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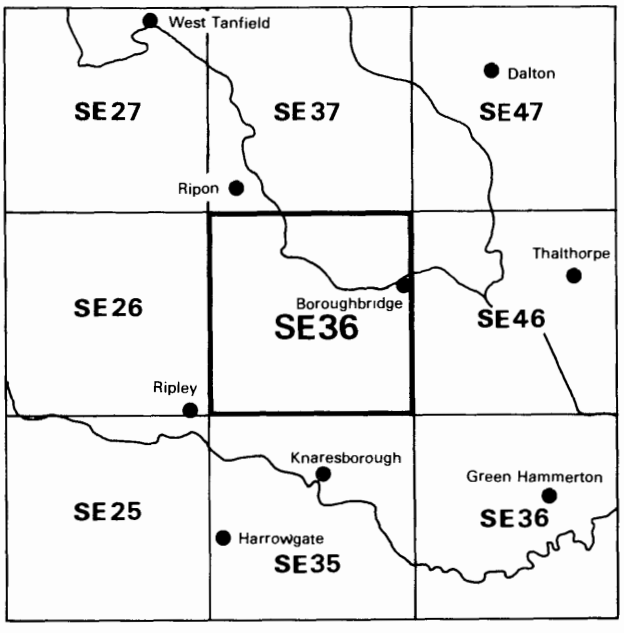

The sand and gravel resources of the country west of Boroughbridge, North Yorkshire

Description of 1: 25 000 resource sheet SE 36

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

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

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PREFACE

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

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

This report describes the resources of sand and gravel west of Boroughbridge, North Yorkshire, shown on the accompanying 1:25 000 resource map SE 36. The survey was conducted between 1975 and 1978 by D. A. Abraham, who was assisted in the drilling and sampling programme by B. J. Taylor, J. W. C. James, A. R. Clayton, D. P. Best, J. R. Gozzard, and R. Stanczyszyn. The work is based on six-inch scale geological surveys carried out in 1973–78 by the Institute's field staff, revising the original survey published in 1874 as Old Series sheet 93NW and subsequently as New Series sheet 62. The geological account of the district was contributed by A. H. Cooper of the Yorkshire and East Midlands Unit.

D. A. Abraham and J. W. Gardner, CBE, (Land Agent) were responsible for negotiating access to land for drilling. The ready cooperation of land owners, tenants, and of Messrs R.M.C. (UK) Ltd, Tilling Construction Services Ltd, Ripon City Gravel Co. Ltd, and British Gas, is gratefully acknowledged.

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The sand and gravel resources of sheet SE 36 (Boroughbridge, North Yorshire) *in pocket*

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The sand and gravel resources of the country west of Boroughbridge, North Yorkshire

Description of 1:25 000 resource sheet SE 36

D. A. ABRAHAM

SUMMARY

The geological maps of the Institute of Geological Sciences, pre-existing borehole information and 89 boreholes drilled for the Industrial Minerals Assessment Unit form the basis of the assessment of sand and gravel resources of the country west of Boroughbridge, North Yorkshire.

All deposits in the area which 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 resource blocks, containing between 2·9 and 13·7 km^2 of sand and gravel. For each block the geology of the deposits is described and the mineral-bearing area, the mean thicknesses 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.

Bibliographical reference

ABRAHAM, D. A. 1981. The sand and gravel resources of the country west of Boroughbridge, North Yorkshire. Description of 1:25 000 resource sheet SE 36. *Miner. Assess. Rep. Inst. Geol. Sci.*, No. 78.

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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, both the economic and the social factors used to decide whether a deposit may be workable in the future cannot 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 the survey seeks to provide, will add significantly to the factual background against which planning policies can be decided (Archer, 1969; Thurrell, 1971; Harris and others, 1974).

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

At the inferred level 'quantitative estimates are based largely on broad knowledge of the geologic character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity or repetition, of which there is geologic evidence: this evidence may include comparison with deposits of similar type. Bodies that are completely concealed may be included if there is specific geologic evidence of their presence. Estimates of inferred reserves should include a statement of the special limits within which the inferred material may lie (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.

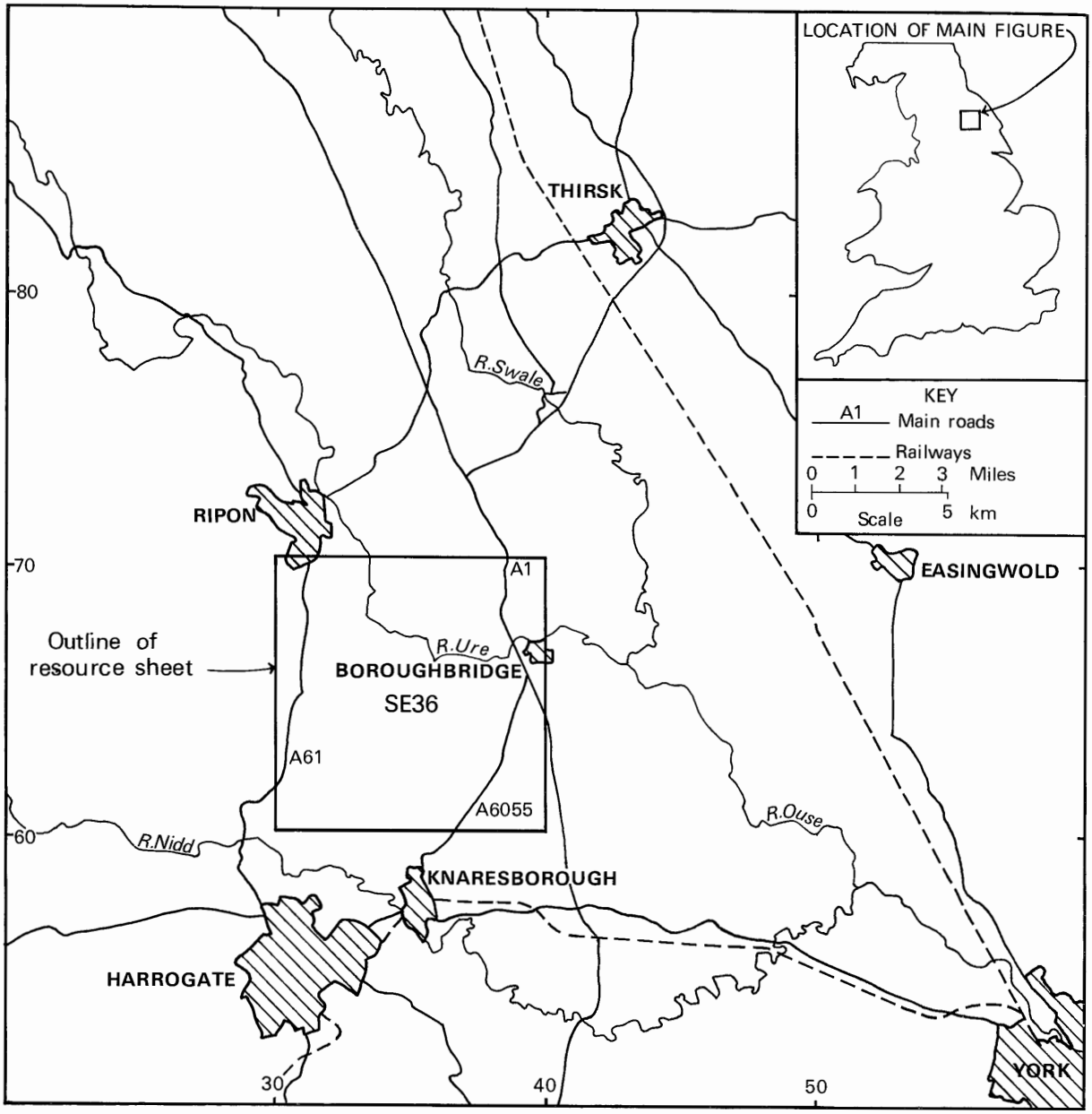


Figure 1 Map showing the location of sheet SE 36.

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

For the purposes of this survey, the unconsolidated, friable parts of the Sherwood Sandstone Group, which, on the basis of the above criteria, would often be classifiable as mineral, have not been assessed.

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 has been adopted. The boundaries between fines (that is, the clay and silt fractions) and sand, and between sand and gravel material, are placed at $\frac{1}{16}$ 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 and 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 the mineral in parts of a block, except in the immediate vicinity of the actual sample points.

DESCRIPTION OF THE DISTRICT

GENERAL

Most of the district is situated between the Harrogate–Ripon (A61) main road and the A1 trunk road (Figure 1); it is mainly agricultural. A description of the soils is given by Hartnup (1975).

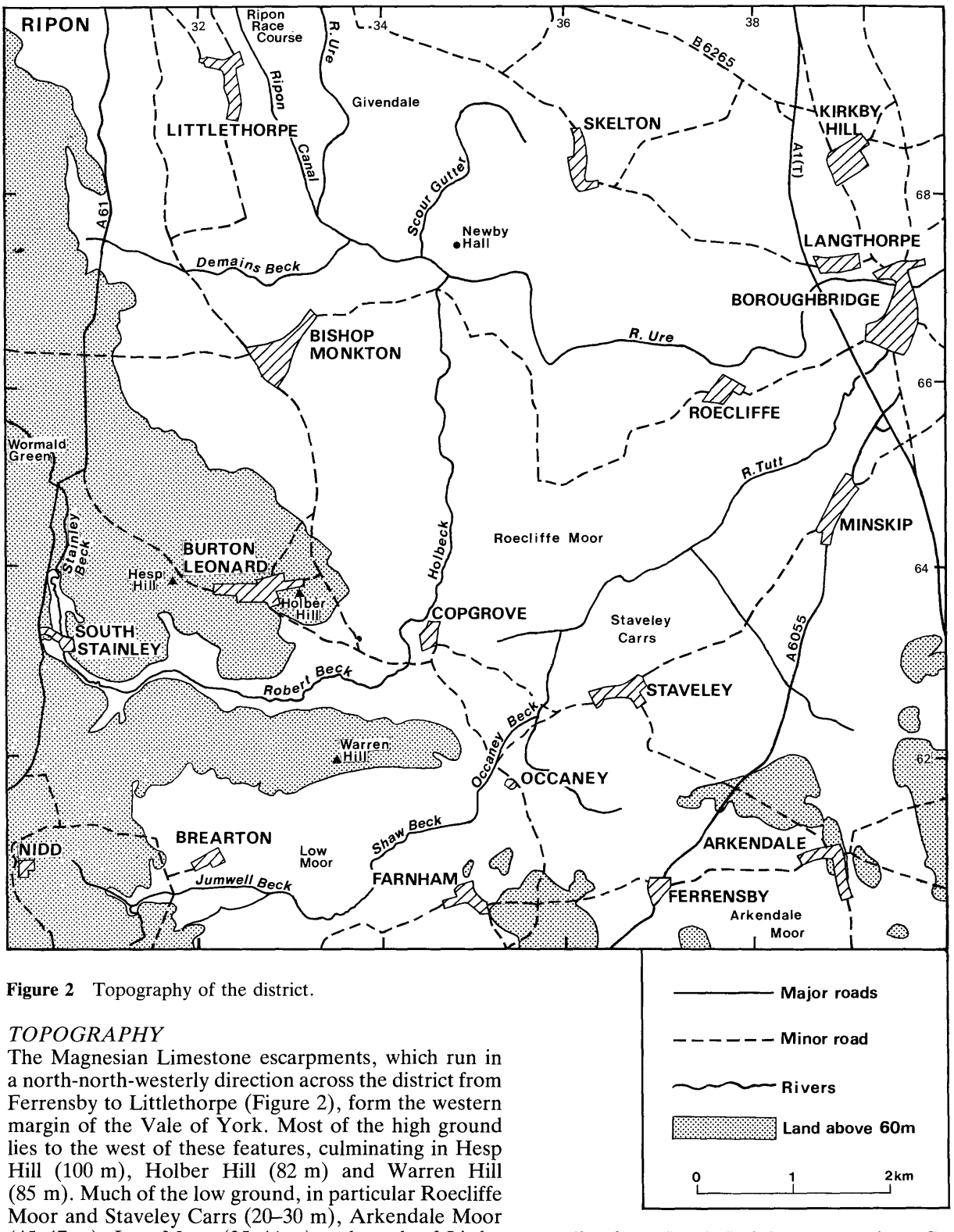


Figure 2 Topography of the district.

TOPOGRAPHY

The Magnesian Limestone escarpments, which run in a north-north-westerly direction across the district from Ferrensby to Littlethorpe (Figure 2), form the western margin of the Vale of York. Most of the high ground lies to the west of these features, culminating in Hesp Hill (100 m), Holber Hill (82 m) and Warren Hill (85 m). Much of the low ground, in particular Roecliffe Moor and Staveley Carrs (20–30 m), Arkendale Moor (45–47 m), Low Moor (35–44 m) and south of Littlethorpe (23–28 m), is notably level and represents the sites of former glacial lakes.

Apart from a small area south of Arkendale, the whole district lies in the drainage basin of the River Ure, which flows south-eastwards past Ripon and then eastwards through Boroughbridge. Between Ripon Race Course and Boroughbridge its floodplain falls from 18 m to 13 m above OD and narrows from about 1 km to 100 m.

The two main tributaries of the Ure, Holbeck and the River Tutt, join the Ure near Bishop Monkton and at Boroughbridge respectively. Holbeck, known as Robert Beck in its upper reaches, flows through a deep valley from South Stainley eastwards to Copgrove before turning north towards the Ure. The River Tutt, as Occaney Beck, cuts through the limestone scarps at Occaney and then drains to the north-east past Staveley Carrs.

GEOLOGY

The geological sequence of the district is detailed in Table 1. The deposits are listed as far as possible in order of increasing age.

SOLID

Carboniferous The mudstones and sandstones of Carboniferous age in the south-west are largely Drift-covered, whereas in the north and east they are overlain

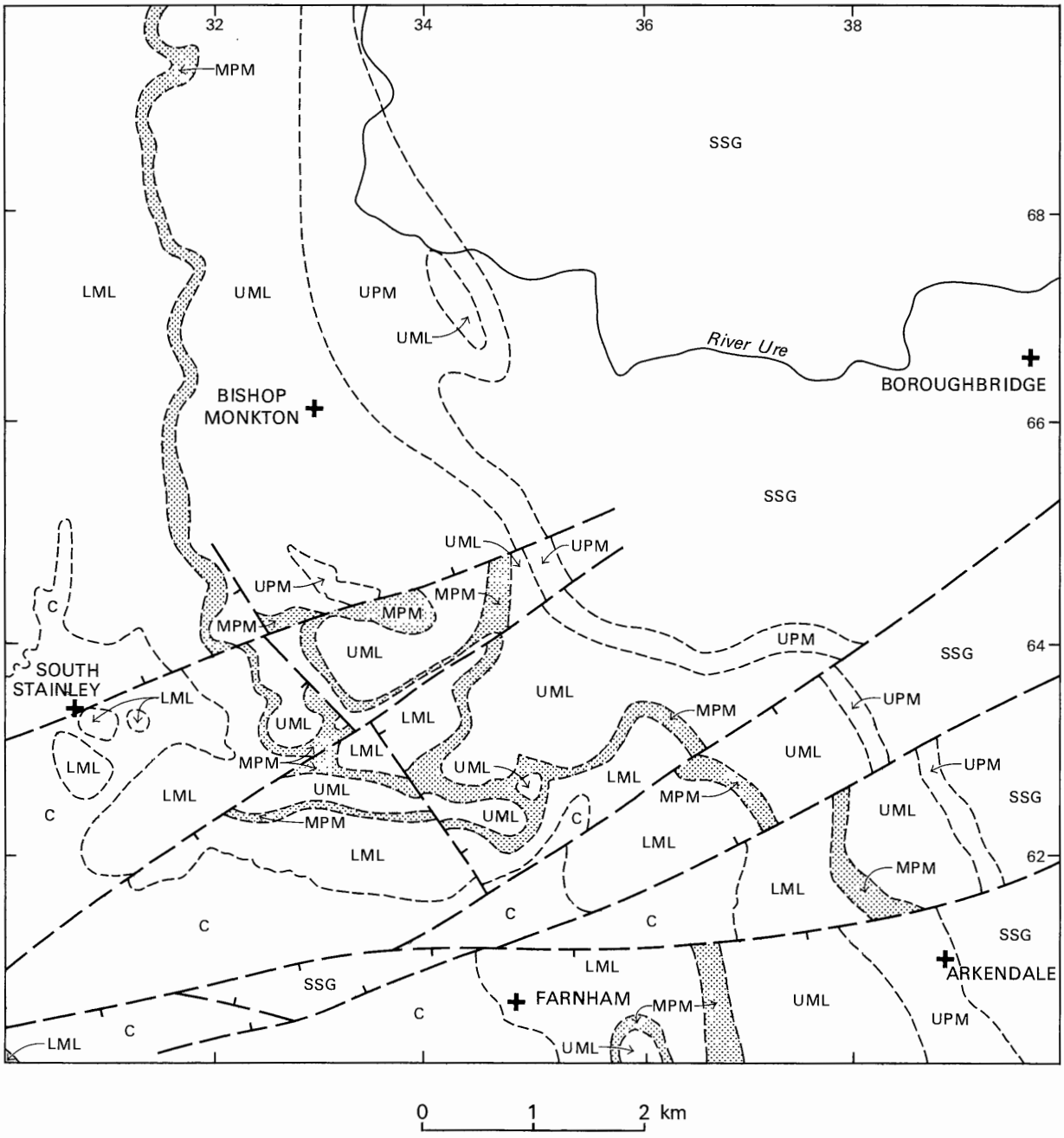


Figure 3 Solid geology.

Table 1 Geological succession exposed at the surface or proved in IMAU boreholes

DRIFT
Quaternary
Peat
Alluvium
Calcareous Tufa
River Terrace Deposits
Glacial Lake Deposits
Silt and clay
Sand
Fluvio-glacial Terrace Deposits, undifferentiated
Glacial Sand and Gravel
Till
Fluvio-glacial and Older River Sand and Gravel (and associated clays)
SOLID
Triassic
Sherwood Sandstone Group
Permian
Upper Marl
Upper Magnesian Limestone
Middle Marl
Lower Magnesian Limestone
Carboniferous
Namurian and Westphalian, undivided

by Permian rocks. Coarse-grained sandstone, probably belonging to one of the Plompton Grits (of Namurian age), crops out beside Stainley Beck [307 630] south of South Stainley, and similar sandstones are exposed at two localities [3275 6164 and 3265 6132] north-east of Brearton.

Lower Magnesian Limestone North of Wormald Green and at Farnham this limestone dips eastwards at less than 3°; in the intervening area, as a result of a swing in the dip to the north, it forms a strong scarp north of Brearton. The limestone, which is exposed in several quarries, is mainly concealed by Quaternary deposits except along scarp slopes. The variations in its thickness (from 25 to 50 m) are largely due to the irregular top of the underlying Carboniferous sequence.

The Lower Magnesian Limestone consists mainly of dolomites and dolomitic limestones with sporadic interbedded mudstones; some strata are oolitic and vughs are quite common. The bedding varies from thinly-bedded to massive and cross-bedding is found also. Small reefs occur, principally where the limestone thins over pre-existing hills of Carboniferous rocks.

Middle Marl Reddish brown thin-bedded calcareous mustones comprise most of the Middle Marl, but interbedded gypsum and anhydrite (and subordinate thin limestones) occur at depth. There are no permanent exposures. Boreholes indicate a thinning from about 40 m south-east of Staveley to between 20 and 25 m in the central and north-eastern parts of the district. A more appreciable thinning (to 4–8 m) around Burton Leonard may be due in part to the solution of interbedded evaporites.

Upper Magnesian Limestone Near Burton Leonard the Upper Magnesian Limestone forms prominent scarps, some of which are fault-controlled. Elsewhere the formation is largely drift-covered. The limestone, composed mainly of dolomite, is 8–10 m thick, white to pale grey (with a pink tinge in places) and contains numerous vughs. It is thinly bedded with some cross-bedding, and the tubular remains of the alga *Calcinema permiana* are common. Certain hollows in the outcrop probably result from subsidence following solution of evaporites in the Middle Marl.

Upper Marl The Upper Marl is almost entirely concealed by Drift deposits. Boreholes, however, prove 25 to 30 m of reddish brown silty mudstone with gypsum and anhydrite at depth. A few thin sandstones are present, mainly near the top of the formation, where it passes into the overlying Sherwood Sandstone Group.

Sherwood Sandstone Group This Group is present in the north-east and east of the area, but is almost entirely drift-covered. It consists of up to 130 m of reddish brown, fine- to medium-grained sandstones, with thin siltstones and mudstones, which occur mainly near the base. This deposit was formerly exposed in road cuttings north-north-west [384 684] of Boroughbridge.

DRIFT (Figure 4)

Fluvio-glacial and Older River Sand and Gravel (and associated clays) Sand and gravel of this deposit fills four distinct buried channels, two of which converge near Westwick (Figure 5).

Up to 9.3 m of sand and gravel has been proved beneath Till south-east of Brearton and a similar thickness is worked south-west of Farnham. Trough cross-bedding has been observed in the quarries and thin beds of clay are present in places. These deposits fill an old west–east channel (Johnson, 1974) which turns south-eastwards near Farnham.

Sand and gravel, overlain by Till, infills a deep channel beneath the present course of Holbeck; this channel joins a buried channel trending south-south-west beneath the Ure near Westwick. The sand and gravel in these channels is often intercalated with pebbly clay (borehole SW 27) or laminated clay (borehole NW 29). Beneath the present Ure Valley 8.3 m of sand and gravel was proved (borehole NW 22) resting on bedrock.

In the buried channels south of Roecliffe, south of Brearton, west of Staveley and north of Copgrove, thick clay and laminated clay (12.5 m thick in borehole NW 34) are associated with the Fluvio-glacial and Older River Sand and Gravel.

Till Till (of Devensian age) covers the bedrock over much of the district and has been proved (borehole SW 26) to be more than 18 m thick in places. The matrix varies from red and brown silty clay, on the Carboniferous and Permian rocks in the west and south-west, to reddish brown sand and clayey sand on the Sherwood Sandstone Group. The dominant erratics are Carboniferous sandstones. Carboniferous limestone erratics are common in the west and locally near Arkendale, but become scarce in the north-east. Permian limestone fragments are largely restricted to localities where these limestones form the bedrock. A few igneous and metamorphic erratics have been

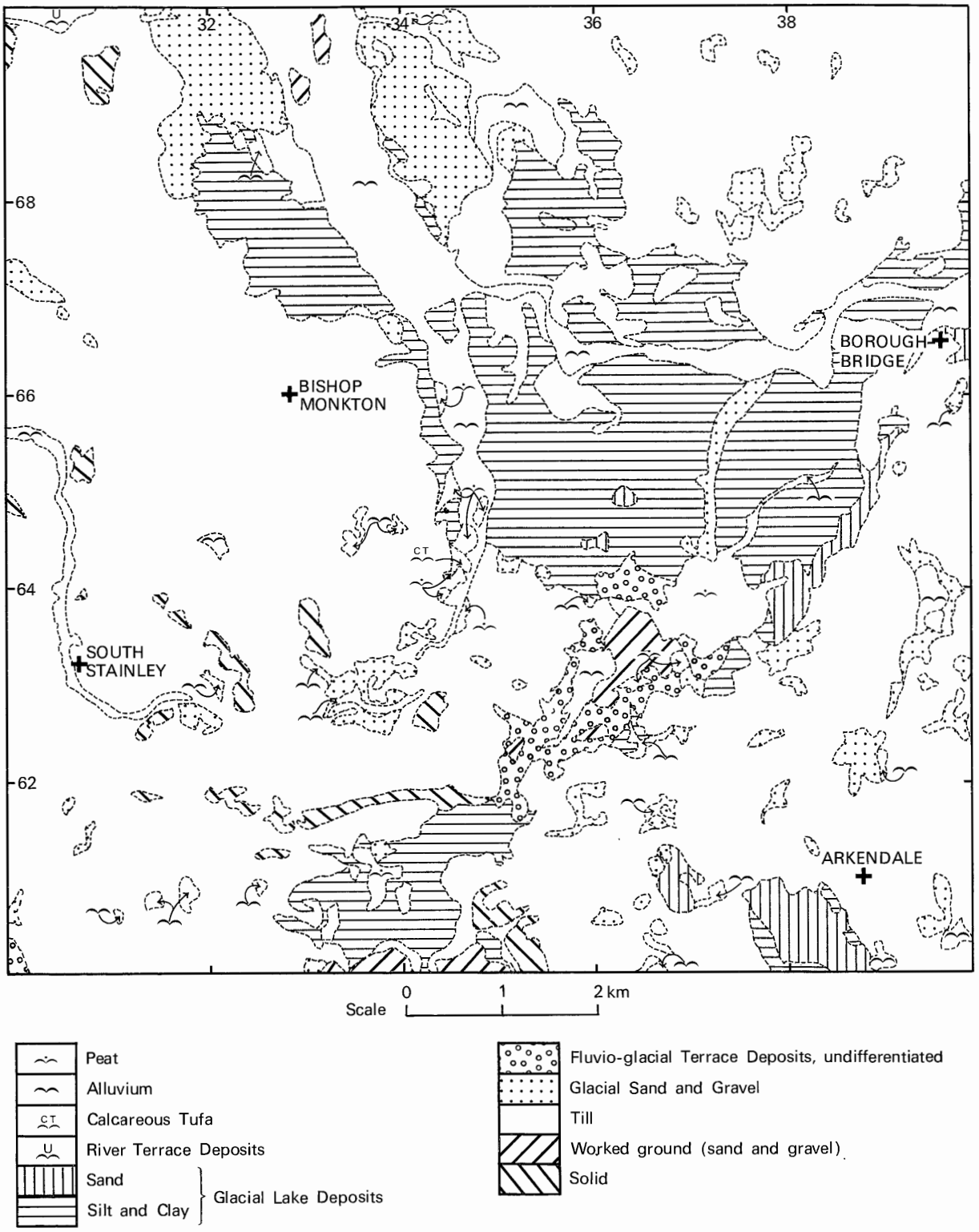


Figure 4 Drift geology.

found. Lenses and discontinuous beds of laminated clay, sand and gravel are present within the till.

