbles in upper metre, subangular to subrounded, quartzite with igneous rock, siltstone and limestone Sand: mainly coarse, angular to subangular	2.4	5.2
	Silt, dark brown	0.9	6.1
	b Gravel Gravel: coarse and fine with cobbles near base, subangular to subrounded, quartzite and igneous rock with siltstone and limestone Sand: mainly coarse to medium, angular to subangular	3.0	9.1
Boulder Clay	Clay, stiff, dark red-brown, with quartzite and sandstone pebbles	4.3+	13.4

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	1	31	68	2.8-3.8	2	1	5	13	31	24	24
				3.8-5.2	0	2	11	27	28	32	0
				Mean	1	2	8	21	29	29	10
b	9	33	58	6.1-7.1	7	17	18	17	29	12	0
				7.1-8.1	20	9	16	9	18	28	0
				8.1-9.1	0	1	2	9	21	39	28
				Mean	9	9	12	12	23	26	9
a+b	5	32	63	Mean	5	6	10	16	26	27	10

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	2.8-5.2	29	1	10	28	30	2	0
b	6.1-8.1	34	6	9	32	17	2	trace
	8.1-9.1	28	3	39	18	11	1	trace

SJ 34 SE 6 **3768 4352** **Ddol Eyton, Erbistock** **Block C**

Surface level +18.0 m
Water struck at +15.0 m
Shell and auger 203 mm and 152 mm diameter
October 1977

Overburden	2.1 m
Mineral	6.8 m
Waste	1.7 m
Mineral	1.4 m
Waste	11.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.3	0.3
River terrace Deposits	Sandy clay, dark brown, soft	1.8	2.1
	a Gravel Gravel: coarse to fine, subrounded to rounded quartzite with siltstone, igneous rock, some sandstone and vien quartz and a trace of chert Sand: medium to coarse, angular to subangular	6.8	8.9
Boulder Clay	Pebbly clay, stiff, dark reddish brown, with fragments of red sandstone	1.7	10.6
Glacial Sand and Gravel	**b** 'Very clayey' sand, brown, fine	1.4	12.0
? Glacial Silt	Silty clay, dark reddish brown, sandy in top 1.5 m, becoming stiff with depth	11.0+	23.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	5	38	57	2.1-3.1	13	8	44	12	19	4	0
				3.1-4.1	1	2	13	16	32	36	0
				4.1-5.1	13	6	21	13	28	19	0
				5.1-6.1	2	2	14	15	30	33	4
				6.1-7.1	1	3	11	10	21	48	6
				7.1-8.1	4	15	18	12	20	31	0
				8.1-8.9	1	3	12	11	29	44	0
				Mean	5	6	19	13	25	31	1
b	33	67	0	10.6-12.0	33	66	1	0	0	0	0
a+b	10	43	47	Mean	10	16	16	11	21	25	1

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	2.1-4.1	44	7	0	25	16	7	1
	4.1-6.1	42	7	0	27	20	4	trace
	6.1-8.9	32	1	0	28	36	3	trace

SJ 34 SE 7 **3541 4348** **Overton Castle, Erbistock** **Block C**

Surface level +41.2 m
Water not encountered
Shell and auger 203 mm diameter
October 1977

Overburden	0.3 m
Mineral	2.6 m
Bedrock	0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.3	0.3
River Terrace Deposits	Gravel, 'very clayey' in top metre Gravel: coarse to fine, subrounded to rounded, siltstone with quartzite, igneous rock and quartz Sand: coarse to medium	2.6	2.9
Erbistock Beds	Sandstone, hard, dark red	0.2+	3.1

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
19	32	49	0.3-1.5	32	15	13	6	11	23	0
			1.5-2.9	8	5	11	14	33	29	0
			Mean	19	10	12	10	23	26	0

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
0.5-2.5	17	2	0	49	21	11	0

SJ 34 SE 8 **3592 4257** **Home Farm, Overton** **Block D**

Surface level +42.6 m
Water not encountered
Shell and auger 203 mm diameter
October 1977

