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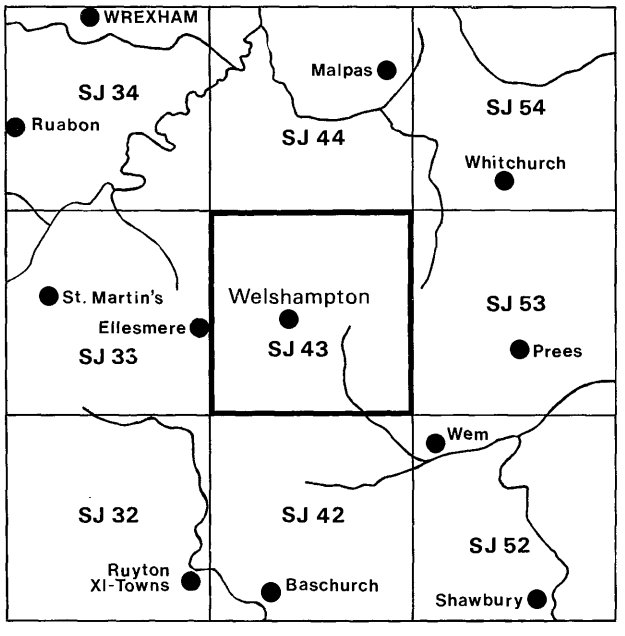

The sand and gravel resources of the Welshampton area, Shropshire and Clwyd

Description of 1:25 000 resource sheet SJ 43

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The first twelve reports on the assessment of British sand and gravel resources appeared in the Report Series of the Institute of Geological Sciences as a subseries. Report No. 13 and subsequent reports appear as Mineral Assessment Reports of the Institute.

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

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PREFACE

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

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

This report describes the sand and gravel resources of 100 km^2 of country around Welshampton, Shropshire/Clwyd, shown on the accompanying 1:25 000 resource map. The survey was conducted by A. C. Wilson and S. J. Mathers, assisted in the drilling and sampling programme by K. A. McL. Adlam, D. F. Ball, B. Cannell, J. R. Gozzard, C. W. Thomas and D. Thomas. The work is based on geological surveys at 1:10 560 between 1911 and 1922 by R. W. Pocock, L. J. Wills and B. Smith and in 1956-57 by A. J. Whiteman.

Messrs. J. D. Burnell, G. I. Coleman and W. N. Pierce (Land Agents) were responsible for negotiating access to land for drilling. The ready cooperation of landowners and tenants in this work is gratefully acknowledged.

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SUMMARY

The geological maps of the Institute of Geological Sciences, pre-existing borehole information, and boreholes drilled for the Industrial Minerals Assessment Unit form the basis of the assessment of the sand and gravel resources of the country around Welshampton, Shropshire/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 1:25 000 map is divided into five resource blocks, containing between 3.6 and 36.5 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 gradings are stated. Detailed borehole data are also given. The geology, the position of the boreholes and the outlines of the resource blocks are shown on the accompanying map.

Notes

Each borehole registered with the Institute is identified by a four-element code (e.g. SJ 43 NW 15). 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 two elements alone (e.g. NW 15).

Bibliographical reference

INSTITUTE OF GEOLOGICAL SCIENCES. 1982. The sand and gravel resources of the Welshampton area, Shropshire/Clwyd: description of 1:25 000 resource sheet SJ 43. **Miner. Assess. Rep. Inst. Geol. Sci.,** No. 105.

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' and 'inferred' levels. Indicated assessments "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". 'Inferred' assessments are those "based largely on broad knowledge of the geologic character of the deposit and for which there are few, if any, samples or measurements." (Bureau of Mines and Geological Survey, 1948, p 15).

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

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

A deposit of sand and gravel that broadly meets these criteria is regarded as 'potentially workable' and is described and assessed as 'mineral' in this report.

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 $\frac{1}{16}$ mm, $\frac{1}{4}$ mm, 1 mm, 4 mm, 16 mm, 64 mm has been adopted. The boundaries between fines (that is, the clay and silt fractions) and sand, and between sand and gravel grade material, are placed at $\frac{1}{16}$ mm and 4 mm respectively (see Appendix C).

The volume and other characteristics are assessed within resource blocks, each of which, ideally, contains approximately 10 km^2 of sand and gravel. No account is taken of any factors, for example roads, villages or land of high agricultural or landscape value, which might stand in the way of sand and gravel being exploited, although towns are excluded. The estimated total volume therefore bears no simple relationship to the amount that could be extracted in practice.

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

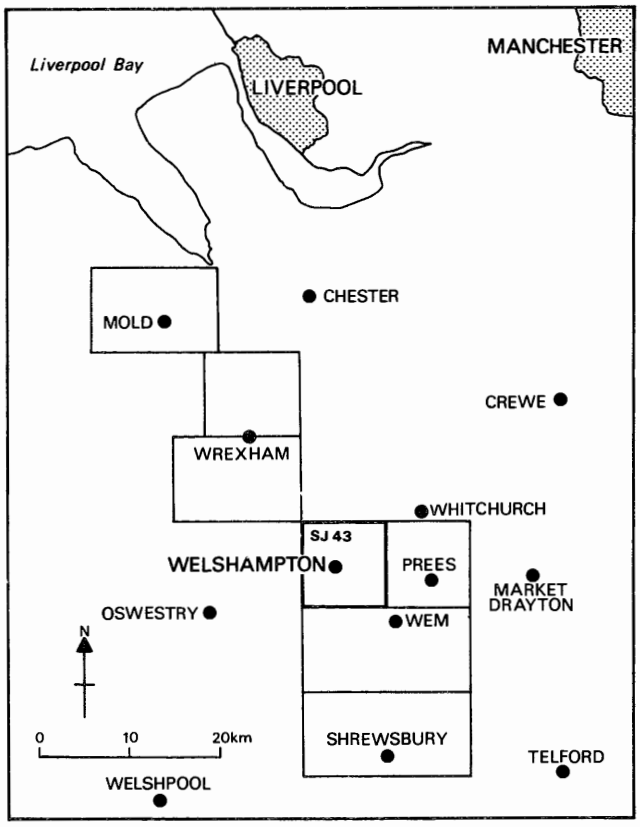


Figure 1 Map showing the location of Sheet SJ 43.

DESCRIPTION OF THE DISTRICT

General

The Welshampton area (Figure 1) lies astride the Shropshire-Clwyd border and is almost exclusively devoted to mixed farming. The town of Ellesmere lies in the west of the area. Much of the southern half of the area is of moderate to low relief and comprises rolling terrain (around the 90 m contour) from which a number of small streams drain south towards the River Severn. Hummocky terrain underlain by till and Glacial Sand and Gravel is well developed along a discontinuous morainic ridge which trends north-east across the Welshampton area from around and south of Ellesmere. Many of the hummocks are whaleback or drumlinoid in form but others are more irregular. Several large meres or lakes are present in depressions within the moraine. The northern part of the area is dissected by a number of incised 'misfit' streams which flow northwards towards the River Dee. All localities mentioned in the text are shown in Figure 2.

Geology

The geology of the northern part is described in the Nantwich and Whitchurch memoir (Poole and Whiteman, 1966) and that of the southern part in the Wem memoir (Pocock and Wray, 1925). There are no exposures of the Solid geology but a gravel pit at Wood Lane [423 325] shows a good section in Drift deposits.

The geological sequence is summarised in Table 1, where the deposits are listed, as far as possible, in order of increasing age. The relationships between the deposits are illustrated in the geological sections (Figure 4), the lines of which are shown on the resource map.

Poole and Whiteman (1961) have described the glacial stratigraphy of the area as a tripartite sequence of Upper Boulder Clay, Middle Sands, Lower Boulder Clay. Due to the variable and complex successions encountered in boreholes, the two Boulder Clays, which are of similar lithology, are described together under the heading 'Till'. The Middle Sands constitute the Glacial Sand and Gravel.

Table 1 Geological sequence.

DRIFT	
Recent and Pleistocene	Peat
	Alluvium
	Alluvial Fan
	Lacustrine Deposits
	Till (Upper Boulder Clay)
	Glacial Sand and Gravel
	Glacial Laminated Clays
	Till (Lower Boulder Clay)
SOLID	
Jurassic/Triassic	Undivided

SOLID

Triassic and Jurassic bedrock lies beneath a thick (30 m +) Drift cover and was not encountered in boreholes drilled for this survey. The bedrock is not considered further in this report.

DRIFT

A varied and complex Drift sequence occurs in the Welshampton area (Figures 3 and 4) and through comparison with deposits found elsewhere in the west Midlands is thought to range in age from late-Devensian to Recent (Wilson, Mathers and Cannell, 1982). A tripartite division of the Drift sequence was recognised during the mapping of the area, with a Middle Sands unit separating Lower and Upper Boulder Clay (Poole and Whiteman, 1961). The Middle Sands was considered to be a pro-glacial outwash deposit laid down during the retreat of an early ice sheet; it was, however, overridden by a later ice sheet which deposited the Upper Boulder Clay. Both of these ice-sheets were considered to be of northern origin but they may have coalesced with a smaller ice sheet moving eastwards off the Welsh hills. The conspicuous morainic ridge, commonly underlain by over 50 m of Drift deposits, which extends intermittently from Wrexham through the Ellesmere area towards Whitchurch, was considered by Poole and Whiteman to be a terminal moraine which was formed during the final phase of Middle Sands deposition. The Middle Sands have been reinterpreted (Wilson, Mathers and Cannell, 1982) as prograding sandur deposits related to the Upper Boulder Clay ice-sheet.

Till This category includes Upper Boulder Clay, which crops out over a large part of the survey area overlying mineral deposits (Middle Sands), and the Lower Boulder Clay proved beneath mineral in some the deeper boreholes in the south of the survey area. The tills are developed throughout the area and most are reddish-brown in colour (typically 5YR 4/3 of the Munsell Soil

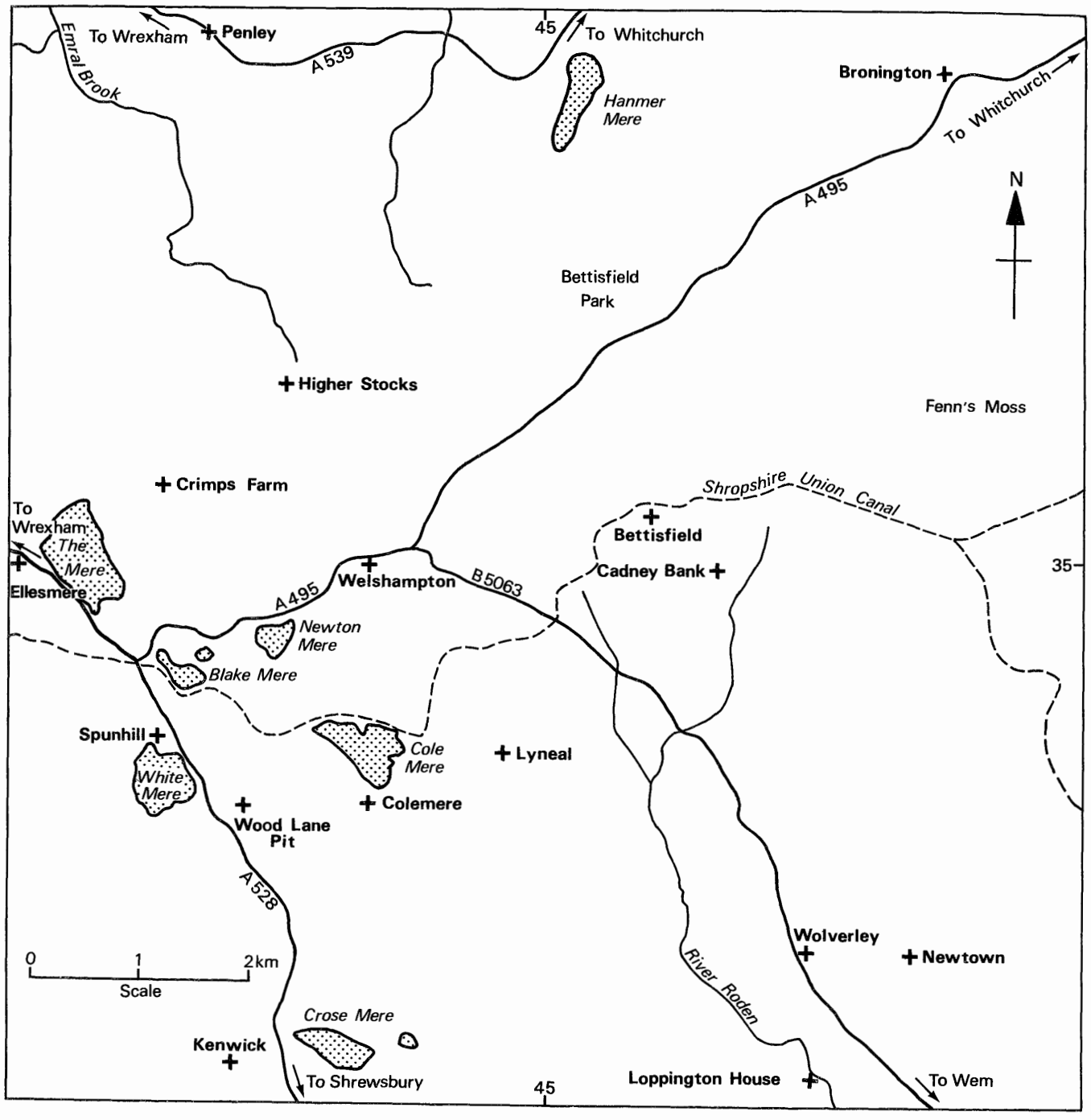


Figure 2 Locality map.

Color Chart). They vary from cohesive and plastic to friable and many contain a small proportion of gravel-sized clasts in a clayey matrix. Some till matrices contain sand and silt which are also present in poorly-defined layers, and these are believed to be flow tills in contrast with the more typical massive tills which are regarded as lodgement. The clasts present in the tills are similar to those in the coarser fractions of the Glacial Sand and Gravel deposits (see 'Composition of the sand and gravel deposits'). In addition, derived marine shells (*Turritella* sp.), coal, Keuper marl and uncemented sand balls occur in minor proportions. Most clasts are rounded, some are angular, others are polished and a few are striated.

Glacial Laminated Clays These deposits comprise reddish-brown stone-free laminated silts and clays. Graded bedding and small scale cross-stratification are well developed in these deposits which are thought to be either varves or small lacustrine turbidites. These sediments do not occur at any specific height and they are considered to represent the infilling of discrete ponds (possibly within or beneath the ice) rather than major lakes.

Glacial Sand and Gravel These deposits are widely developed in the south-western and central parts of the area, where they are in excess of 25 m thick, and also below tills in the north-west. Sands and gravels are the dominant types of sediment although sandy silts and clays are also present. Cobble-sized clasts are the largest normally encountered although boulders do occur. Bedding is uneven within these deposits and the considerable lateral and vertical variability in sedimentary structures, textures, grain size and fabrics is consistent with deposition from braided streams. Such streams commonly operate within sandur (outwash plains) and it is considered that the deposits to the south

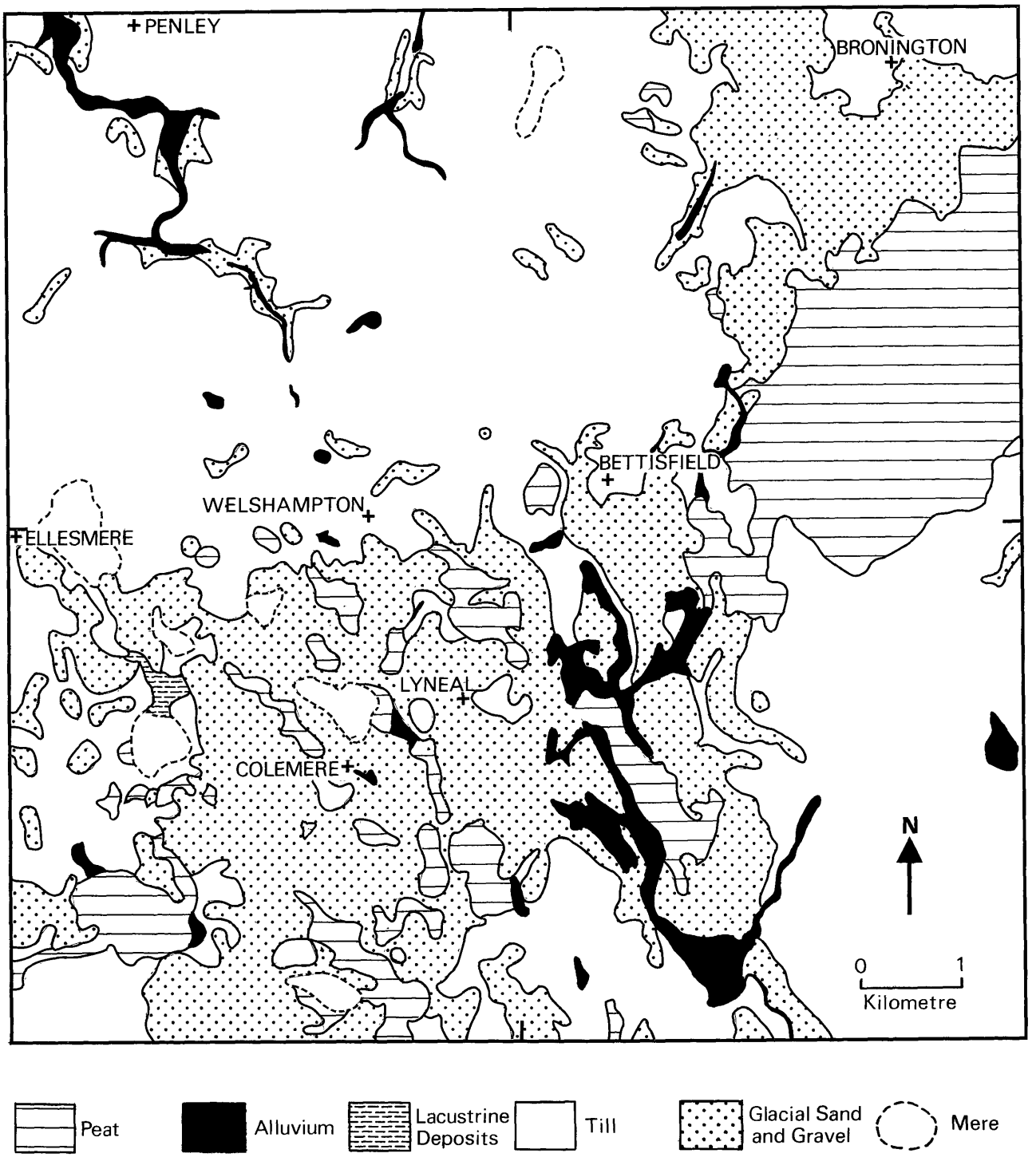


Figure 3 Drift geology.

of the Ellesmere moraine were laid down in such a setting. The deposits exhibit a coarsening-upward trend indicative of sandur progradation and ice advance.

Lacustrine Deposits These sediments are similar to the Glacial Laminated Clays but they occur in flat-lying tracts adjacent to meres or in sites occupied by former meres, the largest of which is that at Fenn's Moss. These deposits were laid down in early post-Glacial times when the meres were more numerous and larger.

Alluvial Fan Two small occurrences are present on valley sides within the survey area. There are no exposures of these deposits.

Alluvium There are no major alluvial tracts within the area, that along the River Roden being the most prominent. The deposits are thin and comprise mainly silts and clays with some sands and gravel which are locally derived from the Glacial Sand and Gravel outcrop.

Peat Peat deposits occur in basinal areas where they commonly cap sequences of Lacustrine Deposits or Alluvium. The most extensive and thickest deposit (reputedly up to 7.6 m - Poole and Whiteman, 1966, p.94) occurs at Fenn's Moss.