Glacial Sand and Gravel These deposits vary considerably in their lithology (see section on Composition of the sand and gravel), thickness, topographic expression, and in their relationship to the till. They occur mainly on the higher ground and have been worked on a small scale in the past. South-east [341 636] of Burton Leonard and in a ridge extending south-westwards from Roecliffe [373 652] the sands and gravels have been proved to be over 24 m and 14 m thick respectively. Elsewhere, however, as in the large spread around Givendale [340 690], they are locally less than 1 m thick. The latter deposit and that around Littlethorpe both rest upon till and have an undulating top. The deposits between South Stainley and Copgrove, which occur in a valley, likewise have an undulating upper surface, but rest partly on till and partly on Permian rocks. Where the sand and gravel is thick (for instance in borehole NW 16, where over 8 m was proved), it is frequently intercalated with till, especially in the east of the district.

Fluvio-glacial Terrace Deposits, undifferentiated In the valley of Occaney Beck sand and gravel forms

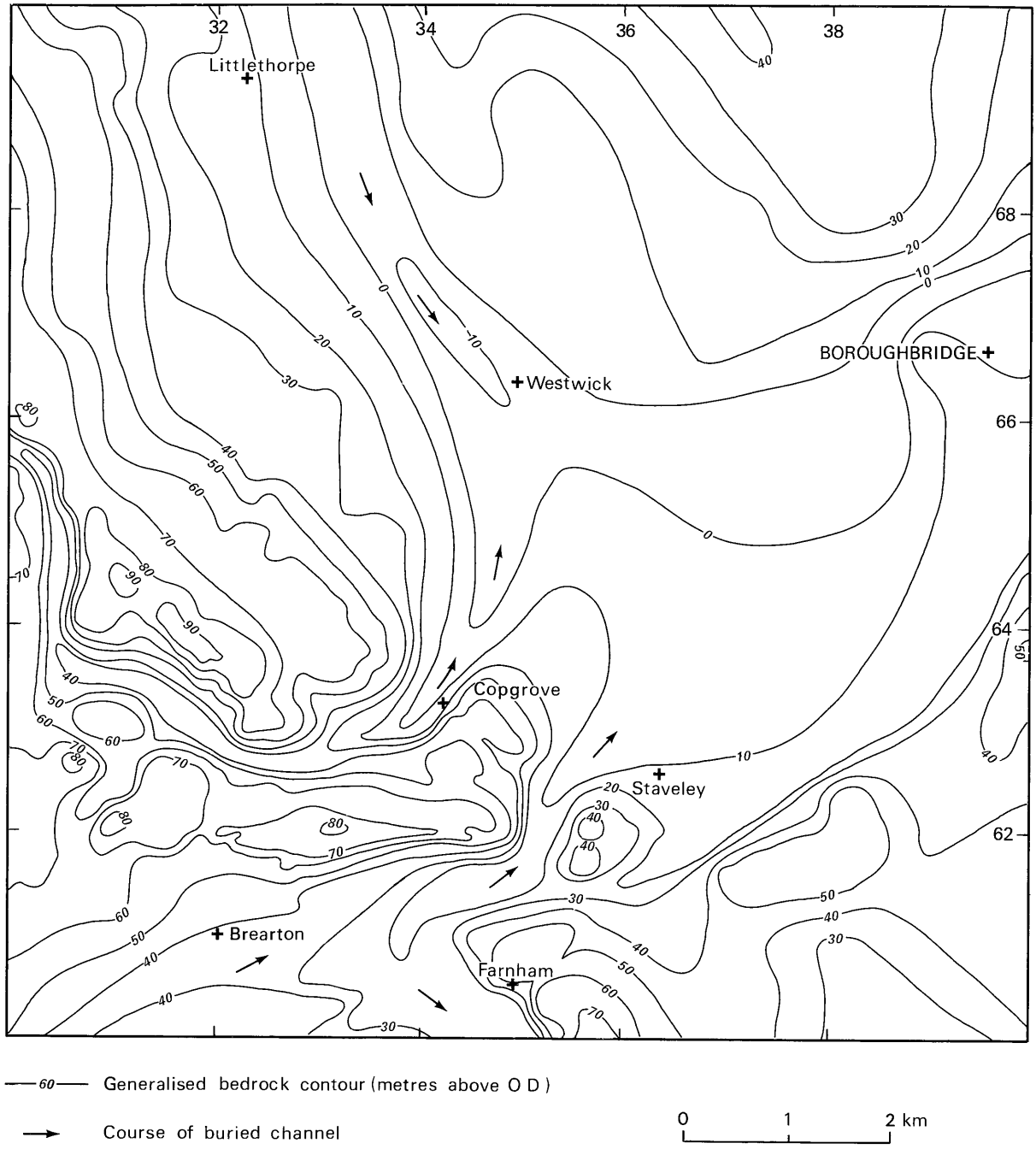


Figure 5 Bedrock contour map.

terrace deposits which in places were formerly more than 3.5 m thick. These deposits have been worked extensively north of Staveley and are currently being worked to the north-west of the village. Associated with the River Nidd in the south-west of the area, at Nidd Park [301 601], there is a thick terrace deposit composed of clays, silts and sands (borehole SW 36).

Glacial Lake Deposits Clays, silts and sands of lacustrine origin occupy much of the low ground and form flat expanses between Littlethorpe and Minskip. Smaller patches occur north of Boroughbridge, west of Farnham and west of Arkendale.

Silt and clay Stiff, grey to brown, stoneless, laminated silt and clay, commonly with numerous laminae of fine sand, forms the bulk of the lacustrine deposits and is more than 15 m thick south of Roecliffe [386 659] and south of Littlethorpe [327 681], where it is still being worked to make garden ware.

Sand Thin beds of sand occur within the lacustrine clays and, near Minskip [388 647], form a beach deposit marginal to the clay flat. Two patches of lacustrine deposits, at Arkendale Moor and Ferrensby Moor, consist largely of fine 'very clayey' sand at the surface.

River Terrace Deposits In the southern outskirts of Ripon a deposit of sand and gravel forms a terrace marginal to the River Skell.

Calcareous Tufa In the valley of Holbeck, to the north of Copgrove, sponge-like calcareous tufa containing sporadic gastropod fossils is present within peat. It occurs both as thin beds and as irregular masses. The latter give rise in places to small hillocks up to 2 m high covered with only a thin veneer of peat. Some of these occur near springs.

Alluvium North-west of Newby Hall the wide flood-

plain of the Ure is underlain by sandy and silty clay resting on sand and gravel. The latter deposit is currently being worked at Ripon Race Course. Between Newby Hall and Boroughbridge the floodplain is narrower and the alluvium consists of clay and clayey sand. The deposits along Stainley Beck, Robert Beck and Holbeck are predominantly clays, although 3.6 m of sand and gravel has been proved in a borehole (SW 27) beside Holbeck. In the same borehole a layer of peat was proved within the alluvial clays.

Numerous ill-drained enclosed hollows contain alluvial silt and clay, commonly associated with peat. Most are situated in localities mantled by glacial deposits and some are typical kettle holes. Other hollows, largely confined to areas underlain by Middle Marl, Upper Magnesian Limestone or Upper Marl are probably subsidence features resulting from the solution of evaporites.

Peat The largest deposits of peat occur north-east of Staveley (a thickness of 1.6 m was proved in borehole SE 21), east of Brearton and in the valley of Holbeck. These deposits occupy low-lying, ill-drained ground. Peat is also present in kettle holes, subsidence hollows and abandoned meanders.

COMPOSITION OF THE SAND AND GRAVEL DEPOSITS

Potentially workable sand and gravel occurs in five deposits: Fluvio-glacial and Older River Sand and Gravel, Glacial Sand and Gravel, Fluvio-glacial Terrace Deposits, Glacial Lake Deposits, and Alluvium. All five deposits are found in the resource blocks prefixed A, whereas in the blocks prefixed B Glacial Sand and Gravel is the dominant mineral-bearing deposit.

Fluvio-glacial and Older River Sand and Gravel The Fluvio-glacial and Older River Sand and Gravel usually has a low (less than 10 per cent) fines content and often contains nearly equal proportions of sand and gravel. Its mean grading is fines 9 per cent, sand 53 per cent and gravel 38 per cent. The sand is mainly coarse and medium with some fine and is composed usually of quartz with some fragments of Carboniferous and Permian limestones. The gravel, coarse and fine with sporadic cobbles (see Table 10), is composed predominantly of Carboniferous sandstone and limestone pebbles, with Permian limestone and small amounts of mudstone, chert and quartzite (Table 2). The proportion of Permian limestone pebbles is variable; they may be almost absent, as in the east of the district, or abundant, as in areas close to the Magnesian Limestone outcrop.

Glacial Sand and Gravel This deposit has a mean grading of fines 16 per cent, sand 57 per cent and gravel 27 per cent. It is usually 'clayey' with a fines content of 10–20 per cent. The sand is very variable in its grading but is composed mostly of quartz with fragments of Carboniferous and Permian limestones. The gravel fraction is commonly composed of approximately equal proportions of fine and coarse material with sporadic cobbles; it consists mainly of Carboniferous sandstone and limestone pebbles, with some Permian limestone and occasional mudstone, chert and quartzite. Carboniferous sandstone pebbles are usually dominant, but east of Arkendale and near Nidd Hall [302 608] substantial amounts of Carboniferous limestone pebbles are present. Between South Stainley and Copgrove both Permian and Carboniferous limestone pebbles are common in the gravels.

Glacial Lake Deposits The lacustrine sands have a high fines content; their mean grading is fines 23 per cent and sand 77 per cent, with only sporadic small pebbles. The sand is composed mainly of fine and medium quartz, locally with some Carboniferous limestone fragments.

Fluvio-glacial Terrace Deposits The mean grading of the mineral in the two IMAU boreholes that proved potentially workable material is fines 14 per cent, sand 65 per cent and gravel 21 per cent. The gravel fraction is composed mainly of pebbles of Carboniferous and Permian limestones with some Carboniferous sandstone.

Alluvium Alluvial sand and gravel in the Ure valley west of Newby Hall and beside Holbeck (Block A^1) has a low fines content and a higher percentage of gravel than of sand. The sand is predominantly medium and coarse with fine and consists mainly of quartz with some fragments of Carboniferous and Permian limestones. The gravel fraction consists of Carboniferous sandstone and limestone and Permian limestone pebbles, of both fine and coarse grade, with some mudstone, chert and traces of quartzite (Table 3). East of Newby Hall the Ure valley contains alluvium composed mainly of 'very clayey' sands. The sand fraction is mainly composed of fine and medium quartz (borehole NE 31). The mean grading for all the alluvial sands

Table 2 Lithological analyses of selected samples of gravel from the Fluvio-glacial and Older River Sand and Gravel

Block	Borehole number	Depth	Percentage by weight (and number)							
			Limestone	Dolomitic limestone	Sandstone	Mudstone	Chert	Quartzite	Calcareous mudstone	Others
A^1	NW 12	11.4–12.4	39 (31)	44 (47)	12 (14)	2 (6)	0	0	3 (2)	3 (2)
		13.8–14.9	27 (22)	38 (44)	16 (14)	2 (2)	0	2 (1)	3 (4)	12 (13)*
	NW 22	13.0–14.0	31 (35)	42 (46)	19 (11)	2 (4)	5 (3)	1 (1)	0	0
	NW 29	20.3–21.4	49 (44)	19 (37)	28 (16)	2 (2)	trace	0	2 (1)	0
	NW 34	6.0–7.0	36 (29)	27 (29)	34 (34)	1 (5)	2 (2)	trace (1)	0	0
A^2	NE 38	20.6–20.9	27 (36)	17 (21)	51 (29)	2 (7)	trace (2)	1 (1)	–	2 (4)
A^3	SW 40	4.2–5.2	32 (28)	35 (45)	27 (18)	3 (5)	1 (2)	trace	2 (2)	–

* Predominantly pebbles of conglomerate composed of the other constituents of this sample bound by a calcareous cement.

and gravels is fines 9 per cent, sand 43 per cent and gravel 48 per cent.

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 topography is shown by contours in green, the geological data 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 map of this area recently surveyed at the scale of 1:10 560. This information was obtained by detailed application of field mapping techniques by the field staff of the Institute's Yorkshire and East Midlands Unit. Borehole data, which include the stratigraphic relations, thickness and mean particle size distribution of the sand and gravel samples collected during the assessment, are also shown.

The geological boundaries are regarded as the best interpretation of the information available at the time of the survey. However, it is inevitable, particularly with deposits which, as in this district, change rapidly vertically and laterally, that local irregularities or discrepancies will be revealed by some boreholes. These are taken into account in the assessment of the resources (see Appendix B).

Mineral resource information The mineral-bearing ground is subdivided into resource blocks (see Appendix A). Within a resource block the mineral is subdivided into areas where it is exposed and areas where it is present beneath overburden. The mineral is identified as 'exposed' where the overburden, commonly consisting only of soil and subsoil, averages less than 1.0 m in thickness. Beneath overburden the mineral may be continuous, or almost continuous. The recognition of these categories is dependent upon the importance attached to the proportion of boreholes which did not find potentially workable sand and gravel and the distribution of barren boreholes within a block. The mineral is described as 'almost continuous' if it is present in 75 per cent or more of the boreholes in a resource block.

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 reason is given (e.g. south of Minskip). In such cases it has been assumed that mineral is absent except in infrequent and relatively minor patches which can neither be outlined or 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 sand and gravel is measured, where possible, from the mapped geological boundary lines. The whole of this area is considered as mineral, although it may include small areas where sand and gravel is not present or is not potentially workable. Inferred boundaries have been inserted 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 convey an approximate location within a likely zone of occurrence rather than to represent the breadth of the zone, its size being limited only by cartographic considerations. For the purpose of measuring areas the centre-line of the symbol is used.

Worked ground The approximate extent of known sand and gravel works to Autumn 1977 is shown on the map; active and disused workings are indicated, together with areas which have been returned to agricultural use and areas partly backfilled with waste from the sand and gravel industry.

RESULTS

The statistical and inferred issessments are summarised in Table 4; fuller particulars of grading are shown in Figure 6.

Accuracy of results For the areas statistically assessed (resource blocks A^1, A^3 and part of B^1) the confidence limits at the 95 per cent probability level (that is, it is probable that, nineteen times out of twenty, the true volumes present lie within these limits) vary between 25 and 44 per cent. However, the true volumes are more likely to be nearer to the figures given than to the limits. Moreover, it is probable that in each block approximately the same percentage limits would apply for the estimate of volume of a very much smaller area of land (say 100 hectares) containing similar sand and gravel deposits, if 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 the quotation of the reserves in part of a block, it can be expected that data from more than ten sample points will be required, even if the area is quite small.

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

NOTES ON THE RESOURCE BLOCKS

The total area assessed amounts to 98.4 km^2, of which 40.8 km^2 is considered to be mineral-bearing. The 1.6-km^2 area not assessed comprises the urban areas of Boroughbridge and the southern outskirts of Ripon,

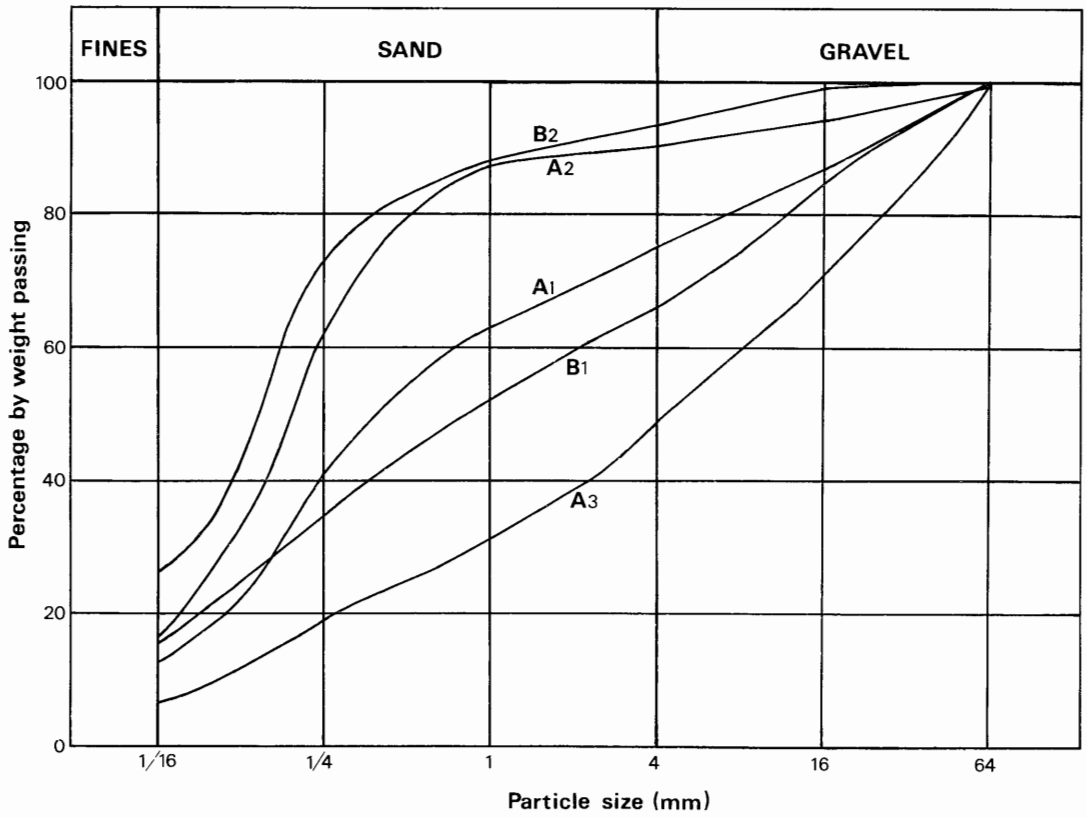
Table 3 Lithological analyses of selected samples of gravel from the Alluvium

Block	Borehole number	Depth	Percentage by weight (and number)							
			Limestone	Dolomitic limestone	Sandstone	Mudstone	Chert	Quartzite	Calcareous mudstone	Others
A^1	NW 12	3.1–5.2	36 (33)	32 (38)	26 (22)	–	2 (4)	trace (1)	–	4 (2)
	NW 15	1.9–2.2	22 (24)	21 (21)	41 (36)	12 (10)	3 (6)	–	–	1 (3)
		3.5–4.3	33 (45)	20 (13)	35 (25)	4 (9)	2 (3)	1 (1)	5 (4)	–
	NW 22	2.7–4.5	29 (28)	18 (14)	47 (45)	2 (7)	trace (1)	3 (4)	–	trace (1)

Table 4 The sand and gravel resources of the area west of Boroughbridge, North Yorkshire: summary of statistical results

Block	Area		Mean thickness			Volume of sand and gravel			Mean grading percentage		
	Block	Mineral	Over-burden	Mineral	Waste*		Limits at the 95% confidence level		Fines $-\frac{1}{16}$	Sand $+\frac{1}{16}-4$	Gravel +4
	km^2	km^2	m	m	m	10^6 m^3	± %	± 10^6 m^3	mm	mm	mm
$A^1(40)$†	13.9	13.7	5.5	4.7	1.4	64.4	41	26.4	13	62	25
$A^2(13)$	11.6	3.4	1.5	7.8	0.7	29.0‡	–	–	16	75	9
$A^3(9)$	4.1	2.9	3.5	8.6	2.1	24.9	44	11.0	7	42	51
$B^1(12)$§	52.5	7.9	3.3	4.3	nil	34.0	25	8.5	20	59	21
$B^1(7)$§	52.5	0.8	3.2	9.6	0.2	5.5	–	–	13	39	48
$B^2(14)$	16.3	12.1	1.4	3.2	0.3	43.7‡	–	–	26	66	8
All blocks	98.4	40.8	3.3	4.8	0.8	201.5	–	–	17	61	22

* Between mineral deposits.
† The number of boreholes used in the assessment of each block is given in parentheses.
‡ Inferred assessment.
§ For details of the parts of Block B^1 referred to here, see 'Notes on the resource blocks'.



RESOURCE BLOCK	Percentage by weight passing					
	1/16 mm	1/4 mm	1mm	4mm	16mm	64 mm
A1	13	41	63	75	87	100
A2	17	62	87	90	94	99
A3	7	19	31	49	71	100
B1	16	35	52	66	85	100
B2	26	73	88	93	99	100

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

and areas worked out or currently being worked for sand and gravel (north and west of Staveley, north of Occaney, south-west of Farnham, at Ripon Race Course, and small abandoned pits north-east of Nidd Hall and south-east of Burton Leonard). It is estimated that, up to Autumn 1977, about 5.5 million m^3 of sand and gravel had been extracted from the district.

Resource blocks prefixed A contain deposits resulting predominantly from deposition in a fluvial or glaciolacustrine environment, whereas blocks prefixed B contain mainly irregular glacial deposits. Because the mineral deposits are so diverse and often of limited extent, it has been necessary to make inferred assessments of the volume of mineral in Blocks A^2, B^2 and parts of B^1. Fluvio-glacial and Older River Sand and Gravel, found mainly in Blocks A^1 and A^3, and Fluvio-glacial Terrace Deposits, found mainly in Block A^1, are the major sources of potentially workable sand and gravel.

Block A^1 (Table 5)

This block, comprising almost 14 km^2 of mineral beneath overburden, encompasses the valley of the Ure as far east as Mulwith, the valley of Holbeck below Copgrove, the western half of Roecliffe Moor and the low ground south of Littlethorpe and north and west of Staveley.

The potentially workable sand and gravel in this block belongs mainly to the Fluvio-glacial and Older River Sand and Gravel, the Fluvio-glacial Terrace Deposits, and the Alluvium, with lesser amounts referred to the Glacial Sand and Gravel, and the Glacial Lake Deposits. Data quoted in Table 5 are supplemented by information from 23 other boreholes, 17 of which are confidential. Excessive overburden renders the sand and gravel found in boreholes NW 3, NW 21, NW 29 and NW 34 not potentially workable.

The thicknesses of potentially workable material belonging to the *Fluvio-glacial and Older River Sand and Gravel* proved in IMAU boreholes range from 1.0 m in (in borehole SE 12) to 10.1 m (in borehole NE 42). The mean thickness of mineral assigned to this deposit is 5.4 m. Locally, waste partings of laminated clay are thick enough to render the sand and gravel with which they are interbedded not potentially workable, as at site NW 29.

'Clayey' gravel of the *Fluvio-glacial Terrace Deposits* was penetrated by only one IMAU borehole (SE 24), in which 2.4 m of mineral was proved.

Potentially workable sand and gravel assigned to the *Alluvium* is confined to the valleys of the Ure and Holbeck; proved thicknesses of mineral range from 1.5 m (borehole NE 31) to 3.6 m (borehole SW 27), with a mean thickness of 2.5 m. The mineral is usually composed of almost equal proportions of sand and gravel, except in the Ure valley east of Newby Hall where it is predominantly 'very clayey' sand (borehole NE 31).

Potentially workable material in the *Glacial Sand and Gravel* is very variable in both thickness and composition; the proved thickness of mineral in this deposit ranges from 1.2 m (borehole NW 14) to 7.6 m (borehole NW 28), with a mean thickness of 4.3 m. Just north of the latter site, at Ryle Hill, the deposit, which has been worked in the past, consists of 'very clayey' and pebbly sands; elsewhere, the Glacial Sand and Gravel may contain either little gravel (as in borehole SE 12) or as much as 81 per cent (borehole NW 14); it is often interbedded with till.

Sand of the *Glacial Lake Deposits* was proved thick enough to be designated as mineral at only one IMAU borehole site (NE 35). Here the sand, 6.0 m thick, is 'clayey' and 'very clayey' with some fine gravel and is interbedded with lacustrine silt and clay. Records of non-IMAU boreholes indicate, however, that this sand is present both north and south of this site.

The combined mineral deposits of the block have a mean grading of fines 13 per cent, sand 62 per cent and gravel 25 per cent. The mean thickness of mineral is 4.7 m and the estimated total volume is 64.4 million m^3 ± 41 per cent.