Overburden	0.5 m
Mineral	5.2 m
Waste	14.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, sandy	0.3	0.3
River Terrace Deposits	Sandy pebbly clay, light brown	0.2	0.5
	Gravel, 'very clayey' near base Gravel: mainly coarse with cobbles, subrounded to subangular, igneous rocks with greywacke and quartzite Sand: coarse to medium, subangular to subrounded	5.2	5.7
Boulder Clay	Clay, stiff, red-brown, with pebbles of quartzite and igneous rock and sandy partings	14.8+	20.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
11	31	58	0.5-1.5	5	3	7	9	12	23	41
			1.5-2.5	5	1	8	14	17	50	5
			2.5-3.5	10	4	24	15	17	30	0
			3.5-4.5	6	5	17	12	17	25	18
			4.5-5.7	28	11	16	10	17	18	0
			Mean	11	5	14	12	16	30	12

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
0.5-2.5	19	2	9	24	46	trace	trace
3.5-5.7	23	4	trace	26	46	1	0

SJ 34 SE 9 **3592 4141** **Boat Inn, Erbistock** **Block D**

Surface level +28.1 m
Water struck at +18.1 m
Shell and auger 203 mm and 152 mm diameter
February 1978

Waste	10.9 m
Bedrock	0.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.4	0.4
River Terrace Deposits	Clay, silty, sandy, soft, red-brown; sporadic pebbles	3.2	3.6
	'Clayey' sandy gravel Gravel: coarse to fine, subangular to rounded, mostly quartzite Sand: medium to coarse, angular to subangular	0.7	4.3
	Clay, stiff, dark brown	4.7	9.0
	Sandy Gravel Gravel: fine to coarse, mostly quartzite Sand: coarse to fine	1.6	10.6
? Erbistock Beds	Clay, stiff, red	0.3	10.9
Erbistock Beds	Marl, red, sandy	0.4+	11.3

SJ 34 SE 10 **3515 4078** **Knolton Hall, Overton** **Block D**

Surface level +76.7 m
Water not encountered
Shell and auger 203 mm and 152 mm diameter
November 1977

Overburden	3.8 m
Mineral	4.1 m
Waste	12.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.4	0.4
Boulder Clay	Clay, silty, reddish brown, stony in upper 1.5 m	3.4	3.8
Glacial Sand and Gravel	Sandy gravel on sand with some pebbles Gravel: mainly fine, rounded quartzite with limestone, igneous rock, sandstone and siltstone Sand: medium, subrounded to rounded quartz with quartzite and fine heamatite stained subangular to subrounded quartz; traces of coal	4.1	7.9
Boulder Clay	Clay, red, stiff, silty, pebbly	5.4	13.3
	Clay, silty, red and grey, interbedded with dark green silty sand in upper part; few pebbles and scattered fragments of coal and red sandstone	6.7	20.0

SJ 34 SE 11 **3669 4419** **Ddol Eyton, Erbistock** **Block C**

Surface level +20.4 m
Water struck at +16.1 m
Shell and auger 152 mm diameter
October 1977

Overburden	1.4 m
Mineral	4.2 m
Bedrock	0.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, loamy	0.3	0.3
Alluvium	Clay, sandy, dark brown, pebbly	1.1	1.4
River Terrace Deposits	Gravel Gravel: alternating layers of fine and coarse, subangular to subrounded, quartzite, igneous rock and siltstone Sand: coarse to medium, angular to subangular	4.2	5.6
Permo-Triassic	Sandstone, dark red, well-cemented	0.9+	6.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
4	27	69	1.4-2.4	3	3	8	10	19	41	16
			2.4-3.4	4	3	10	17	25	36	5
			3.4-4.4	3	3	9	10	15	29	31
			4.4-5.6	5	3	15	13	30	34	0
			Mean	4	3	11	13	23	34	12

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
1.4-3.4	33	3	0	30	33	1	0
3.4-5.6	21	3	0	28	46	2	trace

SJ 34 SE 12 **3644 4333** **Bryn-y-Pys, Overton** **Block D**

Surface level +66.1 m
Water not encountered
Shell and auger 203 mm and 152 mm diameter
October 1977