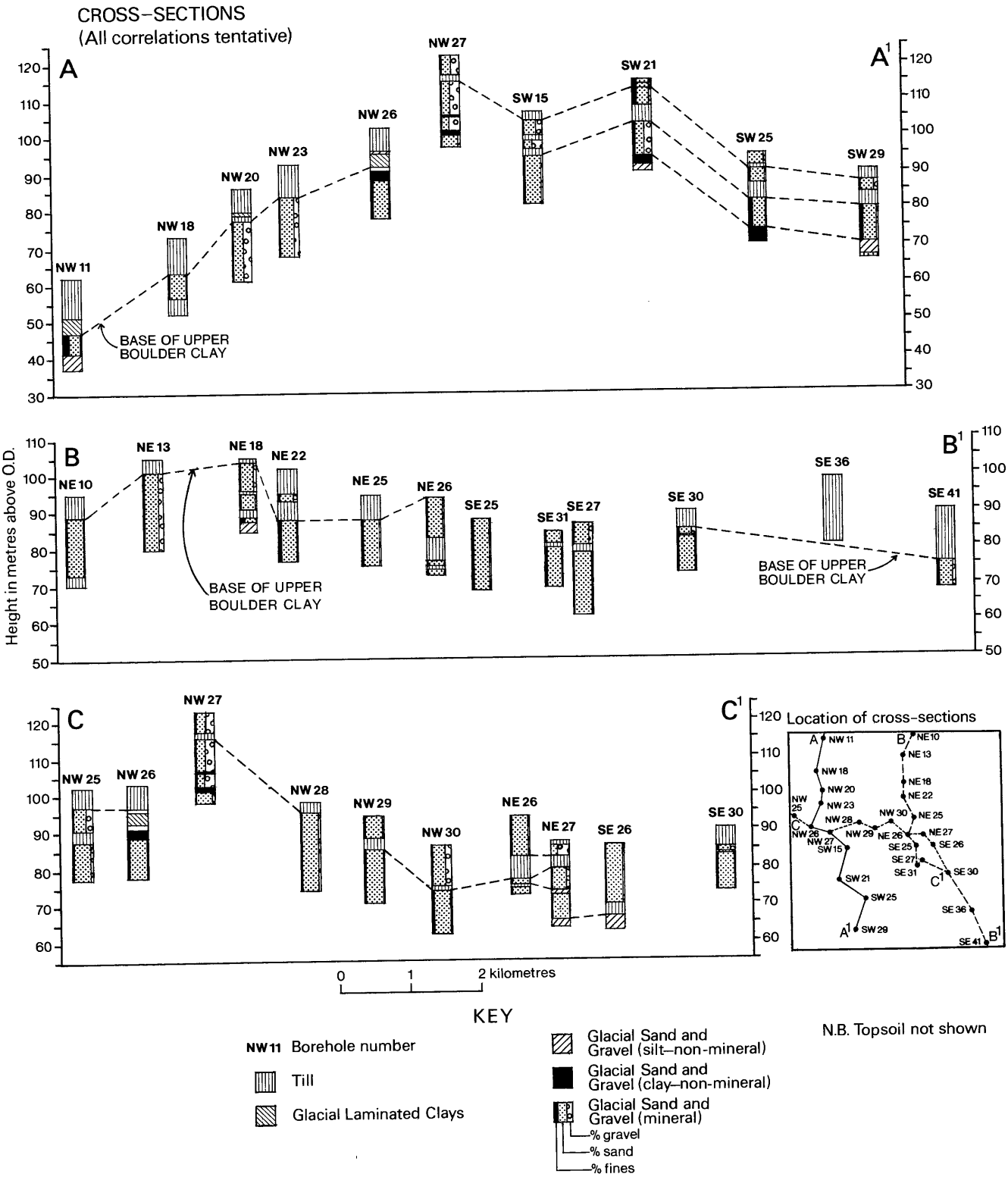


Figure 4 Cross-sections showing the relationships between the Drift deposits.

Table 2 Composition of the coarse gravel fraction (+16-64 mm) of the mineral-bearing deposits

Typical Percentage	Component	Roundness	Shape*	Likely provenance
30-50 %	Lower Palaeozoic argillaceous rocks	rounded	flaky/equant	North Wales/Lake District
10-30 %	Volcanic rocks	subangular/ subrounded	equant	North Wales/Lake District
10-20 %	Carboniferous sandstones	subrounded/ rounded	equant	Wrexham area
5-10 %	Vein quartz	subangular/ rounded	equant/ elongate	Multiple
5-10 %	Carboniferous limestones	rounded/ well rounded	equant	Wrexham area
1-5 %	Lower Palaeozoic arenaceous rocks	rounded	equant/elongate and flaky	North Wales/Lake District
1-5 %	Plutonic rocks	subrounded/ well rounded	equant	Lake District/ South Scotland

Small amounts of recycled 'Bunter' pebbles, Cretaceous flint and Carboniferous chert are present. Traces of deleterious soft materials such as coal, Triassic sandstones and marls occur in the +4-16 mm size fraction.

* The terms used refer to Zinggs's classification. It should be noted that 'flaky' applies to the clast shape and not to its fracturing characteristics.

Composition of the sand and gravel deposits

Potentially workable sand and gravel is present primarily in the Glacial Sand and Gravel and to a very minor extent in the Alluvium.

Glacial Sand and Gravel The Glacial Sand and Gravel is exposed in a broad irregular belt south of the Ellesmere moraine and beneath till in the sides of valleys north of this morainic ridge.

Overall the deposit comprises sands but gravels and sandy gravels are also present. Fine sands and silts are also common within the deposit but clays are poorly developed.

The gravel fraction comprises mainly fine to coarse gravel with some cobble and boulder grade material. The composition of the representative +16 mm -64 mm gravel fraction is shown in Table 2 and the regional variation in Figure 5.

The sand fraction of the 'mineral' deposits is typically medium- to fine-grained, consisting mostly of subrounded and rounded quartz grains; coarse sand is less abundant and consists mainly of quartz and lithic fragments with coal. The reddish-brown colour of the sand grains is due to an oxidised iron coating. Some of these sands may be derived through reworking of Triassic sandstones.

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.

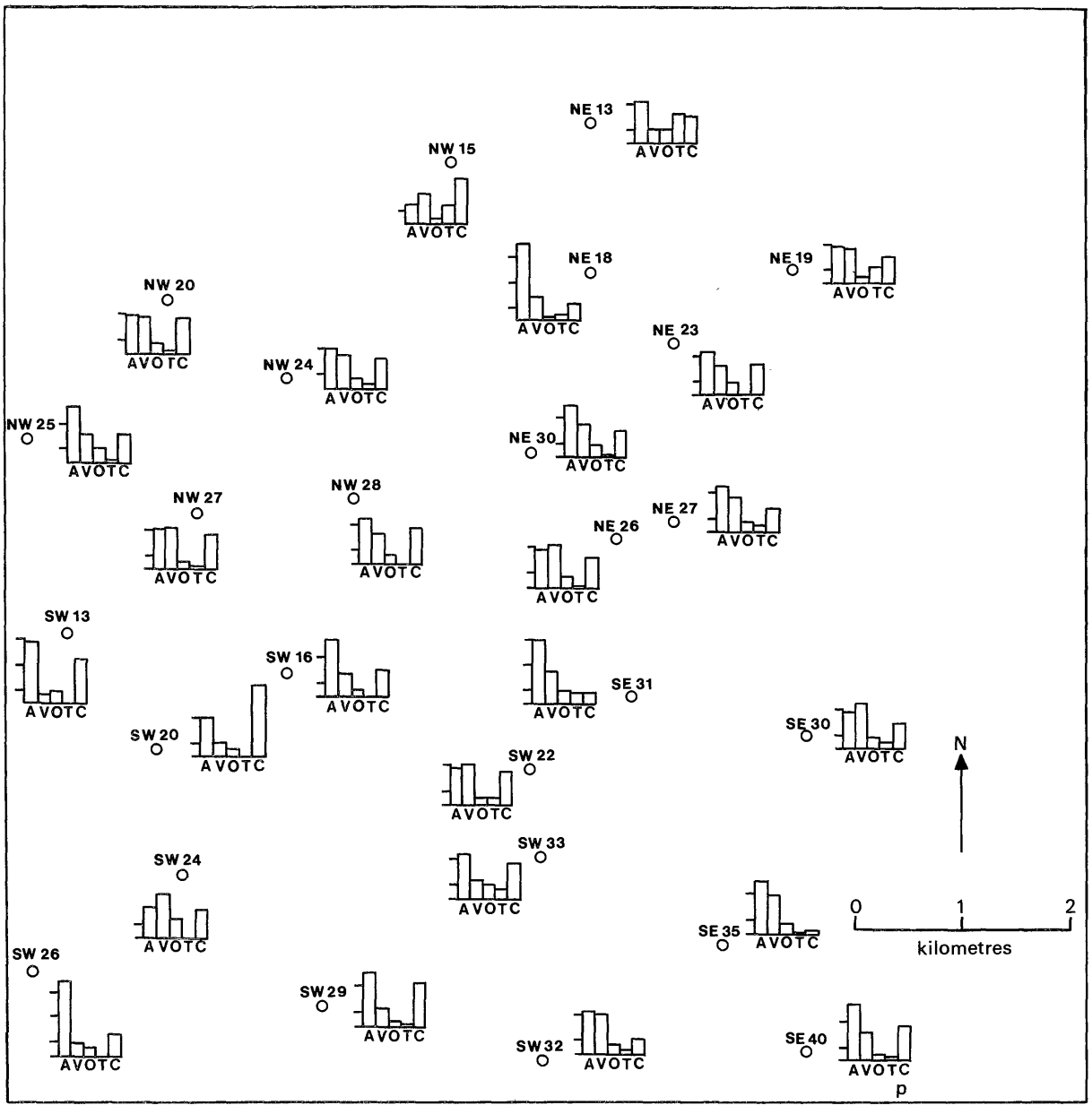
Geological data: The geological boundary lines, symbols etc., shown are taken from the geological maps of this area, which was surveyed at the scale of 1:10 560. Borehole data, which include the stratigraphical relations, thicknesses and mean particle size distribution of the sand and gravel samples collected during the assessment survey, are also shown.

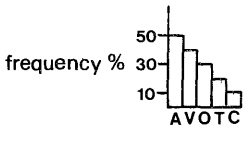
Mineral resource information: The mineral-bearing ground is divided into resource blocks (see Appendix A). Within a resource block the mineral is subdivided into areas where it is exposed, that is where the overburden averages less than 1 m in thickness, and areas where it is present in continuous (or 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. The whole of the area is considered as mineral-bearing, even though it may include small areas where sand and gravel is not present or is not potentially workable. 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 cartographical considerations. For the purpose of measuring areas the centre line of the symbol is used.

Results

For each of the blocks, the accuracy of the results at the symmetrical 95 per cent probability level (that is, the probability that, 19 times out of 20, the true volume of mineral present lies within the stated limits) varies between 17 per cent and 50 per cent (Table 3). However, the true volumes are more likely to be nearer the figure estimated than either of the limits. Moreover, it is probable that roughly the same percentage limits would apply for the statistical estimate of mineral volume within a very much smaller parcel of ground (say 100 hectares) containing similar sand and gravel deposits, if





A Lower Palaeozoic argillaceous and arenaceous rocks

V Lower Palaeozoic volcanic rocks

O Others - including chert, flint quartz, plutonic rocks

T Triassic sandstones siltstones and recycled conglomerate clasts

C Carboniferous sandstones and limestones

Figure 5 Representative composition of the coarse gravel fraction (+16-64 mm) of the Glacial Sand and Gravel.

Table 3 The sand and gravel resources of the district

Block	Area		Mean thickness		Volume of sand and gravel			Mean grading percentage		
	Block	Mineral	Overburden*	Mineral		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	$m^3 \times 10^6$	± %	± $m^3 \times 10^6$			
A	36.5	36.5	6.0	12.8	467	20	93	9	77	14
B	10.0	10.0	3.3	14.1	141	30	42	7	90	3
C	10.8	10.8	7.0	6.5	70	50	35	8	65	27
D	24.4	24.4	0.7	14.7	359	17	61	9	79	12
E†	18.3	3.6	9.7	9.5	34	-	-	7	89	4
A to D	100.0	85.3	4.0	12.6	1071	12	129	9	79	12

* This figure gives the mean thickness of overburden above the first mineral deposit encountered in individual boreholes.
† Only two boreholes in Block E encountered mineral and so no statistical assessment of this block is attempted.

the results from the same number of sample points (as provided by, say, ten boreholes) 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 in blocks A to E. The total volume (1071 million m^3) can be estimated to limits of ±12 per cent at the 95 per cent probability level by a calculation based on the data from the 78 sample points spread across the five resource blocks. However, it must be emphasised that the quoted volume of mineral has no simple relationship with the amount that could be extracted in practice, as no allowance has been made in the calculations for any restraints (such as existing buildings and roads) on the use of the land for mineral working.

Notes on the resource blocks

The sheet is divided into five resource blocks (see Map), the boundaries of which have been drawn to delineate those which contain mineral exposed at surface (Blocks B and D), one in which mineral is present beneath overburden (Block A), one with discontinuous mineral (Block C) and one in which mineral is largely absent (Block E).

Block A
This block occupies 36.5 km^2 of ground in the north-western part of the resource sheet and comprises a dissected till (Upper Boulder Clay) plain which slopes northwards towards Penley. Mineral is present beneath overburden (till) throughout much of the area and is exposed in the sides of some of the more deeply incised valleys. The overburden averages 6.0 m in thickness throughout the block although in boreholes NW 12, 16 and 17, which were sited on interfluves, over 18 m of till is present.

The mineral has a mean thickness of 12.8 m and is predominantly fine and medium sand, although gravel and sandy gravel are concentrated in discrete areas around Bettisfield Park [460 375] and from Crimps Farm [415 356] to Higher Stocks [426 366].

In most of the boreholes several mineral deposits are separated by tills but it is impossible to correlate them with any certainty, implying that the deposits are spatially discontinuous.

The overall grading of the mineral in Block A is fines 9 per cent, sand 77 per cent and gravel 14 per cent (pebbly sand); it has an estimated volume of 467 million m^3 ±20 per cent. The volume calculations are based on information from 29 IMAU boreholes (Table 4). No mineral has been worked on a commercial scale in this block.

Block B
This block comprises some 10.0 km^2 of ground in the north-eastern part of the survey area. In the northern and western parts, mineral is exposed and forms an undulating outwash plain. Thin tills overlying mineral are developed around Bronington [485 396]. In the south-eastern part of the block, the mineral deposits are concealed beneath Peat and Lacustrine Deposits as in borehole NE 20, 21 and 24 at Fenn's Moss. The mean thickness of overburden is 3.3 m and overlies mineral of mean thickness 14.1 m. With the exception of borehole NE 21 all boreholes proved in excess of 10.0 m of this deposit. There are few waste partings within the mineral deposits which grade as fines 7 per cent, sand 90 per cent, gravel 3 per cent (sand). The estimated volume of mineral is 141 million m^3 ±30 per cent, a figure which is based on information from 9 IMAU boreholes (Table 5). No mineral has been worked on a commercial scale in this block.

Block C
This block comprises two separate areas of undulating till (Upper Boulder Clay) plain in the south and south-west of the area. Together these areas total some 10.8 km^2 of ground. Mineral is present at depth beneath till which is exceptionally 18.1 m thick in borehole SE 39 west of Loppington House [4740 3022]. The mean thickness of overburden is 7.0 m and can comprise Peat, Lacustrine Deposits, Glacial Laminated Clays and till. The two first-named deposits are developed in and around depressions within the hummocky moraine topography as in borehole SW 20 [4145 3330] by Spunhill which proved some 14.6 m of Lacustrine Deposits adjacent to White Mere.

The mean thickness of mineral is 6.5 m and this deposit is present in all boreholes except SW 30 and SE 39 where thick tills are developed. The stratigraphy in this block is complicated with considerable variation of gravel content across the area. Significant thicknesses of gravel are present in boreholes SW 24 and 26 near Lee Bridges [4046 3162].

The overall grading of mineral in block C is fines 8 per cent, sand 65 per cent and gravel 27 per cent (sandy gravel) and the estimated volume is 70 million m^3 ±50 per cent. These calculations are based on information from 10 IMAU boreholes (Table 6). There are no working sand and gravel pits within this block.

Block D
This block lies in the central southern part of the

Table 4 Block A: data from IMAU boreholes used in the assessment

Borehole	Recorded thickness (m)		Mean grading percentage					
	Over-burden/ waste	Mineral	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$ -1 mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 mm
NW 10	3.4	13.1	3	33	59	2	1	2
NW 11	19.7	5.3	33	45	17	1	1	3
NW 12	19.0	-	-	-	-	-	-	-
NW 13	7.4	17.6	10	67	23	0	0	0
NW 14	8.6	11.4	11	59	29	1	0	0
NW 15	10.0	15.0	7	25	55	5	5	3
NW 16	18.9	-	-	-	-	-	-	-
NW 17	19.0	-	-	-	-	-	-	
NW 18	14.3	6.7	14	74	12	0	0	0
NW 19	16.3	6.2	30	53	17	0	0	0
NW 20	8.9	16.1	6	22	23	6	12	31
NW 21	10.0	10.5	8	51	34	1	1	5
NW 22	15.1	3.9	6	41	52	0	1	0
NW 23	8.8	16.2	3	34	37	4	8	14
NW 24	2.9	17.1	9	27	28	4	10	22
NW 25	8.4	16.1	6	23	40	7	13	11
NW 26	14.3	10.7	15	75	10	0	0	0
NW 27	3.9	21.1	6	16	26	7	17	28
NW 28	2.9	21.2	4	36	44	3	6	7
NW 29	3.3	20.2	8	54	33	2	3	0
NW 30	1.6	22.4	10	47	23	4	10	6
NE 10	9.3	15.7	7	57	35	0	0	1
NE 13	4.1	21.9	9	22	37	5	9	18
NE 14	9.1	10.4	6	32	49	6	5	2
NE 18	7.7	12.8	11	49	23	5	8	4
NE 22	11.9	13.1	21	58	21	0	0	0
NE 23	8.9	16.1	5	39	46	3	4	3
NE 25	6.8	12.5	11	56	28	1	2	2
SW 15	6.0	19.0	8	39	29	6	9	9
Mean	-	**12.8**	**9**	**41**	**33**	**3**	**6**	**8**

Table 5 Block B: data from IMAU boreholes used in the assessment

Borehole	Recorded thickness (m)		Mean grading percentage					
	Over-burden/ waste	Mineral	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$ -1 mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 mm
NE 11	0.8	16.2	2	30	62	3	2	1
NE 12	0.5	21.5	8	30	57	3	2	0
NE 15	7.0	12.0	9	51	37	1	1	0
NE 16	5.7	11.3	4	42	52	1	1	0
NE 17	6.9	12.1	8	65	27	0	0	0
NE 19	1.8	20.2	3	25	60	4	4	4
NE 20	7.9	15.6	12	40	45	2	1	0
NE 21	19.3	4.2	16	44	39	1	0	0
NE 24	9.8	13.2	7	38	52	2	1	0
Mean	-	**14.1**	**7**	**38**	**50**	**2**	**2**	**1**

Table 6 Block C: data from IMAU boreholes used in the assessment

Borehole	Recorded thickness (m)		Mean grading percentage					
	Over-burden/ waste	Mineral	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$ -1 mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 mm
SW 19	14.6	9.4	10	36	32	8	10	4
SW 20	15.0	5.0	5	10	10	3	25	47
SW 23	11.6	10.9	4	39	43	3	4	7
SW 26	4.8	11.2	4	9	22	12	26	27
SW 27	10.2	9.8	5	29	31	9	17	7
SW 28	14.9	7.6	17	40	29	5	5	4
SW 30	14.7	-	-	-	-	-	-	-
SE 37	16.0	7.0	9	33	23	10	15	10
SE 39	18.1	-	-	-	-	-	-	-
SE 40	17.8	2.2	22	10	18	9	13	28
Mean	-	**6.5**	**8**	**28**	**29**	**8**	**14**	**13**

Table 7 Block D: data from IMAU boreholes used in the assessment

Borehole	Recorded thickness (m)		Mean grading percentage					
	Over-burden/ waste	Mineral	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$ -1 mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 mm
NE 26	8.0	13.5	6	38	51	1	2	2
NE 27	8.5	15.9	6	47	25	4	8	10
SW 13	1.1	23.9	11	47	27	4	6	5
SW 14	23.7	1.3	3	23	35	5	14	20
SW 16	12.3	11.7	21	37	29	3	4	6
SW 17	4.9	12.6	12	55	30	2	1	0
SW 18	5.6	17.1	15	52	30	1	2	0
SW 21	10.2	14.8	14	24	24	8	16	14
SW 22	13.0	12.0	8	36	46	3	4	3
SW 24	0.3	23.2	7	67	25	1	0	0
SW 25	9.7	15.3	13	48	33	2	2	2
SW 29	10.9	13.6	13	44	29	3	5	6
SW 31	10.0	7.5	17	65	15	1	1	1
SW 32	0.9	19.1	7	30	52	4	4	3
SW 33	7.4	10.6	11	38	44	1	3	3
SE 25	0.7	19.0	12	40	43	1	2	2
SE 26	8.1	15.4	3	36	42	5	8	6
SE 27	3.2	21.8	3	31	47	7	7	5
SE 31	1.3	14.0	13	67	17	1	1	1
SE 32	3.6	17.0	4	27	40	9	11	9
SE 34	12.7	9.3	7	11	23	8	21	30
SE 35	14.5	5.5	5	37	48	2	3	5
SE 38	17.8	2.2	10	15	36	6	18	15
Mean	-	**14.7**	**9**	**41**	**35**	**3**	**6**	**6**

Table 8 Block E: data from IMAU boreholes used in the assessment

Borehole	Recorded thickness (m)		Mean grading percentage					
	Over-burden	Mineral	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$ -1 mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 mm
NE 28	19.0	-	-	-	-	-	-	-
SE 28	19.0	-	-	-	-	-	-	-
SE 29	19.0	-	-	-	-	-	-	-
SE 30	5.0	12.0	7	44	42	3	3	1
SE 33	18.0	-	-	-	-	-	-	-
SE 36	18.0	-	-	-	-	-	-	-
SE 41	14.5	7.0	data not available					
Mean*		**9.5**	**7**	**44**	**42**	**3**	**3**	**1**

* The mean mineral thickness refers to borehole SE 30 and 41 and the mean grading is that of SE 30.

resource sheet and occupies 24.4 km^2 of outwash plain lying south of the Ellesmere moraine from Kenwick [4210 3036] through Colemere [4337 3268], Lyneal [4460 3318] to just south of Bettisfield [4400 3530] and near Wolverley [4742 3134]. Glacial Sand and Gravel crops out over most of the block but there are some irregular patches of Peat, Lacustrine Deposits and till capping the mineral deposits. The overburden in this block has a mean thickness of 0.7 m but where it is considered to be in excess of 1.0 m thick the mineral is classified as concealed.