Overburden, which consists of till, lacustrine clay, alluvium, or peat, or a combination of these, varies in thickness from 1.1 m (borehole SW 27) to 16.6 m

Table 5 Data from IMAU boreholes: Block A^1

Borehole	Recorded thickness			Mean grading percentage					
	Mineral m	Overburden m	Waste partings m	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 12	6.6	2.1	6.2	4	5	20	19	27	25
NW 14	1.2	3.1	–	5	3	7	4	33	48
NW 15	2.4	1.9	–	2	3	10	16	31	38
NW 20	4.2	11.9	–	6	8	18	24	28	14
NW 21	absent								
NW 22	10.1	2.7	2.5	7	25	37	11	9	10
NW 28	7.6	7.1	–	17	46	24	9	3	1
NW 29	absent								
NW 34	absent								
NW 35	3.7	7.8	–	40	56	4	trace	trace	0
NE 31	1.5	2.5	–	35	49	16	0	0	0
NE 35	9.5	5.6	4.4*	15	42	17	9	7	10
NE 42	10.1	8.7	1.2	20	49	30	1	0	0
SW 27	12.8	1.1	10.7†	10	24	12	12	18	24
SE 12	7.9	7.8	2.8	10	28	46	13	3	trace
SE 19	6.1	16.6	–	3	4	20	21	25	27
SE 24	2.4	1.5	–	13	6	13	15	25	28

* Total thickness of two waste partings
† Total thickness of three waste partings

(borehole SE 19), with a mean thickness of 5.5 m. Waste partings of till or lacustrine clay and silt are common within the mineral; their mean total thickness is 1.4 m, but ranges up to 10.7 m (borehole SW 27).

Block A[2] (Table 6)

This block includes the valley of the Ure east of Mulwith and the eastern half of Roecliffe Moor; its area is 11.6 km^2, of which 3.4 km^2 is mineral-bearing. The mineral belongs to the Glacial Sand and Gravel, the Glacial Lake Deposits, the Fluvio-glacial Terrace Deposits, and the Older River Sand and Gravel. The data from IMAU boreholes (Table 6) are supplemented by information from the records of seven non-IMAU boreholes, one of which is confidential. The thickness of overburden, particularly beneath parts of Roecliffe Moor, is often such as to render the sand and gravel deposits not potentially workable (as at boreholes NE 29, NE 32, NE 43 and SE 13).

A southerly-trending esker composed mainly of 'clayey' sand extends from Roecliffe, where it is truncated by the River Ure, to Staveley Carrs. The mineral it contains is exposed along its axis, but is concealed by till on its flanks, so that the lateral extent of the deposit is uncertain. The mineral was proved to be 14.1 m thick at borehole NE 38, and the record for the non-IMAU borehole NE 5 suggests that locally it may be as much as 24.4 m thick. Around Waingates Farm [371 649] the esker is underlain by sandy gravel of the Fluvio-glacial and Older River Sand and Gravel. Elsewhere in the block Glacial Sand and Gravel of mineral grading forms small irregular deposits, for example east of Staveley Carrs (borehole SE 22) and north of Boroughbridge (borehole NE 18). It also occurs beneath sand of the Glacial Lake Deposits that is exposed at Minksip (borehole SE 17).

The non-IMAU borehole SE 9 indicates the presence of potentially workable material assigned to the *Fluvio-glacial Terrace Deposits* in a small area around Carr Top Farm.

Sands of the *Glacial Lake Deposits* extend northeastwards from Spellow Grange [378 632] through Minksip almost as far as the A1 trunk road. They are concealed by overburden on both sides of the River Ure north and west of Boroughbridge. They vary in thickness from 1.1 m to 4.2 m and are composed predominantly of 'clayey' and 'very clayey' sand; at Milby (borehole NE 30) the fines content is 34 per cent.

The mineral in the *Alluvium* was proved to be up to 7.8 m thick (borehole NE 23A); it is composed predominantly of sand and is exposed in the Ure valley mainly north-east of Roecliffe: the position of the western limit of the potentially workable material is uncertain.

The mean grading of the combined mineral deposits of the block is fines 16 per cent, sand 75 per cent and gravel 9 per cent.

Inferred estimates indicate that the total volume of mineral present in the block is about 29 million m^3. Overburden, consisting mainly of lacustrine silt and clay, with some peat at Staveley Carrs (borehole SE 15), was proved to vary in thickness from 0.3 m to 4.8 m, with a mean thickness of 1.5 m.

Block A[3] (Table 7)

This, the smallest block, with an area of 4.1 km^2, consists of two areas of flat, low-lying ground bordering the southern margin of the district, namely Low Moor and the valley of Shaw Beck west and north of Farnham, and the northern part of Arkendale Moor. The mineral-bearing area extends to about 2.9 km^2.

The mineral in the western area consists of Fluvio-glacial and Older River Sand and Gravel, whereas that in the eastern area at Arkendale Moor is sand of the Glacial Lake Deposit and gravel that is presumed to belong to the Fluvio-glacial and Older River Sand and Gravel. The data from the IMAU boreholes (Table 7) have been supplemented by information from the records of five non-IMAU boreholes, four of which are confidential.

Boreholes SW 38, SW 39 and SW 40 proved 9.3 m, 4.4 m and 8.4 m respectively of gravel filling a buried channel west of Farnham. The limits of the mineral in this deposit are uncertain both there and at Arkendale

Table 6 Data from IMAU boreholes: Block A^2

Borehole	Recorded thickness			Mean grading percentage					
	Mineral m	Overburden m	Waste partings m	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	absent								
NE 29	absent								
NE 30	4.2	1.2	–	34	62	4	trace	trace	trace
NE 32	absent								
NE 33	absent								
NE 34	2.4	1.9	–	7	22	64	6	1	0
NE 36	absent								
NE 37	absent								
NE 38	14.1	0.7	–	14	57	27	1	trace	1
NE 39	absent								
NE 43	absent								
SE 13	absent								
SE 14	absent								
SE 15	3.1	4.8	–	4	13	43	13	15	12
SE 16	absent								
SE 17	3.2	1.2	–	15	41	10	6	6	18
SE 21	absent								
SE 22	2.8	0.3	–	24	23	7	9	18	14

Table 7 Data from IMAU boreholes: Block A[3]

Borehole	Recorded thickness			Mean grading percentage					
	Mineral m	Overburden m	Waste partings m	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 35	absent								
SW 38	9.3	5.7	–	4	4	15	19	28	30
SW 39	4.4	9.2	–	7	7	8	16	19	41
SW 40	8.4	4.2	–	2	2	17	23	29	27
SE 23	absent								
SE 35	absent								
SE 36	11.5	0.6	7.5	13	29	7	12	14	25

Moor. Near Walkingham Hall [347 614] the deposit thins and becomes not potentially workable owing to excessive clay overburden. The mineral of the *Fluvio-glacial* and *Older River Sand and Gravel* has a proved mean thickness in this block of 7.4 m; it consists of gravel and sandy gravel with a mean fines content of 5 per cent.

Sand of the *Glacial Lake Deposits* was 4.0 m thick in borehole SE 36, where it consists of predominantly fine 'clayey' and 'very clayey' sand, with the highest fines content (38 per cent) at the base. The northern limit of potentially workable material in this deposit is uncertain, but near Moor Lane the deposit is probably less than one metre thick.

The combined mineral deposits have a mean grading of fines 7 per cent, sand 42 per cent and gravel 51 per cent. The mean thickness of the mineral in the block is 8.6 m and its estimated total volume is 24.9 million $m^3 \pm 44$ per cent. The overburden, comprising lacustrine silt and clay and/or till, ranges in thickness from 0.6 m at Arkendale Moor to 9.2 m at Low Moor (borehole SW 39), with a mean thickness of 3.5 m. At Arkendale Moor 7.5 m of lacustrine silt and clay and till occurs as waste between the two mineral deposits (borehole SE 36).

Block B[1] (Table 8)

This, the largest of the five resource blocks, covers a total area of 52.5 km^2; it is in two parts, separated by the valley of Shaw Beck near Occaney. The western part, which includes most of the higher ground of the district, though generally barren, contains the only significant resources of mineral. The eastern part is a broad till-covered tract of country in which there are a number of small irregular bodies of Glacial Sand and Gravel, none of which is extensive enough to be economically attractive, although a total thickness of 6.9 m of 'clayey' pebbly sand (in two deposits separated by 2.3 m of waste) was proved in borehole SE 30.

The potentially workable sand and gravel, which covers a total area of about 8.7 km^2, consists almost exclusively of Glacial Sand and Gravel, most of which is concealed by till overburden. A small area of Fluvio-glacial Terrace Deposits contains concealed mineral at Nidd Park, where 3.9 m of 'clayey' and 'very clayey' sand is found within clays (borehole SW 36). The data from IMAU boreholes tabulated in Table 8 are supplemented by information from the records of 5 non-IMAU boreholes, one of which is confidential. A combined statistical assessment was made for three areas, totalling 7.9 km^2, of concealed mineral at Littlethorpe, east of Bishop Monkton and between Brearton and Nidd. The boundaries of the mineral-bearing ground in these areas are frequently difficult to delineate. The proved thicknesses of the Glacial Sand and Gravel in these areas range from 1.9 m (borehole NW 10) to 6.8 m (borehole SW 37), with a mean thickness of 4.3 m. The grading of the mineral ranges from 'clayey' sand (in borehole NW 27) to 'very clayey' gravel (in borehole NW 19). The mean grading of the combined mineral deposits proved in these areas is fines 20 per cent, sand 59 per cent and gravel 21 per cent. The estimated total volume of mineral is 34.0 million $m^3 \pm 25$ per cent. The overburden, consisting mainly of till, was proved to range in thickness from 0.3 m to 7.9 m, with a mean thickness of 3.3 m. No waste partings were encountered, although 2.2 m of material in borehole NW 11 (north of Littlethorpe) was classified as waste due to non-recovery.

Inferred assessments were made for five small areas (totalling 0.8 km^2) of potentially workable Glacial Sand and Gravel exposed, at Gravel Hill [338 626] and Toll House [337 632] but concealed at South Stainley [305 635], Rakes House [320 627] and Holly Bushes [341 636]. The mineral in these deposits ranges in thickness from 3.4 m at Gravel Hill (borehole SW 31) to 24.1 m at Holly Bushes (borehole SW 29), where a small sinuous esker with a marked topographic expression forms a thick deposit of limited extent. The total volume of mineral inferred to be present in these five small deposits is 5.5 million m^3; it is somewhat variable in its grading, but is commonly 'clayey' gravel or 'clayey' sandy gravel and has a proved mean grading of fines 13 per cent, sand 39 per cent and gravel 48 per cent. The overburden varies in thickness from 0.3 m to 6.3 m, with a mean thickness of 3.2 m.

In the valley of Stainley Beck north of Yew Bank Farm [306 640] the overburden of Alluvium and Till is thick enough to render the deposit of Glacial Sand and Gravel there non-mineral; a presumably lenticular deposit of Glacial Sand and Gravel proved within the till at borehole NW 25 west of Bishop Monkton is likewise overlain by excessive overburden.

East of Occaney some boreholes have proved sand and gravel to be present beneath excessive overburden of till (as at sites SE 28 and SE 37); elsewhere, as in the vicinity of boreholes SE 29 and SE 30, sand and gravel that satisfies the criteria of mineral has been proved to be present, but, as far as is known, only in deposits of limited (less than 0.25 km^2, see Appendix B) areal extent. The deposit of Glacial Sand and Gravel that extends over about 28 hectares west of Ornhams Grange [398 638] has been shown by surface mapping and hand-augering to be predominantly of sand less than 1 m thick. Many of the other smaller deposits in this eastern part of the block are variable in their grad-

Table 8 Data from IMAU boreholes: Block B[1]

Borehole	Recorded thickness			Mean grading percentage					
	Mineral m	Overburden m	Waste partings m	Fines $-\frac{1}{16}$mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$mm	Medium sand $+\frac{1}{4}-1$mm	Coarse sand +1–4mm	Fine gravel +4–16mm	Coarse gravel +16mm
NW 9	absent								
NW 10*	1.9	1.9	–	24	19	28	8	13	8
NW 11*	4.5	0.9	–	25	18	16	10	18	13
NW 18	absent								
NW 19*	3.0	7.5	–	31	4	12	17	24	12
NW 24	absent								
NW 25	absent								
NW 26	absent								
NW 27*	4.0	1.9	–	19	69	8	4	trace	0
NW 30	absent								
NW 31	absent								
NW 32	absent								
NW 33*	5.9	3.2	–	13	49	18	4	6	9
SW 21	absent								
SW 22	absent								
SW 23	absent								
SW 24	absent								
SW 25*	3.2	1.2	–	25	40	13	9	13	0
SW 26	absent								
SW 28†	4.5	6.3	–	7	7	10	18	21	36
SW 29†	24.1‡	1.9	–	12	4	14	22	28	20
SW 30†	7.1	1.2	–	18	11	13	13	24	21
SW 31†	3.4	0.3	–	18	10	19	14	24	15
SW 32*	5.2	0.3	–	19	13	15	14	19	20
SW 33*	3.1	3.2	–	14	12	16	14	23	21
SW 34	absent								
SW 36*	3.9	6.6	–	15	18	63	3	1	0
SW 37*	6.8	7.9	–	20	35	23	6	9	7
SE 18	absent								
SE 25	absent								
SE 26	absent								
SE 27	absent								
SE 28	absent								
SE 29	2.2	0.4	–	22	46	8	5	10	9
SE 30	6.9	1.1	2.3	17	19	37	8	13	6
SE 32	absent								
SE 33	absent								
SE 34	absent								
SE 37	absent								

* These boreholes, together with 5 non-IMAU boreholes, were used in the statistical assessment of parts of Block B[1]; see 'Notes on the resource blocks'.
† These boreholes, together with 3 non-IMAU boreholes, were used for the inferred assessment of part of Block B[1]; see 'Notes on the resource blocks'.
‡ The base of the deposit was not reached.

ing and often exhibit a high fines content. Most of the small kame-like deposits around Staveley and Ferrensby are composed of sand with only small amounts of gravel.

The total volume of mineral inferred to be present in the block is about 39.5 million m^3.

Block B[2] (Table 9)

This block comprises most of the ground north of the River Ure together with a small area south-west of Boroughbridge. It covers 16.3 km^2, of which about 12.1 km^2 is assessed as mineral-bearing; the mineral-bearing areas comprise two patches of exposed mineral amounting to about 1 km^2 between Givendale and Little Givendale, and a large tract of mainly concealed mineral east of Skelton, with an outlying patch of concealed mineral south-west of Boroughbridge; smaller patches of exposed mineral occur at Cottage Farm [382 683] and Street Closes [376 680]. The potentially workable sand and gravel in the block is all Glacial Sand and Gravel. The borehole data are insufficient to enable the extent of the concealed mineral to be delimited accurately, and it may be that mineral is absent from parts of the areas east of the A1 trunk road and south-east and north-east of Skelton. The data from IMAU boreholes quoted in Table 9 have been supplemented by information from the records of 10 non-IMAU boreholes, most of which were drilled in the vicinity of the A1.

At borehole NW 13 'very clayey' pebbly sand and 'very clayey' sandy gravel are interbedded with till, but the proportions of waste and overburden are such as to render them non-mineral. At this site the deposit of 'very clayey' pebbly sand proved at the surface is only 0.5 m thick, but recent surveys indicate that over most of the area thereabouts it is more than 1 m thick;

Table 9 Data from IMAU boreholes: Block B^2

Borehole	Recorded thickness			Mean grading percentage					
	Mineral m	Over-burden m	Waste partings m	Fines $-\frac{1}{16}$mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$mm	Medium sand $+\frac{1}{4}-1$mm	Coarse sand +1–4mm	Fine gravel +4–16mm	Coarse gravel +16mm
NW 13*	absent								
NW 16*	8.0†	0.3	0.9	25	29	25	8	10	3
NW 17	absent								
NW 23	absent								
NE 25	absent								
NE 27*	3.2	3.2	–	25	68	6	1	0	0
NE 28*	5.2†	0.0	–	28	63	6	1	2	0

* These boreholes, together with 10 non-IMAU boreholes, were used in the inferred assessment of parts of Block B^2.
† The base of the deposit was not reached.

moreover, borehole NW 16, sited about 450 m to the south, proved 3.7 m of exposed 'clayey' sandy gravel, separated by a 0.9 m clayey silt waste parting from an underlying bed of 'very clayey' fine and medium sand more than 4.3 m thick. Hence an area of exposed mineral is depicted on the resource map.

The exposed and concealed mineral east of Skelton is commonly 'very clayey' sand. The maximum fines content in the mineral in this area was 28 per cent (borehole NE 28), whereas in the lower deposit proved in borehole NW 16 near Givendale the mean fines content is 35 per cent. However, at the latter site the overlying deposit is 'clayey' sandy gravel with an average fines content of 13 per cent.

The mean grading for the block proved in IMAU boreholes is fines 26 per cent, sand 66 per cent and gravel 8 per cent. The thickness of mineral proved in these boreholes ranges from 3.2 m to 8.0 m, but the smaller thicknesses encountered in the non-IMAU boreholes yield a mean thickness of 3.2 m. Inferred estimates indicate that the total volume of mineral present in the block is about 43.7 million m^3.

The thickness of till overburden proved in the boreholes varied from 0.3 m to 3.2 m. Waste partings are present in places, as at site NW 16.

APPENDIX A

FIELD AND LABORATORY PROCEDURES

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

The mineral shown on each 1:25 000 sheet is divided into resource blocks. The arbitrary size selected, 10 km^2, 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.

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 position 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 152 mm (6 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 British Standard 1377 (1967). Random checks on 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 F.

Detailed records may be consulted at the appropriate offices of the Institute, upon application to the Head, Industrial Minerals Assessment Unit.

APPENDIX B

STATISTICAL PROCEDURE

Statistical assessment

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

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

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

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

4 The above relationship may be transposed such that

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

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 mean thickness, the standard deviation for volume approximates to that for mean thickness.

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

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

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 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 $S_A/S_{\bar{l}_m} \leqslant \frac{1}{3}$ is assumed in all cases. It follows from equation [2] that

$$S_{\bar{l}_m} \leqslant S_V \leqslant 1.05\, S_{\bar{l}_m} \quad .$$

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.)

Block calculation

1:25 000 block: Fictitious

Area
Block: 11.08 km²
Mineral: 8.32 km²

Mean thickness
Overburden: 2.5 m
Mineral: 6.5 m

Volume
Overburden: 21 million m³
Mineral: 54 million m³

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

Thickness estimate (measurements in metres)
l_o = overburden thickness l_m = mineral thickness

Sample point	Weighting 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

Figure 7 Example of resource block assessment: calculation and results.

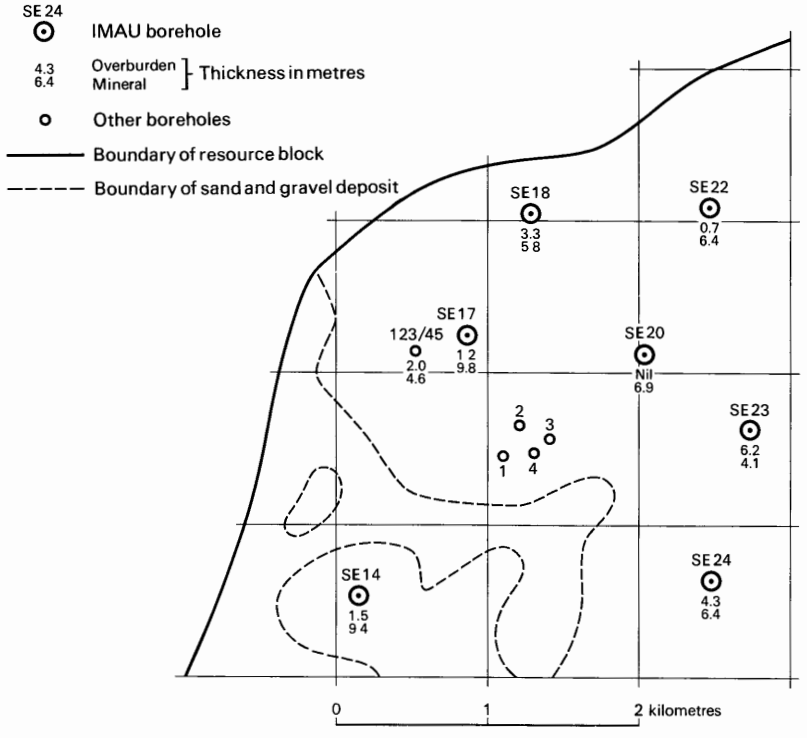


Figure 8 Example of resource block assessment: map of a fictitious block.

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

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

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

9 In calculating confidence limits for volume, L_V, the following inequality corresponding to equation [3] is applied: $L\bar{l}_m \leqslant L_V \leqslant 1.05\ L\bar{l}_m$.

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

11 The application of this procedure to a fictitious area is illustrated in Figures 7 and 8.

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, based on geological and topographical information usually supported by the data from one or two boreholes. The volume of mineral is calculated as the product of the area, measured from field data, and the estimated thickness. Confidence limits are not calculated.

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

14 No assessment is attempted for an isolated area of mineral less than 0.25 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 need be only approximately regular and in estimating the mean thickness only simple weighting is necessary. In practice, equal weighting can often be applied to thicknesses at all sample points. If, however, there is a distinctly unequal distribution of points, bias is avoided by dividing the sampled area into broad zones, to each of which a value roughly proportional to its area is assigned. This value is then shared between the data points within the zone as the weighting factor.

APPENDIX C

CLASSIFICATION AND DESCRIPTION OF SAND AND GRAVEL

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

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

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

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

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

Thus it is possible to classify the mineral into one of twelve descriptive categories (see Figure 9). The procedure is as follows:

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

For example, a deposit grading 11 per cent gravel, 70 per cent sand and 19 per cent fines is classified as 'clayey' pebbly sand. This short description is included in the borehole log (see Note 10, Appendix D).

Many differing proposals exist for the classification of the grain size of sediments (Atterberg, 1905: Udden, 1914; Wentworth, 1922; Wentworth, 1935; Allen, 1936; Twenhofel, 1937; Lane and others, 1947). As Archer (1970a, b) has emphasised, there is a pressing need for a simple metric scale acceptable to both scientific and engineering interests, for which the class limit sizes correspond closely with certain marked changes in the natural properties of mineral particles. For example, there is an important change in the degree of cohesion between particles at about the $\frac{1}{16}$-mm size, which approximates to the generally accepted boundary between silt and sand. These and other requirements are met by a system based on Udden's geometric scale and a simplified form of Wentworth's terminology (Table 10), which is used in this 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 Standard 1377: 1967). In this report the grading is tabulated on the borehole record sheets (Appendix F), 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 approximately equal proportions with neither constituent accounting for less than about 25 per cent of the whole; 'flint with quartz' indicates that flint is dominant and quartz, the principal accessory rock type, comprises 5 to 25 per cent of the whole. Where the accessory material accounts for less than 5 per cent of the whole, but is still readily apparent, the phrase 'with some' has been used. Rare constituents are referred to as 'trace'.

The terms used in the field to describe the degree of rounding of particles, which is concerned with the sharpness of the edges and corners of a clastic fragment and not the shape (after Pettijohn, 1957), are as follows.

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

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

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

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

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

Table 10 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

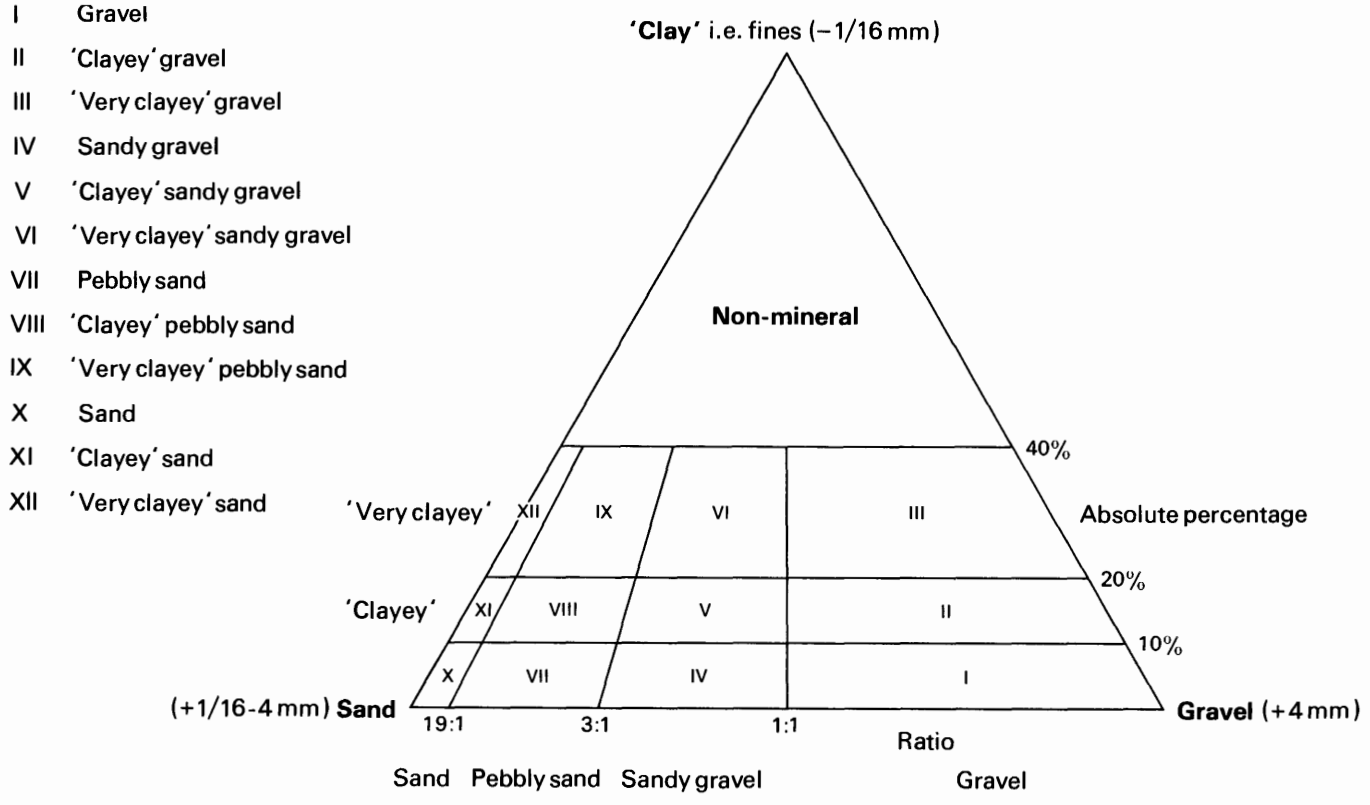


Figure 9 Diagram showing the descriptive categories used in the classification of sand and gravel.