Waste	18.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.5	0.5
Boulder Clay	Clay, sandy, stiff, dark red-brown; sporadic pebbles and silty sandy partings	18.0+	18.5

SJ 34 SE 13 **3688 4149** **Millwood, Overton** **Block D**

Surface level +25.2 m
Water struck at +23.2 m
Shell and auger 203 mm diameter
October 1977

Overburden 2.1 m
Mineral 1.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, loamy, scattered pebbles	0.5	0.5
Alluvium	Clay, sandy, brown-buff	1.6	2.1
River Terrace Deposits	Gravel Gravel: coarse, subangular to rounded, siltstone and greywacke with igneous rock and quartzite Sand: mainly coarse	1.4+	3.5
	Borehole abandoned due to rock obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
3	24	73	2.1-3.5	3	8	0	16	25	48	0

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
2.1-3.5	13	2	0	53	24	8	0

SJ 34 SE 14 **3771 4458** **Race Course, Bangor** **Block C**

Surface level +17.4 m
Water struck at +14.4 m
Shell and auger 203 mm and 152 mm diameter
November 1977

Overburden 1.0 m
Mineral 4.7 m
Waste 15.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, loamy	0.3	0.3
Alluvium	Clay, sandy, especially at base, soft; scattered small pebbles and coal fragments	0.7	1.0
River Terrace Deposits	Gravel Gravel: fine to coarse with cobbles, subrounded to rounded, siltstone, igneous rock (mostly coarse and cobble grade and decreasing with depth) and quartzite Sand: coarse to medium (becoming coarser with depth), subangular to subrounded	4.7	5.7
? Boulder Clay	Clay, mainly very sandy, stiff, red-brown; thin micaceous partings near top	12.3	18.0
Glacial Sand and Gravel	'Clayey' to 'very clayey' sand with bands of clay towards base	3.5	21.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
4	27	69	1.0-2.0	10	1	13	12	25	26	13
			2.0-3.0	3	3	11	10	23	39	11
			3.0-4.0	2	2	5	16	28	36	11
			4.0-5.0	3	4	9	21	22	20	21
			5.0-5.7	2	6	7	15	36	34	0
			Mean	4	3	9	15	26	31	12

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
1.0-2.0	21	1	0	34	41	3	0
2.0-4.0	26	6	0	44	20	4	0
4.0-5.7	17	5	0	48	28	2	0

SJ 34 SE 15 **3703 4278** **Bryn-y-pys, Overton** **Block D**

Surface level +65.2 m
Water not encountered
Shell and auger 203 mm and 152 mm diameter
October 1977

Overburden	1.0 m
Mineral	2.0 m
Waste	17.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy, dark brown	0.3	0.3
Glacial Sand and Gravel	Clay, sandy, pale brown, with small pebbles	0.7	1.0
	'Very clayey' pebbly sand, Gravel: fine, subrounded to rounded, quartzite, sandstone and siltstone Sand: mainly medium, traces of coal	2.0	3.0
Boulder Clay	Clay, sandy, silty, stiff, dark brown, scattered stones	17.0+	20.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
20	69	11	1.0-2.0	22	12	42	13	9	2	0
			2.0-3.0	18	29	32	11	7	3	0
			Mean	20	21	36	12	8	3	0

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
1.0-3.0	27	29	0	28	8	8	0

SJ 34 SE 16 **3802 4244** **Carreg-y-ffranc, Overton** **Block D**

Surface level +61.4 m
Water struck at +56.4 m
Shell and auger 152 mm diameter
October 1977

Overburden	4.0 m
Mineral	2.2 m
Waste	16.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy, brown	0.5	0.5
Glacial Sand and Gravel	Clay, brown, stiff, increasingly sandy with depth, laminated	3.5	4.0
	'Very clayey' sand, pebbly in upper metre Gravel: fine, subangular to rounded quartzite with siltstone and igneous rocks Sand: medium to fine, subangular to subrounded: high proportion of coal	2.2	6.2
? Glacial Silt	Clay, sandy and silty, brown to red-brown, laminated below 13 m	16.8+	23.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
22	76	2	4.0-5.0	41	23	25	5	5	1	0
			5.0-6.2	7	50	39	4	0	0	0
			Mean	22	39	33	4	2	trace	0