The mineral deposits of this block have a mean thickness of 14.7 m and a mean grading of fines 9 per cent, sand 79 per cent and gravel 12 per cent (pebbly sand). The thick successions of mineral within the block contain only thin tills and although the stratigraphy is complex, many boreholes exhibit a coarsening upward, sequence commonly capped by gravels and sandy gravels, as in borehole SE 26 by Cadney Bank [467 348].

The assessment of resources is based on data from 23 IMAU boreholes (see Table 7) and indicates a volume of 359 million m^3 ±17 per cent of mineral within the block. The only existing sand and gravel pit is situated at Wood Lane near Ellesmere.

Block E

Some 18.3 km^2 of till plain in the eastern part of the survey area comprise Block E. Within the block, concealed mineral overlain by till (Upper Boulder Clay) occupies some 3.6 km^2 around Newtown [4840 3174]. Farther east the Upper Boulder Clay becomes thicker and an inferred boundary has been drawn where the overburden ratio exceeds 3:1. On Fenn's Moss in the north of the block, Peat and Lacustrine Deposits overlie till (Upper Boulder Clay).

Of the 7 boreholes in the resource block (Table 8), only two proved mineral (SE 30 and SE 41), with a mean thickness of 7.0 m, beneath overburden which has a mean thickness 9.7 m. Grading of mineral from borehole SE 30 shows the deposit to be a sand. The estimated volume of mineral in this block is 34 million m^3, but no confidence limits have been derived as data from only two boreholes have been used in the calculations.

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WP/KW/LKW

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.

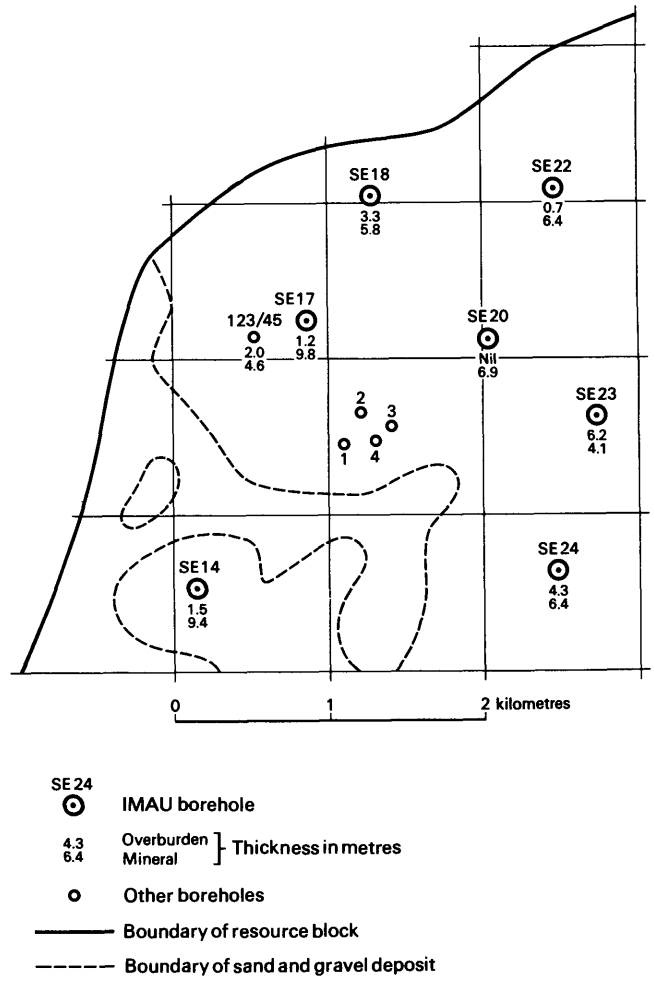
The drilling machine employed should be capable of providing a continuous sample representative of all unconsolidated deposits, so that the in-situ grading can be determined, if necessary, to a depth of 30 m (100 ft) at a diameter of about 200 mm (8 in), beneath different types of overburden. It should 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 $S_A / S_{\bar{l}_m} \leqq 0.\dot{3}$ is assumed in all cases. It follows from Equation [2] that

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

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:

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

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, 1975), are as follows.

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

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

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

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

Well rounded: 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

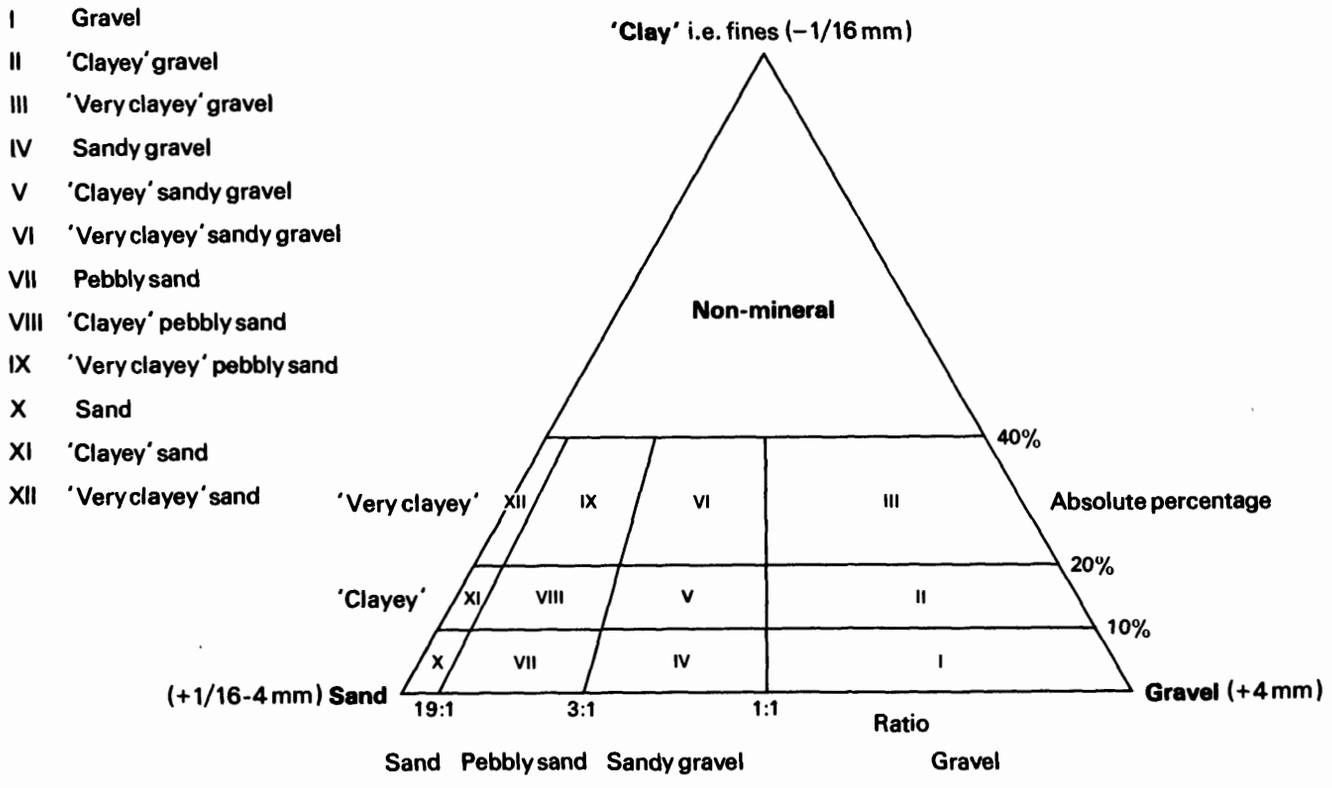


Diagram showing the descriptive categories used in the classification of sand and gravel

APPENDIX D
EXPLANATION OF THE BOREHOLE RECORDS

SJ 43 SW 24[1] **4168 3220**[2] **Varnest Wood, Ellesmere Rural**[3] **Block D**

Surface level +93.0 m OD[4]
Water not struck[5]
December 1979[6]

Overburden 0.3 m[7]
Mineral 23.2 m+[8]

LOG

Geological[9] classification	Lithology[10]	Grading/Description[11]							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Glacial Sand and Gravel	Pebbly sand	6	71	14	2	3	4	0	2.0	2.3
	'Clayey' sand	19	67	14	0	0	0	0	2.0	4.3
	Sand	2	39	58	0	1	0	0	2.0	6.3
	Sand	3	28	66	1	1	1	0	0.9	7.2
	Mean	**8**	**55**	**34**	**1**	**1**	**1**	**0**		
	Clay	Reddish brown (5YR 4/4) mottled yellowish brown (10YR 5/4), friable, silty, sandy layers.							0.8	8.0
	Sand	9	50	41	0	0	0	0	2.0	10.0
	Sand	8	81	9	0	0	0	0	2.0	12.0
	Sand	6	91	3	0	0	0	0	2.0	14.0
	Sand	6	90	4	0	0	0	0	2.0	16.0
	Sand	7	87	6	0	0	0	0	2.0	18.0
	Sand	8	66	25	1	0	0	0	2.0	20.0
	Sand	2	39	55	2	2	0	0	2.5	22.5
	Sand	6	88	6	0	0	0	0	1.0+	23.5
	Mean	**6**	**73**	**21**	**0**	**0**	**0**	**0**		
	Overall Mean	**7**	**67**	**25**	**1**	**0**	**0**	**0**		

COMPOSITION[12]

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.3-23.5 (31)	23	3	6	35	23	0	10	0

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

1 Borehole Registration Number
Each Industrial Minerals Assessment Unit (IMAU) borehole is identified by a Registration Number. This consists of two statements
- a The number of the 1:25 000 sheet on which the borehole lies, for example SJ 43.
- b The quarter of the 1:25 000 sheet on which the borehole lies and the number of the borehole in a series for that quarter, for example SW 24

Thus the full Registration Number is SJ 43 SW 24. Usually this is abbreviated to SW 24 in the text.

2 The National Grid reference
All National Grid references in this publication lie within the 100 km square TL unless otherwise stated. Grid references are given to eight figures, accurate to within 10 m for boreholes locations. (In the text, six-figure grid references are used for more approximate locations, for example for farms).

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

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

5 Groundwater conditions
If groundwater was present the level at which it was encountered is normally given (in metres above or below Ordnance Datum).

6 Date of drilling
Month and year of completion of the borehole are stated.

7 Overburden, mineral, waste and bedrock
Mineral is sand and gravel which, as part of a deposit, fall with the arbitrary definition of potentially workable material (see p1.). 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.

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

9 Geological classification
The geological classification is given wherever possible.

10 Lithology
When sand and gravel is recorded the classification according to the grading characteristics is given. The description of the other rocks is based on visual examination in the field. The colours of deposits are recorded with reference to Munsell Soil Color Charts (Munsell Colour, 1975).

11 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 an appreciable lithological change or at every 1 m of depth.

For each bulk sample the percentages of fines (-1/16 mm), fine sand (+1/16-¼ mm), medium sand (+¼-1 mm), coarse sand (+1-4 mm), fine gravel (+4-16 mm) coarse gravel (+16-64 mm) and cobble gravel (+64 mm) are stated. The mean grading of groups of samples making up an identified bed of mineral is also given. Where more than one bed is recognised the mean grading for the whole of the mineral in the borehole is also given. Where necessary, in calculating the mean grading, 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 suggests that in borehole samples the proportion of sand may be higher and the porportion of fines and coarse gravel may be lower.

12 Composition
Details of the compsition of the coarse gravel fraction (+16-64 mm) may be given. The interval of mineral over which the count was made is given. The figure in brackets refers to the numbers of clasts counted.

APPENDIX E

INDUSTRIAL MINERALS ASSESSMENT UNIT BOREHOLE RECORDS

SJ 43 NW 10 **4051 3990** **Penley Mill, Penley** **Block A**

Surface level +40.0 m OD
Water struck + 35.6 m OD
April 1980

Overburden 3.4 m
Mineral 13.1 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
Alluvium	Clay	Sandy, soft with few pebbles							3.4	3.4
Glacial Sand and Gravel	Pebbly sand	8	16	51	3	8	8	6	1.0	4.4
	Sand	3	35	62	0	0	0	0	3.0	7.4
	Sand	3	35	59	2	1	0	0	9.1+	16.5
	Mean	**3**	**33**	**59**	**2**	**1**	**1**	**1**		

SJ 43 NW 11 **4165 3974** **The Grange, Penley** **Block A**

Surface level +62.0 m OD
Water not struck
April 1980

Overburden 15.3 m
Mineral 5.3 m
Waste 4.4 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Till	Clay	Reddish brown (5YR 4/4), sandy, pebbly with shell fragments.							10.7	11.0
Glacial Laminated Clay	Clay	Dark brown (7.5YR 3/4), soft, laminated with silty layers.							4.3	15.3
Glacial Sand and Gravel	'Very clayey' pebbly sand	33	45	17	1	1	3	0	5.3	20.6
	Silt	Brown (7.5YR 5/2), sandy.							4.4+	25.0

SJ 43 NW 12 **4281 3987** **Street Lydan, Halghton** **Block A**

Surface level +62.0 m OD
Water not struck
April 1980

Waste 19.0 m+

LOG

Geological classification	Lithology	Grading/Description	Thickness	Depth
		Fines / Sand: Fine, Medium, Coarse / Gravel: Fine, Coarse, Cobble	m	m
	Soil		0.5	0.5
Till	Clay	Dark reddish brown (5YR 3/3), silty laminae, sand balls, not plastic, non-cohesive, very calcareous.	4.5	5.0
	Clay	Reddish brown (5YR 4/3), sandy, non-cohesive, non-plastic.	7.8	12.8
	Clay	Reddish brown (5YR 4/3), silty, cohesive, non-plastic, quite calcareous.	5.7	18.4
Glacial Sand and Gravel	Silt	Reddish brown.	0.1+	18.5

SJ 43 NW 13 **4440 3979** **Cumber's Bank, Hanmer** **Block A**

Surface level +77.0 m OD
Water not struck
April 1980

Overburden 7.4 m
Mineral 17.6 m+

LOG

Geological classification	Lithology	Grading/Description	Fines	Sand: Fine	Sand: Medium	Sand: Coarse	Gravel: Fine	Gravel: Coarse	Gravel: Cobble	Thickness m	Depth m
	Soil									0.7	0.7
Till	Clay	Dark reddish brown (5YR 4/3), silty, with few pebbles and coal fragments, traces of carbonaceous material, gleyed to 2 m, sandy at top, cohesive.								6.7	7.4
Glacial Sand and Gravel	'Clayey' sand		12	79	9	0	0	0	0	1.0	8.4
	Sand		7	43	50	0	0	0	0	5.0	13.4
	Sand		6	76	18	0	0	0	0	5.0	18.4
	'Clayey' sand		15	78	7	0	0	0	0	6.6+	25.0
	Mean		**10**	**67**	**23**	**0**	**0**	**0**	**0**		

SJ 43 NW 14 **4240 3904** **Old Sand Pit, Penley** **Block A**

Surface level +78.0 m OD
Water struck +63.1 m OD
April 1980

Overburden 3.5 m
Mineral 11.4 m
Waste 5.1 m+

LOG

Geological classification	Lithology	Grading/Description	Fines	Sand			Gravel			Thickness	Depth
				Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil									0.6	0.6
Till	Clay	Dark reddish brown (5YR 4/3), becomes sandy 3.2 - 3.5, gleyed down to 1.5 m, traces of carbonaceous material, crude lamination in parts, plastic, tough, quite calcareous.								2.9	3.5
Glacial Sand and Gravel	'Clayey' sand		12	43	44	1	0	0	0	1.0	4.5
	'Clayey' sand		14	62	24	0	0	0	0	3.0	7.5
	Sand		5	54	40	1	0	0	0	4.2	11.7
	'Very clayey' sand		37	43	18	1	1	0	0	0.4	12.1
	'Clayey' sand		12	72	14	2	0	0	0	2.8	14.9
	Mean		**11**	**59**	**29**	**1**	**0**	**0**	**0**		
Till	Clay	Dark reddish brown (5YR 3/3), silty, some coal, crudely laminated, slightly cohesive and slightly plastic, quite calcareous, sporadic green reduction spots								5.1+	20.0

SJ 43 NW 15 **4418 3861** **Scrape Wood, Hanmer** **Block A**

Surface level +90.0 m OD
Water struck +76.5 m OD
April 1980

Overburden 10.0 m
Mineral 15.0 m+

LOG

Geological classification	Lithology	Grading/Description	Fines	Sand			Gravel			Thickness	Depth
				Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil									0.3	0.3
Till	Clay	Reddish brown (5YR 5/4), pebbly, clasts of L. Palaeozoic argillaceous rocks, Bunter sandstone, coal and shell fragments.								8.7	9.0
Glacial Sand and Gravel	Silt									1.0	10.0
	Sand		5	39	55	1	0	0	0	2.0	12.0
	Sand		4	33	63	0	0	0	0	1.8	13.8
	Pebbly sand		3	24	63	5	1	4	0	3.2	17.0
	'Clayey' sand		15	16	61	6	2	0	0	2.0	19.0
	Sandy gravel		4	15	36	8	19	18	0	1.0	20.0
	Sandy gravel		0	7	27	23	29	14	0	1.0	21.0
	'Clayey' pebbly sand		10	25	55	5	4	1	0	4.0+	25.0
	Mean		**7**	**25**	**55**	**5**	**5**	**3**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
10.0-25.0 (92)	13	4	0	26	25	10	1	21

SJ 43 NW 16 **4444 3769** **Werrion, Bettisfield** **Block A**

Surface level +96.0 m OD
Water struck +94.0 m OD
February 1980

Waste 18.9 m+

LOG

Geological classification	Lithology	Grading/Description	Thickness	Depth
		Fines / Sand: Fine, Medium, Coarse / Gravel: Fine, Coarse, Cobble	m	m
	Soil		0.2	0.2
Till	Clay	Very pale brown (10YR 7/3) and yellowish red (5YR 4/6), gleyed.	0.5	0.7
	Clay	Reddish brown (5YR 4/4), sandy and silty in parts, pebbly.	18.2+	18.9

SJ 43 NW 17 **4046 3855** **Northwood House, Ellesmere Rural** **Block A**

Surface level +84.0 m OD
Water struck +71.8 m OD
April 1980

Waste 19.0 m+

LOG

Geological classification	Lithology	Grading/Description	Thickness	Depth
		Fines / Sand: Fine, Medium, Coarse / Gravel: Fine, Coarse, Cobble	m	m
	Soil		0.3	0.3
Till	Clay	Reddish brown (5YR 4/3), few stones, shell fragments and coal, plastic, calcareous.	9.2	9.5
	Clay	Reddish brown (5YR 4/4), some stones, shell fragments, friable, strongly calcareous.	1.8	11.3
	Clay	Brown, silty, some sandy layers.	5.3	16.6
	Clay	Reddish brown, (5YR 4/3), stones present, sandy, slightly cohesive, friable, calcareous.	2.4+	19.0

SJ 42 NW 18 **4129 3832** **Evan's Wood, Ellesmere Rural** **Block A**

Surface level +73.0 m OD
Water not struck
June 1980

Overburden 10.0 m
Mineral 6.7 m
Waste 4.3 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Till	Clay	Reddish brown (5YR 3/4), few pebbles of Keuper mudstones, Carboniferous sandstones, few shell fragments and coal, poorly cohesive, calcareous.							9.7	10.0
Glacial Sand and Gravel	'Clayey' sand	12	87	1	0	0	0	0	3.0	13.0
	'Clayey' sand	16	63	21	0	0	0	0	3.7	16.7
	Mean	**14**	**74**	**12**	**0**	**0**	**0**	**0**		
Till	Clay	Reddish brown (5YR 4/4), finely laminated with silty partings, stiff.							2.2	18.9
	Clay	Dark brown, (7.5YR 4/2), faintly laminated.							2.1+	21.0

SJ 43 NW 19 **4085 3726** **Gamebuck Rough, Ellesmere Rural** **Block A**

Surface level +85.0 m OD
Water struck +66.8 m OD
April 1980

Overburden 12.0 m
Mineral 6.2 m
Waste 4.3 m

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.5	0.5
Till	Clay	Reddish brown (5YR 5/4), weathered and gleyed to 2.4 m, few pebbles, sandy at the top.							3.5	4.0
Glacial Sand and Gravel	Silt	Very sandy.							8.0	12.0
	'Very clayey' sand	35	53	12	0	0	0	0	2.0	14.0
	'Very clayey' sand	23	50	27	0	0	0	0	2.0	16.0
	'Very clayey' sand	32	55	13	0	0	0	0	2.2	18.2
	Mean	**30**	**53**	**17**	**0**	**0**	**0**	**0**		
	Silt	Sandy.							4.3+	22.5