APPENDIX D

EXPLANATION OF THE BOREHOLE RECORDS

Annotated fictitious example

CK 66 SW 15[1] **6251 6384**[2] **Southfields**[3] **Block A**[1]

Surface level +27.6 m (+90 ft)[4]
Water struck at +19.8 m[5]
Shell and auger 152 mm[6]
June 1976

Overburden[7] 7.8 m
Mineral 6.9 m
Waste 2.8 m
Mineral 1.9 m
Bedrock 1.0 m+[8]

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey brown, silty, pebbly	0.2	0.2
Glacial Lake Deposits	Clay, yellow brown and grey, firm to stiff, laminated, silty	3.3	3.5
Till	Clay, brown and grey, firm, silty, pebbly	4.3	7.8
Glacial Sand and Gravel	**a** Sand, becoming a pebbly sand from 8.8–9.8 m Sand: medium with fine and coarse, subangular clear and yellow brown quartz with black limestone	3.0	10.8
	b Sand, becoming 'clayey' from 10.8–12.8 m and 13.8–14.7 m Sand: medium and fine with coarse, subangular and subrounded clear and yellow brown quartz with some black limestone Fines: yellow brown	3.9	14.7
Till	Clay, red and brown, firm–very soft, very sandy, pebbly	2.8	17.5
Glacial sand and Gravel	**c** 'Clayey' pebbly sand Gravel: fine with coarse, sub-angular and subrounded sandstone with some black limestone Sand: coarse, medium and fine subangular clear quartz with some black and white limestones Fines: reddish brown	1.0	18.5
Sherwood Sandstone Group	Sandstone, reddish brown, medium and coarse, very weak to moderately strong	1.0+	19.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$ mm	$+\frac{1}{16}-\frac{1}{4}$ mm	$+\frac{1}{4}-1$ mm	+1–4 mm	+4–16 mm	+16–64 mm	+64 mm
a	8	89	3	7.8–8.8	9	11	61	16	3	0	
				8.8–9.8	6	15	49	25	4	1	
				9.8–10.8	9	30	45	15	1	0	
				Mean	8	19	52	52	18	3	
b	11	89	0	10.8–11.8	14	41	42	3	0	0	
				11.8–12.8	13	28	51	8	0	0	
				12.8–13.8	7	27	57	7	2	0	
				13.8–14.7	11	44	44	1	0	0	
				Mean	11	35	49	5	0	0	
c	13	74	13	17.5–18.5	13	27	19	28	12	1	
a + b + c	10	87	3	Mean	10	28	46	13	3	0	

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

1 Borehole Registration Number
Each Industrial Minerals Assessment Unit (IMAU) borehole is identified by a Registration Number. This consists of two statements.

1 The number of the 1:25 000 sheet on which the borehole lies, for example SE 36.

2 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 SE 12

Thus the full Registration Number is SE 36 SE 12. Usually this is abbreviated to SE 12 in the text.

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

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

4 Surface level
The surface level at the borehole site is given in metres and feet above Ordnance Datum. All measurements were made in metres; approximate conversions to feet are given in brackets.

5 Groundwater conditions
If groundwater was present the level at which it was encountered is normally given (in metres and feet above OD).

6 Types of drill and date of drilling
Unless otherwise stated, all boreholes were drilled by a shell and auger rig using 6-inch casing. The month and year of completion of the hole are stated.

7 Overburden, Mineral, Waste and Bedrock
Mineral is sand and gravel which, as part of a deposit, falls within the arbitrary definition of potentially workable material (see p. 1). Bedrock is the 'formation', 'country rock' or 'rock head' below which potentially workable sand and gravel will not be found. Waste is any material other than bedrock or mineral, and may include deposits of 'Bunter Sand' which are not associated with Drift sand and gravel deposits: detailed grading data may be given for such 'Bunter Sand' deposits. 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 (Table 1) is given whenever possible.

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

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 ($-\frac{1}{16}$ 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) and coarse gravel ($+16$ mm) are stated. The mean gradings of groups of samples making up an identified mineral horizon are also given in detail and, to the left, in summary. Where more than one horizon 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 proportion of fines and coarse gravel may be lower.

APPENDIX E

LIST OF BOREHOLES USED IN THE ASSESSMENT OF RESOURCES

Borehole number*	Grid reference†	Resource block
1 IMAU BOREHOLES		
NW 9	3159 6906	B[1]
NW 10	3202 6958	B[1]
NW 11	3240 6945	B[1]
NW 12	3273 6961	A[1]
NW 13	3404 6932	B[2]
NW 14	3215 6843	A[1]
NW 15	3330 6831	A[1]
NW 16	3397 6888	B[2]
NW 17	3434 6843	B[2]
NW 18	3018 6709	B[1]
NW 19	3173 6764	B[1]
NW 20	3290 6782	A[1]
NW 21	3308 6700	A[1]
NW 22	3423 6762	A[1]
NW 23	3488 6780	B[2]
NW 24	3095 6691	B[1]
NW 25	3160 6626	B[1]
NW 26	3228 6671	B[1]
NW 27	3331 6619	B[1]
NW 28	3399 6666	A[1]
NW 29	3480 6689	A[1]
NW 30	3045 6548	B[1]
NW 31	3212 6573	B[1]
NW 32	3329 6506	B[1]
NW 33	3413 6564	B[1]
NW 34	3476 6513	A[1]
NW 35	3494 6585	A[1]
NE 25	3510 6847	B[2]
NE 26	3543 6810	A[2]
NE 27	3692 6858	B[2]
NE 28	3825 6831	B[2]
NE 29	3584 6754	A[2]
NE 30	3988 6741	A[2]
NE 31	3599 6641	A[1]
NE 32	3696 6678	A[2]
NE 33	3798 6643	A[2]
NE 34	3936 6696	A[2]
NE 35	3566 6527	A[1]
NE 36	3673 6553	A[2]
NE 37	3687 6580	A[2]
NE 38	3723 6511	A[2]
NE 39	3870 6570	A[2]
NE 42	3508 6544	A[1]
NE 43	3806 6561	A[2]
SW 21	3060 6437	B[1]
SW 22	3213 6457	B[1]
SW 23	3215 6429	B[1]
SW 24	3273 6463	B[1]
SW 25	3390 6499	B[1]
SW 26	3417 6466	B[1]
SW 27	3465 6422	A[1]
SW 28	3055 6348	B[1]
SW 29	3407 6353	B[1]
SW 30	3187 6280	B[1]
SW 31	3380 6269	B[1]
SW 32	3053 6173	B[1]
SW 33	3099 6105	B[1]
SW 34	3275 6116	B[1]
SW 35	3439 6162	A[3]
SW 36	3015 6010	B[1]
SW 37	3192 6028	B[1]
SW 38	3327 6072	A[3]
SW 39	3355 6073	A[3]
SW 40	3451 6027	A[3]
SE 12	3573 6455	A[1]
SE 13	3649 6419	A[2]
SE 14	3659 6471	A[2]
SE 15	3722 6416	A[2]
SE 16	3785 6464	A[2]
SE 17	3864 6470	A[2]
SE 18	3949 6406	B[1]
SE 19	3504 6368	A[1]
SE 20	3615 6345	–
SE 21	3700 6366	A[2]
SE 22	3817 6349	A[2]
SE 23	3512 6214	A[3]
SE 24	3606 6263	A[1]
SE 25	3740 6279	B[1]
SE 26	3812 6234	B[1]
SE 27	3887 6226	B[1]
SE 28	3987 6283	B[1]
SE 29	3580 6149	B[1]
SE 30	3679 6175	B[1]
SE 31	3824 6148	B[1]
SE 32	3564 6071	B[1]
SE 33	3691 6086	B[1]
SE 34	3757 6009	B[1]
SE 35	3772 6090	A[3]
SE 36	3863 6018	A[3]
SE 37	3965 6076	B[1]
2 OTHER BOREHOLES		
NW 1D	3194 6720	B[1]
NW 3	3495 6631	A[1]
NW 5	3297 6995	A[1]
NW 41	3164 6660	B[1]
NW 43	3365 6747	A[1]
NW 44	3370 6755	A[1]
NW 45	3414 6873	B[2]
NW 48	3452 6965	B[2]
NE 2B	3882 6824	B[2]
NE 3A	3858 6614	A[2]
NE 3B	3793 6578	A[2]
NE 5	3768 6587	A[2]
NE 7	3724 6940	B[2]
NE 11	3553 6641	A[1]
NE 18	3950 6723	A[2]
NE 22A	3952 6532	B[1]
NE 22C	3935 6565	B[2]
NE 22E	3913 6610	B[2]
NE 22G	3901 6637	B[2]
NE 22K	3886 6669	B[2]
NE 22L	3858 6724	B[2]
NE 23A	3868 6700	A[2]
NE 23H	3868 6710	A[2]
NE 23L	3847 6892	B[2]
NE 40	3945 6574	B[2]
NE 41	3884 6554	B[2]
SW 5	3035 6336	B[1]
SW 10	3050 6330	B[1]
SW 11	3206 6377	B[1]
SW 12	3069 6266	B[1]
SW 13	3350 6402	B[1]
SW 15	3371 6316	B[1]
SW 17	3000 6236	B[1]
SE 1	3718 6153	B[1]
SE 2	3604 6483	A[1]
SE 5	3875 6235	B[1]
SE 6	3528 6002	A[3]
SE 9	3662 6399	A[2]
SE 39B	3709 6494	A[2]

In addition many other borehole records were used which are held on a 'commercial-in-confidence' basis.

* By sheet quadrant. The full registration numbers all have the prefix SE 36.
† All fall in 100-km square SE.

APPENDIX F

INDUSTRIAL MINERALS ASSESSMENT UNIT BOREHOLE RECORDS

SE 36 NW 9 3169 6906 Bellwood, Littlethorpe **Block B[1]**

Surface level +27.3 m (+89 ft)
Groundwater conditions not recorded
Shell and auger 152 mm
July 1976

Waste 8.8 m
Bedrock 0.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Alluvium	Clay, brown and grey, sandy; silty and laminated below 1.2 m	2.3	2.6
Till	Clay, grey, firm, pebbly, with sand pockets	6.2	8.8
Lower Magnesian Limestone	Limestone, buff, dolomitic, becoming strong	0.9+	9.7

SE 36 NW 10 3202 6958 Littlethorpe **Block B[1]**

Surface level +28.0 m (+92 ft)

Water struck at +20.1 m
Shell and auger 152 mm
July 1976

Overburden 1.9 m
Mineral 1.9 m
Waste 3.9 m
Bedrock 4.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown, firm, slightly sand	1.6	1.9
Glacial Sand and Gravel	'Very clayey' sandy gravel Gravel: fine and coarse, subrounded with some subangular, black limestone and grey sandstone Sand: medium and fine with coarse, subangular quartz with some limestone Fines: buff to red brown	1.9	3.8
Till	Clay, brown, sandy, pebbly, incohesive between 4.0–4.3 m	3.9	7.7
Upper Magnesian Limestone	Limestone, black, with dolomitic fragments in a buff clay	0.2	7.9
	Limestone, buff, with etched surfaces	3.8	11.7
	Shale–Mudstone, mid grey, tenacious to indurated	0.6	12.3

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
24	55	21	1.9–2.9	26	18	30	6	11	9	
			2.9–3.8	21	19	26	11	15	8	
			Mean	24	19	28	8	13	8	

SE 36 NW 11 3240 6945 Grange Farm, Littlethorpe **Block B[1]**

Surface level c +25 m (+82 ft)
Groundwater conditions not recorded
Minuteman 76 mm
April 1955

Overburden 0.9 m
Mineral 1.8 m
Waste 2.2 m
Mineral 2.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	No recovery	0.9	0.9
Glacial Sand and Gravel	**a** Gravel, 'clayey' for first 0.9 m Gravel: fine and coarse, subangular to subrounded limestone and sandstone Sand: medium, coarse and fine, subangular to subrounded limestone and sandstone with some quartz	1.8	2.7
	No recovery	2.2	4.9
	b 'Very clayey' pebbly sand Gravel: fine limestone Sand: fine and medium with coarse, angular to subrounded quartz with limestone Fines: red brown	2.7+	7.6

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
a	10	25	65	0.9–1.8	11	9	14	10	33	23	
				1.8–2.7	8	5	8	5	31	43	
				Mean	10	7	11	7	32	33	
b	35	57	8	4.9–5.8	34	25	23	13	5	0	
				5.8–6.7	34	23	19	13	11	0	
				6.7–7.6	38	27	17	9	9	0	
				Mean	35	25	20	12	8	0	
a + b	25	44	31	Mean	25	18	16	10	18	13	

SE 36 NW 12 3273 6961 Ripon Race Course **Block A[1]**

Surface level +18.7 m (+61 ft)
Water struck at +16.4 m
Shell and auger 152 mm
October 1976

Overburden 2.1 m
Mineral 3.1 m
Waste 6.2 m
Mineral 3.5 m
Waste 1.6 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey black, very silty, pebbly	0.4	0.4
Alluvium	Clay, yellow brown, soft to stiff, very silty	1.7	2.1
	a Gravel Gravel: fine and coarse, subangular and subrounded white and black limestones with some sandstone Sand: medium and coarse with fine, angular to subrounded clear quartz with black and some white limestones	3.1	5.2
Glacial Lake Deposits	Clay, black, laminated	6.2	11.4
Fluvio-glacial and Older River Sand and Gravel and associated clays	**b** Gravel, becoming a sandy gravel below 13.8 m Gravel: fine and coarse, rounded to subangular white and black limestone with sandstone. Sporadic cobbles. Sand: coarse and medium with fine, angular to subrounded, clear with yellow brown quartz with black and some white limestones	3.5	14.9
	Clay, grey and brown, firm, very silty	0.6	15.5
	Clay, red brown, soft to firm, silty, pebbly	1.0	16.5
Upper Marl	Marl, red brown, silty, very weak with marl and limestone pebbles	1.0+	17.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	4	46	50	2.1–3.1	7	7	21	14	27	24	
				3.1–5.2	3	2	26	20	27	22	
				Mean	4	4	24	18	27	23	
b	4	42	54	11.4–12.4	4	5	9	19	32	31	
				12.4–13.8	6	3	16	22	21	32	
				13.8–14.9	2	12	22	19	29	16	
				Mean	4	6	16	20	27	27	
a + b	4	44	52	Mean	4	5	20	19	27	25	

SE 36 NW 13 3404 6932 Givendale **Block B²**

Surface level +26.1 m (+85 ft)
Water struck at +17.1 m
Shell and auger 152 mm
June 1976

Waste 14.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	'Very clayey' pebbly sand Gravel: coarse and fine, subangular with some subrounded sandstone Sand: fine and medium with some coarse, subangular brown quartz	0.5	0.5
Till	Clay, yellow brown, firm and soft, sandy	3.3	3.8
Glacial Sand and Gravel	'Very clayey' sand Sand: fine with medium, subangular red-brown quartz	1.0	4.8
Till	Clay, red and grey-brown, firm, sandy, pebbly	2.9	7.7
Glacial Sand and Gravel	'Very clayey' pebbly sand Gravel: fine with coarse, subangular weathered dolomitic limestone with black limestone, grey sandstone and some chert Sand: fine and medium with coarse, subangular quartz with some limestone Fines: yellow brown	2.1	9.8
Till	Clay, brown, firm, pebbly	3.3	13.1
Glacial Sand and Gravel	'Very clayey' sandy gravel Gravel: coarse with fine, subrounded grey sandstone and black limestone Sand: fine with medium and coarse, subangular quartz with traces of mica Fines: red-brown	1.4+	14.5

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
22	65	13	0.0–0.5	22	41	21	3	4	9	
28	72	0	3.8–4.8	28	68	4	0	0	0	
23	73	4	7.7–8.7	25	33	33	5	3	1	
			8.7–9.8	21	39	33	3	3	1	
			Mean	23	36	33	4	3	1	
21	58	21	13.1–14.5	21	46	8	4	3	18	

SE 36 NW 14 3215 6843 Park Hill **Block A[1]**

Surface level +26.1 m (+85 ft)
Water struck at +22.6 m
Shell and auger 152 mm
August 1976

Overburden 3.1 m
Mineral 1.2 m
Waste 3.8 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey, silty, pebbly	0.5	0.5
Glacial Lake Deposits	Clay, grey and brown, stiff to hard, pebbly	1.5	2.0
	Clay, grey and brown, firm to stiff, laminated, silty	1.1	3.1
Glacial Sand and Gravel	Gravel Gravel: coarse and fine, subangular and subrounded sandstone, quartzite and white limestone Sand: medium and coarse with fine, subangular clear quartz with some black limestone	1.2	4.3
Till	Clay, grey and brown, firm to stiff, silty, pebbly	2.5	6.8
Glacial Sand and Gravel	'Very clayey' gravel Gravel: fine with coarse angular and subangular white with black limestones and some sandstone Sand: medium and coarse, angular and subangular clear quartz with some limestone Fines: grey	0.6	7.4
Till	Clay, light brown, soft, very pebbly	0.7	8.1
Upper Magnesian Limestone	Limestone, grey-white, weak	0.1 +	9.1

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
5	14	81	3.1–4.3	5	3	7	4	33	48	

SE 36 NW 15 3330 6831 Ox Close House, Park Hill **Block A[1]**

Surface level +16.4 m (+54 ft)
Water struck at +13.0 m
Shell and auger 152 mm
July 1976

Overburden 1.9 m
Mineral 2.4 m
Waste 14.2m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, clayey	1.4	1.4
	Clay, grey, soft with sandy partings	0.5	1.9
	Gravel, sandy at top Gravel: coarse and fine, subangular to subrounded sandstones with some quartzite and limestone Sand: medium and coarse with fine, subangular to subrounded, sandstone and quartzite with quartz and some black limestone	2.4	4.3
Glacial Lake Deposits	Clay, brown and grey, soft-stiff, silty, pebbly	2.3	6.6
	Clay, grey brown, very soft, very sandy and silty	3.0	9.6
	Silt, grey brown, very soft, very clayey	1.4	11.0
	Clay, grey brown, firm to stiff, silty	0.9	11.9
	Silt, yellow brown, very soft, clayey and sandy	6.6+	18.5

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
2	29	69	1.9–2.2	7	12	29	7	23	22	
			2.2–3.5	2	1	7	17	30	43	
			3.5–4.3	1	4	7	18	35	35	
			Mean	2	3	10	16	31	38	

SE 36 NW 16 3397 6888 Givendale **Block B[2]**

Surface level c +28 m (+92 ft)
Groundwater conditions not recorded
Minuteman 76 mm
April 1975

Overburden 0.3 m
Mineral 3.7 m
Waste 0.9 m
Mineral 4.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	No recovery	0.3	0.3
Glacial Sand and Gravel	**a** 'Clayey' sandy gravel Gravel: fine and coarse, subrounded limestone and sandstone Sand: medium with coarse and fine, subangular to subrounded quartz and limestone	3.7	4.0
	Silt, red brown, laminated, clayey	0.9	4.9
	b 'Very clayey' sand Sand: fine and medium with coarse, quartz with rare lithics Fines: red brown	4.3+	9.2

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	13	60	27	0.3–1.8	17	20	21	10	22	10	
				1.8–2.7	8	9	30	14	29	10	
				2.7–4.0	11	11	43	20	15	0	
				Mean	13	14	31	15	21	6	
b	35	65	0	4.9–5.8	33	29	34	4			
				5.8–9.2	36	45	16	3	0	0	
				Mean	35	42	20	3	0	0	
a + b	25	62	13	Mean	25	29	25	8	10	3	

SE 36 NW 17 **3434 6843** **Givendale Grange** **Block B[2]**

Surface level +26.9 m (+88 ft)
Groundwater conditions not recorded
Shell and auger 152 mm
June 1976

Waste 11.0 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Sand, slightly clayey, pebbly	0.3	0.3
Till	Clay, red brown, firm, slightly sandy, pebbly	7.0	7.3
	Clay, grey, laminated with partings of fine sand	1.0	8.3
	Sand, 'very clayey', fine	0.2	8.5
	Clay, brown and grey sandy, pebbly	2.5	11.0
Sherwood Sandstone Group	Sandstone, red brown, poorly cemented, fissile	1.0+	12.0

SE 36 NW 18 3018 6709 Markingfield Hall **Block B[1]**

Surface level +75.1 m (+246 ft)
Groundwater not encountered
Shell and auger 152 mm
July 1976

Waste 3.5 m
Bedrock 1.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, light brown, silty, and made ground	0.5	0.5
Glacial Sand and Gravel	'Clayey' gravel Gravel: coarse and fine, subrounded sandstone and white and black limestone. Sporadic cobbles Sand: coarse and medium with fine, subangular clear and white quartz with black limestone Fines: yellow brown	0.9	1.4
Till	Clay, brown, firm and soft, pebbly	2.1	3.5
Lower Magnesian Limestone	Limestone, creamy white, weak	1.5+	5.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
12	37	51	0.5–1.4	12	4	14	19	23	28	

SE 36 NW 19 3173 6764 Moor End, Park Hill **Block B[1]**

Surface level +34.7 m (+114 ft)
Groundwater not encounterd
Shell and auger 152 mm
October 1976

Overburden 7.5 m
Mineral 3.0 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey black, sandy and pebbly	0.3	0.3
Till	Clay, yellow brown, orange and grey, silty, sandy and pebbly	7.2	7.5
Glacial Sand and Gravel	'Very clayey' gravel Gravel: fine and coarse, angular and subangular strong grey limestone with some moderately strong pink siltstone Sand: coarse and medium with fine, angular and subangular grey with some black limestone Fines: light brown to purplish pink	3.0	10.5
Upper Magnesian Limestone	Limestone grey pink, fine grained, thinly bedded; interbedded with pink brown and green clayey marl	0.5+	11.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
31	33	36	7.5–8.5	30	3	11	17	27	12	
			8.5–9.5	35	3	13	18	20	11	
			9.5–10.5	27	5	11	18	25	14	
			Mean	31	4	12	17	24	12	

SE 36 NW 20 3290 6782 Fair Field, Park Hill **Block A[1]**

Surface level +23.5 m (+77 ft)
Water struck at +15.6 m
Shell and auger 152 mm
August 1976

Overburden 11.9 m
Mineral 4.2 m
Bedrock 1.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Lake Deposits	Clay, grey and yellow brown, stiff, silty, becoming laminated	3.4	3.4
	'Very clayey' sand Sand: fine, subangular, clear quartz Fines: yellow brown	0.4	3.8
Till	Clay, brown with grey, firm to stiff, silty, sandy and pebbly	1.9	5.7
Glacial Sand and Gravel	Gravel Gravel: fine and coarse, subangular with subrounded white with black limestone and with some sandstone Sand: coarse and medium with fine, subrounded, clear quartz with subangular white and black limestone and some sandstone	1.4	7.1
Till	Clay, red brown, firm to stiff, sandy, pebbly		8.8
Glacial Sand and Gravel	Sandy gravel, composition as for 5.7–7.1 m Gravel: fine and coarse Sand: medium and coarse with fine	2.2	11.0
	Clay, grey with brown, firm, pebbly	0.9	11.9
Fluvio-glacial and Older River Sand and Gravel	Sandy gravel Gravel: fine and coarse, subangular, white with black limestones with some sandstone Sand: coarse and medium with fine, subangular, clear quartz with white and some black limestone	4.1	16.0
	Limestone cobble	0.1	16.1
Upper Marl	Marl, red brown, weak	1.4+	17.5

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
6	46	48	5.7–7.1	6	7	19	20	26	22	
6	63	31	8.8–9.8	4	6	24	25	30	11	
			9.8–11.0	8	10	32	27	14	9	
			Mean	6	8	29	26	21	10	
6	50	44	11.9–12.9	5	8	18	28	32	9	0
			12.9–13.9	10	13	18	20	25	14	0
			13.9–14.9	4	4	12	24	33	23	0
			14.9–16.0	4	7	27	26	23	13	0
			16.0–16.1	0	0	0	0	0	0	100
			Mean	6	8	18	24	28	14	2

SE 36 NW 21 3308 6700 Skewfe Farm, Bishop Monkton **Block A[1]**

Surface level +27.4 m (+90 ft)
Groundwater not encountered
Shell and auger 152 mm
May 1976