COMPOSITION

Depth below surface (m)	percentages by weight in +8 mm fraction						
	Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
4.0-5.0	55	8	0	17	12	8	trace

SJ 34 SE 17 **3749 4174** **Fairleigh, Overton** **Block D**

Surface level +66.5 m
Water struck at +62.0 m
Shell and auger 152 mm diameter
October 1977

Overburden	3.0 m
Mineral	2.0 m
Waste	1.5 m
Mineral	5.9 m
Waste	9.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, loamy	0.3	0.3
Glacial Sand and Gravel	Clay, brown to grey, increasingly sandy with depth; stones and bands of sand	2.7	3.0
	a 'Very clayey' sandy gravel Gravel: mainly fine subrounded to rounded, mostly quartzite Sand: medium with coarse and fine, high coal content	2.0	5.0
Boulder Clay	Clay, sandy, pebbly	1.5	6.5
Glacial Sand and Gravel	**b** 'Pebbly' sand on sand Gravel: fine, subrounded, quartzite Sand: medium, high coal content	5.9	12.4
? Glacial Silt	Clay, soft, dark brown with sandy laminations to 15 m; more massive, grey, silty clay below	9.1+	21.5

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	22	50	28	3.0-5.0	22	14	24	12	19	9	0
b	2	95	3	6.5-7.5	6	18	53	10	9	4	0
				7.5-9.0	3	15	71	9	1	1	0
				9.0-12.4	1	30	63	5	1	0	0
				Mean	2	24	64	7	2	1	0
a+b	7	83	10	Mean	7	22	53	8	7	3	0

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	3.0-5.0	64	8	0	14	7	7	0

SJ 34 SE 18 **3859 4456** **Althrey Farm, Bangor** **Block C**

Surface level +18.0 m
Water struck at +13.6 m
Shell and auger 203 mm and 152 mm diameter
November 1977

Overburden	1.0 m
Mineral	17.2 m
Waste	1.8 m
Mineral	0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy, dark brown	0.2	0.2
River Terrace Deposits	Clay, sandy, brown	0.8	1.0
	a Gravel, Gravel: coarse to fine with cobbles, mostly subangular to rounded, siltstone and mudstone with igneous rock and quartzite Sand: coarse, medium and angular to subrounded, quartzite and quartz; with some red sandstone	7.0	8.0
Glacial Sand and Gravel	**b** Sand, 'very clayey' between 12.0 m and 13.0 m, buff to red, medium to fine, subrounded to rounded	7.0	15.0
	c 'Pebbly' sand and sandy gravel, Gravel: mainly fine, rounded to subangular, quartzite and igneous rock with silstone Sand: medium with fine and coarse, subrounded	3.2	18.2
	Clay, soft, brown, pebbly at top; light grey silty laminations	1.8	20.0
	d Sand: fine	0.5+	20.5
	Borehole abandoned due to rising sand		

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	3	39	58	1.0-2.0	4	5	13	11	19	27	21
				2.0-3.0	2	4	20	15	19	40	0
				3.0-5.0	3	2	12	14	24	32	13
				5.0-6.0	4	2	7	19	30	38	0
				6.0-7.0	1	7	18	13	44	12	5
				7.0-8.0	3	20	49	9	14	5	0
				Mean	3	6	19	14	25	26	7
b	6	94	0	8.0-9.0	3	24	70	2	1	0	0
				9.0-10.0	3	57	38	2	0	0	0
				10.0-11.0	2	49	48	1	0	0	0
				11.0-12.0	2	46	50	2	0	0	0
				12.0-13.0	21	45	33	1	0	0	0
				13.0-14.0	9	48	41	2	0	0	0
				14.0-15.0	5	43	49	3	0	0	0
				Mean	6	45	47	2	trace	0	0
c	2	71	27	15.0-16.0	2	31	44	10	10	3	0
				16.0-17.0	2	22	42	15	16	3	0
				17.0-18.2	2	10	24	17	27	20	0
				Mean	2	20	37	14	18	9	0
d	15	85	0	20.0-20.5	15	79	5	1	0	0	0
b+c+d	6	85	9	Mean	6	39	40	6	6	3	0
a-d	4	68	28	Mean	4	26	33	9	13	12	3