SJ 43 NW 20 **4156 3740** **Spout, Ellesmere Rural** **Block A**

Surface level +86.0 m OD
Water not struck
May 1980

Overburden 8.9 m
Mineral 16.1 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Till	Clay	Dark reddish gray (5YR 4/2), few stones and shell fragments, semi-cohesive, non-plastic, calcareous.							2.4	2.7
Glacial Lake Deposits	Clay	Reddish brown (5YR 4/3), laminated, calcareous.							0.4	3.1
Till	Clay	Reddish brown (5YR 4/3), few stones, mica grains, friable, sand lens between 6.4 - 7.2 m.							5.8	8.9
Glacial Sand and Gravel	'Clayey' sandy gravel	12	23	23	5	12	25	0	1.5	10.4
	'Very clayey' pebbly sand	25	35	19	3	5	13	0	1.6	12.0
	Gravel	0	6	8	7	19	35	25	1.0	13.0
	Gravel	0	2	6	16	29	27	20	1.0	14.0
	Gravel	0	9	24	13	22	32	0	2.4	16.4
	Sandy gravel	6	24	40	4	16	10	0	1.0	17.4
	'Clayey' pebbly	14	52	22	1	1	5	5	2.4	19.8
	Sandy gravel	2	21	23	7	17	28	2	2.0	21.8
	Gravel	2	10	19	1	8	36	24	2.0	23.8
	Sandy gravel	1	14	48	3	2	16	16	1.2+	25.0
	Mean	**6**	**22**	**23**	**6**	**12**	**23**	**8**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
6.4-25.0 (235)	28	3	2	30	14	14	3	6

SJ 43 NW 21 **4242 3723** **Brook House, Ellesmere Rural** **Block A**

Surface level +70.0 m OD
Water struck +68.0 m OD
May 1980

Overburden 0.4 m
Mineral 3.3 m
Waste 9.6 m
Mineral 7.2 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.4	0.4
Glacial Sand and Gravel	Sandy gravel	5	16	37	1	8	18	16	1.6	2.0
	Sand	1	36	61	0	2	0	0	1.7	3.7
	Mean	**3**	**26**	**49**	**1**	**4**	**9**	**8**		
Till	Clay	Reddish brown (5YR 4/3), few stones, mica grains, sand balls, shell fragments, plastic, cohesive, calcareous.							9.6	13.3
Glacial Sand and Gravel	'Clayey' sand	19	72	9	0	0	0	0	2.7	16.0
	Sand	4	57	38	1	0	0	0	4.5+	20.5
	Mean	**10**	**62**	**27**	**1**	**0**	**0**	**0**		
	Overall Mean	**8**	**51**	**34**	**1**	**1**	**3**	**2**		

SJ 43 NW 22 **4394 3725** **Hill Farm, Welshampton** **Block A**

Surface level +77.0 m OD
Water not struck
February 1980

Overburden 11.0 m
Mineral 3.9 m
Waste 4.1 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.2	0.2
Till	Silt	Reddish yellow (5YR 6/6) and reddish brown (5YR 5/4), pebbly clasts of Carboniferous sandstones and quartzites, sandy in parts.								3.8
	Clay	Reddish brown (5YR 4/4) silty, pebbly, clasts of Carboniferous sandstone and quartzite and L. Palaeozoic argillaceous rocks.							4.2	8.2
	Silt	Red (2.5YR 4/8), clayey, with thin sandy laminae.							2.6	11.0
Glacial Sand and Gravel	Sand	7	48	45	0	0	0	0	2.0	13.0
	Sand	4	34	60	0	2	0	0	1.9	14.9
	Mean	**6**	**41**	**52**	**0**	**1**	**0**	**0**		
Till	Clay	Gray (5YR 5/1), pebbly, clasts of Carboniferous sandstone, L. Palaeozoic argillaceous rocks and acid plutonic rocks.							1.0	15.9
	Silt	Red (2.5YR 4/6), with thin clay layers, sandy in parts.							3.1+	19.0

SJ 43 NW 23 **4145 3683** **Coptiviney, Ellesmere Rural** **Block A**

Surface level +92.0 m OD
Water not struck
June 1980

Overburden 8.8 m
Mineral 16.2 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Made Ground								0.5	0.5
Till	Clay	Gray and brown, mottled, few stones, silty, weathered.							3.3	3.8
	Clay	As above but more sandy.							5.0	8.8
Glacial Sand and Gravel	Gravel	0	8	19	8	26	34	5	1.2	10.0
	Sandy gravel	9	34	23	4	11	19	0	2.0	12.0
	Pebbly sand	2	40	46	2	2	5	3	3.0	15.0
	Sand	5	38	53	2	2	0	0	3.0	18.0
	Sand	3	69	27	1	0	0	0	2.5	20.5
	Pebbly sand	2	30	58	5	4	1	0	1.7	22.2
	Gravel	0	8	21	8	18	41	4	2.8+	25.0
	Mean	**3**	**34**	**37**	**4**	**8**	**13**	**1**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
8.8-25.0 (141)	31	1	0	18	22	10	4	4

SJ 43 NW 24 **4264 3662** **Higher Stocks, Ellesmere Rural** **Block A**

Surface level +82.0 m OD
Water struck +70.5 m OD
June 1980

Overburden 1.5 m
Mineral 5.7 m
Waste 1.4 m
Mineral 11.4 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Till	Clay	Reddish brown (5YR 4/4), faintly laminated, plastic, cohesive.							1.2	1.5
Glacial Sand and Gravel	'Clayey' sandy gravel	16	27	18	3	8	20	8	2.5	4.0
	'Very clayey'	23	34	19	2	2	9	11	3.2	7.2
	Mean	**20**	**31**	**19**	**2**	**4**	**14**	**10**		
	Clay	Silty							1.4	8.6
	Gravel	1	5	13	6	18	55	2	2.0	10.6
	Sandy gravel	2	16	41	7	18	16	0	2.7	13.3
	Sand	7	50	41	1	0	1	0	3.0	16.3
	Sandy gravel	2	28	32	7	9	17	5	2.2	18.5
	Sandy gravel	2	16	28	6	29	19	0	1.5+	20.0
	Mean	**3**	**25**	**33**	**5**	**13**	**20**	**1**		
	Overall Mean	**9**	**27**	**28**	**4**	**10**	**18**	**4**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
1.5-20.0 (205)	30	3	3	27	16	10	5	6

SJ 43 NW 25 **4029 3614** **Haughton, Ellesmere Urban** **Block A**

Surface level +102.0 m OD
Water struck +99.1 m OD
January 1980

Overburden 5.2 m
Mineral 6.1 m
Waste 3.2 m
Mineral 10.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Till	Clay	Brown (7.5YR 4/2) mottled yellowish red (5YR 5/6), pebbly, clasts of L. Palaeozoic argillaceous rocks.							4.9	5.2
Glacial Sand and Gravel	Pebbly sand	7	30	43	4	8	8	0	1.0	6.2
	Sand	4	46	47	1	2	0	0	1.0	7.2
	Sandy gravel	1	7	28	15	34	15	0	4.1	11.3
	Mean	**2**	**17**	**34**	**11**	**25**	**11**	**0**		
Till	Clay	Strong brown (7.5YR) to yellowish brown (10YR 5/4), pebbly, clasts of L. Palaeozoic argillaceous rocks, cohesive and semi-plastic, laminated in parts.							3.2	14.5
Glacial Sand and Gravel	'Clayey' sandy and gravel	15	23	20	6	9	22	5	2.0	16.5
	'Very clayey' sandy gravel	24	16	20	5	9	18	8	1.0	17.5
	'Clayey' pebbly sand	16	20	40	6	6	9	3	1.0	18.5
	Pebbly sand	1	14	55	8	10	12	0	1.0	19.5
	Pebbly sand	1	18	64	5	8	4	0	1.0	20.5
	Sand	6	47	46	1	0	0	0	1.5	22.0
	Sand	3	22	67	5	2	1	0	1.0	23.0
	Sand	4	40	52	2	2	0	0	1.5+	24.5
	Mean	**9**	**27**	**43**	**4**	**6**	**9**	**2**		
	Overall Mean	**6**	**23**	**40**	**7**	**13**	**10**	**1**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
5.2-24.5 (366)	43	1	4	21	14	9	3	5

SJ 43 NW 26 **4090 3572** **Haughton, Ellesmere Urban** **Block A**

Surface level +103.0 m OD
Water not struck
May 1980

Overburden 14.3 m
Mineral 10.7 m+

LOG

Geological classification	Lithology	Grading/Description	Fines	Sand			Gravel			Thickness	Depth
				Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil									0.3	0.3
Till	Clay	Dark brown (7.5YR 4/2), silty, semi-plastic, non-cohesive, quite calcareous.								2.7	3.0
	Clay	Dark reddish gray (5YR 4/2), few stones, stiff.								3.3	6.3
Glacial Sand and Gravel	Sand	Reddish brown (5YR 5/4) with some till layers.								0.9	7.2
Glacial Laminated Clays	Clay	Reddish brown (5YR 5/4), silty, soft, with thin laminae of reddish brown (2.5YR 5/4) clay, some shell fragments.								3.4	10.6
Glacial Sand and Gravel	'Clayey' gravel		10	13	9	2	14	34	18	1.0	11.6
	Clay	Sandy.								2.7	14.3
	'Very clayey' sand		21	74	5	0	0	0	0	2.0	16.3
	'Very clayey' sand		21	74	5	0	0	0	0	2.0	18.3
	'Clayey' sand		14	72	14	0	0	0	0	2.0	20.3
	'Clayey' sand		11	78	11	0	0	0	0	2.0	22.3
	'Clayey' sand		12	75	13	0	0	0	0	2.7+	25.0
	Mean		**15**	**75**	**10**	**0**	**0**	**0**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
6.3-25.0 (75)	39	2	1	24	19	11	1	3

SJ 43 NW 27 **4183 3541** **Lea Wood, Ellesmere Rural** **Block A**

Surface level +122.0 m OD
Water struck +104.2 m OD
May 1980

Overburden	0.4 m
Mineral	4.9 m
Waste	2.0 m
Mineral	13.2 m
Waste	1.5 m
Mineral	3.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel			m	m
			Fine	Medium	Coarse	Fine	Coarse	Cobble		
	Soil								0.4	0.4
Glacial Sand and Gravel	'Clayey' sandy gravel	15	13	25	7	13	27	0	2.0	2.4
	'Clayey' pebbly sand	15	24	38	6	8	7	2	1.0	3.4
	Gravel	3	10	19	7	22	31	8	1.0	4.4
	Gravel	4	8	9	4	18	40	17	0.9	5.3
	Mean	**10**	**14**	**24**	**6**	**15**	**26**	**5**		
Till	Clay	Reddish brown (5YR 4/3), sandy, few stones, semi-plastic, non-cohesive, calcareous.							0.6	5.9
	Clay	Stony, layers of sandy gravel.							1.4	7.3
Glacial Sand and Gravel	'Clayey' gravel	11	13	17	5	24	22	8	1.0	8.3
	Gravel	3	14	22	5	18	35	3	1.0	9.3
	Sandy gravel	2	8	25	12	6	24	3	1.0	10.3
	Gravel	1	4	22	14	31	20	8	1.0	11.3
	Gravel	1	2	8	14	38	34	3	1.0	12.3
	Gravel	0	3	5	3	18	59	12	1.3	13.6
	Sandy gravel	2	12	40	2	3	6	35	1.5	15.1
	Sand	4	38	57	1	0	0	0	1.3	16.4
	Clay	Reddish brown (5YR 4/3), sandy few stones.							0.5	16.9
	'Clayey' sandy gravel	10	15	20	8	23	22	2	0.9	17.8
	Gravel	8	11	14	10	25	32	0	1.5	19.3
	Gravel	8	12	11	7	27	30	5	1.2	20.5
	Mean	**5**	**13**	**23**	**7**	**19**	**25**	**8**		
	Clay	Pebbly, sandy.							1.5	22.0
	'Clayey' sand	10	38	46	2	4	0	0	2.0	24.0
	Sandy gravel	1	12	41	6	31	9	0	1.0+	25.0
	Mean	**7**	**29**	**45**	**3**	**13**	**3**	**0**		
	Overall Mean	**6**	**16**	**26**	**7**	**17**	**22**	**6**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.4-25.0 (263)	32	0	3	33	13	14	1	4

SJ 43 NW 28 **4323 3586** **The Rough, Welshampton** **Block A**

Surface level +98.0 m OD
Water struck +91.7 m OD
January 1980

Overburden 2.9 m
Mineral 21.2 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								1.1	1.1
Till	Clay	Red (2.5YR 5/6), very sandy, with shell and coal fragments, pebbly, clasts of L. Palaeozoic argillaceous rocks, cohesive and semi-plastic.							1.8	2.9
Glacial Sand and Gravel	'Clayey' sand	16	57	24	1	0	2	0	1.3	4.2
	Gravel	5	17	19	5	20	34	0	1.0	5.2
	Gravel	6	17	16	7	24	30	0	1.1	6.3
	Sand	5	57	36	1	1	0	0	1.0	7.3
	Sand	3	53	43	1	0	0	0	1.0	8.3
	Sand	4	46	50	0	0	0	0	1.0	9.3
	Sand	5	35	59	1	0	0	0	1.5	10.8
	Pebbly sand	5	30	48	2	5	10	0	1.0	11.8
	Gravel	1	4	27	12	25	31	0	1.0	12.8
	Sandy gravel	1	6	30	10	25	28	0	1.0	13.8
	Sandy gravel	3	14	47	8	17	9	2	1.0	15.0
	Pebbly sand	5	43	39	2	6	4	0	1.0	16.0
	Sand	2	76	22	0	0	0	0	1.0	17.0
	Sand	1	62	36	1	0	0	0	1.0	18.0
	Sand	5	30	65	0	0	0	0	1.0	19.0
	Sand	2	42	56	0	0	0	0	2.0	21.0
	Sand	3	35	61	1	0	0	0	2.0	23.0
	Sand	3	20	73	3	1	0	0	1.1+	24.1
	Mean	**4**	**36**	**44**	**3**	**6**	**7**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
2.9-24.1 (303)	35	2	1	25	18	11	4	4

SJ 43 NW 29 **4401 3553** **Welshampton Station, Welshampton** **Block A**

Surface level +94.0 m OD
Water struck +79.0 m OD
January 1980

Overburden 0.4 m
Mineral 5.7 m
Waste 2.9 m
Mineral 14.5 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.4	0.4
Glacial Sand and Gravel	'Clayey' pebbly sand	18	27	48	3	3	1	0	1.1	1.5
	Pebbly sand	6	31	28	15	18	2	0	0.9	2.5
	Pebbly sand	2	49	20	13	13	3	0	1.1	3.5
	Pebbly sand	1	69	20	5	4	1	0	0.9	4.4
	Sand	2	73	25	0	0	0	0	1.1	5.5
	'Clayey' sand	14	72	14	0	0	0	0	0.6	6.1
	Mean	**7**	**52**	**27**	**6**	**7**	**1**	**0**		
Till	Clay	Reddish brown (5YR 5/4), pebbly, clasts of L. Palaeozoic argillaceous rocks and volcanic rocks, thin sandy laminae between 8.7 and 9.0 m.							2.9	9.0
Glacial Sand and Gravel	Pebbly sand	6	48	38	2	3	3	0	1.0	10.0
	Sand	6	66	27	0	1	0	0	1.0	11.0
	Sand	4	61	35	0	0	0	0	1.0	12.0
	Sand	4	55	41	0	0	0	0	2.0	14.0
	Sand	3	48	49	0	0	0	0	2.0	16.0
	Sand	4	69	27	0	0	0	0	2.0	18.0
	'Clayey' sand	17	80	3	0	0	0	0	2.0	20.0
	'Clayey' sand	17	38	40	2	2	1	0	2.4	22.4
	Sand	2	25	72	1	0	0	0	1.1+	23.5
	Mean	**8**	**55**	**35**	**1**	**1**	**0**	**0**		
	Overall Mean	**8**	**54**	**33**	**2**	**3**	**0**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.4-23.5 (104)	37	6	4	29	10	6	6	2

SJ 43 NW 30 **4481 3592** **The Hollies, Welshampton** **Block A**

Surface level +86.0 m OD
Water struck +82.0 m OD
January 1980

Overburden 0.4 m
Mineral 10.7 m
Waste 1.2 m
Mineral 11.7 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.4	0.4
Glacial Sand and Gravel	Sandy gravel	9	20	38	7	11	15	0	1.6	2.0
	Sandy gravel	8	23	33	7	16	13	0	1.0	3.0
	Gravel	8	10	17	8	26	27	4	1.0	4.0
	Pebbly sand	1	40	45	1	6	7	0	1.0	5.0
	Sand	3	21	73	1	2	0	0	1.0	6.0
	Sand	4	14	76	3	2	1	0	1.0	7.0
	Sandy gravel	3	8	39	5	25	20	0	1.0	8.0
	Gravel	2	5	22	18	42	11	0	2.5	10.5
	Gravel	1	3	13	17	35	31	0	0.6	11.1
	Mean	**4**	**15**	**38**	**9**	**21**	**13**	**0**		
Till	Clay	Red, pebbly.							1.2	12.3
Glacial Sand and Gravel	'Clayey' sand	13	45	39	2	1	1	0	1.7	14.0
	'Clayey' sand	13	86	1	0	0	0	0	2.0	16.0
	'Very clayey' sand	20	79	1	0	0	0	0	2.0	18.0
	'Very clayey' sand	31	67	2	0	0	0	0	2.0	20.0
	'Clayey' sand	12	77	11	0	0	0	0	2.0	22.0
	Sand	5	91	4	0	0	0	0	2.0+	24.0
	Mean	**16**	**75**	**9**	**0**	**0**	**0**	**0**		
	Overall Mean	**10**	**47**	**23**	**4**	**10**	**6**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.8-24.0 (360)	38	3	1	26	21	0	6	4

SJ 43 NE 10 **4601 3993** **Hanmer Hall Wood, Hanmer** **Block A**

Surface level +95.0 m OD
Water struck +73.0 m OD
April 1980

Overburden 6.3 m
Mineral 15.7 m
Waste 3.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Till	Clay	Reddish brown (5YR 5/4), pebbly, clasts of quartzite and L. Palaeozoic argillaceous rocks, sand balls and coal fragments, becomes sandy towards the base.							6.0	6.3
Glacial Sand and Gravel	Sand	16	42	38	1	1	2	0	1.0	7.3
	Pebbly sand	5	33	48	0	1	13	0	1.3	8.6
	'Clayey' sand	10	72	18	0	0	0	0	3.4	12.0
	Sand	6	56	38	0	0	0	0	4.0	16.0
	Sand	4	56	40	0	0	0	0	6.0	22.0
	Mean	**7**	**57**	**35**	**0**	**0**	**1**	**0**		
Till	Clay	Sandy.							3.0+	25.0

SJ 43 NE 11 **4672 3991** **Brookhouse Cottages, Hanmer** **Block B**

Surface level +88.0 m OD
Water struck +84.7 m OD
April 1980

Overburden 0.8 m
Mineral 16.2 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.8	0.8
Glacial Sand and Gravel	Sand	3	31	65	1	0	0	0	2.5	3.3
	'Clayey' pebbly sand	11	21	50	5	4	9	0	1.0	4.3
	Pebbly sand	1	53	37	1	1	7	0	1.0	5.3
	Sand	3	46	51	0	0	0	0	4.1	9.4
	Sand	0	20	76	4	0	0	0	5.1	14.5
	Pebbly sand	2	13	63	9	11	2	0	2.5+	17.0
	Mean	**2**	**30**	**62**	**3**	**2**	**1**	**0**		

SJ 43 NE 12 **4793 3976** **Maesllwyn Lane, Bronington** **Block B**

Surface level +101.0 m OD
Water struck +83.5 m OD
May 1980

Overburden 0.5 m
Mineral 21.5 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.5	0.5
Glacial Sand and Gravel	Sand	7	54	39	0	0	0	0	1.0	1.5
	'Clayey' sand	12	48	40	0	0	0	0	3.5	5.0
	Sand	3	22	71	3	1	0	0	5.0	10.0
	Sand	3	25	68	3	1	0	0	4.0	14.0
	'Clayey' pebbly sand	11	24	54	6	4	1	0	6.0	10.0
	'Clayey' sand	12	30	54	2	2	0	0	2.0+	22.0
	Mean	**8**	**30**	**57**	**3**	**2**	**0**	**0**		

SJ 43 NE 13 **4552 3896** **Park Meadows, Hanmer** **Block A**

Surface level +105.0 m OD
Water not struck
June 1980

Overburden 4.1 m
Mineral 20.9 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Till	Clay	Dark reddish brown (5YR 3/4), few stones, shell fragments, friable, calcareous.							3.8	4.1
Glacial Sand and Gravel	'Very clayey' sandy gravel	27	32	12	3	12	10	4	1.2	5.3
	Gravel	4	9	8	10	29	40	0	1.9	7.2
	'Clayey' sand	17	32	44	3	2	2	0	2.4	9.6
	Gravel	1	9	11	7	18	40	14	2.0	11.6
	Gravel	1	2	7	7	18	42	23	1.4	13.0
	Pebbly sand	3	25	47	4	3	18	0	1.8	14.8
	Sand	6	38	56	0	0	0	0	2.0	16.8
	Sand	2	38	58	1	1	0	0	3.0	19.8
	Pebbly sand	0	15	65	8	5	7	0	2.7	22.5
	'Very clayey' pebbly sand	32	17	24	4	13	7	3	2.5+	25.0
	Mean	**9**	**22**	**37**	**5**	**9**	**14**	**4**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
4.1-25.0 (233)	34	0	4	11	12	9	6	24