Waste 12.0 m
Bedrock 4.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown	0.1	0.1
Glacial Lake Deposits	Clay, yellow and brown, firm to stiff, laminated silty	3.4	3.5
	Silt, yellow brown, soft, sandy	1.5	5.0
Till	Clay, grey and brown, sandy with pebbles and cobbles	7.0	12.0
Upper Marl	Marl, red brown, silty, very weak	4.0+	16.0

SE 36 NW 22 3423 6762 Newby Hall **Block A[1]**

Surface level +16.1 m (+53 ft)
Water struck at +13.1 m
Shell and auger 152 mm
June 1976

Overburden 2.7 m
Mineral 1.8 m
Waste 2.5 m
Mineral 8.3 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, grey, silty	0.2	0.2
	Clay, yellow and brown, firm silty	0.8	1.0
	Clay, brown and grey, very soft, silty, pebbly	1.7	2.7
	a Gravel Gravel: fine and coarse, subangular, creamy limestone with grey black limestone and grey sandstone Sand: coarse, medium and fine, subangular and subrounded, clear with some opaque quartz with black limestone	1.8	4.5
Till	Silt, yellow brown, soft, sandy, pebbly	0.7	5.2
	Clay, grey, firm, slightly sand, pebbly	0.9	6.1
	Silt, grey, clayey, with some fine sand	0.9	7.0
Fluvio-glacial and Older River Sand and Gravel	**b** Sand, 'clayey' at top Sand: medium and fine with some coarse, subangular and subrounded, clear with some opaque quartz with some black limestone Fines: grey	5.2	12.2
	c Sandy gravel, with some cobbles Gravel: coarse and fine, subangular to rounded, sandstone and limestone with quartzite Sand: medium with coarse and fine, subangular and subrounded, clear and opaque quartz with black limestone	3.1	15.3
Upper Marl	Marl, red brown, very weak, clayey matrix	1.0+	16.3

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
a	9	40	51	2.7–4.5	9	10	11	19	28	23	
b	9	91	0	7.0–9.0	16	64	20	0	0		
				9.0–10.5	8	33	58	1	0		
				10.5–11.2	2	17	76	5	0		
				11.2–12.2	1	9	75	14	1		
				Mean	9	38	49	4	0		
c	3	62	35	12.2–13.0	6	14	48	13	7	12	0
				13.0–14.0	2	9	16	12	17	37	7
				14.0–15.3	3	13	35	25	15	9	0
				Mean	3	12	32	18	14	19	2
a + b + c	7	73	20	Mean	7	25	37	11	9	10	1

SE 36 NW 23 3488 6780 Newby Hall **Block B[2]**

Surface level c +25 m (+82 ft)
Groundwater conditions not recorded
Minuteman 76 mm
April 1975

Waste 7.3 m

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, pebbly	0.5	0.5
Till	Clay, red brown and grey, silty, with poor laminations	1.9	2.4
	Silt, red brown, clayey, with some fine sand	4.3	6.7
	Clay, grey brown, slightly sandy, pebbly	0.6+	7.3

SE 36 NW 24 3095 6691 Hollin Hall **Block B[1]**

Surface level +64.7 m (+212 ft)
Groundwater not encountered
Shell and auger 152 mm
July 1976

Waste 11.4 m
Bedrock 1.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, light brown, sandy	0.5	0.5
Till	Clay, brown and grey, with numerous pebbles	10.9	11.4
Lower Magnesian Limestone	Limestone, creamy, moderately strong	1.1+	12.5

SE 36 NW 25 3160 6626 Southlands, Bishop Monkton **Block B[1]**

Surface level +50.5 m (+166 ft)
Groundwater not encountered
Shell and auger 152 mm
October 1976

Waste 11.5 m
Bedrock 1.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey, sandy	0.3	0.3
Till	Clay, yellow brown and grey, firm to stiff, sandy, pebbly	4.2	4.5
	Clay, grey and brown, soft to stiff, sandy and silty, pebbly	2.5	7.0
Glacial Sand and Gravel	Gravel: coarse with fine, angular and subangular, creamy limestone with some grey black limestone	0.5	7.5
Till	Clay, brown, stiff to hard, silty, pebbly	1.1	8.6
Glacial Sand and Gravel	Gravel Gravel: coarse and fine, angular-subrounded creamy and black limestones with some sandstone Sand: coarse and medium with fine, subangular and subrounded, creamy and black limestones and clear quartz	2.9	11.5
Lower Magnesian Limestone	Limestone, yellow white, moderately strong	1.6+	13.1

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
6	39	55	8.6– 9.6	5	4	10	19	32	30	
			9.6–10.6	8	5	11	21	18	37	
			10.6–11.5	5	4	14	31	20	26	
			Mean	6	4	12	23	24	31	

SE 36 NW 26 3228 6671 Park Green, Bishop Monkton **Block B[1]**

Surface level +37.4 m (+123 ft)
Groundwater not encountered
Shell and auger 152 mm
August 1976

Waste 2.8 m
Bedrock 1.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, silty, becoming sandy	0.4	0.4
Till	Clay, brown and reddish brown, sandy and pebbly	2.4	2.8
Upper Magnesian Limestone	Limestone, creamy, strong	1.2+	4.0

SE 36 NW 27 3331 6619 Nantodd Hill, Bishop Monkton **Block B[1]**

Surface level +35.8 m (+117 ft)
Groundwater not encountered
Shell and auger 152 mm
October 1976

Overburden 1.9 m
Mineral 4.0 m
Bedrock 1.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Sand, dark brown, silty	0.3	0.3
Till	Clay, red brown, very soft to firm, very sandy	1.6	1.9
Glacial Sand and Gravel	'Very clayey' sand, becoming 'clayey' below 2.9 m Sand: fine with medium and some coarse, subangular and subrounded clear and orange quartz; contains a few very thin seams of very sandy clay Fines: red brown	4.0	5.9
Upper Marl	Sandstone, red brown, weak	0.6	6.5
	Marl, red brown, thinly bedded, very weak, sandy	1.0+	7.5

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
19	81	0	1.9–2.9	26	71	3	0	0		
			2.9–3.9	18	78	3	1	0		
			3.9–4.9	14	80	5	1	0		
			4.9–5.9	17	45	21	16	1		
			Mean	19	69	8	4	0		

SE 36 NW 28 3399 6666 Ryle Hill, Bishop Monkton **Block A**[1]

Surface level +25.6 m (+84 ft)
Water struck at +16.1 m
Shell and auger 152 mm
May 1976

Overburden 7.1 m
Mineral 7.6 m
Waste 10.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey, brown, silty	0.3	0.3
Glacial Lake Deposits	Clay, brown, silty and laminated, very sandy below 6.1 m	6.8	7.1
Glacial Sand and Gravel	**a** 'Very clayey' sand Sand: fine with medium, subangular clear and yellow quartz Fines: yellow brown with some grey	3.1	10.1
	b Pebbly sand Gravel: fine with coarse, subangular and subrounded black limestone and yellow sandstone Sand: medium with fine and coarse, subangular clear quartz with some black limestone	3.2	13.3
	Sand: fine with medium and coarse, subrounded and subangular clear quartz with some black limestone Fines: yellow to brown	1.4	14.7
Till	Clay, grey and brown, sandy, with numerous pebbles; laminated and stone-free between 19.0 and 22.0 m; reddish brown below 22.8 m	10.3+	25.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	27	73	0	7.1– 8.1	32	66	2				
				8.1– 9.1	25	72	3				
				9.1–10.1	24	68	8				
				Mean	27	69	4				
b	7	86	7	10.1–11.1	6	23	51	12	5	3	0
				11.1–12.1	8	20	51	14	6	1	0
				12.1–13.3	8	17	40	0	28	5	2
				Mean	7	20	47	19	5	2	0
c	20	79	1	13.3–14.7	20	58	13	8	1		
a + b + c	18	79	3	Mean	17	46	24	9	3	1	

SE 36 NW 29 3480 6689 Holbeck Wood, Westwick **Block A[1]**

Surface level +20.4 m (+67 ft)
Water struck at +15.2 m
Shell and auger 152 mm
May 1976

Waste 23.6 m

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, yellow grey, silty	0.3	0.3
Glacial Lake deposits	Clay, blue grey, firm to stiff, silty	2.7	3.0
	Clay, grey blue, soft to firm, laminated	2.2	5.2
	'Very clayey sand Sand: subangular and subrounded quartz Fines: yellow brown	0.4	5.6
	Clay, grey, stiff, silty	0.8	6.4
Till	Clay, grey and brown, firm, sandy, pebbly	4.0	10.4
Fluvio-glacial and Older River Sand and Gravel and associated Clays	Clay, grey, stiff, finely laminated	1.0	11.4
	Sand, 'clayey' in places Sand: fine with medium, subangular clear quartz with some white yellow quartz and black limestone Fines: yellow grey	1.1	12.5
	Clay, grey, firm, faintly laminated	1.9	14.4
	Silt, grey, soft, clayey, sandy	1.0	15.4
	'Very clayey' sand, becoming 'clayey' below 16.4 m Sand: fine with medium and some coarse, subangular clear quartz with some black limestone Fines: grey	1.7	17.1
	Clay, grey, soft to firm, finely laminated, silty	3.2	20.3
	Gravel Gravel: coarse and fine, subangular and subrounded black and creamy limestones with some grey white sandstone Sand: medium and fine with coarse, subangular and subrounded clear and yellow quartz with black limestone	1.1	21.4
Till	Clay, brown and grey, firm to stiff, very pebbly	2.2+	23.6

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
6	94	0	11.4–12.5	6	87	7	0			
22	78	0	15.4–16.4	26	67	7	0			
			16.4–17.1	16	39	41	4			
			Mean	22	55	21	2			
4	41	55	20.3–21.4	4	11	23	7	20	30	5

SE 36 NW 30 3045 6548 Wormald Green **Block B[1]**

Surface level +66.1 m (+217 ft)
Water struck at +56.5 m
Shell and auger 152 mm
July 1976

Waste 17.5 m
Bedrock 0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, light brown, silty	0.6	0.6
	Clay, yellow and brown, soft to firm, silty	1.8	2.4
Till	Clay, brown, very soft, very pebbly	0.4	2.8
	Clay, brown, firm (becoming stiff to hard), very pebbly	7.1	9.9
Glacial Sand and Gravel	Gravel Gravel: coarse and fine, subangular and subrounded creamy and grey black limestones with some sandstone Sand: coarse with medium and some fine, subangular creamy and grey black limestones and subrounded clear quartz	0.8	10.7
Till	Clay, grey brown, stiff, laminated, silty	1.2	11.9
Glacial Sand and Gravel	Gravel, 'clayey' in places Gravel: coarse and fine, subangular and subrounded white and grey to black limestones with sandstone Sand: coarse and medium with fine, subangular and subrounded white and black limestones and subrounded clear quartz	1.3	13.2
Till	Clay, brown, stiff to hard, very pebbly	4.3	17.5
Lower Magnesian Limestone	Limestone, creamy, moderately strong	0.5+	18.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
3	23	74	9.9–10.7	3	1	5	17	35	39	
5	25	70	11.9–13.2	5	3	7	15	33	37	

SE 36 NW 31 3212 6573 Mains Lane, Bishop Monkton **Block B[1]**

Surface level +48.8 m (+160 ft)
Groundwater not encountered
Shell and auger 152 mm
May 1976

Waste 9.0 m
Bedrock 1.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey brown, silty	0.3	0.3
Till	Clay, brown and grey, silty, sandy and pebbly; laminated from 5.7 to 6.4 m	8.7	9.0
Upper Magnesian Limestone	Limestone, white to creamy, moderately strong	1.2+	10.2

SE 36 NW 32 3329 6506 Burton House, Burton Leonard **Block B[1]**

Surface level +39.6 m (+130 ft)
Water struck at +31.6 m
Shell and auger 152 mm
August 1976

Waste 11.2 m
Bedrock 1.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, yellow brown, silty and sandy with pebbles	0.4	0.4
Till	Clay, grey and brown, firm to stiff, very sandy, pebbly	7.6	8.0
Glacial Sand and Gravel	'Very clayey' sandy gravel Gravel: coarse and fine, subangular limestone with sandstone Sand: fine and medium, subangular and subrounded clear and yellow brown quartz with some limestone	0.4	8.4
Till	Clay, yellow and brown, silty, sandy and pebbly	3.8	11.2
Upper Magnesian Limestone	Limestone, creamy, moderately strong	1.3+	12.5

SE 36 NW 33 3413 6564 Bleach House Farm, Burton Moor **Block B[1]**

Surface level +27.5 m (+90 ft)
Water struck at +21.5 m
Shell and auger 152 mm
May 1976

Overburden 3.2 m
Mineral 5.9 m
Waste 3.4 m
Bedrock 3.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, yellow brown, silty	0.4	0.4
Till	Clay, yellow brown and grey, soft to firm, silty	1.7	2.1
	Clay, red brown, firm, silty, pebbly	0.8	2.9
	Silt, yellow brown, clayey, with some fine sand	0.3	3.2
Glacial Sand and Gravel	**a** 'Clayey' sand with clay bands below 5.4 m Sand: fine with medium subangular and subrounded, yellow brown quartz with some black limestone Fines: yellow brown	4.1	7.3
	b Gravel, with some cobbles Gravel: coarse and fine, subangular, black and creamy limestones with some grey green sandstone/quartzite Sand: medium and coarse with fine, subangular and subrounded, clear quartz with black and some white limestones	1.8	9.1
Till	Clay red brown, stiff, silty, pebbly	0.7	9.8
	Clay, grey, stiff, pebbly	2.7	12.5
Upper Marl	Marl, red brown, soft to firm, clayey	2.5	15.0
	Marl, red brown, weak	1.0+	16.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	17	83	0	3.2–3.8	14	85	1				
				4.0–5.0	16	81	3				
				5.0–5.4	16	79	5				
				5.4–5.5	Non-mineral						
				5.5–7.3	15	50	35				
				Mean	17	66	17				
b	3	43	54	7.3–9.1	3	9	22	12	21	30	3
a + b	13	71	16	Mean	13	49	18	4	6	9	1

SE 36 NW 34 3476 6513 Holbeck, Foster Flat **Block A[1]**

Surface level +16.6 m (+54 ft)
Water struck at +10.6 m
Shell and auger 152 mm
May 1976

Waste 18.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, grey brown, silty	0.2	0.2
	Clay, yellow and brown, soft	0.8	1.0
	Clay, grey blck, vey soft, silty, peaty	1.5	2.5
Peat	Peat, dark brown, very soft, silty	3.5	6.0
Fluvio-glacial and Older River Sand and Gravel and associated clays	Gravel Gravel: fine and coarse, subrounded and subangular grey black siltstone, sandstone and white and grey limestones Sand: coarse and medium	1.0	7.0
	Clay, grey and brown, laminated, silty	12.5+	19.5

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
3	17	80	6.0–7.0	3	1	6	10	44	36	

SE 36 NW 35 3494 6585 Westwick **Block A[1]**

Surface level +17.1 m (+56 ft)
Shell and auger 152 mm
May 1976

Overburden 7.8 m
Mineral 3.7 m
Waste 10.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, peaty	0.1	0.1
Glacial Lake Deposits	Clay, blue grey and yellow, firm, silty, becoming laminated	2.3	2.4
	Silt, light brown, very clayey	0.1	2.5
Till	Clay, grey and brown, firm to soft, sandy, very pebbly	2.5	5.0
	Clay, grey and brown, soft, very sandy, pebbly	2.8	7.8
Fluvio-glacial and Older River Sand and Gravel and associated clays	'Very clayey' sand Sand: fine with medium and some coarse, subangular and subrounded clear and yellow quartz with some black limestone Fines: grey	3.7	11.5
	Silt, yellow brown, sandy	0.1	11.6
	Clay, grey, firm to stiff, laminated, silty	2.2	13.8
	Silt, grey brown, with some fine sand	2.9	16.7
Till	Clay, brown red, sandy, pebbly	5.3+	22.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
40	60	0	7.8–8.8	40	51	7	1	1		
			8.8–11.5	40	58	2	0	0		
			Mean	40	56	4	0	0		

SE 36 NE 25 3510 6847 Newby Farm, Skelton **Block B[2]**

Surface level +22.3 m (+73 ft)
Water struck at +15.6 m
Shell and auger 152 mm
June 1976

Waste 16.8 m
Bedrock 1.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Sand, clayey, pebbly	0.4	0.4
Till	Clay, reddish brown and grey, sandy and pebbly	6.3	6.7
Glacial Sand and Gravel	**a** 'Clayey' sand Sand: medium and fine with some coarse, subangular, quartz and black limestone Fines: brown	1.8	8.5
Till	Clay, dark brown, sandy, pebbly	1.6	10.1
	Clay, dark grey, faintly laminated, sandy	0.5	10.6
Glacial Sand and Gravel	**b** 'Clayey' sand, with a trace of fine gravel Sand: fine and medium with some coarse, subangular brown quartz Fines: grey	1.4	12.0
Till	Clay, red brown, sandy, very pebbly	4.8	16.8
Sherwood Sandstone Group	**c** 'Very clayey' sand Sand: fine with medium and some coarse, subangular with some subrounded, red brown quartz Fines: red brown Clasts of moderately strong sandstone occur below 17.5 m	1.7+	18.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	13	87	0	6.7–8.5	13	34	51	2			
b	15	84	1	10.6–12.0	15	45	37	2	1		
c	26	74	0	16.8–18.5	26	62	10	2			

SE 36 NE 26 3543 6810 Newby Farm, Skelton **Block A[2]**

Surface level c +23 m (+75 ft)
Groundwater not encountered
Minuteman 76 mm
April 1975

Waste 9.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, loamy	0.3	0.3
Glacial Lake Deposits	Silt, grey	0.6	0.9
	Clay, brown grey, becoming laminated	4.3	5.2
	Silt, red brown, becoming very sandy	3.9+	9.1

SE 36 NE 27 3692 6858 High Moor Road, Skelton **Block B²**

Surface level c +32 m (+105 ft)
Groundwater struck at approximately +28.5 m
Minuteman 76 mm
April 1975

Overburden 3.2 m
Mineral 3.2 m
Waste 1.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Silt, brown, sandy, pebbly	2.9	3.2
Glacial Sand and Gravel	'Very clayey' sand Sand: fine with some medium quartz Fines: red brown	3.2	6.4
Till	Silt, red brown, very sandy, pebbly	1.2+	7.6

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
25	75	0	3.2–3.7	25	68	5	1	1		
			3.7–4.6	22	71	5	1	1		
			4.6–5.5	25	68	6	1	0		
			5.5–6.4	28	65	6	1	0		
			Mean	25	68	6	1	0		

SE 36 NE 28 3825 6831 Cottage Farm, Kirby Hill **Block B²**

Surface level c +41 m (+135 ft)
Groundwater not encountered
Minuteman 76 mm
April 1975

Mineral 5.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	'Very clayey' sand, with sporadic pebbles Gravel: fine Sand: fine with medium and some coarse quartz Fines: red brown silty clay bands	5.2+	5.2

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
28	70	2	0.0–0.9	28	56	10	2	4		
			0.9–1.8	33	53	6	2	6		
			1.8–2.7	23	69	7	1	0		
			2.7–4.6	28	66	4	0	2		
			4.6–5.2	28	68	4	0	0		
			Mean	28	63	6	1	2		

SE 36 NE 29 3584 6754 Church Wood, Newby Park **Block A[2]**

Surface level +22.3 m (+73 ft)
Water struck at +11.3 m
Shell and auger 152 mm
June 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown	0.2	0.2
Glacial Lake Deposits	Clay, brown and grey, silty, sandy and faintly laminated; pebbly between 3.0 and 6.7 m	7.1	7.3
	Silt, yellow brown and grey, clayey and sandy	0.7	8.0
	a 'Clayey' sand Sand: fine with medium, subangular and subrounded clear quartz with some black limestone Fines: grey	1.7	9.7
	Clay, grey firm to stiff, faintly laminated, silty	1.3	11.0
	b 'Clayey' sand Sand: fine with medium and some coarse, subangular and subrounded clear quartz with some black limestone Fines: grey	2.2	13.2
Glacial Sand and Gravel	**c** Sandy gravel Gravel: coarse with fine, subangular white and black limestones and grey sandstone Sand: medium and fine with coarse, subangular clear (with some opaque) quartz with some black limestone	0.8	14.0
Till	Clay, red brown, firm to soft, sandy, pebbly	3.0	17.0
Fluvio-glacial and Older River Sand and Gravel	'Very clayey' pebbly sand Gravel: fine and coarse, subangular limestone and sandstone Sand: medium and coarse	1.0+	18.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
a	16	84	0	8.0–9.7	16	70	14	0			
b	13	87	0	11.0–12.0	13	81	6	0			
				12.0–13.2	13	66	20	1			
				Mean	13	73	14	0			
c	3	70	27	13.2–14.0	3	26	38	6	6	21	

SE 36 NE 30 3988 6741 Milby Road, Boroughbridge **Block A[2]**

Surface level +17.6 m (+57 ft)
Water struck at +3.6 m
Shell and auger 152 mm
September 1976

Overburden 1.2 m
Mineral 4.2 m
Waste 9.3 m
Bedrock 4.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial Lake Deposits	Clay, pale brown	1.0	1.2
	'Very clayey' sand, with clay partings up to 0.2 m thick Sand: fine with some medium, and a trace of coarse at base, quartz Fines: yellow brown	4.2	5.4
Till	Clay, purple, pebbly	9.3	14.7
Sherwood Sandstone Group	'Clayey' sand, with clasts of weak, red brown sandstone Sand: fine with medium and some coarse, quartz Fines: red brown	4.5+	19.2

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
34	66	0	1.2–2.8	29	68	3	0	0	0	
			2.8–3.8	26	70	4	0	0	0	
			3.8–4.0	Non-mineral						
			4.0–4.8	35	59	4	0	0	0	
			4.8–5.4	38	54	5	1	1	1	
			Mean	34	62	4	0	0	0	

SE 36 NE 31 3599 6641 River Ure, Mulwith **Block A[1]**

Surface level +14.9 m (+49 ft)
Water struck at +11.9 m
Shell and auger 152 mm

Overburden 2.5 m
Mineral 1.5 m
Waste 10.8 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, brown, clayey	0.3	0.3
	Clay, brown, sandy	2.2	2.5
	'Very clayey' sand Sand: fine with medium, subangular quartz Fines: dark brown to black	1.5	4.0
Clays associated with Fluvio-glacial and Older River Sand and Gravel	Clay, dark grey, with sand partings	6.0	10.0
	Clay, red brown, soft, sandy	3.3	13.3
Fluvio-glacial and Older River Sand and Gravel	'Clayey' sand, with sporadic pebbles Sand: medium, subangular quartz with some black limestone	1.5	14.8
Sherwood Sandstone Group	Sandstone, red brown, friable	0.2+	15.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
35	65	0	2.5–4.0	35	49	16				

SE 36 NE 32 3696 6678 Brampton Hall, Longthorpe **Block A[1]**

Surface level +19.8 m (+65 ft)
Groundwater conditions not recorded
Shell and auger 152 mm
September 1976

Waste 8.5 m
Bedrock 10.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial Lake Deposits	Clay, brown and grey, stiff, laminated, silty, pebbly	6.0	6.4
Glacial Sand and Gravel	Gravel, becoming 'clayey' below 7.4 m Gravel: coarse and fine, subangular and subrounded white and black limestones with some fine quartz Sand: coarse, medium and fine, angular to subrounded limestone with quartz Fines: red brown	2.1	8.5
Sherwood Sandstone Group	'Clayey' sand, becoming 'very clayey' below 13.5 m, with some fine- and coarse-gravel-size subangular clasts of red brown, very weak, fine and medium grained sandstone Sand: fine with medium and some coarse, subangular and subrounded clear quartz Fines: red brown	10.5+	19.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
7	39	54	6.4–7.4	4	14	10	8	24	40	0
			7.4–8.5	10	20	13	11	13	29	4
			Mean	7	17	12	10	18	34	2
16	82	2	8.5–9.5	17	64	15	3	0	1	
			9.5–10.5	16	63	13	4	1	3	
			10.5–11.5	15	62	20	3	0	0	
			11.5–12.5	15	63	12	5	2	3	
			12.5–13.5	18	65	12	4	1	0	
			Mean	16	64	14	4	1	1	
25	74	1	13.5–14.5	20	62	13	4	1	0	
			14.5–15.5	22	60	14	3	1	0	
			15.5–16.3	22	59	16	3	0	0	
			16.3–17.4	24	60	13	3	0	0	
			17.4–19.0	24	57	13	4	1	1	
			Mean	25	59	12	3	1	0	

SE 36 NE 33 3768 6643 Low Fields, Langthorpe **Block A[2]**

Surface level +13.4 m (+44 ft)
Water struck at +8.6 m
Shell and auger 152 mm
June 1976

Waste 6.0 m
Bedrock 7.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, grey, silty	0.3	0.3
	Clay, grey to yellow, soft, peaty, very silty	3.0	3.3
Till	Clay, brown, firm to stiff, sandy, very pebbly	1.5	4.8
	Clay, brown, very soft, very sandy	1.2	6.0
Sherwood Sandstone Group	Silt, red brown, sandy	1.5	7.5
	Sand, 'clayey' below 8.5 m with clasts of red brown sandstone Sand: fine with medium and coarse, subangular and subrounded clear quartz	5.0	12.5
	Sandstone, red brown, very weak to weak	1.0+	13.5