COMPOSITION

	Depth below surface (m)	percentages by weight in +8 mm fraction						
		Quartzite	Sandstone	Limestone	Siltstone/ Greywacke	Igneous Rock	Quartz	Chert/ Flint
a	1.0-5.0	19	5	0	42	33	1	0
	6.0-8.0	36	6	0	14	37	7	trace
c	15.0-18.2	37	6	9	17	17	4	0

SJ 34 SE 19 **3855 4151** **Plas-yn-y-coed, Overton** **Block D**

Surface level +56.8 m
Water not encountered
Shell and auger 152 mm diameter
October 1977

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.3	0.3
Boulder Clay	Clay, silty, stiff, red-brown, with grey laminations	17.7+	18.0

SJ 34 SE 20 **3975 4305** **Cloy Bank, Overton** **Block D**

Surface level +39.9 m
Water not encountered
Shell and auger 152 mm diameter
October 1977

Overburden 7.3 m
Mineral 7.4 m
Waste 5.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, clayey	0.3	0.3
Boulder Clay	Clay, stiff, red-brown, pebble free, silty laminations	7.0	7.3
Glacial Sand and Gravel	'Clayey' sand, grey: fine to medium	7.4	14.7
Boulder Clay	Clay, silty, red-brown, calcareous: rare laminations, traces of coal and white shell fragments	5.3+	20.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
15	85	0	7.3-8.3	18	46	36	0	0	0	0
			8.3-9.3	14	5	79	2	0	0	0
			9.3-14.7	15	62	22	1	0	0	0
			Mean	15	52	32	1	0	0	0

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Dd 617406 K8

Printed in England for Her Majesty's Stationery Office by Commercial Colour Press, London E7