SJ 43 NE 14 **4624 3888** **Arowry, Hanmer** **Block A**

Surface level +86.0 m OD
Water struck +76.9 m OD
May 1980

Overburden 9.1 m
Mineral 10.4 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Peat	Peat								0.9	1.2
Lacustrine Deposits	Clay	Gray (5YR 5/1), very soft, laminated, silty.							1.6	2.8
Till	Clay	Reddish brown (5YR 414), soft, pebbly, clasts of red sandstone and quartzite, silty and laminated in parts.							6.3	9.1
Glacial Sand and Gravel	'Clayey' pebbly sand	10	30	45	4	5	6	0	1.0	10.1
	'Clayey' pebbly sand	16	29	45	3	3	4	0	1.0	11.1
	Sand	3	34	60	2	0	1	0	1.0	12.1
	Sand	4	36	58	1	1	0	0	1.0	13.1
	Pebbly sand	4	32	47	9	7	1	0	6.4+	19.5
	Mean	**6**	**32**	**49**	**6**	**5**	**2**	**0**		

SJ 43 NE 15 **4725 3841** **Smithy Farmn, Bronington** **Block B**

Surface level +94.0 m OD
Water struck +89.5 m OD
March 1980

Overburden 0.8 m
Mineral 12.0 m
Waste 6.2 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.8	0.8
Glacial Sand and Gravel	Sand	6	55	36	1	1	1	0	1.0	1.8
	Sand	5	60	33	1	1	0	0	1.0	2.8
	'Clayey' sand	19	33	47	1	0	0	0	1.0	3.8
	Sand	5	16	74	3	1	1	0	1.0	4.8
	Sand	7	46	44	2	1	0	0	1.0	5.8
	'Clayey' sand	11	47	40	1	0	0	0	1.0	6.8
	Sand	1	22	69	3	3	2	0	1.0	7.8
	'Clayey' sand	17	46	24	2	1	0	0	1.0	8.8
	Sand	4	77	18	0	1	0	0	1.0	9.8
	Sand	6	51	39	1	1	2	0	1.0	10.8
	'Clayey' sand	10	83	7	0	0	0	0	1.0	11.8
	'Clayey' sand	14	78	8	0	0	0	0	1.0	12.8
	Mean	**9**	**51**	**37**	**1**	**1**	**1**	**0**		
	Silt	Reddish brown, sandy.							5.2	18.0
	Sand	Medium to fine grained.							1.0+	19.0

SJ 43 NE 16 **4857 3840** **Heath House, Bronington** **Block B**

Surface level +93.0 m OD
Water struck +87.3 m OD
June 1980

Overburden 5.7 m
Mineral 11.3 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.7	0.7
Glacial Sand and Gravel	Clay	Orange-brown, sandy.							5.0	5.7
	'Clayey' sand	10	35	51	3	1	0	0	3.0	8.7
Till	Clay	Dark reddish brown (5YR 3/3), sandy, few stones, semi-plastic, cohesive.							0.6	9.3
Glacial Sand and Gravel	Sand	2	44	53	0	1	0	0	7.7+	17.0
	Mean	**4**	**42**	**52**	**1**	**1**	**0**	**0**		

SJ 43 NE 17 **4995 3889** **The Conery, Bronington** **Block B**

Surface level +92.0 m OD
Water struck +88.0 m OD
June 1980

Overburden 6.9 m
Mineral 12.1 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.6	0.6
Till	Clay	Reddish brown (2.5YR 4/4), sandy at base, non-calcareous, weathered, slightly grayish white mottling, friable.							7.3	7.9
Glacial Sand and Gravel	'Clayey' sand	18	57	25	0	0	0	0	2.0	9.9
	Sand	7	61	32	0	0	0	0	2.0	11.9
	Sand	4	74	22	0	0	0	0	2.0	13.9
	Sand	5	67	28	0	0	0	0	5.1+	19.0
	Mean	**8**	**65**	**27**	**0**	**0**	**0**	**0**		

SJ 43 NE 18 **4550 3757** **Bettisfield Park, Hanmer** **Block A**

Surface level +105.0 m OD
Water struck +87.5 m OD
May 1980

Overburden	1.5 m
Mineral	7.4 m
Waste	0.9 m
Mineral	4.2 m
Waste	2.3 m
Mineral	1.2 m
Waste	3.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.2	0.2
Till	Clay	Reddish brown (5YR 5/4), silty with a few pebbles, non-calcareous.							1.3	1.5
Glacial Sand and Gravel	'Very clayey' pebbly sand	20	14	21	3	6	3	3	1.0	2.5
	Gravel	4	13	13	17	34	18	1	1.0	3.5
	Sandy gravel	2	30	28	15	22	3	0	1.0	4.5
	Sandy gravel	4	29	29	16	20	2	0	1.0	5.5
	Sand	6	56	35	2	0	1	0	1.0	6.5
	'Clayey' sand	14	69	15	1	0	1	0	1.0	7.5
	'Clayey' sand	18	67	14	1	0	0	0	1.4	8.9
	Mean	**10**	**45**	**22**	**7**	**11**	**4**	**1**		
Till	Clay	Reddish brown (5YR 4/4) with a few pebbles, friable, calcareous.							0.9	9.8
Glacial Sand and Gravel	'Clayey' pebbly sand	15	58	20	3	2	2	0	1.0	10.8
	Pebbly sand	5	38	45	5	7	0	0	1.0	11.8
	Pebbly sand	7	35	35	7	7	9	0	1.0	12.8
	Sand	6	66	26	1	1	0	0	1.2	14.0
	Mean	**8**	**50**	**31**	**4**	**4**	**3**	**0**		
Till	Clay	Reddish brown (5YR 4/3), friable and calcareous.							2.3	16.3
Glacial Sand and Gravel	'Very clayey' sand	25	72	2	0	0	1	0	1.2	17.5
	Overall Mean	**11**	**49**	**23**	**5**	**8**	**4**	**0**		
	Silt	Reddish brown (5YR 4/4), clayey, sandy, with mica grains, friable, with faint laminae.							3.0+	20.5

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
1.5-17.5 (108)	57	3	1	19	6	7	1	6

SJ 43 NE 19 **4744 3768** **Stimmy Farm, Bronington** **Block B**

Surface level +98.0 m OD
Water struck +89.2 m OD
May 1980

Overburden 0.3 m
Mineral 7.6 m
Waste 1.5 m
Mineral 12.6 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Glacial Sand and Gravel	Pebbly sand	4	58	32	1	0	5	0	2.2	2.5
	'Clayey' pebbly sand	7	39	48	2	3	1	0	2.0	4.5
	'Clayey' sand	11	42	44	0	0	3	0	1.0	5.5
	Sand	5	40	54	0	1	0	0	1.0	6.5
	Sand	2	47	48	0	1	2	0	1.4	7.9
	Silt								1.5	9.4
	Pebbly sand	2	21	63	3	5	6	0	1.0	10.4
	Sandy gravel	1	6	48	9	16	20	0	1.0	11.4
	Sand	2	23	73	1	0	1	0	1.0	12.4
	Pebbly sand	1	14	79	1	3	2	0	1.0	13.4
	Pebbly sand	2	11	75	3	3	6	0	1.0	14.4
	Pebbly sand	1	9	78	2	2	8	0	1.0	15.4
	Pebbly sand	1	16	70	5	7	1	0	1.0	16.4
	Pebbly sand	1	9	73	7	8	2	0	2.0	18.4
	Pebbly sand	2	9	71	7	7	4	0	2.0	20.4
	Pebbly sand	2	12	73	5	3	5	0	1.6+	22.0
	Mean	**3**	**25**	**60**	**4**	**4**	**4**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.3-15.4 (126)	27	3	2	29	21	0	5	13

SJ 43 NE 20 **4872 3739** **Malt House, Bronington** **Block B**

Surface level +92.0 m OD
Water struck +88.2 m OD
May 1980

Overburden 3.8 m
Mineral 5.9 m
Waste 4.1 m
Mineral 9.7 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Made ground								1.5	1.5
Peat	Peat	Dark Brown.							2.3	3.8
Glacial Sand and Gravel	'Clayey' pebbly sand	15	42	34	4	4	1	0	3.6	7.4
	'Very clayey' sand	26	51	22	1	0	0	0	2.3	9.7
	Mean	**19**	**46**	**29**	**3**	**2**	**1**	**0**		
Till	Clay	Reddish brown (5YR 4/4), mica grains, cohesive, plastic, calcareous.							4.1	13.8
Glacial Sand and Gravel	Sand	2	33	64	1	0	0	0	3.2	17.0
	Sand	3	31	65	1	0	0	0	4.3	21.3
	'Very clayey' sand	26	53	20	1	0	0	0	2.2+	23.5
	Mean	**8**	**37**	**54**	**1**	**0**	**0**	**0**		
	Overall Mean	**12**	**40**	**45**	**2**	**1**	**0**	**0**		

SJ 43 NE 21 **4966 3810** **Lodge Farm, Bronington** **Block B**

Surface level +92.0 m OD
Water struck +88.2 m OD
May 1980

Overburden 4.3 m
Mineral 4.2 m
Waste 15.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Made ground								1.3	1.3
Peat	Peat	Dark brown (7.5YR 3/2).							1.7	3.0
Lacustrine Deposits	Clay	Dark brown, peaty and sandy.							1.3	4.3
Glacial Sand and Gravel	'Very Clayey' sand	26	46	27	1	0	0	0	2.0	6.3
	Sand	7	43	50	0	0	0	0	2.2	8.5
	Mean	**16**	**44**	**39**	**1**	**0**	**0**	**0**		
Till	Clay	Reddish brown (5YR 4/3), very silty, sandy in part, calcareous, plastic, cohesive.							15.0+	23.5

SJ 43 NE 22 **4544 3702** **Little Hall, Bettisfield** **Block A**

Surface level +102.0 m OD
Water struck +97.2 m OD
June 1980

Overburden 6.8 m
Mineral 2.2 m
Waste 5.1 m
Mineral 10.9 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel			m	m
			Fine	Medium	Coarse	Fine	Coarse	Cobble		
	Soil								0.2	0.2
Till	Clay	Reddish brown (5YR 4/4), some pebbles, coal and shell fragments, sand balls, semi-plastic, cohesive, quite calcareous.							6.6	6.8
Glacial Sand and Gravel	'Clayey' pebbly sand	14	25	36	6	11	8	0	2.2	9.0
Till	Clay	Dark reddish brown (5YR 3/4), sandy, few stones.							5.1	14.1
Glacial Sand and Gravel	'Very clayey' sand	22	48	29	1	0	0	0	3.1	17.2
	'Very clayey' sand	31	60	9	0	0	0	0	2.0	20.0
	'Clayey' sand	12	66	22	0	0	0	0	2.0	22.0
	'Clayey' sand	18	62	20	0	0	0	0	3.0+	25.0
	Mean	**21**	**58**	**21**	**0**	**0**	**0**	**0**		
	Overall Mean	**20**	**52**	**24**	**1**	**2**	**1**	**0**		

SJ 43 NE 23 **4631 3686** **Avenue Farm, Bettisfield** **Block A**

Surface level +101.0 m OD
Water Struck +98.2 m OD
March 1980

Overburden	3.2 m
Mineral	3.0 m
Waste	1.3 m
Mineral	2.0 m
Waste	4.4 m
Mineral	11.1 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Till	Clay	Dark reddish brown (5YR 3/4), sandy, some stones, probably layered.							2.9	3.2
Glacial Sand and Gravel	Gravel	4	9	15	12	24	36	0	1.0	4.2
	Pebbly sand	3	18	56	8	10	5	0	1.0	5.2
	Sandy gravel	2	9	50	13	17	9	0	1.0	6.2
	Mean	**3**	**12**	**40**	**11**	**17**	**17**	**0**		
Till	Clay	Reddish brown (5YR 4/3), sand balls, laminated, cohesive, plastic, calcareous.							1.3	7.5
Glacial Sand and Gravel	'Clayey'	10	52	28	3	4	3	0	1.0	8.5
	Pebbly sand	6	65	27	1	0	1	0	1.0	9.5
	Mean	**8**	**58**	**28**	**2**	**2**	**2**	**0**		
Till	Clay	Reddish brown (5YR 4/3), few stones, mica grains, semi-plastic, cohesive, calcareous.							4.4	13.9
Glacial Sand and Gravel	'Clayey' sand	16	40	42	1	1	0	0	1.1	15.0
	Sand	7	40	46	3	2	2	0	1.0	16.0
	'Clayey' sand	12	46	42	0	0	0	0	1.0	17.0
	Sand	3	32	65	0	0	0	0	1.0	18.0
	Sand	4	19	77	0	0	0	0	1.0	19.0
	Sand	2	32	65	0	1	0	0	1.0	20.0
	Sand	2	36	62	0	0	0	0	1.0	21.0
	Sand	4	50	46	0	0	0	0	1.0	22.0
	Sand	4	57	39	0	0	0	0	1.0	23.0
	Sand	3	49	47	1	0	0	0	1.0	24.0
	Sand	3	64	33	0	0	0	0	1.0+	25.0
	Mean	**5**	**43**	**51**	**1**	**0**	**0**	**0**		
	Overall Mean	**5**	**39**	**46**	**3**	**4**	**3**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
3.2-25.0 (254)	35	1	3	25	20	6	5	5

SJ 43 NE 24 **4785 3672** **The Fields, Bronington** **Block B**

Surface level +92.0 m OD
Water struck +91.2 m OD
May 1980

Overburden 7.0 m
Mineral 4.3 m
Waste 2.8 m
Mineral 8.9 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Made ground								1.7	1.7
Peat	Peat	Dark brown, few stones between 2.8-3.8 m.							2.1	3.8
Till	Clay	Reddish brown (5YR 4/3), shell and coal fragments, sand balls, few stones, friable, slightly calcareous.							3.2	7.0
Glacial Sand and Gravel	Sand	7	38	52	2	1	0	0	4.3	11.3
Till	Clay	Reddish brown (5YR 4/3), silty, cohesive, plastic, possibly bedded, calcareous.							1.3	12.6
	Clay	Brown.							1.5	14.1
Glacial Sand and Gravel	Sand	No details available; grading estimated in field as 5% fines and 95% sand.							8.9+	23.0

SJ 43 NE 25 **4596 3602** **Station Farm, Bettisfield** **Block A**

Surface level +95.0 m OD
Water struck +94.5 m OD
February 1980

Overburden 6.8 m
Mineral 12.5 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.5	0.5
Till	Clay	Pale brown (10YR 6/3) and reddish brown (5YR 5/4), pebbly, clasts of L. Palaeozoic argillaceous rocks, volcanic rocks and Carboniferous sandstones, thin sandy layers.							6.3	6.8
Glacial Sand and Gravel	'Very clayey'	23	77	0	0	0	0	0	2.2	9.0
	'Clayey' sand	11	42	42	3	2	0	0	1.0	10.0
	Sand gravel	4	19	38	4	16	19	0	1.2	11.2
	Sand	5	52	38	2	1	2	0	1.0	12.2
	Sand	5	53	41	1	0	0	0	0.8	13.0
	Sand	7	61	31	1	0	0	0	1.0	14.0
	Sand	6	74	20	0	0	0	0	1.0	15.0
	Sand	8	83	9	0	0	0	0	1.0	16.0
	'Very clayey' sand	29	51	20	0	0	0	0	1.0	17.0
	Sand	5	40	55	0	0	0	0	1.0	18.0
	Sand	4	50	43	0	1	2	0	1.3+	19.3
	Mean	**11**	**56**	**28**	**1**	**2**	**2**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.5-19.3 (229)	28	3	2	30	17	8	4	8

SJ 43 NE 26 **4570 3524** **Clapping Gate Bridge, Bettisfield** **Block D**

Surface level +94.0 m OD
Water struck +84.0 m OD
February 1980

Overburden	0.6 m
Mineral	10.4 m
Waste	6.4 m
Mineral	1.2 m
Waste	1.0 m
Mineral	1.9 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.6	0.6
Glacial Sand and Gravel	Sandy gravel	6	26	36	6	13	13	0	1.0	1.6
	Pebbly sand	6	31	40	4	9	10	0	1.1	2.7
	Sand	4	54	41	1	0	0	0	0.9	3.6
	Sand	3	51	43	2	1	0	0	1.0	4.6
	Sand	2	42	52	1	1	2	0	1.0	5.6
	Sand	1	25	74	0	0	0	0	1.4	7.0
	Sand	4	35	61	0	0	0	0	1.0	8.0
	'Clayey' sand	14	42	44	0	0	0	0	1.0	9.0
	Sand	7	37	55	1	0	0	0	1.0	10.0
	Sand	4	43	53	0	0	0	0	1.0	11.0
	Mean	**5**	**38**	**51**	**1**	**2**	**3**	**0**		
Till	Clay	Yellowish red (5YR 4/6), with inter-bedded silts, pebbly in parts.							6.4	17.4
Glacial Sand and Gravel	Sand	9	50	41	0	0	0	0	1.2	18.6
Till	Clay								1.0	19.6
Glacial Sand and Gravel	Sand	8	28	60	2	1	1	0	0.9	20.5
	Sand	9	36	54	1	1	0	0	1.0+	21.5
	Mean	**9**	**32**	**57**	**1**	**1**	**0**	**0**		
	Overall Mean	**6**	**38**	**51**	**1**	**2**	**2**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.6-18.4 (146)	29	2	0	33	25	0	8	3

SJ 43 NE 27 **4622 3531** **Bettisfield, Bettisfield** **Block D**

Surface level +87.0 m OD
Water struck +85.0 m OD
February 1980

Overburden	1.4 m
Mineral	2.5 m
Waste	4.7 m
Mineral	13.4 m
Waste	2.4 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.4	0.4
Till	Clay	Red (2.5YR 4/8) and light gray (2.5YR 7/2).							1.0	1.4
Glacial Sand and Gravel	Gravel	7	11	18	6	19	33	6	1.0	2.4
	Gravel	1	5	18	11	29	36	0	1.0	3.4
	Gravel	2	5	14	4	30	43	2	0.5	3.9
	Mean	**4**	**7**	**17**	**8**	**25**	**36**	**3**		
Till	Clay	Red (2.5YR 4/8), silty, pebbly layers.							4.7	7.6
Glacial Sand and Gravel	Gravel	4	2	14	19	28	33	0	1.0	8.6
	Gravel	1	7	27	12	30	22	1	1.0	9.6
	'Clayey' sand	15	76	8	1	0	0	0	2.0	11.6
	'Clayey' sand	16	70	14	0	0	0	0	1.0	12.6
	Sand	5	63	32	0	0	0	0	1.0	13.6
	Silt	Very sandy.							1.0	14.6
	Sand	3	70	27	0	0	0	0	1.0	15.6
	Sand	2	59	39	0	0	0	0	1.0	16.6
	Sand	3	56	41	0	0	0	0	1.0	17.6
	Sand	4	39	56	1	0	0	0	1.0	18.6
	Sand	3	68	29	0	0	0	0	1.0	19.6
	Sand	6	72	22	0	0	0	0	1.4	21.0
	Mean	**7**	**55**	**26**	**3**	**5**	**4**	**0**		
	Overall Mean	**6**	**47**	**25**	**4**	**8**	**10**	**0**		
	Silt								2.4+	23.4

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
1.4-21.0 (436)	36	1	3	28	10	10	3	9

SJ 43 NE 28 **4977 3538** **Moss Lane, Whixall** **Block E**

Surface level +90.0 m OD
Water struck +86.6 m OD
May 1980

Waste 19.0 m+

LOG

Geological classification	Lithology	Grading/Description	Thickness	Depth
			m	m
	Soil		1.4	1.4
Till	Clay	Reddish brown (5YR 4/3), few stones, friable, calcareous.	2.0	3.4
	Clay	Reddish brown (5YR 4/3), semi-cohesive, semi-plastic, quite calcareous.	15.6+	19.0