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
12	88	0	7.5–8.5	9	61	20	10			
			8.5–10.5	15	67	13	5			
			10.5–12.5	11	71	12	6			
			Mean	12	68	14	6			

SE 36 NE 34 3936 6696 River Ure, Boroughbridge **Block A²**

Surface level +17.6 m (+57 ft)
Water struck at +13.4 m
Shell and auger 152 mm
June 1976

Overburden 1.9 m
Mineral 2.4 m
Waste 9.2 m
Bedrock 2.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Lake Deposits	Clay, brown sandy	1.6	1.9
	Sand, with some fine gravel Sand: medium with fine and coarse, angular to subrounded clear and opaque quartz wiith some limestone and quartzite	2.4	4.3
	Silt, red brown, sandy	4.2	8.5
	'Clayey' sand, with some fine gravel Sand: medium and fine with some coarse, angular to subrounded, mostly quartz Fines: brown	1.0	9.5
Till	Clay, red brown, firm, silty and sandy, pebbly	4.0	13.5
Sherwood Sandstone Group	'Clayey' to 'very clayey' sand with clasts of red brown sandstone Sand: subrounded clear quartz Fines: red brown	0.5	14.0
	Sandstone, red brown, very weak	1.9+	15.9

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
7	92	1	1.9–2.9	5	19	70	5	1		
			2.9–4.3	9	25	59	6	1		
			Mean	7	22	64	6	1		

SE 36 NE 35 3566 6527 Wheatlands Farm, Roecliffe **Block A[1]**

Surface level +26.3 m (+86 ft)
Groundwater stood at +22.6 m on completion of drilling
Shell and auger 152 mm
October 1976

Overburden 5.6 m
Mineral 2.2 m
Waste 3.8 m
Mineral 3.8 m
Waste 0.6 m
Mineral 3.5 m
Waste 1.5 m
Bedrock 2.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Lake Deposits	Clay, red brown, silty and sandy	2.5	2.8
	Clay, brown, pebbly	1.1	3.9
	Silt, brown and grey, sandy	1.7	5.6
	a 'Very clayey' sand Sand: fine with some medium, angular to rounded, mostly quartz Fines: brown	2.2	7.8
	Clay, grey	3.8	11.6
	b 'Clayey' sand, with a trace of fine gravel Sand: fine with medium and some coarse, angular to rounded, mostly quartz Fines: brown	3.8	15.4
	Clay, brown, silty, pebbly	0.6	16.0
Fluvio-glacial and Older River Sand and Gravel and associated clay	**c** Sandy gravel, 'clayey' in top metre Gravel: coarse and fine, subangular to well-rounded, white and black limestones with grey sandstone Sand: coarse, medium and fine, subangular to rounded, clear quartz with grey white and black limestones	3.5	19.5
	Clay, yellow and red brown, soft to firm, sandy, very pebbly	1.5	21.0
Sherwood Sandstone Group	Sandstone, red brown, very weak, with sandy marl	2.2+	23.2

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	26	74	0	5.6–6.6	24	72	4				
				6.6–7.8	27	70	3				
				Mean	26	71	3				
b	17	82	1	11.6–12.6	20	65	15	0	0		
				12.6–13.6	17	49	30	3	1		
				13.6–14.6	14	42	38	5	1		
				14.6–15.4	17	53	24	4	2		
				Mean	17	52	27	3	1		
c	6	50	44	16.0–17.0	15	24	18	18	9	16	
				17.0–19.5	3	8	15	23	21	30	
				Mean	6	13	16	21	18	26	
a + b + c	15	69	16	Mean	15	42	17	9	7	10	

SE 36 NE 36 3673 6553 Byergates Field, Roecliffe **Block A²**

Surface level c +24 m (+78 ft)
Groundwater not encountered
Minuteman 76 mm
May 1975

Waste 9.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Lake Deposits	Clay, grey-red brown, initially laminated	2.8	3.1
	Clay, grey brown, silty	3.6	6.7
	No recovery	0.9	7.6
	'Very clayey' sand Sand: fine quartz and some lithics Fines: grey	1.6+	9.2

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
28	72	0	7.6–9.2	28	49	23				

SE 36 NE 37 3687 6580 Sike Plantation, Roecliffe **Block A²**

Surface level +23.3 m (+76 ft)
Groundwater not encountered
Shell and auger 152 mm
June 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey brown, silty	0.1	0.1
Glacial Lake Deposits	Clay, grey and brown, firm, laminated, silty	7.9	8.0
Till	Clay, red-brown to grey-brown, firm to very soft, very sandy, pebbly	10.0+	18.0

SE 36 NE 38 3723 6511 Waingates Farm, Roecliffe **Block A[2]**

Surface level +25.8 m (+84 ft)
Water struck at +20.8 m
Shell and auger 152 mm
June 1976

Overburden 0.7 m
Mineral 14.1 m
Waste 7.3 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil, brown, sandy	0.3	0.3
Till	Clay, yellow brown, very sandy	0.4	0.7
Glacial Sand and Gravel	'Clayey' sand with sporadic pebbles Sand: fine with medium and a trace of coarse, subangular and subrounded, clear and yellow brown quartz with black limestone Fines: yellow brown to grey brown	14.1	14.8
Till	Clay, yellow, brown and grey, firm to stiff, silty, sandy, pebbly; laminated between 17.0 and 18.6 m	5.6	20.6
Fluvio-glacial and Older River Sand and Gravel and associated clays	Sandy gravel Gravel: subangular and subrounded, yellow and light grey sandstones and black limestone with some red brown sandstone Sand: subangular and subrounded, clear quartz with some black limestone	0.3	20.9
	Clay red to brown, sandy, pebbly	1.2	22.1
Sherwood Sandstone Group	Sandstone, red brown, very weak	1.0+	23.1

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
14	85	1	0.7–1.8	10	23	62	2	2	1	
			1.8–2.8	13	25	61	1	0	0	
			2.8–3.8	14	56	29	1	0	0	
			3.8–5.0	14	73	13	0	0	0	
			5.0–6.0	28	50	21	1	0	0	
			6.0–7.0	15	61	20	0	1	3	
			7.0–8.0	14	66	19	1	0	0	
			8.0–9.0	11	36	52	1	0	0	
			9.0–10.0	19	68	12	1	0	0	
			10.0–11.0	9	62	28	1	0	0	
			11.0–12.0	9	68	22	0	0	1	
			12.0–13.0	11	67	22	0	0	0	
			13.0–14.0	22	70	5	0	1	2	
			14.0–14.8	14	72	13	0	0	1	
			Mean	14	57	27	1	0	1	

SE 36 NE 39 3870 6570 Becklands Lane, Roecliffe **Block A[2]**

Surface level +22.6 m (+74 ft)
Groundwater not encountered
Shell and auger 152 mm
June 1976

Waste 18.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Glacial Lake Deposits	Clay, brown and grey, silty and sandy	3.9	4.0
Till	Clay, brown, soft to firm, sandy, pebbly	8.3	12.3
	Silt, brown and grey	1.1	13.4
Clay associated with Fluvio-glacial and Older River Sand and Gravel	Clay, brown, laminated, silty	5.1+	18.5

SE 36 NE 42 3508 6544 Holbeck Plantation, Westwick **Block A[1]**

Surface level c +22 m (+72 ft)
Water struck approximately +14.8 m
Shell and auger 203 mm and 152 mm
April 1978

Overburden 8.7 m
Mineral 8.1 m
Waste 1.2 m
Mineral 2.0 m
Waste 4.2 m
Bedrock 0.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey brown	0.2	0.2
Glacial Lake Deposits	Clay yellow brown and grey, soft–stiff, laminated, becoming pebbly	2.1	2.3
Till	Clay, red brown and grey, soft–stiff, sandy and pebbly with scattered cobbles	6.4	8.7
Fluvio-glacial and Older River Sand and Gravel and associated clays	**a** 'Clayey' sand, with clay band between 11.0 m and 11.5 m and less than 10 % fines below 13.5 m Sand: fine and medium with a trace of coarse, subangular and subrounded, clear with some yellow brown quartz with some black and white limestones Fines: yellow brown	8.1	16.8
	Clay, grey brown, soft, very silty	1.2	18.0
	b 'Very clayey' sand Sand: fine with medium with a trace of coarse. subangular, yellow brown and clear quartz with some black and white limestones Fines: light brown	2.0	20.0
Till	Clay brown, firm–stiff, silty and sandy, pebbly	2.3	22.3
	Silt, yellow brown, very sandy	1.2	23.5
Glacial Sand and Gravel	'Clayey' gravel Gravel: fine with coarse, angular and subangular white and black limestones with quartz Fines: yellow brown	0.5	24.0
Till	Clay, yellow brown, firm–stiff, sandy, very pebbly	0.2	24.2
Sherwood Sandstone Group	Clay, red, stiff–hard, silty, with clasts of red brown micaceous marl and sandstone	0.8+	25.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	18	82	0	8.7–9.7	14	64	21	1			
				9.7–11.0	24	54	21	1			
				11.0–11.5	100	0	0	0			
				11.5–12.5	21	74	5	0			
				12.5–13.5	14	52	33	1			
				13.5–16.8	6	37	56	1			
				Mean	18	47	34	1			
b	26	74	0	18.0–20.0	26	58	15	1			
a + b	20	80	0	Mean	20	49	30	1			

SE 36 NE 43 **3805 6559** **South-east of Roecliffe** **Block A[2]**

Surface level c +23 m (+75 ft)
Water struck at approximately +14.9 m
Shell and auger 203 mm and 152 mm
April 1978

Waste 21.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, silty and clayey	0.2	0.2
Glacial Lake Deposits	Clay, yellow-brown to dark brown, laminated, silty	8.7	8.9
Glacial Sand and Gravel	'Very clayey' pebbly sand Gravel: coarse with fine, mainly rounded sandstone Sand: fine with medium and some coarse, red brown with some clear quartz Fines: dark red brown	2.1	11.0
Till	Clay, red brown, soft to firm, sandy, pebbly	3.0	14.0
	Clay, grey brown, soft to firm, silty, pebbly	6.7	20.7
Fluvio-glacial and Older River Sand and Gravel	Gravel Gravel: fine with coarse, subrounded to rounded dark grey limestone	0.1	20.8
	Limestone boulder, dark grey	0.7+	21.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
	30	62	8	8.9–10.0	31	46	11	6	0	6	
				10.0–11.0	29	47	11	4	4	5	
				Mean	30	46	11	5	2	6	

SE 36 SW 21 3060 6437 Riseley Hall, Wormald Green **Block B[1]**

Surface level +61.4 m (+201 ft)
Water struck at +53.5 m
Shell and auger 152 mm
July 1976

Waste 19.1 m
Bedrock 1.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, yellow, brown, sandy	1.1	1.1
	Clay, yellow and brown, soft, sandy	1.2	2.3
Till	Clay, yellow brown, sandy, pebbly	5.6	7.9
Glacial Sand and Gravel	**a** Sandy gravel Gravel: fine and coarse, subangular and subrounded, white and black limestones with sandstone Sand: coarse and medium with fine, angular and subangular, white and black limestones with sandstone, and subrounded clear quartz	2.1	10.0
Till	Clay, brown and grey, firm to stiff, pebbly	5.4	15.4
Glacial Sand and Gravel	**b** Sandy gravel with sporadic cobbles at top Gravel: fine and coarse subangular and subrounded, white and black limestones and sandstone Sand: medium and coarse with fine, subangular and subrounded, clear quartz with white and black limestones	3.7	19.1
Carboniferous	Silt, grey and yellow, sandy	0.9	20.0
	Sandstone, yellow, streaked with black moderately strong	1.0+	21.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
a	8	51	41	7.9–8.9	5	3	19	20	29	24	
				8.9–10.0	11	6	22	30	18	13	
				Mean	8	5	21	25	23	18	
b	3	50	47	15.4–16.0	4	5	12	16	29	31	3
				16.0–16.6	4	19	49	24	4	0	0
				16.6–17.6	2	7	13	18	33	27	0
				17.6–19.1	3	4	24	22	23	24	0
				Mean	3	7	23	20	24	22	1

SE 36 SW 22 3213 6457 Park House, Burton Leonard **Block B[1]**

Surface level +69.4 m (+228 ft)
Water struck at +61.9 m
Shell and auger 152 mm
August 1976

Waste 7.1 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, yellow and grey, sandy	0.3	0.3
Till	Clay, brown, reddish brown and grey, sandy, pebbly	6.8	7.1
Upper Magnesian Limestone	Marl, red brown, calcareous, thinly bedded, very weak	0.4	7.5
	Limestone, grey white, moderately strong	0.6+	8.1

SE 36 SW 23 3215 6429 Mount Pleasant, Burton Leonard **Block B[1]**

Surface level c +76 m (+249 ft)
Groundwater not encountered
Minuteman 76 mm
August 1975

Waste 8.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, silty	0.5	0.5
Till	Clay, reddish brown and greyish green, silty and pebbly; pebbly silt between 1.5 and 5.0 m	7.8	8.3
	No recovery	0.5	8.8

SE 36 SW 24 3273 6463 North of Burton Leonard **Block B[1]**

Surface level c +68 m (+223 ft)
Groundwater not encountered
Minuteman 76 mm
August 1975

Waste 2.7 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, silty	1.2	1.2
Till	Silt, brown, pebbly	1.5	2.7
Upper Magnesian Limestone	Limestone, creamy, fine-grained	1.0+	3.7

SE 36 SW 25 3390 6499 Burton Moor, Burton Leonard **Block B[1]**

Surface level c +35 m (+115 ft)
Groundwater not encountered
Minuteman 76 mm
August 1975

Overburden 1.2 m
Mineral 3.2 m
Waste 4.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Silt, light brown, sandy	1.0	1.2
Glacial Sand and Gravel	'Very clayey' pebbly sand Gravel: fine, angular to subangular, white and black limestones and grey sandstone Sand: fine with medium and coarse, angular to subrounded, quartz with limestone and sandstone Fines: brown	3.2	4.4
Till	Silt, grey, sandy	4.6+	9.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
25	62	13	1.2–2.2	27	43	13	7	10		
			2.2–3.2	20	38	13	10	19		
			3.2–4.4	27	39	14	10	10		
			Mean	25	40	13	9	13		

SE 36 SW 26 3417 6466 Moor Farm, Burton Leonard **Block B[1]**

Surface level +37.0 m (+121 ft)
Groundwater level on completion of drilling was +20.1 m
Shell and auger 152 mm
May 1976

Waste 18.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, yellow brown, silty	0.3	0.3
Till	Clay, brown, yellow and grey, sandy, pebbly; laminated and silty below 16.0 m	16.9	17.2
	'Very clayey' sand Sand: fine, subangular and subrounded yellow brown quartz Fines: grey brown	0.4	17.6
	Clay, grey, firm to stiff, silty, pebbly	0.6+	18.2

SE 36 SW 27 3465 6422 Holbeck, north of Copgrove **Block A[1]**

Surface level +18.9 m (+62 ft)
Water struck at +17.5 m
Shell and auger 152 mm
August 1976

Overburden 1.1 m
Mineral 3.6 m
Waste 8.9 m
Mineral 1.4 m
Waste 0.9 m
Mineral 2.8 m
Waste 0.9 m
Mineral 5.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, grey brown, peaty	0.6	0.6
Peat	Peat, grey black, very soft, clayey	0.5	1.1
Alluvium	**a** Gravel, becoming 'clayey' below 3.1 m Gravel: coarse and fine, subangular and subrounded, black with some white limestones and sandstone Sand: coarse and medium with fine, subangular and subrounded, clear quartz with some black limestone	3.6	4.7
Glacial Lake Deposits	Clay, grey brown, very soft to firm, silty and sandy	3.8	8.5
Till	Clay, brown, firm to stiff, silty, pebbly	5.1	13.6
Glacial Sand and Gravel	**b** 'Clayey' sand, yellow brown Sand: fine with medium and some coarse, subangular and subrounded clear quartz with some black limestone	1.4	15.0
Till	Clay, brown, soft, very sandy, pebbly	0.9	15.9
Fluvio-glacial and Older River Sand and Gravel and associated clays	**c** Gravel Gravel: fine and coarse, subangular and subrounded, black limestone and grey sandstone Sand: coarse, fine and medium, subangular and subrounded, clear quartz with limestone	1.1	17.0
	d 'Very clayey' sand, with scattered pebbles Sand: fine with medium and coarse, subangular clear quartz with some black limestone Fines: yellow brown	1.7	18.7
	Clay, brown, firm, pebbly	0.9	19.6
	e Gravel, with band of pebbly clay from 20.4–20.5 Gravel: coarse and fine, subangular and subrounded, black limestone with grey sandstone Sand: coarse and fine with medium, subangular and subrounded, clear quartz with some black limestone	3.4	23.0
	'Very clayey' sand Sand: fine, subangular and subrounded, clear quartz with some black limestone Fines: brown	1.6+	24.6

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	7	41	52	1.1–2.1	4	8	20	16	21	31	
				2.1–3.1	2	5	17	23	33	20	
				3.1–4.7	13	1	19	17	22	28	
				Mean	7	4	19	18	25	27	
b	17	83	0	13.6–15.0	17	71	11	1			
c	1	38	61	15.9–17.0	1	12	10	16	31	30	
d	20	78	2	17.0–18.7	20	62	11	5	1	1	
e	10	29	61	19.6–20.4	9	17	8	16	16	34	
				20.4–20.5	Non-mineral						
				20.5–23.0	7	7	6	13	21	40	
				Mean	10	10	6	13	21	40	
				23.0–24.6	No grading data available						
a + b + c + d + e	11	47	42	Mean	11	23	12	12	18	24	

SE 36 SW 28 3055 6348 Stainley Beck, South Stainley **Block B[1]**

Surface level +58.8 m (+193 ft)
Water struck at +56.4 m
Shell and auger 152 mm
July 1976

Overburden 6.3 m
Mineral 4.5 m
Waste 3.4 m
Bedrock 1.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, yellow brown, silty	0.8	0.8
	Clay, yellowish and greyish brown, soft, silty and sandy	1.1	1.9
Till	Clay, soft, sandy, pebbly	2.0	3.9
Glacial Sand and Gravel	Gravel Gravel: coarse and fine, subangular and subrounded, white and black limestones and sandstone Sand: medium and coarse with fine, subangular and subrounded, clear quartz and white and black limestones	1.0	4.9
Till	Silt, yellow and brown, clayey	1.4	6.3
Glacial Sand and Gravel	Gravel, contains sporadic cobbles at top Gravel: coarse and fine, subangular (subrounded and rounded below 9.0 m), white and black limestone with sandstone Sand: coarse with medium and fine, angular-subrounded, clear and opaque quartz and black and white limestone	4.5	10.8
Till	Clay, brown and grey, stiff, faintly laminated, silty, pebbly	3.4	14.2
Carboniferous	Marl and mudstone, grey (becoming purple), very weak	1.5+	15.7

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
2	18	80	3.9–4.9	2	1	10	7	25	55	
8	34	58	6.3–8.3	10	9	8	12	16	42	3
			8.3–9.3	8	8	7	10	16	51	0
			9.3–10.4	3	2	8	27	37	23	0
			10.4–10.8	5	8	22	43	16	6	0
			Mean	8	7	9	18	21	36	1

SE 36 SW 29 3407 6353 Holly Bushes, Copgrove **Block B[1]**

Surface level +38.3 m (+126 ft)
Water struck at +24.5 m
Shell and auger 152 mm
August 1976

Overburden 1.9 m
Mineral 24.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil, grey brown, sandy, pebbly	0.9	0.9
Till	Clay, grey and brown, stiff, pebbly	1.0	1.9
Glacial Sand and Gravel	**a** 'Clayey' gravel, with sporadic cobbles Gravel: fine and coarse, subangular and subrounded, black with white limestones with sandstone Sand: coarse and medium with fine, subangular and subrounded, clear quartz and white and black limestones with some yellow sandstone	14.1	16.0
	b Gravel, with sporadic cobbles Gravel: fine and coarse, subangular and subrounded, black and white limestones with sandstone Sand: coarse with medium and some fine, subangular black and white limestones and sandstone with clear quartz	4.0	20.0
	c Sandy gravel (composition as **b**) Gravel: fine and coarse Sand: coarse and medium with some fine	3.0	23.0
	d Gravel (composition as **b**) Gravel: fine and coarse Sand: coarse with medium and some fine	3.0+	26.0

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	18	40	42	1.9–3.0	19	5	10	15	30	21	
				3.0–4.3	23	6	10	17	29	15	
				4.3–5.0	18	9	60	9	3	1	
				5.0–6.0	20	4	18	21	22	15	
				6.0–7.0	17	6	23	22	20	12	
				7.0–8.0	17	5	15	23	26	14	
				8.0–9.0	23	8	9	14	21	25	
				9.0–10.5	14	5	10	26	31	14	
				10.5–11.7	20	7	17	20	25	11	
				11.7–12.7	22	12	14	13	21	18	
				12.7–13.8	19	9	12	12	28	20	
				13.8–14.8	16	4	10	19	33	18	
				14.8–16.0	10	5	16	18	26	16	
				Mean	18	6	16	18	26	16	
b	2	24	74	16.0–17.0	3	1	4	12	46	34	
				17.0–18.0	3	1	3	14	44	37	
				18.0–19.0	1	0	4	23	44	28	
				19.0–20.0	1	1	10	24	40	24	
				Mean	2	1	5	18	43	31	
c	3	66	31	20.0–21.0	5	3	43	33	9	7	
				21.0–22.0	3	2	20	31	26	18	
				22.0–23.0	2	1	12	53	24	8	
				Mean	3	2	25	39	20	11	
d	2	36	62	23.0–24.0	3	2	7	19	28	41	
				24.0–25.0	2	1	11	34	26	26	
				25.0–26.0	1	1	7	28	38	25	
				Mean	2	1	8	27	31	31	
a + b + c + d	12	40	48	Mean	12	4	14	22	28	20	

SE 36 SW 30 3187 6280 Mill Hill, South Stainley **Block B[1]**

Surface level +58.2 m (+191 ft)
Groundwater not encountered
Shell and auger 152 m
August 1976

Overburden 1.2 m
Mineral 7.1 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil, brown, sandy, pebbly	0.4	0.4
Till	Clay, yellow brown, soft, sandy, pebbly	0.8	1.2
Glacial Sand and Gravel	'Clayey' gravel with band of pebbly clay from 4.6 to 4.7 m Gravel: fine and coarse, angular to subrounded, white with black limestones and sandstone Sand: coarse, medium and fine, subangular with subrounded, clear quartz with some white limestone	7.1	8.3
Lower Magnesian Limestone	Limestone, greyish white, weak	1.0 +	9.3

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
18	37	45	1.2–2.2	15	10	11	13	28	23	
			2.2–3.2	19	10	12	16	25	18	
			3.2–4.6	16	10	15	13	26	20	
			4.6–4.7	Non-mineral						
			4.7–5.7	22	13	13	15	23	14	
			5.7–7.0	19	12	9	11	26	23	
			7.0–7.4	14	13	21	19	21	12	
			7.4–8.3	14	9	12	12	20	33	
			Mean	18	11	13	13	24	21	

SE 36 SW 31 3380 6269 Gravel Hill, Copgrove **Block B[1]**

Surface level +47.2 m (+155 ft)
Groundwater not encountered
Shell and auger 152 mm
August 1976

Overburden 0.3 m
Mineral 3.4 m
Bedrock 0.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground, pebbles and cobbles	0.3	0.3
Glacial Sand and Gravel	'Clayey' sandy gravel Gravel: fine and coarse, rounded and subrounded white and black limestone with sandstone; sporadic cobbles Sand: medium and coarse with fine, subangular yellow brown and clear quartz with some black limestone	3.4	3.7
Lower Magnesian Limestone	Limestone, creamy white, moderately strong	0.9+	4.6

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
18	43	39	0.3–1.3	16	8	22	15	24	15	
			1.3–2.3	18	10	19	14	26	13	
			2.3–3.7	19	12	16	13	22	18	
			Mean	18	10	19	14	24	15	

SE 36 SW 32 3053 6173 Green Lane Farm, Nidd **Block B**[1]

Surface level +77.6 m (+254 ft)
Groundwater not encountered
Shell and auger 152 mm
July 1976

Overburden 0.3 m
Mineral 5.2 m
Waste 1.2 m
Bedrock 2.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground, mainly cobbles	0.3	0.3
Glacial Sand and Gravel	'Clayey' sandy gravel, with sporadic cobbles Gravel: coarse and fine, subrounded and subangular, black with white limestone with sandstone Sand: medium, coarse and fine, subangular and subrounded, clear quartz with white and black limestone	5.2	5.5
Till	Clay, yellow brown and grey, firm, sandy, pebbly	0.2	5.7
	Silt, yellow, clayey, sandy	1.0	6.7
Carboniferous	Clay bluish grey, stiff, silty	0.9	7.6
	Shale, bluish black, platy, weak	1.5+	9.1

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
19	42	39	0.3–2.3	21	17	15	14	18	15	
			2.3–3.3	20	13	14	13	20	20	
			3.3–4.3	13	8	13	15	22	29	
			4.3–5.5	18	9	17	14	19	23	
			Mean	19	13	15	14	19	20	

SE 36 SW33 3099 6105 Susacre Farm, Nidd **Block B**[1]

Surface level +67.4 m (+221 ft)
Groundwater not encountered
Shell and auger 153 mm
July 1976