INSTITUTE OF GEOLOGICAL SCIENCES

INDUSTRIAL MINERALS ASSESSMENT UNIT

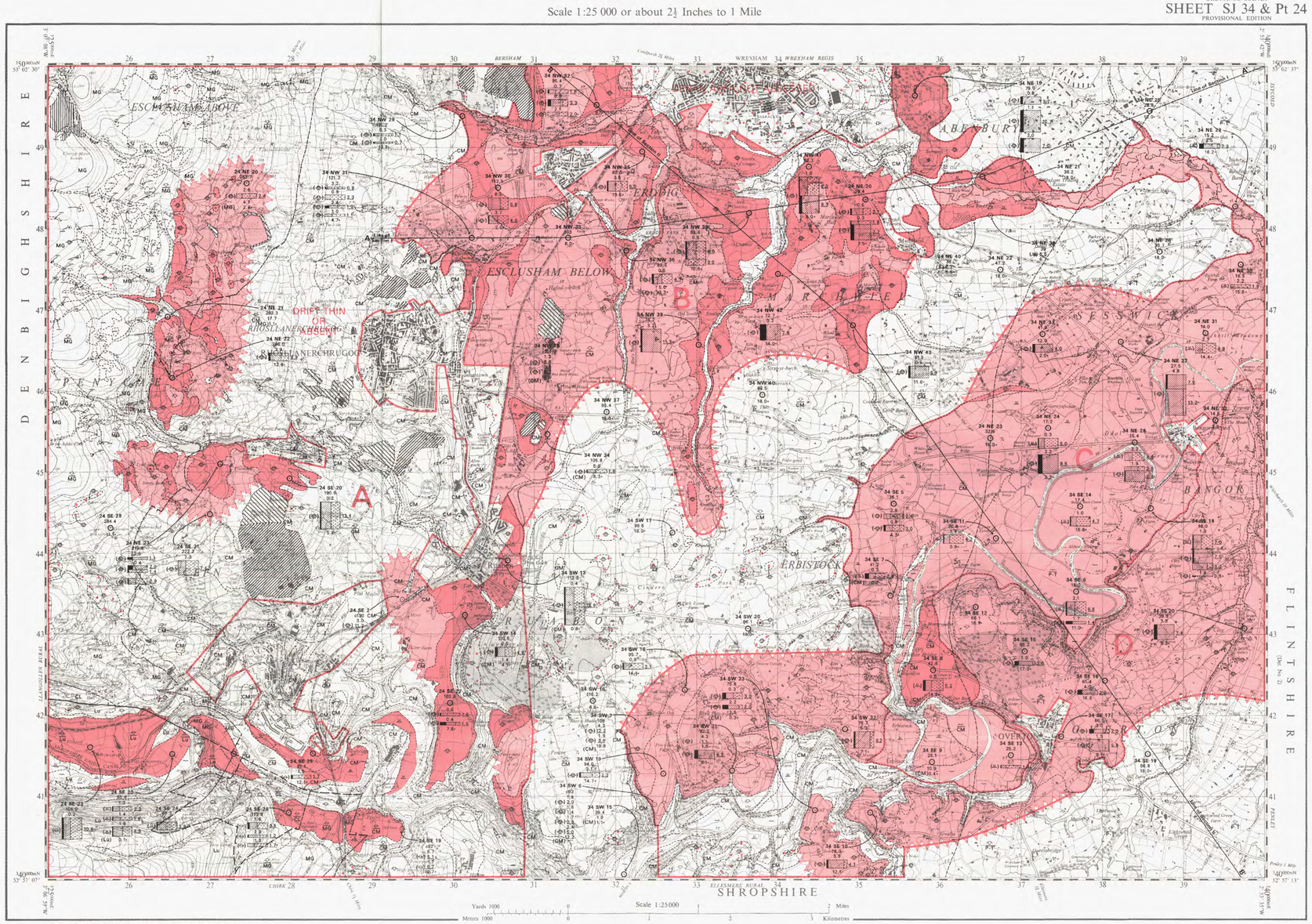
THE SAND AND GRAVEL RESOURCES OF THE AREA SOUTH OF WREXHAM

Scale 1:25 000 or about 2½ Inches to 1 Mile

ORDNANCE SURVEY
SHEET SJ 34 & Pt 24
PROVISIONAL EDITION

This map should be read in conjunction with the accompanying report which contains details of the assessment of the resources.

106



The representation on this map of a road, track, or footpath, is no evidence of the existence of a right of way

Original geological survey published on Old Series One-inch maps in 1850 and 1855 with some revisions in 1895. Resurveyed by D.A. MacAlister, H.H. Thomas, C.P. Wedd and L.J. Wills in 1910-13, and E.G. Poole and A.J. Whiteman in 1956-57, partially revised by D.J. Lowe, A.J. Needham and R.J. Tappin in 1977-78.

I.P. Stevenson, District Geologist.

Sand and Gravel survey by D.F. Ball, K.A. McAdam and P.N. Dunkley in 1977-78.

R.G. Thurrell, Head, Industrial Minerals Assessment Unit.

1:25,000 Sand and Gravel Resource sheet published 1982.

G.M. Brown, D.Sc., F.R.S., Director, Institute of Geological Sciences.

The GRID lines on this sheet are at 1 Kilometre interval. Heights are in feet above Mean Sea Level at Newlyn. Contour values are in feet: 1 square inch on this map represents 99 633 metres on the ground.

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 in a whole in each Resource Block are given in the Report.

Compiled from 6" sheets last fully revised 1899-24. Other partial systematic revision 1938-48 has been incorporated. Major roads revised 1965-74.

SJ 25	SJ 35	SJ 45
SJ 24	SJ 34	SJ 44
	121 122	
	137 138	

Diagram showing the relation of the National Grid 1:25,000 sheets to the New Series Geological Sheets 121, 122, 137 and 138.