SJ 43 SW 13 **4061 3436** **Castle Field, Ellesmere Urban** **Block D**

Surface level +104.4 m OD
Water not struck
December 1979

Overburden 1.1 m
Mineral 23.9 m+

LOG

Geological classification	Lithology	Grading/Description	Fines	Sand			Gravel			Thickness	Depth
				Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil									0.3	0.3
Till	Clay	Reddish brown (5YR 4/4), pebbly, clasts of L. Palaeozoic argillaceous rocks, fragments of coal and shell, friable.								0.8	1.1
Glacial Sand and Gravel	'Clayey' gravel		13	7	19	11	25	18	7	1.0	2.1
	'Clayey' sandy gravel		11	22	27	11	16	13	0	1.7	3.8
	'Very clayey' pebbly sand		32	53	8	2	3	2	0	1.0	4.8
	'Very clayey' pebbly sand		21	63	12	0	2	2	0	1.2	6.0
	Sandy gravel		6	16	22	11	23	22	0	1.0	7.0
	Sandy gravel		2	14	28	13	25	18	0	1.0	8.0
	Sand		7	55	36	1	1	0	0	1.0	9.0
	Sand		3	41	56	0	0	0	0	1.0	10.0
	Pebbly sand		2	25	65	3	4	1	0	1.0	11.0
	Pebbly sand		3	17	59	6	7	8	0	1.0	12.0
	'Very clayey' pebbly sand		34	36	15	6	7	2	0	1.3	13.3
	Sandy gravel		5	15	40	11	16	13	0	1.0	14.3
	Sand		3	26	70	1	0	0	0	1.0	15.3
	Sand		4	43	53	0	0	0	0	2.0	17.3
	Sand		5	72	23	0	0	0	0	2.0	19.3
	'Clayey' sand		14	81	5	0	0	0	0	2.0	21.3
	'Very clayey' sand		20	78	2	0	0	0	0	2.0	23.3
	'Clayey' sand		10	87	3	0	0	0	0	1.7+	25.0
	Mean		**11**	**47**	**27**	**4**	**6**	**5**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
1.1-25.0 (500)	56	3	0	14	10	12	2	3

SJ 43 SW 14 **4120 3433** **Ellemere Lodge, Ellesmere Rural** **Block D**

Surface level +109.0 m OD
Water not struck
January 1980

Overburden 1.3 m
Mineral 23.7 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Made ground								1.3	1.3
Glacial Sand and Gravel	Pebbly sand	6	24	63	2	3	2	0	1.0	2.3
	Sand	2	22	72	1	2	1	0	1.7	4.0
	'Clayey' sandy gravel	13	18	26	5	11	21	6	0.9	4.9
	Sand	4	73	20	1	1	1	0	1.6	6.5
	Sand	6	36	55	1	1	1	0	1.3	7.8
	Gravel	6	20	17	3	13	39	2	1.0	8.8
	Gravel	1	2	3	6	29	41	18	1.0	9.8
	Gravel	1	5	7	8	44	33	2	1.0	10.8
	Gravel	0	3	4	4	34	51	4	1.0	11.8
	Gravel	1	3	20	15	38	23	0	1.0	12.8
	Gravel	1	8	27	8	21	35	0	1.0	13.8
	Gravel	1	6	25	5	12	46	5	1.0	14.8
	Gravel	3	24	14	8	14	29	8	1.6	16.4
	Mean	**3**	**22**	**29**	**5**	**15**	**23**	**3**		
	Silt	Brown (7.5YR 5/4) to light yellowish brown (10YR 6/4), clayey, laminated.							0.8	17.2
	Pebbly sand	5	45	39	4	3	4	0	1.0	18.2
	Pebbly sand	2	28	51	6	9	4	0	1.0	19.2
	Sandy gravel	1	14	56	3	12	14	0	1.0	20.2
	Pebbly sand	2	9	79	4	2	4	0	1.0	21.2
	Gravel	3	15	16	7	38	21	0	1.0	22.2
	Sandy gravel	3	13	28	15	28	11	2	1.0	23.2
	Sand	3	36	54	6	1	0	0	1.8+	25.0
	Mean	**3**	**24**	**47**	**6**	**12**	**8**	**0**		
	Overall Mean	**3**	**23**	**35**	**5**	**14**	**18**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
1.3-25.0 (379)	40	2	3	27	7	9	5	7

SJ 43 SW 15 **4266 3472** **Newton, Ellesmere Rural** **Block A**

Surface level +106.0 m OD
Water not struck
June 1980

Overburden	2.5 m
Mineral	3.8 m
Waste	1.6 m
Mineral	2.0 m
Waste	1.9 m
Mineral	13.2 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.6	0.6
Till	Clay	Orange-brown, sandy, some stones.							1.9	2.5
Glacial Sand and Gravel	Sandy gravel	3	19	41	8	11	15	3	2.0	4.5
	Sandy gravel	2	12	29	16	30	11	0	1.8	6.3
	Mean	**2**	**16**	**35**	**12**	**20**	**13**	**2**		
Till	Clay	Reddish brown (5YR 4/4), silty, some stones, semi-plastic, cohesive, quite calcareous.							1.6	7.9
Glacial Sand and Gravel	Gravel	4	11	21	9	18	34	3	2.0	9.9
Till	Clay	Reddish brown (5YR 4/4), silty and sandy, some stones, plastic, cohesive, calcareous.							1.9	11.8
Glacial Sand and Gravel	'Clayey' pebbly sand	No data; assumed to be as sample below.							2.0	13.8
	'Clayey' pebbly sand	11	26	40	7	9	7	0	3.8	17.6
	'Clayey' sand	15	63	21	1	0	0	0	3.4	21.0
	Sand	8	72	20	0	0	0	0	4.0+	25.0
	Mean	**11**	**50**	**29**	**3**	**4**	**3**	**0**		
	Overall Mean	**8**	**39**	**29**	**6**	**9**	**8**	**1**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
2.5-25.0 (94)	35	8	0	16	11	15	7	8

SJ 43 SW 16 **4266 3407** **Newton Mere, Ellesmere Rural** **Block D**

Surface level +106.0 m OD
Water struck +99.7 m OD
June 1980

Overburden	0.4 m
Mineral	6.5 m
Waste	4.8 m
Mineral	5.2 m
Waste	7.1 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.4	0.4
Glacial Sand and Gravel	'Very clayey' pebbly sand	32	23	37	3	3	2	0	1.0	1.4
	'Very clayey' pebbly sand	31	22	40	2	5	0	0	0.7	2.1
	'Clayey' pebbly sand	10	14	54	9	8	5	0	1.3	3.4
	Sandy gravel	2	12	44	4	14	21	3	2.0	5.4
	'Clayey' pebbly sand	10	18	49	6	6	11	0	1.5	6.9
	Mean	**13**	**17**	**46**	**5**	**8**	**10**	**1**		
Till	Clay	Dark reddish brown (5YR 3/3), silty and with sand balls, some pebbles, cohesive, plastic, calcareous.							0.6	7.5
Glacial Sand and Gravel	Gravel	6	6	17	11	21	23	16	0.6	8.1
Till	Clay	Reddish brown (5YR 4/4), semi-cohesive, non-plastic, quite calcareous.							1.1	9.2
Glacial Sand and Gravel	'Very clayey' pebbly sand	21	32	34	3	4	6	0	0.8	10.0
Till	Clay	Reddish brown, few stones.							1.7	11.7
Glacial Sand and Gravel	'Very clayey' sand	30	62	8	0	0	0	0	5.2	16.9
	Overall Mean	**21**	**37**	**29**	**3**	**4**	**5**	**1**		
	Silt	Brown, sandy.							7.1+	24.0

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.4-16.9 (105)	37	10	0	19	21	5	5	3

SJ 43 SW 17 **4411 3441** **Balmer, Ellesmere Rural** **Block D**

Surface level +96.0 m OD
Water struck +92.5 m OD
April 1980

Overburden	0.3 m
Mineral	10.3 m
Waste	3.1 m
Mineral	1.6 m
Waste	1.5 m
Mineral	0.7 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Glacial Sand and Gravel	Sand	3	26	60	7	4	0	0	1.0	1.3
	'Clayey' pebbly sand	11	25	52	6	6	0	0	1.0	2.3
	'Clayey' sand	14	77	8	1	0	0	0	1.0	3.3
	'Clayey' sand	17	76	7	0	0	0	0	1.0	4.3
	'Clayey' sand	10	82	8	0	0	0	0	1.0	5.3
	'Very clayey'	21	76	3	0	0	0	0	1.0	6.3
	'Clayey' sand	18	50	32	0	0	0	0	1.0	7.3
	'Clayey' sand	12	67	21	0	0	0	0	1.0	8.3
	Sand	9	59	32	0	0	0	0	1.0	9.3
	'Clayey' sand	12	60	28	0	0	0	0	1.3	10.6
	Mean	**13**	**60**	**25**	**1**	**1**	**0**	**0**		
	Clay	Dark reddish brown (5YR 3/3), pebble-sized Triassic material, non-cohesive, plastic, calcareous.							3.1	13.7
	Pebbly sand	7	33	55	3	1	1	0	1.0	14.7
	'Clayey' sand	12	36	47	4	1	0	0	0.6	15.3
	Mean	**9**	**34**	**52**	**3**	**1**	**1**	**0**		
	Clay	Dark brown (7.5YR 3/2).							1.5	16.8
	'Clayey' sand	10	24	57	6	3	0	0	0.7+	17.5
	Overall Mean	**12**	**55**	**30**	**2**	**1**	**0**	**0**		

SJ 43 SW 18 **4488 3453** **Hampton Bank Bridge, Welshampton** **Block D**

Surface level +100.0 m OD
Water struck +97.5 m OD
April 1980

Overburden	0.6 m
Mineral	2.9 m
Waste	3.2 m
Mineral	14.2 m
Waste	1.8 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.6	0.6
Glacial Sand and Gravel	Sand	3	39	52	2	1	3	0	1.0	1.6
	Sand	4	33	57	2	3	1	0	0.9	2.5
	'Clayey' pebbly sand	19	32	28	4	12	5	0	1.0	3.5
	Mean	**9**	**35**	**45**	**3**	**5**	**3**	**0**		
	Silt								1.1	4.6
Till	Clay	Dark reddish brown (5YR 3/4), pebbly, silty, coal and shell fragments, quite calcareous.							2.1	6.7
Glacial Sand and Gravel	'Very clayey' sand	27	49	22	1	1	0	0	1.3	8.0
Till	Clay	Sandy.							0.9	8.9
Glacial Sand and Gravel	'Clayey' pebbly sand	18	41	31	4	4	2	0	1.0	9.9
	'Very clayey' pebbly sand	24	43	23	5	5	0	0	1.0	10.9
	'Clayey' sand	19	61	17	1	1	1	0	1.0	11.9
	'Very clayey' sand	21	77	2	0	0	0	0	1.0	12.9
	Sand	9	47	44	0	0	0	0	1.0	13.9
	Sand	1	48	51	0	0	0	0	1.0	14.9
	Sand	4	38	58	0	0	0	0	1.0	15.9
	Sand	2	55	43	0	0	0	0	1.0	16.9
	Sand	4	55	41	0	0	0	0	1.0	17.9
	Sand	10	73	16	0	0	1	0	1.0	18.9
	'Clayey' sand	13	78	9	0	0	0	0	1.0	19.9
	'Clayey' sand	15	50	30	1	2	2	0	1.0	20.9
	Mean	**16**	**56**	**26**	**1**	**1**	**0**	**0**		
	Overall Mean	**15**	**52**	**30**	**1**	**2**	**0**	**0**		
	Silt	Brown (7.5YR 5/2).							1.8+	22.7

SJ 43 SW19 **4026 3324** **St. Oswald's College, Ellesmere Rural** **Block C**

Surface level +109 m OD
Water struck +89.4 m OD
November 1979

Overburden	2.8 m
Mineral	2.4 m
Waste	1.3 m
Mineral	1.5 m
Waste	10.5 m
Mineral	5.5 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.9	0.9
Glacial Laminated Clays	Clay	Reddish brown (5YR 5/4) to red (2.5YR 4/6), laminated with thin organic rich partings, cohesive and plastic.							1.9	2.8
Glacial Sand and Gravel	Sand	2	54	44	0	0	0	0	1.0	3.8
	'Clayey' sand	13	62	25	0	0	0	0	1.4	5.2
	Mean	**8**	**59**	**33**	**0**	**0**	**0**	**0**		
Glacial Laminated Clays	Clay	Dark brown (7.5YR 4/4), laminated, silty layers and sporadic coal fragments.							1.3	6.5
Glacial Sand and Gravel	'Very clayey' sandy gravel	29	25	17	6	11	12	0	1.0	7.5
	'Very clayey' sandy gravel	27	20	16	7	14	12	4	0.5	8.0
	Mean	**29**	**23**	**17**	**6**	**12**	**12**	**1**		
Till	Clay	Dark brown (7.5YR 4/4) and reddish brown (5YR 4/4), sandy, pebbly, clasts of L. Palaeozoic argillaceous rocks, shell fragments, calcareous.							10.5	18.5
Glacial Sand and Gravel	'Clayey' sandy gravel	11	10	19	23	26	9	2	1.1	19.6
	Pebbly sand	1	8	59	18	9	5	0	1.0	20.6
	Pebbly sand	1	11	51	14	21	2	0	1.0	21.6
	Pebbly sand	6	50	25	9	9	1	0	1.0	22.6
	Sand	5	61	31	1	1	1	0	1.4+	24.0
	Mean	**5**	**30**	**36**	**12**	**13**	**4**	**0**		
	Overall Mean	**10**	**36**	**32**	**8**	**10**	**4**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
6.5-8.0 (213)	45	4	1	7	20	15	2	6
18.5-24.0 (170)	32	3	1	29	18	8	7	12

SJ 43 SW 20 **4145 3330** **Spunhill, Ellesmere Rural** **Block C**

Surface level +95.0 m OD
Water struck +91.5 m OD
December 1979

Overburden 15.0 m
Mineral 5.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.4	0.4
Lacustrine Deposits	Clay	Brown (10YR 5/3) mottled pale gray (5YR 6/1), laminated, with coal fragments.							2.7	3.1
	Clay	Grayish brown (10YR 5/2) with brown sand partings (10YR 5/3), laminated with layers 1-5 mm thick, a few pebbles near the base.							11.9	15.0
Glacial Sand and Gravel	'Clayey' gravel	10	21	21	3	7	37	1	1.0	16.0
	Gravel	5	8	8	2	24	53	0	2.0	18.0
	Gravel	3	7	7	3	34	46	0	2.0+	20.0
	Mean	**5**	**10**	**10**	**3**	**25**	**47**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
15.0-20.0 (361)	29	1	1	10	43	11	4	1

SJ 43 SW 21 **4219 3322** **Burns Wood, Ellesmere Rural** **Block D**

Surface level +115.0 m OD
Water struck +102.5 m OD
June 1980

Overburden	0.2 m
Mineral	1.0 m
Waste	1.0 m
Mineral	4.8 m
Waste	4.7 m
Mineral	9.0 m
Waste	4.3 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.2	0.2
Glacial Sand and Gravel	'Very clayey' sandy gravel	22	25	17	7	12	17	0	1.0	1.2
	Silt	Reddish brown, laminated, sandy, coal fragments.							1.0	2.2
	'Clayey' pebbly sand	No data; assumed to be as sample below.							1.8	4.0
	'Clayey' pebbly sand	19	37	24	5	8	7	0	2.0	6.0
	'Clayey' pebbly sand	18	31	26	6	12	7	0	1.0	7.0
	Mean	**19**	**36**	**24**	**5**	**9**	**7**	**0**		
Till	Clay	Dark brown (10YR 4/3), sandy, few stones, shell and coal fragments, friable, calcareous.							1.7	8.7
	Clay	Reddish brown (5YR 4/4), few stones, shell fragments, friable, calcareous.							3.0	11.7
Glacial Sand and Gravel	'Clayey' sandy gravel	18	17	17	9	13	22	4	1.0	12.7
	'Clayey' sandy gravel	19	20	20	6	12	23	0	3.0	15.7
	Sandy gravel	4	16	28	13	23	16	0	2.5	18.2
	Sandy gravel	5	14	31	11	28	11	0	2.5	20.7
	Mean	**11**	**17**	**25**	**9**	**20**	**17**	**1**		
	Overall Mean	**14**	**24**	**24**	**8**	**16**	**14**	**0**		
	Clay	Reddish brown, sandy, with pebbles.								2.1
	Sand	Reddish brown, fine.						2.2+	25.0	

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.2-20.7 (113)	36	6	0	14	16	22	4	2

SJ 43 SW 22 **4490 3308** **Village Farm, Ellesmere Rural** **Block D**

Surface level +87.0 m OD
Water struck +81.5 m OD
March 1980

Overburden	0.6 m
Mineral	4.6 m
Waste	8.8 m
Mineral	7.4 m
Waste	3.6 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel			m	m
			Fine	Medium	Coarse	Fine	Coarse	Cobble		
	Soil								0.6	0.6
Glacial Sand and Gravel	'Clayey' pebbly sand	17	23	40	4	8	8	0	1.0	1.6
	'Very clayey' pebbly sand	27	28	27	2	8	8	0	1.0	2.6
	Sandy gravel	5	35	25	7	17	11	0	1.0	3.6
	Mean	**16**	**29**	**31**	**4**	**11**	**9**	**0**		
Till	Clay	Reddish brown (5YR 4/3).							0.8	4.4
Glacial Sand and Gravel	Pebbly sand	4	8	50	16	14	8	0	0.8	5.2
Till	Clay	Reddish brown (5YR 4/3), sandy, pebbly, silty layers, cohesive.							8.8	14.0
Glacial Sand and Gravel	Sand	9	41	50	0	0	0	0	1.0	15.0
	Sand	7	31	60	0	1	1	0	1.0	16.0
	Sand	8	55	37	0	0	0	0	1.0	17.0
	Sand	4	44	52	10	0	0	0	1.0	18.0
	Sand	2	30	67	1	0	0	0	1.0	19.0
	Sand	4	55	41	0	0	0	0	1.0	20.0
	Sand	5	45	49	0	0	0	0	1.4	21.4
	Mean	**5**	**43**	**51**	**1**	**0**	**0**	**0**		
	Overall Mean	**8**	**36**	**46**	**3**	**4**	**3**	**0**		
Till	Clay	Dark brown (7.5YR 4/2), sandy, pebbly, cohesive, slightly calcareous.							3.6+	25.0

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.6-21.4 (55)	25	4	0	31	25	2	5	8

SJ 43 SW 23 **4044 3226** **Lee, Ellesmere Rural** **Block C**

Surface level +94.0 m OD
Water struck +92.5 m OD

Overburden 11.6 m
Mineral 10.9 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.5	0.5
Till	Clay	Brown (7.5YR 4/2) with patches of dark grayish brown (10YR 4/2) and reddish brown (2.5YR 4/4), gleyed to 2.0 m, sandy in parts, clasts of Carboniferous sandstones, limestone and coal, also volcanic rocks and L. Palaeozoic argillaceous rocks.							11.1	11.6
Glacial Sand and Gravel	Gravel	3	8	17	4	28	36	4	1.0	12.6
	Sand Gravel	3	26	24	3	11	33	0	1.2	13.8
	Sand	4	48	45	3	0	0	0	1.0	14.8
	Sand	3	45	50	1	0	0	0	1.2	16.0
	Sand	7	43	50	0	0	0	0	2.0	18.0
	Sand	5	31	56	8	0	0	0	1.0	19.0
	Sand	5	38	50	7	0	0	0	1.5	20.5
	Sand	4	57	37	2	0	0	0	2.0+	22.5
	Mean	**4**	**39**	**43**	**3**	**4**	**7**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
11.6-22.5 (265)	29	3	2	31	14	1	6	5

SJ 43 SW 24 **4168 3220** **Varnest Wood, Ellesmere Rural** **Block D**

Surface level +93.0 m OD
Water not struck
December 1979

Overburden 0.3 m
Mineral 23.2 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Glacial Sand and Gravel	Pebbly sand	6	71	14	2	3	4	0	2.0	2.3
	'Clayey' sand	19	67	14	0	0	0	0	2.0	4.3
	Sand	2	39	58	0	1	0	0	2.0	6.3
	Sand	3	28	66	1	1	1	0	0.9	7.2
	Mean	**8**	**55**	**34**	**1**	**1**	**1**	**0**		
	Clay	Reddish brown (5YR 4/4) mottled yellowish brown (10YR 5/4), friable, silty, sandy layers.							0.8	8.0
	Sand	9	50	41	0	0	0	0	2.0	10.0
	Sand	8	81	9	0	0	0	0	2.0	12.0
	Sand	6	91	3	0	0	0	0	2.0	14.0
	Sand	6	90	4	0	0	0	0	2.0	16.0
	Sand	7	87	6	0	0	0	0	2.0	18.0
	Sand	8	66	25	1	0	0	0	2.0	20.0
	Sand	2	39	55	2	2	0	0	2.5	22.5
	Sand	6	88	6	0	0	0	0	1.0+	23.5
	Mean	**6**	**73**	**21**	**0**	**0**	**0**	**0**		
	Overall Mean	**7**	**67**	**25**	**1**	**0**	**0**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.3-23.5 (31)	23	3	6	35	23	0	10	0