Overburden 3.2 m
Mineral 3.1 m
Bedrock 4.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, yellow brown, sandy	0.4	0.4
Till	Clay, yellow and brown, firm to stiff, sandy and silty, pebbly	2.8	3.2
Glacial Sand and Gravel	'Clayey' gravel Gravel: fine and coarse, subangular and subrounded pebbles of black with white limestone, with sandstone; sporadic cobbles Sand: medium, coarse and fine, subangular and subrounded clear quartz with black and white limestones	3.1	6.3
Carboniferous	'Very clayey' sand Sand: fine with some medium and some coarse, subrounded and subangular clear and yellow orange quartz Fines: orange brown	3.2	9.5
	Marl, brown, sandy, very weak	1.1+	10.6

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
14	42	44	3.2–4.2	13	13	18	14	24	18	
			4.2–5.2	15	11	18	12	22	22	
			5.2–6.3	15	13	12	15	22	23	
			Mean	14	12	16	14	23	21	

SE 36 SW 34 **3275 6116** **East of Brearton** **Block B[1]**

Surface level +49.7 m (+163 ft)
Groundwater not encountered
Shell and auger 152 mm
July 1976

Waste 8.9 m
Bedrock 3.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, silty, pebbly	0.6	0.6
Till	Clay, brown, grey and bluish grey, silty sandy and pebbly	7.8	8.4
Glacial Sand and Gravel	'Very clayey' gravel Gravel: fine and coarse, subangular and subrounded black and white limestones and sandstone Sand: coarse, medium and fine, subangular and subrounded clear quartz with some black limestone Fines: yellow brown	0.5	8.9
Carboniferous	'Clayey' sand, becoming 'very clayey' below 10.5 m Sand: fine and medium with some coarse, subangular red brown and clear quartz. Few shale fragments	3.6+	12.5

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
29	32	39	8.4– 8.9	29	10	9	13	21	18	
19	81	0	8.9–10.5	16	59	34	1	0	0	
			10.5–11.5	22	51	26	1	0	0	
			11.5–12.5	21	66	13	0	0	0	
			Mean	19	59	21	1	0	0	

SE 36 SW 35 3439 6162 Walkingham Hall, Occaney **Block A[3]**

Surface level +35.7 m (+117 ft)
Water struck at +22.8 m
Shell and auger 152 mm
July 1976

Waste 15.1 m
Bedrock 2.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, yellow brown, silty	0.6	0.6
Glacial Lake Deposits	Clay, yellowish brown, grey, and brown, silty, laminated; pebbly between 2.5 and 3.6 m	8.4	9.0
Till	Clay, grey and brown, firm to soft, silty and sandy, pebbly	3.7	12.7
	Clay, red brown, firm, silty, pebbly	0.2	12.9
Fluvio-glacial and Older River Sand and Gravel	Sand Sand: medium with fine, subangular and subrounded clear quartz with black and white limestones	0.8	13.7
	Gravel Gravel: fine and coarse, angular and subangular black and white limestones with sandstone and some quartzite Sand: coarse, medium and fine, subangular and subrounded clear quartz and black and white limestones	1.4	15.1
Carboniferous	Marl, red and green, calcareous, sandy, weak	2.0+	17.1

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
5	38	57	13.7–14.7	6	22	9	10	21	28	4
			14.7–15.1	3	4	9	17	40	27	0
			Mean	5	17	9	12	26	28	3

SE 36 SW 36 3015 6010 Home Farm, Nidd **Block B[1]**

Surface level +72.5 m (+238 ft)
Water struck at +65.9 m
Shell and auger 152 mm
July 1976

Overburden 6.6 m
Mineral 3.9 m
Waste 7.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, yellow brown, silty, pebbly	0.8	0.8
Fluvio-glacial Terrace Deposits	Clay, yellowish brown, brown and grey, silty, laminated; silt layer with some sand between 3.0 and 5.0 m	5.8	6.6
	'Clayey' sand, with scattered pebbles Sand: medium with fine and some coarse, subangular and subrounded, clear quartz with some black limestone Fines: yellow brown	3.9	10.5
	Clay, grey, firm, laminated, very silty	2.4	12.9
	Silt, grey brown, clayey, very sandy	4.1	17.0
	Clay, grey, firm, very silty	1.0+	18.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
15	84	1	6.6–7.6	25	31	43	1	0		
			7.6–10.5	12	13	70	4	1		
			Mean	15	18	63	3	1		

SE 36 SW 37 3192 6028 Brearton Grange, Brearton **Block B[1]**

Surface level +58.7 m (+192 ft)
Groundwater not encountered
Shell and auger 152 mm
July 1976

Overburden 7.9 m
Mineral 6.8 m
Bedrock 1.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, yellow brown, silty	0.3	0.3
Till	Clay, brown, firm, pebbly	0.9	1.2
	Clay, yellow and brown, soft, sandy, very pebbly	0.8	2.0
	Silt, yellow brown and grey, very clayey, sandy	3.7	5.7
	Clay, grey and brown, soft to stiff, very silty	2.2	7.9
Glacial Sand and Gravel	**a** 'Very clayey' sand, with band of clay from 10.1 to 10.3 m Sand: fine with medium and a trace of coarse, subangular and subrounded, clear with some yellow quartz and black limestone Fines: yellow brown	4.5	12.4
	b 'Clayey' gravel Gravel: fine and coarse, subrounded with subangular white and black limestones with some grey green sandstone or quartzite Sand: medium and coarse with fine, subangular and subrounded, clear quartz with some black and white limestones	2.3	14.7
Carboniferous	Sandstone, yellow brown, thinly bedded, weak	1.2+	15.9

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	22	77	1	7.9–8.9	26	73	1	0	0		
				8.9–9.9	25	63	12	0	0		
				9.9–10.1	13	29	55	2	1		
				10.1–12.4	Non-mineral						
				10.3–12.4	13	37	46	3	1		
				Mean	22	49	27	1	1		
b	15	38	47	12.4–13.5	13	8	20	13	24	22	
				13.5–14.7	17	10	12	13	28	20	
				Mean	15	9	16	13	26	21	
a + b	20	64	16	Mean	20	35	23	6	9	7	

SE 36 SW 38 3327 6072 Low Moor Lane, Brearton **Block A[3]**

Surface level +43.5 m (+143 ft)
Water struck at +37.8 m
Shell and auger 152 mm
July 1976

Overburden 5.7 m
Mineral 9.3 m
Bedrock 3.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, yellow brown, silty	0.8	0.8
Till	Clay, grey and brown, soft to firm, pebbly	4.9	5.7
Fluvio-glacial and Older River Sand and Gravel	Gravel, 'clayey' near top Gravel: coarse and fine, subangular to rounded white and black limestones with sandstone Sand: coarse and medium with fine, angular to subrounded, clear and yellow brown quartz with black and white limestones	9.3	15.0
Sherwood Sandstone Group	Marl, red brown, very weak, with fine sandstone	3.1+	18.1

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
4	38	58	5.7–6.7	8	9	28	22	20	13	0
			6.7–8.2	11	5	18	19	26	21	0
			8.2–9.2	4	4	10	16	33	33	0
			9.2–10.2	1	2	13	19	31	31	3
			10.2–11.2	1	3	22	18	27	29	0
			11.2–12.2	0	2	8	20	31	39	0
			12.2–13.2	2	3	12	23	28	32	0
			13.2–15.0	1	3	13	19	27	37	0
			Mean	4	4	15	19	28	30	0

SE 36 SW 39 3355 6073 The Mires, Brearton **Block A[3]**

Surface level +37.6 m (+123 ft)
Water struck at +32.3 m
Shell and auger 152 mm
July 1976

Overburden 9.2 m
Mineral 4.4 m
Waste 0.7 m
Bedrock 1.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey brown, silty, pebbly	0.5	0.5
Glacial Lake Deposits	Clay, grey and brown, firm to stiff, laminated, very silty	3.2	3.7
Till	Clay, grey and brown, firm, silty and sandy, pebbly	5.5	9.2
Fluvio-glacial and Older River Sand and Gravel	Gravel, with cobbles at top Gravel: coarse and fine, subangular and subrounded, black and white limestones with some sandstone Sand: coarse with medium and fine, angular to subrounded, black and white limestones with clear quartz	4.4	13.6
Till	Clay, brown, firm to stiff, silty, pebbly	0.7	14.3
Sherwood Sandstone Group	Silt, red brown, sandy	0.7	15.0
	Marl, red brown, thinly bedded, silty, weak, with some weak sandstone	1.1+	16.1

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
7	31	62	9.2–11.0	6	6	4	7	13	58	6
			11.0–12.0	5	6	10	23	26	30	0
			12.0–13.6	8	8	11	22	22	29	0
			Mean	7	7	8	16	19	41	2

SE 36 SW 40 3451 6027 Driffields Plantation, Farnham **Block A[3]**

Surface level +38.0 m (+125 ft)
Water struck at +33.8 m
Shell and auger 152 mm
August 1976

Overburden 4.2 m
Mineral 8.4 m
Bedrock 1.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey brown, sandy, pebbly	0.2	0.2
Till	Clay, grey and brown, stiff, silty, pebbly	4.0	4.2
Fluvio-glacial and Older River Sand and Gravel	Gravel Gravel: fine and coarse, subangular and subrounded black and white limestones with sandstone and some quartzite Sand: coarse and medium with some fine, angular and subangular clear and yellow brown quartz and white and black limestones with some sandstone	8.4	12.6
Carboniferous	Clay, blue grey, firm to stiff, silty	0.6	13.2
	Shale, blue black, thinly bedded, weak	1.8+	15.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
2	42	56	4.2–5.2	3	2	12	21	39	23	
			5.2–6.2	4	1	17	22	22	34	
			6.2–7.2	1	2	28	26	24	19	
			7.2–8.2	1	2	21	18	29	29	
			8.2–9.2	1	2	14	25	27	31	
			9.2–10.2	5	4	18	16	28	29	
			10.2–11.2	2	2	18	31	26	21	
			11.2–12.6	2	2	14	21	34	27	
			Mean	2	2	17	23	29	27	

SE 36 SE 12 3573 6455 Roecliffe Lodge, Roecliffe **Block A[1]**

Surface level +27.6 m (+90 ft)
Water struck at +19.8 m
Shell and auger 152 mm
June 1976

Overburden 7.8 m
Mineral 6.9 m
Waste 2.8 m
Mineral 1.0 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey brown, silty, pebbly	0.2	0.2
Glacial Lake Deposits	Clay, yellow brown and grey, firm to stiff, laminated, silty	3.3	3.5
Till	Clay, brown and grey, firm, silty, pebbly	4.3	7.8
Glacial Sand and Gravel	**a** 'Clayey' sand, with some pebbles Sand: medium and fine with coarse, subangular and subrounded, clear and yellow brown quartz with some black limestone Fines: yellow brown	6.9	14.7
Till	Clay, red and brown, firm to very soft, very sandy, pebbly	2.8	17.5
Fluvio-glacial and Older River Sand and Gravel	Gravel: fine with coarse, subangular and subrounded, sandstone with some black limestone Sand: coarse, medium and fine, subangular, clear quartz with some black and white limestones Fines: red brown	1.0	18.5
Sherwood Sandstone Group	Sandstone, red brown, medium to coarse, very weak to moderately strong	1.0 +	19.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	10	89	1	7.8–8.8	9	11	61	16	3	0	
				8.8–9.8	6	15	49	25	4	1	
				9.8–10.8	9	30	45	15	1	0	
				10.8–11.8	14	41	42	3	0	0	
				11.8–12.8	13	28	51	8	0	0	
				12.8–13.8	7	27	57	7	2	0	
				13.8–14.7	11	44	44	1	0	0	
				Mean	10	28	50	11	1	0	
b	13	74	13	17.5–18.5	13	27	19	28	12	1	
a + b	10	87	3	Mean	10	28	46	13	3		

SE 36 SE 13 3649 6419 Newfields, Roecliffe **Block A[2]**

Surface level +25.3 m (+83 ft)
Water struck at +13.6 m
Shell and auger 152 mm
June 1976

Waste 20.2 m
Bedrock 1.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Fluvio-glacial Terrace Deposits	Pebbles, and sand	0.7	0.7
	Clay, grey and brown, firm to stiff, laminated, silty and sandy	5.1	5.8
Till	Clay, brown, reddish brown and grey, firm, silty and sandy, pebbly	10.5	16.3
Fluvio-glacial and Older River Sand and Gravel	Sandy gravel Gravel: fine and coarse, subangular with some subrounded, white limestone and grey sandstone with some black limestone and red siltstone Sand: coarse and medium with fine, subangular and subrounded, quartz with limestone	3.9	20.2
Sherwood Sandstone Group	Marl, red brown, sandy	1.3+	21.5

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
4	68	28	16.3–17.3	1	1	24	40	30	4	
			17.3–18.3	2	5	35	26	20	12	
			18.3–18.8	7	34	19	15	15	10	
			18.8–20.2	6	25	25	23	12	9	
			Mean	4	15	26	27	19	9	

SE 36 SE 14 3659 6471 Roecliffe Whin, Roecliffe **Block A[2]**

Surface level +26.2 m (+86 ft)
Water struck at +9.9 m
Shell and auger 152 mm
June 1976

Waste 16.7 m
Bedrock 1.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown clayey	0.2	0.2
Glacial Lake Deposits	Clay, grey and brown, firm, laminated, silty and sandy	2.8	3.0
Till	Clay, grey and brown, sandy and pebbly; silt layer from 10.5 to 12.5 m	13.3	16.3
Fluvio-glacial and Older River Sand and Gravel	Gravel Gravel: coarse and fine, subrounded and subangular yellow and red sandstone and grey limestone Sand: fine and medium with coarse, subangular and subrounded clear quartz with some black limestone	0.4	16.7
Sherwood Sandstone Group	Sandstone, red brown, very weak, with siltstone	1.3+	18.0

SE 36 SE 15 3722 6416 Staveley Carrs, Staveley **Block A²**

Surface level +26.0 m (+85 ft)
Water struck at +21.5 m
Shell and auger 152 mm
June 1976

Overburden 4.8 m
Mineral 3.1 m
Waste 11.2 m
Bedrock 0.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, black, peaty	0.2	0.2
Peat	Peat, brown and grey black, very soft	1.4	1.6
Glacial Lake Deposits	Clay, blue grey, stiff, laminated, silty	3.2	4.8
Fluvio-glacial and Older River Sand and Gravel	Sandy gravel 'clayey' at top Gravel: fine and coarse, subangular and subrounded, grey black limestone with white limestone and yellow green sandstone and some quartzite Sand: medium with fine and coarse, subangular, clear with opaque and yellow brown quartz and some black limestone	3.1	7.9
Till	Clay, brown, firm to soft, sandy, pebbly	3.3	11.2
	'Very clayey' sand, subangular and subrounded clear and yellow brown quartz with some black limestone	0.2	11.4
	Clay, brown and grey, stiff to very soft, sandy, pebbly	7.7	19.1
Sherwood Sandstone Group	Marl, red brown, sandy, very weak	0.9+	20.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
4	69	27	4.8–5.5	10	31	47	6	5	1	
			5.5–6.5	4	12	52	6	12	14	
			6.5–7.5	1	5	34	20	23	17	
			7.5–7.9	2	5	34	26	22	11	
			Mean	4	13	43	13	15	12	

SE 36 SE 16 3785 6464 Ox Closes, Minskip **Block A²**

Surface level +24.0 m (+78 ft)
Groundwater not encountered
Shell and auger 152 mm
September 1976

Waste 20.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, silty	0.2	0.2
	Made ground, sand and pebbles	0.2	0.4
	Made ground, clay, brown-grey, pebbly	1.2	1.6
Glacial Lake Deposits	Clay, green, grey and purple, laminated, silty and sandy	3.8	5.4
Till	Clay, brown and grey sandy, pebbly	9.1	14.5
Clay associated with Fluvio-glacial and Older River Sand and Gravel	Clay, brown, laminated, sandy	5.5+	20.0

SE 36 SE 17 3864 6470 Minskip **Block A²**

Surface level +25.9 m (+85 ft)
Water struck at +14.9 m
Shell and auger 152 mm
September 1976

Overburden 1.2 m
Mineral 1.1 m
Waste 2.8 m
Mineral 2.1 m
Waste 10.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, yellow brown, sandy	1.2	1.2
Glacial Lake Deposits	**a** 'Very clayey' sand, with clay partings Sand: fine with a trace of medium, subrounded, clear and yellow brown quartz	1.1	2.3
	Clay, grey, soft to firm, with fine brown sand partings	2.8	5.1
Glacial Sand and Gravel	**b** Sandy gravel, with several cobbles Gravel: coarse and fine, subangular and subrounded, mostly sandstone Sand: fine and medium with coarse, mostly subrounded quartz	2.1	7.2
Till	Clay, red brown, sandy, pebbly	3.8	11.0
Clay associated with Fluvio-glacial and Older River Sand and Gravel	Clay, grey brown, laminated, very sandy	1.3	12.3
	'Very clayey' sand	0.4	12.7
	Clay, brown, becoming pebbly, with sand lenses	4.3	17.0
	Clay, brown	1.1+	18.1

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
a	29	71	0	1.2–2.3	29	70	1				
b	8	50	42	5.1–5.5	11	52	25	7	3	2	0
				5.5–7.2	7	21	12	9	10	33	8
				Mean	8	27	14	9	9	27	6
a + b	15	57	25	Mean	15	41	10	6	6	18	4

SE 36 SE 18 3949 6406 South-east of Minskip **Block B[1]**

Surface level +39.0 m (+128 ft)
Groundwater conditions not recorded
Shell and auger 152 mm
September 1976

Waste 18.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Alluvium	Soil, yellow and brown, pebbly with few cobbles	1.0	1.0
	Clay, grey black, laminated, pebbly	0.5	1.5
Glacial Lake Deposits	Clay, greyish black, firm to stiff, initially laminated	4.3	5.8
Till	Clay, grey and brown, silty, sandy, pebbly; laminated, silty, stone-free clay from 7.9 to 8.6 m	6.7	12.5
	No recovery	1.1	13.6
Glacial Sand and Gravel	Gravel	3.3	16.9
	Gravel: coarse and fine, well rounded to subrounded black limestone and pale sandstone		
	Sand: coarse with medium and fine		
Till	Clay, red brown, pebbly	1.3+	18.2

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
7	31	62	13.6–14.7	8	4	5	15	45	23	
			14.7–15.3	4	8	8	19	24	37	
			15.3–16.9	8	8	9	16	21	38	
			Mean	7	7	8	16	29	33	

SE 36 SE 19 3504 6368 Little Pasture Wood, Copgrove **Block A**[1]

Surface level +36.1 m (+118 ft)
Water struck at +23.4 m
Shell and auger 152 mm
August 1976

Overburden 16.6 m
Mineral 6.1 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, yellow brown, sandy, pebbly	0.3	0.3
Till	Clay, yellow and grey, hard, very sandy, pebbly	0.9	1.2
	a 'Clayey' gravel Gravel: fine and coarse, angular and subangular, black limestone with sandstone Sand: fine with medium and coarse, subangular and subrounded, clear quartz with some black limestone Fines: yellow brown	0.5	1.7
	Clay, brown, grey and reddish brown, sandy, pebbly	11.0	12.7
Glacial Sand and Gravel	**b** Gravel Gravel: coarse and fine, subangular and subrounded, white and black limestones with sandstone Sand: coarse and medium with fine, subangular black and white limestones with some sandstone and clear quartz	1.9	14.6
Till	Clay, red and brown, firm to stiff, sandy, pebbly	2.0	16.6
Fluvio-glacial and Older River Sand and Gravel	**c** Gravel, becoming sandy below 19.6 m Gravel: coarse and fine, subangular and subrounded, white and black limestones with sandstone and some angular white limestone near base Sand: coarse and medium with fine, subangular white and black limestones with clear quartz and some sandstone	6.1	22.7
Upper Magnesian Limestone	Limestone, grey white, moderately strong	1.0+	23.7

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	19	28	53	1.2–1.7	19	18	6	4	30	23	
b	2	36	62	12.7–13.7	2	3	10	17	25	43	
				13.7–14.6	2	1	19	23	27	28	
				Mean	2	2	14	20	26	36	
c	3	44	53	16.6–17.6	4	2	5	13	35	41	
				17.6–18.6	3	3	13	18	30	33	
				18.6–19.6	4	7	17	20	26	26	
				19.6–20.6	2	5	27	22	27	17	
				20.6–21.6	3	2	25	29	24	17	
				21.6–22.7	4	5	28	22	13	28	
				Mean	3	4	19	21	26	27	

SE 36 SE 20 3615 6345 Holme Hill, Staveley

Surface level +24.9 m (+81 ft)
Water struck at +15.5 m
Shell and auger 152 mm
September 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, pebbly	0.4	0.4
Till	Clay, brown and grey, firm, sandy and silty, pebbly	9.0	9.4
Glacial Sand and Gravel	Gravel Gravel: fine and coarse, rounded to subrounded white and black limestones and sandstone with some quartzite. Scattered cobbles Sand: medium and coarse with fine, limestone and sandstone with some quartz	2.4	11.8
Till	Clay, reddish brown, stiff, sandy, pebbly	6.2+	18.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
2	38	60	9.4–10.4	1	3	14	11	32	39	
			10.4–11.4	2	3	26	20	25	24	
			11.4–11.8	3	4	21	14	32	26	
			Mean	2	3	20	15	29	31	

SE 36 SE 21 3700 6366 Staveley Carrs, Staveley **Block A[2]**

Surface level +26.4 m (+86 ft)
Water struck at +22.3 m
Shell and auger 152 mm
June 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Peat	Peat, brown black, very soft	1.6	1.6
Glacial Lake Deposits	Clay, grey and brown, soft to firm, laminated, very silty	1.6	3.2
Till	Clay, grey and brown, sandy, pebbly; very clayey sandy silt from 16.3 to 18.0 m	14.8+	18.0

SE 36 SE 22 3817 6349 High Moor Fields, Minskip **Block A[2]**

Surface level +32.0 m (+105 ft)
Groundwater conditions not recorded
Shell and auger 152 mm
September 1976

Overburden 0.3 m
Mineral 2.8 m
Waste 15.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown	0.3	0.3
Glacial Sand and Gravel	'Very clayey' sandy gravel, with numerous cobbles Gravel: fine and coarse, rounded to subrounded, mostly sandstone Sand: fine with coarse and medium, mostly subrounded quartz	2.8	3.1
Till	Clay, brown, sandy, pebbly; laminated below 17.1 m	15.0+	18.1

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
24	39	37	0.3–1.0	20	20	7	10	19	7	0
			1.0–1.7	24	20	8	12	23	13	0
			1.7–3.1	24	23	7	9	18	14	5

SE 36 SE 23 3512 6214 North-west of Occaney **Block A[3]**

Surface level +38.0 m (+125 ft)
Groundwater encountered
Shell and auger 152 mm
August 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Fluvio-glacial Terrace	Soil, brown, silty and sandy , pebbly	0.9	0.9
Deposits, undifferentiated	Clay, brown, soft, sandy	0.5	1.4
	Clay, brown and grey, very soft to stiff, laminated, silty and sandy	11.4	12.8
Till	Clay, brown and grey, sandy, silty and pebbly	5.2+	18.0

SE 36 SE 24 3606 6263 Staveley Mill, Staveley **Block A**[1]

Surface level +29.9 m (+98 ft)
Water struck at +27.0 m
Shell and auger 152 mm
August 1976

Overburden 1.5 m
Mineral 2.4 m
Waste 13.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Fluvio-glacial Terrace Deposits, undifferentiated	Soil, grey, sandy, pebbly	0.3	0.3
	Clay, brown, firm, sandy, and pebbly	1.2	1.5
	'Clayey' gravel, with cobbles Gravel: coarse and fine, angular to subrounded, black white limestones with sandstone Sand: coarse and medium with fine subangular and subrounded, clear quartz with black and some white limestones and some sandstone Fines: yellow brown	2.4	3.9
Till	Clay, brown, stiff and sandy, pebbly; reddish brown below 12.9 m	13.1+	17.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
13	34	53	1.5–2.5	17	9	15	12	22	25	
			2.5–3.2	13	6	9	13	29	30	
			3.2–3.9	6	3	13	21	26	31	
			Mean	13	6	13	15	25	28	

SE 36 SE 25 3740 6279 New Plantation, Staveley **Block B**[1]

Surface level +31.5 m (+103 ft)
Water stuck at +14.2 m
Shell and auger 152 mm
June 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, yellowish brown, sandy	0.4	0.4
Glacial Sand and Gravel	'Very clayey' pebbly sand Gravel: subangular grey and white sandstone to quartzite Sand: fine, subangular and subrounded yellow brown with clear quartz Fines: brown	0.9	1.3
Till	Clay, brown and grey, firm to stiff, silty, pebbly	16.7+	18.0

SE 36 SE 26 3812 6234 Spellow Hill **Block B[1]**

Surface level c +54 m (+177 ft)
Groundwater not encountered
Minuteman 76 mm
May 1975

Waste 3.4 m
Bedrock 0.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, silty	0.3	0.3
Till	Silt, red brown, sandy	0.6	0.9
Glacial Sand and Gravel	'Very clayey' pebbly sand Gravel: coarse and fine, subangular Sand: fine with medium and some coarse, subangular and subrounded quartz and lithics Fines: red brown	0.4	1.8
Till	Clay, red brown, faintly laminated, silty	1.6	3.4
Upper Magnesian Limestone	Limestone, creamy	0.9+	4.3