EXPLANATION OF SYMBOLS AND ABBREVIATIONS

Landslip L-1

DRIFT

	Peat P-1	RECENT AND PLEISTOCENE
	Alluvium - clays and silts A-21	
	Alluvial Fan, Cone or Delta AF-5	
	River Terrace Deposits, undifferentiated - mainly gravel RT-24	
	Late-Glacial Flood-Gravels - mainly sand and gravel LG-3	
	Boulder Clay - stiff, stony clay and soft, partly laminated silty clay BC-39	
	Glacial Sand and Gravel - sand and sandy gravel GS-23	
	Glacial Silt - partly laminated brown silt GSI-9	

SOLID

P-T	**Undivided** - mainly red sandstone with pebbly bands and conglomerates	PERMIAN TRIASSIC
CM	**Coal Measures** - shale, sandstone, marl and coal seams	CARBONIFEROUS
MG	**Millstone Grit 'Series'** - sandstone with subordinate mudstone	
CL	**Carboniferous Limestone 'Series'** - limestone with shale and, especially in upper part, sandstone	
Lu	**Ludlow Series** - grey mudstone and thin sandy beds	SILURIAN

Made Ground MG-2

Worked-out area WO-11

BOUNDARY LINES

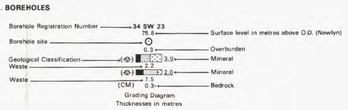
- Geological boundary, Drift
- Geological boundary, Solid
- Fault; crossmark indicates downthrow side
- Inferred boundary between recognised categories of deposits
- Resource Block boundary
- Broken lines denote uncertainty

BOREHOLE DATA

SITE LOCATIONS

- Industrial Minerals Assessment Unit (I.M.A.U.) Boreholes
- Other Boreholes

I.M.A.U. 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, eg. 34 NE 28. The first number and letters refer to the quarter sheet and the last number to the I.G.S. serial number for that quarter. The unique designation for borehole 34 SW 23 is SJ 34 SW 23.

Grading Diagrams

Each grading diagram shows the mean particle size distribution of a distinct deposit of mineral.

The height of the diagram is proportional to the mineral thickness
The widths of the divisions show the proportion of **Fines**, **Sand** and **Gravel**, but small amounts of gravel may be omitted or exaggerated.

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, assessed	CAT-E2
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

Where appropriate on other sheets a category 'Discontinuous spreads of mineral beneath overburden' is recognised

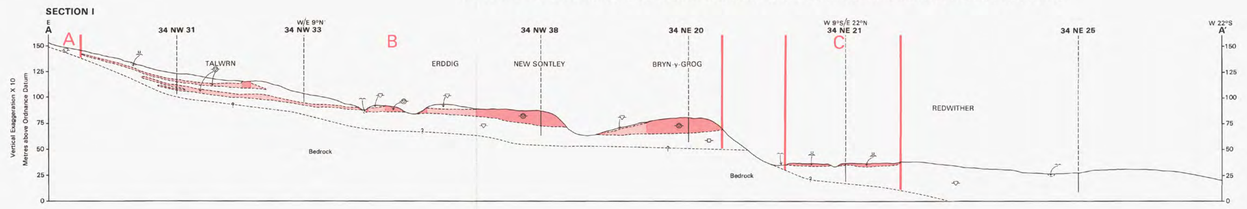
RESOURCE BLOCKS

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

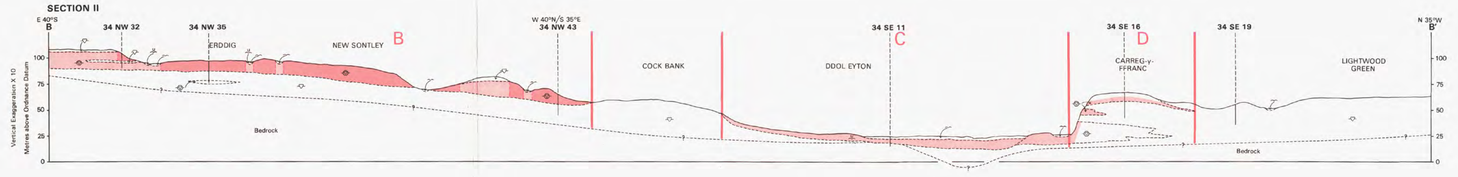
Detailed records may be consulted on application to Head, Industrial Minerals Assessment Unit, Institute of Geological Sciences, Nottingham, NG12 5GG.

GENERALISED HORIZONTAL SECTIONS SHOWING THE RELATIONSHIPS BETWEEN DRIFT DEPOSITS

SECTION I



SECTION II



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