SJ 43 SW 25 **4349 3232** **Colemere House, Ellesmere Rural** **Block D**

Surface level +95.0 m OD
Water struck +90.3 m OD
May 1980

Overburden	0.2 m
Mineral	3.5 m
Waste	1.0 m
Mineral	3.8 m
Waste	4.5 m
Mineral	8.0 m
Waste	4.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.2	0.2
Glacial Sand and Gravel	Sandy gravel	6	14	38	8	15	19	0	1.0	1.2
	Pebbly sand	5	29	57	4	2	3	0	2.5	3.7
	Mean	**5**	**25**	**52**	**5**	**6**	**7**	**0**		
Till	Clay	Reddish brown, few stones, sandy, soft.							1.0	4.7
Glacial Sand and Gravel	'Clayey' sand	11	29	52	4	4	0	0	1.0	5.7
	'Clayey' sand	13	18	66	2	0	1	0	2.8	8.5
	Mean	**12**	**21**	**63**	**2**	**1**	**1**	**0**		
Till	Clay	Reddish brown (2.5YR 4/4), few stones, sandy, friable.							4.5	13.0
Glacial Sand and Gravel	'Clayey' sand	10	72	18	0	0	0	0	4.0	17.0
	'Very clayey' sand	25	70	5	0	0	0	0	4.0	21.0
	Mean	**18**	**71**	**11**	**0**	**0**	**0**	**0**		
	Overall Mean	**13**	**48**	**33**	**2**	**2**	**2**	**0**		
	Clay	Sandy.							1.0	22.0
	Clay	Sandy and silty.							3.0+	25.0

SJ 43 SW 26 **4021 3124** **Lee Bridges, Ellesmere Rural** **Block C**

Surface level +90.0 m OD
Water struck +80.0 m OD
November 1979

Overburden	0.8 m
Mineral	1.6 m
Waste	4.0 m
Mineral	9.6 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.8	0.8
Glacial Sand and Gravel	Sandy gravel	6	12	23	17	33	9	0	1.6	2.4
Till	Clay	Brown (7.5YR 4/2), pebbly and sandy in parts, cohesive and plastic.							4.0	6.4
Glacial Sand and Gravel	'Clayey' sand	11	36	42	4	4	3	0	1.0	7.4
	Gravel	6	6	15	11	21	41	0	1.0	8.4
	Gravel	1	2	12	15	20	50	0	1.0	9.4
	Gravel	2	3	17	14	22	36	0	0.6	10.0
	Gravel	2	2	23	22	45	6	0	0.8	10.8
	Gravel	1	2	12	9	30	41	5	1.0	11.8
	Gravel	1	1	8	13	42	35	0	1.0	12.8
	Gravel	2	3	18	18	30	27	2	0.7	13.5
	Pebbly sand	4	23	51	7	8	7	0	1.1	14.6
	Gravel	1	4	20	8	28	39	0	1.4+	16.0
	Mean	**3**	**9**	**22**	**11**	**25**	**29**	**1**		
	Overall Mean	**4**	**9**	**22**	**12**	**26**	**26**	1		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
3.5-16.0 (453)	55	6	1	12	11	8	43	54

SJ 43 SW 27 **4067 3147** **Spring Brook, Cockshutt** **Block C**

Surface level +84.0 m OD
Water struck +83.2 m OD
November 1979

Overburden 6.0 m
Mineral 9.8 m
Waste 4.2 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
Peat	Peat	Shell fragments 4.0-4.1 m.							4.5	4.5
Lacustrine Deposits	Clay	Olive gray (5YR 4/2), very soft, cohesive and plastic.							1.5	6.0
Glacial Sand and Gravel	Sandy gravel	3	8	53	9	14	13	0	1.0	7.0
	Gravel	2	5	18	13	35	24	0	1.2	8.2
	'Clayey' pebbly sand	11	35	27	13	13	1	0	1.0	9.2
	Pebbly sand	6	44	34	5	10	1	0	1.0	10.2
	Pebbly sand	7	45	35	4	8	1	0	1.3	11.5
	Sandy gravel	2	18	21	4	37	8	0	1.0	12.5
	Pebbly sand	6	44	36	6	7	1	0	1.0	13.5
	Sandy gravel	4	33	30	7	22	4	0	1.0	14.5
	Sandy gravel	6	27	25	8	27	7	0	1.3	15.8
	Mean	**5**	**29**	**31**	**9**	**19**	**7**	**0**		
Till	Clay	Reddish brown (5YR 4/3) silty, with sandy layers, plastic, cohesive.							3.2	19.0
Glacial Sand and Gravel	Sand	7	48	43	2	0	0	0	1.0	20.0
	Overall Mean	**5**	**31**	**32**	**9**	**17**	**6**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
6.0-15.8 (308)	23	2	1	11	33	24	2	3

SJ 43 SW 28 **4098 3073** **The Springs, Cockshutt** **Block C**

Surface level +90.0 m OD
Water struck +83.0 m OD
November 1979

Overburden 7.0 m
Mineral 7.6 m
Waste 7.9 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.2	0.2
Till	Clay	Reddish brown (5YR 4/4) and brown (7.5YR 5/4), pebbly, clasts of L. Palaeozoic argillaceous rocks, Carboniferous sandstone, shale and coal, laminated in parts.							6.8	7.0
Glacial Sand and Gravel	'Very clayey' pebbly sand	34	36	16	2	1	5	6	1.5	8.5
	'Very clayey' sand	29	52	17	2	0	0	0	1.5	10.0
	'Clayey' sand	14	53	30	3	0	0	0	2.0	12.0
	Pebbly sand	4	25	42	10	14	5	0	2.6	14.6
	Mean	**17**	**40**	**29**	**5**	**5**	**3**	**1**		
Till	Clay	Dark brown (7.5YR 4/2) and dark grayish brown (2.5YR 4/2), pebbly, clasts of L. Palaeozoic argillaceous rocks, Carboniferous sandstone, coal and shale, cohesive and plastic, sandy in parts.							7.9+	22.5

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
7.0-14.6 (192)	36	4	4	21	23	5	4	6

SJ 43 SW 29 **4295 3088** **Whatall Moss, Cockshutt** **Block D**

Surface level +90.0 m OD
Water struck +77.3 m OD
December 1979

Overburden	3.2 m
Mineral	3.3 m
Waste	4.2 m
Mineral	8.5 m
Waste	3.5 m
Mineral	1.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.6	0.6
Till	Clay	Reddish brown (5YR 5/3) sandy, pebbly, clasts of Carboniferous limestone, sandstone and coal and L. Palaeozoic argillaceous rocks, friable.							2.6	3.2
Glacial Sand and Gravel	Pebbly sand	5	30	54	1	4	6	0	2.0	5.2
	Sand gravel	5	18	28	9	19	23	0	1.3	6.5
	Mean	**5**	**25**	**44**	**4**	**10**	**12**	**0**		
Till	Clay	Red (2.5YR 4/4), pebbly, clasts mostly L. Palaeozoic argillaceous rocks, also shell fragments including *Turitella*.							4.2	10.7
Glacial Sand and Gravel	Sand	7	65	28	0	0	0	0	0.8	11.5
	Pebbly sand	6	25	43	9	8	9	0	1.2	12.7
	Pebbly sand	8	20	43	5	14	10	0	0.6	13.3
	Sandy gravel	3	33	35	3	11	15	0	1.1	14.4
	Sand	3	49	43	1	2	2	0	1.6	16.0
	'Clayey' sand	19	60	20	0	1	0	0	2.0	18.0
	'Very clayey' sand	37	60	3	0	0	0	0	2.0	20.0
	Mean	**15**	**48**	**27**	**2**	**4**	**4**	**0**		
	Silt	Reddish brown (5YR 5/4), very sandy.							3.5	23.5
	'Very clayey' sand	23	76	1	0	0	0	0	1.0+	24.5
	Overall Mean	**13**	**44**	**29**	**3**	**5**	**6**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
3.2-6.5 (154)	40	3	1	14	31	5	3	3
10.7-24.5 (223)	36	5	2	24	21	3	5	5

SJ 43 SW 30 **4464 3092** **Pikesend, Cockshutt** **Block C**

Surface level +98.0 m OD
Water struck +95.5 m OD
April 1980

Overburden 14.0 m
Mineral 0.7 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Till	Clay	Dark reddish brown (5YR 3/3), pebbly, sandy, with shell fragments, plastic, cohesive, calcareous.							4.9	5.2
	Clay	Dark brown (7.5YR 4/2), with a few pebbles, poorly laminated, plastic, cohesive, quite calcareous.							6.5	11.7
Glacial Sand and Gravel	Silt	Sandy							2.3	14.0
	'Very clayey' sand	23	50	26	1	0	0	0	0.7+	14.7

SJ 43 SW 31 **4324 3001** **Crose Mere, Cockshutt** **Block D**

Surface level +93.0 m OD
Water struck +89.3 m OD
April 1980

Overburden 0.9 m
Mineral 0.9 m
Waste 3.7 m
Mineral 6.6 m
Waste 5.4 m

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.9	0.9
Glacial Sand and Gravel	'Clayey' pebbly sand	13	9	50	7	11	10	0	0.9	1.8
Till	Clay	Dark reddish brown (5YR 3/4), pebbly with coal and shell fragments, cohesive and plastic, calcareous.							3.7	5.5
Glacial Sand and Gravel	'Clayey' sand	19	70	8	2	1	0	0	1.0	6.5
	'Clayey' sand	11	86	3	0	0	0	0	1.0	7.5
	'Very clayey' sand	25	74	1	0	0	0	0	1.0	8.5
	'Clayey' sand	17	79	3	0	1	0	0	1.0	9.5
	'Clayey' sand	18	48	34	0	0	0	0	1.0	10.5
	'Clayey' sand	13	77	10	0	0	0	0	1.6	12.1
	Mean	**17**	**73**	**10**	**0**	**0**	**0**	**0**		
	Overall Mean	**17**	**65**	**15**	**1**	**1**	**1**	**0**		
Till	Clay	Dark brown (7.5YR 4/2), few stones, not cohesive or plastic, quite calcareous, sandy laminae.							2.7	14.8
Glacial Sand and Gravel	Silt	Reddish brown (5YR 5/4), sandy.							2.7+	17.5

SJ 43 SW 32 **4492 3036** **Frankton Grange, Cockshutt** **Block D**

Surface level +114.0 m OD
Water struck +100.2 m OD
March 1980

Overburden 0.9 m
Mineral 19.1 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.9	0.9
Glacial Sand and Gravel	'Clayey' pebbly sand	26	34	29	3	5	3	0	1.0	1.9
	'Clayey' pebbly sand	10	23	48	6	8	5	0	1.0	2.9
	'Clayey' pebbly sand	11	35	42	4	6	2	0	1.0	3.9
	Pebbly sand	3	25	53	4	7	8	0	1.0	4.9
	Sand	5	20	70	2	2	1	0	1.0	5.9
	Pebbly sand	3	22	64	6	5	0	0	1.0	6.9
	Sand	5	35	39	17	4	0	0	1.0	7.9
	Sand	3	16	72	7	2	0	0	1.0	8.9
	Sand	2	21	75	2	0	0	0	1.0	9.9
	Pebbly sand	5	23	63	4	4	1	0	1.0	10.9
	Sandy gravel	7	10	30	9	21	23	0	1.0	11.9
	Pebbly sand	5	27	60	3	2	3	0	1.0	12.9
	Sand	6	28	59	6	1	0	0	1.0	13.9
	Pebbly sand	4	26	47	7	8	8	0	1.1	15.0
	Sand	7	44	46	2	1	0	0	3.0	18.0
	Sand	5	45	50	0	0	0	0	2.0+	20.0
	Mean	**7**	**30**	**52**	**4**	**4**	**3**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.9-20.0 (115)	36	0	3	34	13	0	7	7

SJ 43 SW33 **4494 3224** **Lyneal Hall, Ellesmere Rural** **Block D**

Surface level +92.0 m OD
Water struck +90.0 m OD
March 1980

Overburden	0.5 m
Mineral	5.6 m
Waste	3.5 m
Mineral	5.0 m
Waste	3.4 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.5	0.5
Glacial Sand and Gravel	'Clayey' sand	14	26	53	3	2	2	0	1.0	1.5
	'Clayey' sand	15	32	52	1	0	0	0	1.0	2.5
	Sand	7	31	61	1	0	0	0	1.0	3.5
	Pebbly sand	8	33	51	3	5	0	0	1.0	4.5
	'Clayey' sand	15	65	20	0	0	0	0	1.6	6.1
	Mean	**12**	**41**	**45**	**1**	**1**	**0**	**0**		
Till	Clay	Brown (7.5YR 5/2).							3.5	9.6
Glacial Sand and Gravel	'Clayey' sandy gravel	10	22	27	7	12	22	0	1.0	10.6
	'Very clayey' pebbly sand	23	25	34	3	5	10	0	1.0	11.6
	Sand	8	30	57	1	1	3	0	1.0	12.6
	Sand	3	41	55	1	0	0	0	1.0	13.6
	Sand	8	49	43	0	0	0	0	1.0	14.6
	Mean	**10**	**34**	**43**	**2**	**4**	**7**	**0**		
	Overall Mean	**11**	**38**	**44**	**1**	**3**	**3**	**0**		
Till	Clay	Brown (7.5YR 5/2), silty and sandy laminae.							1.0	15.6
	Clay	Brown (7.5YR 5/2).							2.4+	18.0

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.5-14.6 (52)	35	0	6	15	21	8	6	9

SJ 43 SE 25 **4605 3475** **New House, Bettisfield** **Block D**

Surface level +88.0 m OD
Water struck +81.3 m OD
February 1980

Overburden 0.7 m
Mineral 19.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.7	0.7
Glacial Sand and Gravel	Sand	2	18	80	0	0	0	0	1.0	1.7
	Sand	2	15	82	1	0	0	0	1.0	2.7
	Sand	3	11	83	1	2	0	0	1.0	3.7
	Sandy gravel	3	16	46	4	11	20	0	1.0	4.7
	'Clayey' sandy gravel	12	15	37	5	12	20	0	1.0	5.7
	Pebbly sand	7	33	51	3	3	3	0	1.0	6.7
	'Clayey' sand	10	62	27	1	0	0	0	1.0	7.7
	Sand	5	47	47	1	0	0	0	1.0	8.7
	Sand	3	33	61	3	0	0	0	1.0	9.7
	Sand	4	38	56	2	0	0	0	1.0	10.7
	Sand	5	48	46	1	0	0	0	1.0	11.7
	Sand	8	50	41	1	0	0	0	1.0	12.7
	'Clayey' sand	11	61	28	0	0	0	0	1.0	13.7
	'Very clayey' sand	25	50	25	0	0	0	0	1.0	14.7
	'Very clayey' sand	26	54	20	0	0	0	0	1.0	15.7
	'Very clayey' sand	21	55	24	0	0	0	0	1.0	16.7
	'Very clayey' sand	20	55	25	0	0	0	0	1.0	17.7
	'Very clayey' sand	32	45	23	0	0	0	0	1.0	18.7
	'Very clayey' sand	34	45	21	0	0	0	0	1.0+	19.7
	Mean	**12**	**40**	**43**	**1**	**2**	**2**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.7-19.6 (115)	46	2	2	27	16	1	2	6

SJ 43 SE 26 **4677 3475** **Cadney Bank, Bettisfield** **Block D**

Surface level +86.0 m OD
Water struck +85.2 m OD
February 1980

Overburden 0.8 m
Mineral 15.4 m
Waste 7.3 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.8	0.8
Glacial Sand and Gravel	Gravel	7	10	24	9	24	22	4	1.0	1.8
	Sandy gravel	6	9	33	9	18	25	0	1.0	2.8
	Sandy gravel	1	7	45	11	24	12	0	1.0	3.8
	Pebbly sand	3	59	31	2	1	4	0	1.0	4.8
	Sand	2	74	23	1	0	0	0	1.0	5.8
	Pebbly sand	2	56	33	3	4	2	0	1.0	6.8
	Sandy gravel	1	30	31	10	20	8	0	1.0	7.8
	Pebbly sand	1	32	45	7	11	4	0	1.0	8.8
	Pebbly sand	2	38	41	4	9	6	0	1.0	9.8
	Sand	2	33	52	9	3	1	0	1.0	10.8
	Sand	2	41	50	5	2	0	0	1.0	11.8
	Sand	4	30	60	4	2	0	0	1.0	12.8
	Sand	2	42	51	2	3	0	0	1.0	13.8
	Sand	6	47	46	1	0	0	0	1.0	14.8
	Sand	2	36	59	0	3	0	0	1.4	16.2
	Mean	**3**	**36**	**42**	**5**	**8**	**6**	**0**		
Till	Clay	Dark reddish brown (5YR 3/4), thin sandy laminae (18.0-19.5), calcareous, pebbly in parts.							3.3	19.5
	Silt	Reddish brown (5YR 4/3), sandy.							4.0+	23.5

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.8-16.2 (380)	33	1	2	31	18	4	5	6

SJ 43 SE 27 **4622 3405** **Blackhurst Farm, Bettisfield** **Block D**

Surface level +86.0 m OD
Water struck +81.8 m OD
February 1980

Overburden	0.7 m
Mineral	5.0 m
Waste	2.5 m
Mineral	16.8 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.7	0.7
Glacial Sand and Gravel	Sandy gravel	5	10	50	10	13	12	0	1.0	1.7
	Sand	3	46	48	1	0	2	0	1.0	2.7
	Sand	3	42	54	1	0	0	0	1.0	3.7
	'Clayey' sandy gravel	15	11	26	7	16	25	0	1.0	4.7
	Gravel	0	14	22	2	37	25	0	1.0	5.7
	Mean	**5**	**25**	**40**	**4**	**13**	**13**	**0**		
Till	Clay	Yellowish red (5YR 4/6), pebbly.							2.5	8.2
Glacial Sand and Gravel	Sand	8	44	43	3	2	0	0	1.1	9.3
	Sand	7	39	46	4	2	2	0	1.0	10.3
	Sand	3	42	51	3	1	0	0	1.0	11.3
	Sand	3	47	48	2	0	0	0	1.1	12.4
	Sand	3	43	48	4	2	0	0	1.0	13.4
	Pebbly sand	2	35	35	7	12	9	0	0.9	14.3
	Sand	3	11	46	38	2	0	0	1.0	15.3
	'Clayey' pebbly sand	3	22	51	6	7	1	0	1.0	16.3
	Sandy gravel	1	24	33	6	14	22	0	1.0	17.3
	Pebbly sand	2	32	43	5	10	8	0	1.1	18.4
	Pebbly sand	2	19	64	10	3	2	0	1.0	19.4
	Sandy gravel	1	15	44	14	15	11	0	0.9	20.3
	Sand	3	36	57	1	1	2	0	1.1	21.4
	Sand	4	42	53	1	0	0	0	1.0	22.4
	Sand	4	32	61	1	2	0	0	1.0	23.4
	Pebbly sand	3	31	58	3	4	1	0	1.6+	25.0
	Mean	**3**	**33**	**49**	**7**	**5**	**3**	**0**		
	Overall Mean	**3**	**31**	**47**	**7**	**7**	**5**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.7-25.0 (355)	32	3	3	26	14	6	6	11

SJ 43 SE 28 **4811 3426** **Hornspike, Whixall** **Block E**

Surface level +88.0 m OD
Water struck +80.5 m OD
March 1980

Overburden 14.7 m
Mineral 4.3 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.6	0.6
Till	Clay	Reddish brown (2.5YR 5/4), few pebbles, friable to 3.0 m, plastic and cohesive to 14.7 m gleyed to 3.0 m.							14.1	14.7
Glacial Sand and Gravel	'Very clayey' sand	23	57	20	0	0	0	0	4.3+	19.0

SJ 43 SE 29 **4988 3440** **Ladywell, Whixall** **Block E**

Surface level +89.0 m OD
Water struck +82.7 m OD
March 1980

Overburden 14.5 m
Mineral 2.0 m
Waste 2.5 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.5	0.5
Till	Clay	Reddish brown (2.5YR 4/4), gleyed and mottled, grades at 8 m into a more sandy, dark reddish gray (5YR 4/2) stony clay, tough, becomes more plastic and cohesive with depth: below 11 m both types of clay occur in layers.							14.0	14.5
Glacial Sand and Gravel	Sand	7	19	73	1	0	0	0	1.0	15.5
	Sand	6	44	48	1	1	0	0	1.0	16.5
	Mean	**7**	**31**	**60**	**1**	**1**	**0**	**0**		
Till	Clay	Dark reddish brown (5YR 3/2).							2.5+	19.0

SJ 43 SE 30 **4752 3338** **Top House, Wem Rural** **Block E**

Surface level +90.0 m OD
Water struck +89.0 m OD
March 1980

Overburden 5.0 m
Mineral 12.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.2	0.2
Till	Clay	Reddish brown (2.5YR 5/4), clasts of rotted green marl and red sandstone (Triassic), shell fragments, cohesive and plastic.							4.8	5.0
Glacial Sand and Gravel	'Clayey' sandy gravel	12	18	37	8	13	9	3	1.0	6.0
	'Clayey' pebbly sand	17	15	40	8	13	7	0	0.6	6.6
Till	Clay	Reddish brown (5YR 4.3), cohesive and plastic.							0.5	7.1
Glacial Sand and Gravel	'Clayey' sand	10	27	56	5	2	0	0	1.0	8.1
	Pebbly sand	3	28	62	2	5	0	0	1.0	9.1
	Sand	4	34	59	2	1	0	0	1.0	10.1
	Sand	4	40	54	2	0	0	0	1.0	11.1
	Sand	4	53	42	1	0	0	0	1.0	12.1
	Sand	4	41	51	2	1	1	0	1.0	13.1
	Sand	5	69	26	0	0	0	0	1.0	14.1
	Sand	5	58	33	2	1	1	0	1.0	15.1
	'Clayey' sand	10	70	19	1	0	0	0	1.0	16.1
	Sand	8	68	23	1	0	0	0	0.9+	17.0
	Mean	**7**	**44**	**42**	**3**	**3**	**1**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
5.0-17.0 (132)	25	4	3	37	12	8	0	11

SJ 43 SE 31 **4602 3374** **Blackhurstford Bridge, Ellesmere Rural** **Block D**

Surface level +84.0 m OD
Water struck +83.5 m OD
February 1980

Overburden 0.2 m
Mineral 2.9 m
Waste 1.1 m
Mineral 11.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.2	0.2
Glacial Sand and Gravel	Sand	8	28	62	1	1	0	0	0.9	1.1
	Sand	2	44	54	0	0	0	0	1.1	2.2
	Sandy gravel	3	24	41	7	10	10	5	1.0	3.2
	Mean	**4**	**32**	**52**	**3**	**4**	**3**	**2**		
Till	Clay	Yellowish red (5YR 4/6), pebbly, with shell and coal fragments and sand balls, semi-cohesive and plastic, slightly calcareous matrix.							1.1	4.3
Glacial Sand and Gravel	'Very clayey' pebbly sand	27	66	3	0	0	4	0	1.0	5.3
	'Very clayey' sand	35	64	1	0	0	0	0	1.0	6.3
	'Very clayey' sand	27	78	3	0	0	0	0	1.0	7.3
	'Clayey' sand	18	78	4	0	0	0	0	1.0	8.3
	'Clayey' sand	18	75	57	0	0	0	0	1.0	9.3
	'Clayey' sand	14	83	3	0	0	0	0	1.0	10.3
	'Clayey' sand	13	83	4	0	0	0	0	1.0	11.3
	'Clayey' sand	11	86	3	0	0	0	0	1.0	12.3
	Sand	6	89	5	0	0	0	0	1.0	13.3
	Sand	5	82	13	0	0	0	0	1.0	14.3
	Sand	5	54	36	3	2	0	0	1.0+	15.3
	Mean	**16**	**76**	**8**	**0**	**0**	**0**	**0**		
	Overall Mean	**13**	**67**	**17**	**1**	**1**	**1**	**0**		

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.2-15.3	48	1	1	25	8	8	6	3

SJ 43 SE 32 **4699 3250** **Rookery Plantation, Wem Rural** **Block D**

Surface level +83.0 m OD
Water struck +80.6 m OD
March 1980

Overburden 0.6 m
Mineral 17.0 m
Waste 3.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.6	0.6
Glacial Sand and Gravel	Pebbly sand	7	24	46	5	15	3	0	1.0	1.6
	'Clayey' pebbly sand	10	36	32	2	6	14	0	1.0	2.6
	Gravel	3	7	29	8	25	28	0	1.0	3.6
	Sandy gravel	1	3	45	20	18	13	0	1.0	4.6
	Sandy gravel	3	6	41	9	17	21	3	1.0	5.6
	Sandy gravel	2	4	55	12	14	13	0	1.0	6.6
	Sandy gravel	0	7	43	19	15	16	0	1.0	7.6
	Sandy gravel	1	4	19	36	29	11	0	1.0	8.6
	Sandy gravel	0	7	19	29	33	12	0	1.0	9.6
	Sandy gravel	2	10	32	7	22	27	0	1.0	10.6
	Sand	4	50	46	0	0	0	0	1.0	11.6
	Sand	4	65	31	0	0	0	0	1.0	12.6
	'Clayey' sand	10	55	35	0	0	0	0	1.0	13.6
	Sand	7	59	34	0	0	0	0	1.0	14.6
	Sand	4	41	55	0	0	0	0	1.0	15.6
	Sand	5	31	64	0	0	0	0	1.0	16.6
	Sand	2	42	56	0	0	0	0	1.0	17.6
	Mean	**4**	**27**	**40**	**9**	**11**	**9**	**0**		
	Clay	Silty in parts, pebbly.							3.0+	20.6

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.6-17.6 (254)	37	2	2	28	16	9	3	3

SJ 43 SE 33 **4911 3320** **Ossage Bridge, Whixall** **Block E**

Surface level +88.0 m OD
Water not struck
March 1980

Overburden 18.0 m+

LOG

Geological classification	Lithology	Grading/Description	Thickness	Depth
	Soil		0.2	0.2
Till	Clay	Reddish brown (2.5YR 5/4), some sandy patches, plastic, cohesive.	15.3	15.5
Glacial Sand and Gravel	Sand	Medium to coarse with till layers.	1.0	16.5
Till	Clay	Reddish brown (2.5YR 5/4), plastic, cohesive.	1.5+	18.0

SJ 43 SE 34 **4590 3210** **Lyneal Wood, Ellesmere Rural** **Block D**

Surface level +81.0 m OD
Water struck +73.5 m OD
March 1980

Overburden 0.4 m
Mineral 9.3 m
Waste 12.3 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.4	0.4
Alluvium	'Clayey' pebbly sand	26	18	25	5	11	15	0	1.0	1.4
Glacial Sand and Gravel	Gravel	4	9	23	11	29	21	3	1.0	2.4
	Gravel	1	4	17	10	35	33	0	1.0	3.4
	Gravel	4	4	11	5	26	50	0	1.0	4.4
	Sandy gravel	3	9	35	7	15	31	0	0.5	4.9
	Gravel	6	11	10	6	26	34	7	2.6	7.5
	Sand	3	10	74	13	0	0	0	1.0	8.5
	Sandy gravel	6	23	22	7	14	25	3	1.2	9.7
	Mean	**7**	**11**	**23**	**8**	**21**	**27**	**3**		
Till	Clay	Dark reddish brown (5YR 3/4), pebbly, clasts of quartzite, siltstone, volcanics and granites.							12.3+	22.0

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.4-9.7 (252)	31	2	3	31	11	8	5	9

SJ 43 SE 35 **4669 3145** **Hall, Wem Rural** **Block D**

Surface level +76.0 m OD
Water struck +75.0 m OD
March 1980

Overburden 0.4 m
Mineral 5.5 m
Waste 14.1 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.4	0.4
Alluvium	'Clayey' sandy gravel	12	16	35	5	11	15	6	1.0	1.4
Glacial Sand and Gravel	Pebbly sand	2	33	58	2	4	1	0	1.0	2.4
	Sand	3	52	42	1	1	1	0	1.0	3.4
	Pebbly sand	4	45	45	1	2	3	0	1.0	4.4
	Sand	3	36	60	0	1	0	0	1.0	5.4
	Sand	1	46	49	0	1	3	0	0.5	5.9
	Mean	**5**	**37**	**48**	**2**	**3**	**4**	**1**		
Till	Clay	Dark reddish brown (5YR 3/4), pebbly, clasts of sandstone, quartz and fine-grained igneous rocks.							14.1+	20.0

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.4-5.9 (32)	47	6	3	31	4	0	6	3

SJ 43 SE 36 **4863 3160** **Newtown Farm, Wem Rural** **Block E**

Surface level +98.0 m OD
Water struck +94.5 m OD
May 1980

Waste 18.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.7	0.7
Till	Clay	Reddish brown, stones present.							17.3+	18.0

SJ 43 SE 37 **4556 3082** **Quaikin, Cockshutt** **Block C**

Surface level +92.0 m OD
Water struck +91.0 m OD
March 1980

Overburden	11.0 m
Mineral	3.8 m
Waste	2.0 m
Mineral	3.2 m
Waste	3.0 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.3	0.3
Till	Clay	Mottled dark reddish brown (5YR 3/3) and gray (5YR 5/1), sandy in parts, pebbles present.							4.3	4.6
	Clay	Reddish brown (5YR 3/3), sandy, pebbly, cohesive, plastic and calcareous.							6.4	11.0
Glacial Sand and Gravel	Gravel	2	8	10	21	42	17	0	1.0	12.0
	Sandy gravel	3	8	32	16	19	22	0	1.0	13.0
	Sandy gravel	2	6	30	22	27	13	0	1.0	14.0
	'Very clayey' gravel	31	6	17	8	17	21	0	0.8	14.8
	Mean	**8**	**7**	**23**	**17**	**27**	**18**	**0**		
Till	Clay	Dark reddish brown (5YR 3/3), sandy, few pebbles, plastic, cohesive and calcareous.							2.0	16.8
Glacial Sand and Gravel	'Clayey' sand	10	61	26	2	1	0	0	2.0	18.8
	'Clayey' sand	12	67	20	1	0	0	0	1.2	20.0
	Mean	**11**	**63**	**24**	**1**	**1**	**0**	**0**		
	Overall Mean	**9**	**33**	**23**	**10**	**15**	**10**	**0**		
	Silt	Reddish brown (5YR 4/3), sandy with thin clayey partings.							3.0+	23.0

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
11.0-20.0 (138)	39	5	1	20	17	7	5	6

SJ 43 SE 38 **4728 3127** **Park Farm, Wem Rural** **Block D**

Surface level +84.0 m OD
Water not struck
March 1980

Overburden 0.5 m
Mineral 2.2 m
Waste 17.3 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil								0.5	0.5
Glacial Sand and Gravel	'Very clayey' pebbly sand	22	22	38	5	10	3	0	0.9	1.4
	Sandy gravel	2	11	34	6	24	23	0	1.3	2.7
	Mean	**10**	**15**	**36**	**6**	**18**	**15**	**0**		
Till	Clay	Dark reddish brown (5YR 3/4), becoming dark reddish gray (5YR 4/2), pebbly, with sandstone, quartz, siltstone and igneous material, cohesive and plastic.							17.3+	20.0

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
0.5-2.7 (46)	30	4	0	33	26	0	4	3

SJ 43 SE 39 **4672 3022** **Rough Hayes, Loppington** **Block C**

Surface level +89.0 m OD
Water struck +86.9 m OD
March 1980

Waste 18.1 m+

LOG

Geological classification	Lithology	Grading/Description							Thickness	Depth
		Fines	Sand			Gravel				
			Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
Till	Clay	Reddish brown (5YR 4/4), sandy, few stones, shell fragments, cohesive, not plastic.							2.4	2.4
	Clay	Dark brown (7.5YR 4/2), some stones, shell fragments and coal, cohesive, semi-plastic.							1.7	4.1
	Clay	Dark brown (7.5YR 4/2), silty, few stones, semi-plastic, cohesive, quite calcareous.							14.0+	18.1

SJ 43 SE 40 **4743 3050** **Loppington House, Loppington** **Block C**

Surface level +79.0 m OD
Water struck +76.4 m OD
March 1980

Overburden 1.4 m
Mineral 2.2 m
Waste 16.4 m+

LOG

Geological classification	Lithology	Grading/Description	Fines	Sand			Gravel			Thickness	Depth
				Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil									0.5	0.5
Till	Clay	Reddish brown (5YR 4/3), sandy, pebbly.								0.9	1.4
Glacial Sand and Gravel	'Very clayey' sandy gravel		20	10	23	9	16	22	0	1.0	2.4
	'Very clayey' gravel		24	10	13	8	11	34	0	1.2	3.6
	Mean		**22**	**10**	**18**	**9**	**13**	**28**	**0**		
Till	Clay	Dark brown (7.5YR 4/2), between 11.2-11.8 m the clay becomes dark gray (5YR 4/1) with reddish brown (5YR 4/3) tinges, non-cohesive, non-plastic, silty, pebbles, calcareous and slightly cohesive.								16.4+	20.0

COMPOSITION

Depth below surface (m)	Percentage by weight in coarse gravel fraction							
	Lower Palaeozoic		Igneous		Carboniferous		Quartz	Others
	Arenaceous	Argillaceous	Plutonic	Volcanic	Arenaceous	Limestone		
1.4-3.6 (82)	37	6	2	22	10	16	2	5

SJ 43 SE 41 **4921 3019** **Horton, Wem Rural** **Block E**

Surface level +90.0 m OD
Water struck +79.7 m OD
May 1980

Overburden 14.5 m
Mineral 7.0 m+

LOG

Geological classification	Lithology	Grading/Description	Fines	Sand			Gravel			Thickness	Depth
				Fine	Medium	Coarse	Fine	Coarse	Cobble	m	m
	Soil									0.7	0.7
Till	Clay	Dark reddish brown (5YR 3/4), some stones, sand balls, shell fragments, friable.								13.8	14.5
Glacial Sand	Sandy gravel	No details available: grading estimated in field as 5% fines, 55% sand and 40% gravel.								1.0	15.5
	'Clayey' pebbly sand	No details available: grading estimated in field as 15% fines, 75% sand and 10% gravel.								6.0	21.5

The following reports of the Institute relate particularly to bulk mineral resources

Reports of the Institute of Geological Sciences

Assessment of British Sand and Gravel Resources

1 The sand and gravel resources of the country south-east of Norwich, Norfolk: Resource sheet TG 20.
E. F. P. Nickless.
Report 71/20 ISBN 0 11 880216 X £1.15

2 The sand and gravel resources of the country around Witham, Essex: Resource sheet TL 81. H. J. E. Haggard.
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3 The sand and gravel resources of the area south and west of Woodbridge, Suffolk: Resource sheet TM 24.
R. Allender and S. E. Hollyer.
Report 72/9 ISBN 0 11 880596 7 £1.70

4 The sand and gravel resources of the country around Maldon, Essex: Resource sheet TL 80. J. D. Ambrose.
Report 73/1 ISBN 0 11 880600 9 £1.20

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Report 73/5 ISBN 0 11 880608 4 £1.20

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ISBN 0 11 880745 5 £3.25

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ISBN 0 11 880748 X £3.00

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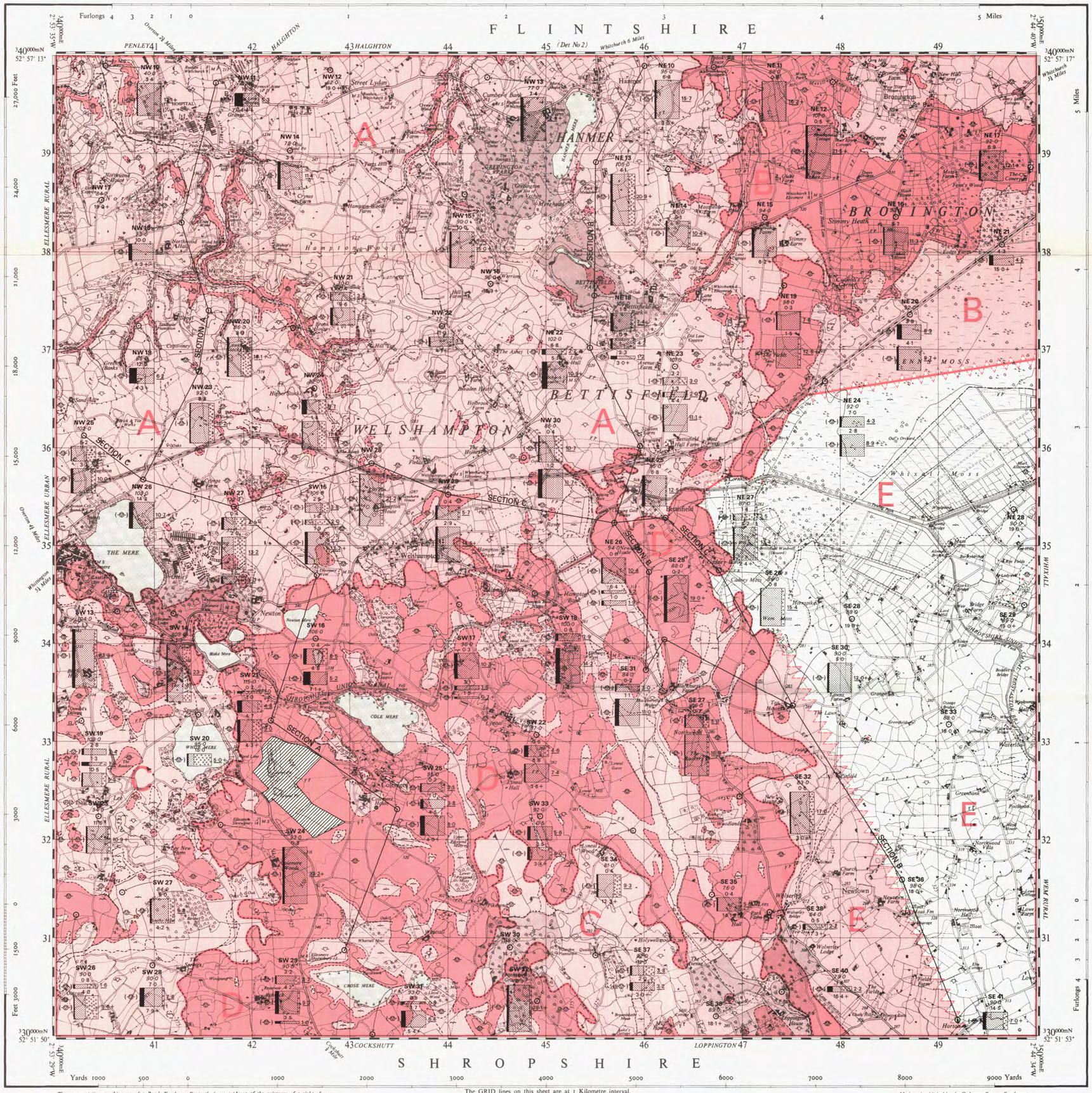
INSTITUTE OF GEOLOGICAL SCIENCES

INDUSTRIAL MINERALS ASSESSMENT UNIT

THE SAND AND GRAVEL RESOURCES OF THE AREA AROUND WELSHAMPTON, SHROPSHIRE/CLWYD

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

ORDNANCE SURVEY
SHEET SJ43
PROVISIONAL EDITION



The representation on this map of a Road, Track, or Footpath, is no evidence of the existence of a right of way.

The GRID lines on this sheet are at 1 Kilometre interval.
Heights are in feet above Mean Sea Level at Newlyn.
Contours values are in feet.
1 square inch on this map represents 99·639 acres on the ground

Compiled from 6" sheets last fully revised 1909–29.
Other partial systematic revision 1949 has been incorporated.

Made and published by the Ordnance Survey, Southampton.

Original geological survey (on the one-inch scale) published and revised on Old Series maps in 1855, 1857 and 1858.
Resurveyed (on the six-inch scale) in 1911-22 by R.W.Pocock, B.Smith and L.J.Wills and in 1956/7 by A.J.Whiteman.
T.C.Cantrill, J.V.Stephens and B.J.Taylor (District Geologists).
Sheet 138 (Wem) on the one-inch scale, published 1924.
Sheet 122 (Nantwich and Whitchurch) on the one-inch scale, published 1967.
Minor amendments to the Drift by S.J.Mathers and A.C.Wilson in 1980.

1:25 000 Sand and Gravel Resource Sheet published 1982;
G.M.Brown D.Sc., F.R.S., Director, Institute of Geological Sciences (N.E.R.C.)

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

SJ 34	SJ 44	SJ 54
121 137 SJ 33	122 138 SJ 43	SJ 53
SJ 32	SJ 42	SJ 52

Diagram showing the relation of this sheet to the National Grid 1:25 000 sheets and with One-Inch Geological Sheets 121, 122, 137 and 138.

THE SAND AND GRAVEL RESOURCES OF WELSHAMPTON, SHROPSHIRE/CLWYD

105

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

EXPLANATION OF SYMBOLS AND ABBREVIATIONS

DRIFT

RECENT AND PLEISTOCENE

- Peat P-1
- Alluvium A-2
- Alluvial Fan AF-4
- Lacustrine Deposits LA-9
- Glacial Laminated Clays GLC-1
- Glacial Sand and Gravel GS-17
- Till TL-8
- Opencast sand and gravel workings WO-22

BOUNDARY LINES

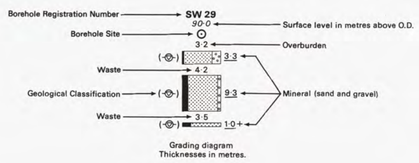
- Geological boundary, Drift
- Inferred boundary between recognised categories of deposits
- Resource Block boundary
- Lines of section (see Figure 4 of Report)

BOREHOLE DATA

SITE LOCATIONS

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

I.M.A.U. BOREHOLES



Note:-
(i) Figures underlined denote thicknesses used in 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.

Borehole Registration Number
Each I.M.A.U. borehole is identified by a Registration Number, e.g. SW 29. The letters refer to the quarter sheet and the figures to the I.G.S. serial number for that quarter. All fall within the 1:25 000 sheet SJ 43.

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 proportions of **Fines**, **Sand** and **Gravel** but small amounts of Gravel may be omitted or exaggerated.

CATEGORIES OF DEPOSITS

- **Exposed mineral (assessed).** CAT-E2
- **Continuous or almost continuous spreads of mineral beneath overburden (assessed).** CAT-C1
- **Sand and gravel either not potentially workable (see Report) or absent.** CAT-A2
- **Sand and gravel not assessed.** CAT-N1

RESOURCE BLOCKS

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

Cross-sections showing the general relations of the drift deposits along the lines shown, constitute Figure 4 of the Report.
Detailed records may be consulted on application to the Head, Industrial Minerals Assessment Unit, Institute of Geological Sciences, Keyworth, Nottingham NG12 5GG.

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