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
25	65	10	1.4–1.8	25	53	10	2	4	6	

SE 36 SE 27 3887 6226 Forms House, Arkendale **Block B[1]**

Surface level +49.0 m (+161 ft)
Water struck at +38.4 m
Shell and auger 152 mm
September 1976

Waste 10.7 m
Bedrock 0.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown, sandy	0.4	0.4
Till	Clay, brown, reddish brown, sandy, pebbly	10.3	10.7
Upper Magnesian Limestone	Limestone, creamy white, friable, porous, weak	0.9+	11.6

SE 36 SE 28 3987 6283 Brooms House, Arkendale **Block B[1]**

Surface level +59.5 m (+195 ft)
Groundwater conditions are not recorded
Shell and auger 152 mm
September 1976

Waste 19.1 m
Bedrock 6.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, brown and yellow, very sandy, pebbly	0.9	0.9
Till	Clay, brown and reddish brown, sandy, pebbly	16.5	17.4
Glacial Sand and Gravel	'Very clayey' pebbly sand, pebbles mostly at top Gravel: fine and coarse mostly well-rounded and subrounded sandstone Sand: fine with some medium and coarse, mostly subrounded quartz Fines: light grey	1.7	19.1
Sherwood Sandstone Group	Marl, red and green, bedded	0.2	19.3
	'Very clayey' sand Sand: fine with some medium, subangular and subrounded, brown and yellowish green quartz	2.7	22.0
	Sandstone, yellow, very weak, thin bedded	3.2+	25.2

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
23	72	5	17.4–18.0	26	38	15	7	9	5	
			18.0–18.9	21	77	1	1	0	0	
			18.9–19.1	22	71	3	3	1	0	
			Mean	23	63	6	3	3	2	
26	74		19.3–19.9	40	59	1				
			19.9–21.0	18	80	2				
			21.0–22.0	27	72	1				
			Mean	26	72	2				

SE 36 SE 29 3580 6149 Hollins Hill, Occaney **Block B[1]**

Surface level +45.1 m (+148 ft)
Groundwater encountered
Shell and auger 152 mm
August 1976

Overburden 0.4 m
Mineral 2.2 m
Waste 17.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, orange brown, sandy with pebbles and cobbles	0.4	0.4
Glacial Sand and Gravel	'Very clayey' pebbly sand, pebbles mostly at top Gravel: fine and coarse, subangular, white and black limestones with sandstone Sand: fine with medium and coarse subrounded, orange brown and clear quartz with some limestone Fines: orange brown	2.2	2.6
Till	Clay, brown and yellow, silty, sandy, pebbly; thin beds of 'very clayey' sand at 9.9 and 10.6 m	8.8	11.4
	Silt, yellow and brown, clayey, with some sand	6.0	17.4
Glacial Sand and Gravel	'Clayey' sandy gravel Gravel: fine and coarse, subangular and subrounded, white with black limestones with some sandstone Sand: medium and coarse with fine, subangular, clear and yellow brown quartz with white limestone	1.1	18.5
Till	Silt, yellow and brown, sandy and clayey	1.5+	20.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
22	59	19	0.4–1.7	22	31	8	7	17	15	
			1.7–2.6	22	67	8	3	0	0	
			Mean	22	46	8	5	10	9	
10	47	43	17.4–18.0	12	11	20	18	20	19	
			18.0–18.5	8	6	14	24	24	24	
			Mean	10	9	17	21	22	21	

SE 36 SE 30 3679 6175 Moor End, Staveley **Block B[1]**

Surface level +40.3 m (+132 ft)
Water struck at +33.8 m
Shell and auger 152 mm
October 1976

Overburden 1.1 m
Mineral 3.1 m
Waste 2.3 m
Mineral 3.8 m
Waste 8.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil, brown, sandy	0.2	0.2
Till	Clay, yellow brown, soft, very sandy	0.9	1.1
Glacial Sand and Gravel	**a** 'Very clayey' gravel, sandy gravel from 2.7–3.7 m and becoming 'clayey' below 3.7 m Gravel: fine and coarse, subangular to rounded grey white sandstone and yellow and black limestones Sand: medium and coarse with fine, subangular and subrounded clear and yellow quartz with black and some white limestones Fines: yellow and brown	3.1	4.2
Till	Clay, red brown, very soft, very sandy	1.2	5.4
	Silt, brown, sandy	1.1	6.5
Glacial Sand and Gravel	**b** 'Clayey' sand Sand: medium and fine (with coarse below 8.5 m), subangular and subrounded clear quartz with some black and white limestones Fines: red brown	3.8	10.3
Till	Silt, red and brown, sandy and clayey	1.7	12.0
	Clay, grey and brown, soft to firm, laminated, very silty	6.3+	18.3

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
a	21	38	41	1.1–2.7	22	8	11	16	29	14	
				2.7–3.7	20	11	16	14	27	12	
				3.7–4.2	19	7	17	12	23	22	
				Mean	21	9	14	15	27	14	
b	14	86	0	6.5–8.5	17	31	52	0			
				8.5–10.3	10	22	62	5			
				Mean	14	27	57	2			
a + b	17	64	19	Mean	17	19	37	8	13	6	

SE 36 SE 31 3824 6148 West Field, Arkendale **Block B[1]**

Surface level +64.6 m (+212 ft)
Groundwater not encountered
Shell and auger 152 mm
September 1976

Overburden 0.7 m
Mineral 2.2 m
Waste 10.0 m
Bedrock 2.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Sand and Gravel	Soil, dark brown, sandy	0.3	0.3
Till	Clay, orange brown, very soft, very sandy	0.4	0.7
Glacial Sand and Gravel	'Very clayey' sandy gravel Gravel: coarse and fine, subangular with subrounded yellow sandstone with grey limestone and some chert Sand: fine and medium with coarse, subrounded with subangular clear quartz with some black limestone	2.2	2.9
Till	Clay, brown and orange, sandy, pebbly, with cobbles of sandstone	10.0	12.9
Middle Marl	Marl, reddish brown, clayey, sandy, very weak	2.1+	15.0

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
20	40	40	0.7–1.7	19	19	15	9	17	21	
			1.7–2.9	20	15	12	11	21	21	
		Mean	20	17	13	10	19	21	0	

SE 36 SE 32 3564 6071 North-east of Farnham **Block B[1]**

Surface level +63.1 m (+207 ft)
Groundwater not encountered
Shell and auger 152 mm
July 1976

Waste 10.1 m
Bedrock 1.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground, brown pebbly soil and cobbles	1.3	1.3
Till	Clay, brown, reddish brown, sandy, pebbly	8.8	10.1
Lower Magnesian Limestone	Limestone, creamy and grey white, thinly bedded, weak	1.3+	11.4

SE 36 SE 33 3691 6086 Ferrensby Moor, Ferrensby **Block B[1]**

Surface level +47.7 m (+156 ft)
Groundwater not encountered
Shell and auger 152 mm
September 1976

Waste 7.0 m
Bedrock 1.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial Lake Deposits	Soil, grey brown, silty, sandy and peaty	0.6	0.6
	Clay, grey, orange and brown, soft, very sandy, pebbly	1.4	2.0
Till	Clay, grey, orange and brown, firm, very pebbly	1.7	3.7
Glacial Sand and Gravel	'Very clayey' pebbly sand Gravel: fine, subrounded black limestone Sand: fine and medium with black and some white limestones Fines: yellow brown	0.8	4.5
Till	Clay, grey and brown, soft to firm, sandy and silty, pebbly	2.2	6.7
	Clay, yellowish white, very soft, silty, pebbly	0.3	7.0
Upper Magnesian Limestone	Limestone, yellowish white, weak	1.3+	8.3

GRADING

Mean for Deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
21	71	8	3.7–4.5	21	46	18	7	6	2	

SE 36 SE 34 3757 6009 South-east of Ferrensby **Block B[1]**

Surface level +55.2 m (+181 ft)
Groundwater not encountered
Shell and auger 152 mm
September 1976

Waste 13.6 m
Bedrock 3.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown, sandy and peaty	0.2	0.2
Till	Clay, grey, yellow and brown, firm to stiff, silty and sandy, pebbly	13.4	13.6
Upper Magnesian Limestone	Marl, brown and grey, calcareous, silty, very weak	0.6	14.2
	Limestone, yellow-grey white, weak	3.2+	17.4

SE 36 SE 35 3772 6090 White Crofts, Ferrensby **Block A[3]**

Surface level +46.6 m (+153 ft)
Water struck at +39.8 m
Shell and auger 152 mm
September 1976

Waste 10.6 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground, grey and brown soil and cobbles	1.0	1.0
Till	Clay, yellow and brown, very soft to firm, very sandy, pebbly	5.7	6.7
Glacial Sand and Gravel	'Clayey' gravel Gravel: coarse and fine, subrounded to angular black and white limestones and grey, white and red brown sandstones Sand: medium, coarse and fine, subangular and subrounded clear quartz with some black limestone Fines: yellow brown	1.0	7.7
	Sandy gravel Composition as for 6.7–7.7 m	0.8	8.5
Till	Clay, red brown, firm to stiff, silty	2.1	10.6
Upper Magnesian Limestone	Limestone, white grey, moderately strong	1.0+	11.6

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
9	37	54	6.7–7.7	10	8	11	9	20	39	3
			7.7–8.5	8	13	17	17	18	27	0
			Mean	9	10	14	13	19	34	1

SE 36 SE 36 3863 6018 Arkendale Moor, Arkendale **Block A[3]**

Surface level +45.8 m (+150 ft)
Water struck at +33.7 m
Shell and auger 152 mm
September 1976

Overburden 0.6 m
Mineral 4.0 m
Waste 7.5 m
Mineral 7.5 m
Bedrock 1.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, grey brown, sandy	0.6	0.6
Glacial Lake Deposits	**a** 'Very clayey' sand Sand: fine with some medium and a trace of coarse, subrounded and subangular, clear quartz with some limestone Fines: yellow brown and grey	4.0	4.6
	Clay, grey, soft to firm, laminated, very silty	0.7	5.3
Till	Clay, grey and brown, soft to stiff, sandy, pebbly	6.8	12.1
Fluvio-glacial and Older River Sand and Gravel	**b** Gravel Gravel: coarse and fine, angular to rounded black limestone and yellow and grey and white sandstones with white limestone Sand: coarse and medium with fine, subangular, clear quartz with black and some white limestones	7.5	19.6
Upper Magnesian Limestone	Limestone, green and brown with some white, weak	1.9+	21.5

GRADING

	Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
a	27	73	0	0.6–1.6	18	75	6	1			
				1.6–2.6	14	84	2	0			
				2.6–4.6	38	60	2	0			
				Mean	27	70	3	0			
b	5	36	59	12.1–14.0	7	6	8	23	25	31	
				14.0–15.0	4	4	6	14	20	52	
				15.0–17.0	Missing data						
				17.0–18.0	3	5	9	18	23	42	
				18.0–19.6	6	15	19	24	20	16	
				Mean	5	7	10	19	22	37	
a + b	13	48	39	Mean	13	29	7	12	14	25	

SE 36 SE 37 3965 6076 Hill Wood, Arkendale **Block B[1]**

Surface level +58.1 m (+191 ft)
Groundwater not encountered
Shell and auger 152 mm
September 1976

Waste 14.8 m
Bedrock 1.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground, brown soil with gravel and cobbles	1.3	1.3
Till	Clay, brown, yellow and grey, sandy, pebbly, with a silt layer from 11.5 to 12.0 m	12.0	13.3
Glacial Sand and Gravel	'Clayey' gravel Gravel: fine and coarse, subangular and subrounded black limestone and yellow and opaque sandstones Sand: coarse and medium and fine, subangular and subrounded clear quartz with some limestone Fines: brown	1.5	14.8
Sherwood Sandstone Group	Marl, red brown, thinly bedded, silty, weak–very weak	1.5+	16.3

GRADING

Mean for deposit *percentages*			Depth below surface (m)	*percentages*						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
19	37	44	13.3–14.8	19	11	13	13	22	22	

APPENDIX G

LIST OF WORKINGS

Location	*Approximate area worked*	*Grid reference*	*Operator*	*Principal deposit worked*
ACTIVE (December 1978)				
Ripon Race Course	12 ha	332 699	Ripon City Gravel Co. Ltd	Alluvium
River Ure (Givendale)	—	335 686	R. W. Potter (Boroughbridge) Ltd	Alluvium
Staveley (North)	45	362 630	R. M. C. (UK) Ltd	Fluvio-glacial Terrace Deposits
Farnham	12	347 600	Tilling Construction Services Ltd	Fluvio-glacial and Older River Sand and Gravel
ABANDONED				
Ripon	3	315 699		Glacial Sand and Gravel
Toll House	1	338 632		Glacial Sand and Gravel
Nidd	1	306 613		Glacial Sand and Gravel
Staveley (South-west)	4 & 2	360 625 & 357 624		Fluvio-glacial Terrace Deposits
Occaney	5	352 623		Fluvio-glacial Terrace Deposits
Scotton	2 12	332 600 & 337 600		Fluvio-glacial and Older River Sand and Gravel

APPENDIX H

CONVERSION TABLE, METRES TO FEET (to nearest 0.5 ft)

m	ft	m	ft	m	ft	m	ft	m	ft
0.1	0.5	6.1	20	12.1	39.5	18.1	59.5	24.1	79
0.2	0.5	6.2	20.5	12.2	40	18.2	59.5	24.2	79.5
0.3	1	6.3	20.5	12.3	40.5	18.3	60	24.3	79.5
0.4	1.5	6.4	21	12.4	40.5	18.4	60.5	24.4	80
0.5	1.5	6.5	21.5	12.5	41	18.5	60.5	24.5	80.5
0.6	2	6.6	21.5	12.6	41.5	18.6	61	24.6	80.5
0.7	2.5	6.7	22	12.7	41.5	18.7	61.5	24.7	81
0.8	2.5	6.8	22.5	12.8	42	18.8	61.5	24.8	81.5
0.9	3	6.9	22.5	12.9	42.5	18.9	62	24.9	81.8
1.0	3.5	7.0	23	13.0	42.5	19.0	62.5	25.0	82
1.1	3.5	7.1	23.5	13.1	43	19.1	62.5	25.1	82.5
1.2	4	7.2	23.5	13.2	43.5	19.2	63	25.2	82.5
1.3	4.5	7.3	24	13.3	43.5	19.3	63.5	25.3	83
1.4	4.5	7.4	24.5	13.4	44	19.4	63.5	25.4	83.5
1.5	5	7.5	24.5	13.5	44.5	19.5	64	25.5	83.5
1.6	5	7.6	25	13.6	44.5	19.6	64.5	25.6	84
1.7	5.5	7.7	25.5	13.7	45	19.7	64.5	25.7	84.5
1.8	6	7.8	25.5	13.8	45.5	19.8	65	25.8	84.5
1.9	6	7.9	26	13.9	45.5	19.9	65.5	25.9	85
2.0	6.5	8.0	26	14.0	46	20.0	65.5	26.0	85.5
2.1	7	8.1	26.5	14.1	46.5	20.1	66	26.1	85.5
2.2	7	8.2	27	14.2	46.5	20.2	66.5	26.2	86
2.3	7.5	8.3	27	14.3	47	20.3	66.5	26.3	86.5
2.4	8	8.4	27.5	14.4	47	20.4	67	26.4	86.5
2.5	8	8.5	28	14.5	47.5	20.5	67.5	26.5	87
2.6	8.5	8.6	28	14.6	48	20.6	67.5	26.6	87.5
2.7	9	8.7	28.5	14.7	48	20.7	68	26.7	87.5
2.8	9	8.8	29	14.8	48.5	20.8	68	26.8	88
2.9	9.5	8.9	29	14.9	49	20.9	68.5	26.9	88.5
3.0	10	9.0	29.5	15.0	49	21.0	69	27.0	88.5
3.1	10	9.1	30	15.1	49.5	21.1	69	27.1	89
3.2	10.5	9.2	30	15.2	50	21.2	69.5	27.2	89
3.3	11	9.3	30.5	15.3	50	21.3	70	27.3	89.5
3.4	11	9.4	31	15.4	50.5	21.4	70	27.4	90
3.5	11.5	9.5	31	15.5	51	21.5	70.5	27.5	90
3.6	12	9.6	31.5	15.6	51	21.6	71	27.6	90.5
3.7	12	9.7	32	15.7	51.5	21.7	71	27.7	91
3.8	12.5	9.8	32	15.8	52	21.8	71.5	27.8	91
3.9	13	9.9	32.5	15.9	52	21.9	72	27.9	91.5
4.0	13	10.0	33	16.0	52.5	22.0	72	28.0	92
4.1	13.5	10.1	33	16.1	53	22.1	72.5	28.1	92
4.2	14	10.2	33.5	16.2	53	22.2	73	28.2	92.5
4.3	14	10.3	34	16.3	53.5	22.3	73	28.3	93
4.4	14.5	10.4	34	16.4	54	22.4	73.5	28.4	93
4.5	15	10.5	34.5	16.5	54	22.5	74	28.5	93.5
4.6	15	10.6	35	16.6	54.5	22.6	74	28.6	94
4.7	15.5	10.7	35	16.7	55	22.7	74.5	28.7	94
4.8	15.5	10.8	35.5	16.8	55	22.8	75	28.8	94.5
4.9	16	10.9	36	16.9	55.5	22.9	75	28.9	95
5.0	16.5	11.0	36	17.0	56	23.0	75.5	29.0	95
5.1	17	11.1	36.5	17.1	56	23.1	76	29.1	95.5
5.2	17	11.2	36.5	17.2	56.5	23.2	76	29.2	96
5.3	17.5	11.3	37	17.3	57	23.3	76.5	29.3	96
5.4	17.5	11.4	37.5	17.4	57	23.4	77	29.4	96.5
5.5	18	11.5	37.5	17.5	57.5	23.5	77	29.5	97
5.6	18.5	11.6	38	17.6	57.5	23.6	77.5	29.6	97
5.7	18.5	11.7	38.5	17.7	58	23.7	78	29.7	97.5
5.8	19	11.8	38.5	17.8	58.5	23.8	78	29.8	98
5.9	19.5	11.9	39	17.9	58.5	23.9	78.5	29.9	98
6.0	19.5	12.0	39.5	18.0	59	24.0	78.5	30.0	98.5

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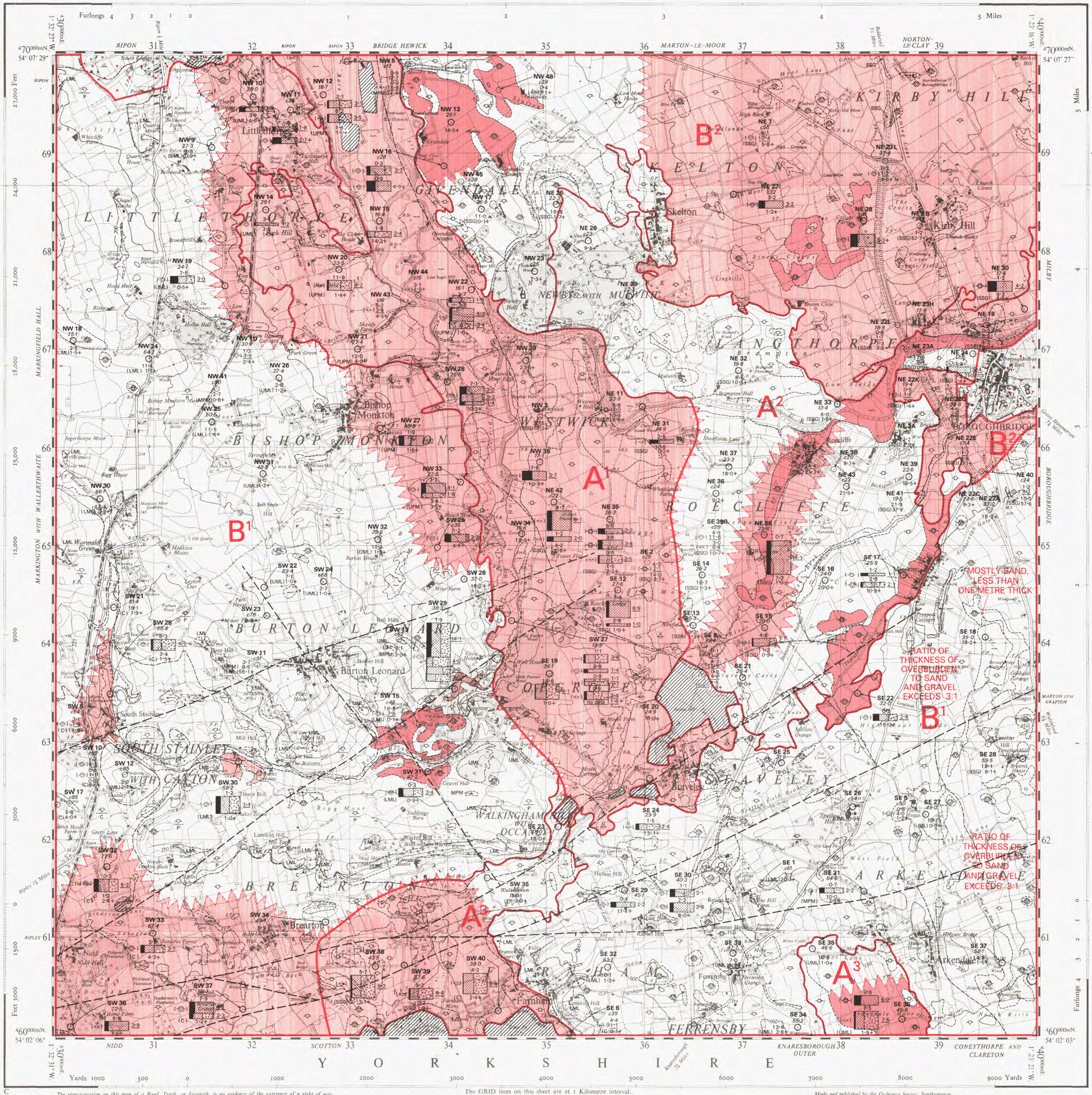
INSTITUTE OF GEOLOGICAL SCIENCES

INDUSTRIAL MINERALS ASSESSMENT UNIT

THE SAND & GRAVEL RESOURCES OF SHEET SE 36 (BOROUGHBRIDGE, NORTH YORKSHIRE)

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

ORDNANCE SURVEY
SHEET SE36
PROVISIONAL EDITION



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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

- **Peat** P-1
- **Alluvium** – mainly silty clay, gravel, and 'clayey' sand. A-52
- **Calcareous Tufa** CT-2
- **River Terrace Deposits** – mainly clay and 'clayey' sand. RT-20
- **Sand** S-3 } Glacial Lake Deposits.
- **Silt and Clay** SI-5
- **Fluvio-glacial Terrace Deposits, undifferentiated** – clay, sand and gravel. FL-8
- **Glacial Sand and Gravel** GS-17
- **Till** TL-8
- **Fluvio-glacial and Older River Sand and Gravel with associated clays** FL-9

RECENT AND PLEISTOCENE

SOLID

- SSG **Sherwood Sandstone Group** – sandstones with thin siltstones and mudstones. — TRIASSIC
- UPM **Upper Marl** – silty mudstones with gypsum, anhydrite and thin sandstones.
- UML **Upper Magnesian Limestone**
- MPM **Middle Marl** – mudstones with gypsum, anhydrite and thin limestones.
- LML **Lower Magnesian Limestone** — PERMIAN
- P **Permian (undivided)**
- C **Carboniferous (undivided)** – mudstones and sandstones. — CARBONIFEROUS

Worked-out-ground (sand and gravel) WO-4

BOUNDARY LINES

- Geological boundary, Drift.
- Geological boundary, Solid.
- Fault at surface; crossmark indicates downthrow side.
- Inferred boundary between recognised categories of deposits.
- Resource Block boundary.

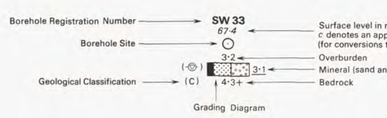
Broken lines denote uncertainty. Deposits with an area less than 0·01 sq. km. are not shown.
The Solid geology on this map is shown in a simplified form. A geological sketch map showing the divisions of the Permian is included in the Report (Figure 3).

BOREHOLE DATA

SITE LOCATIONS

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

I.M.A.U. BOREHOLES



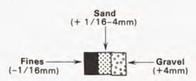
Note:
1. Figures underlined denote thicknesses used in the assessment of resources.
2. The + sign indicates that the base of the deposit was not reached.
3. The Geological Classification is given only for mineral and bedrock.

Borehole Registration Number

Each I.M.A.U. borehole is identified by a Registration Number, eg. **SW 33**. The first number and letters refer to the quarter sheet, and the second to the I.G.S. serial number for that quarter. The unique designation for borehole **SW 33** is **SE 36 SW 33**.

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 are omitted.

OTHER BOREHOLES

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

CATEGORIES OF DEPOSITS

- **Exposed mineral.** CAT-E6
- **Continuous or almost continuous spreads of mineral beneath overburden.** CAT-C1
- **Sand and gravel not assessed.** CAT-N1
- **Sand and gravel not potentially workable or absent.** CAT-A4.

RESOURCE BLOCKS

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

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

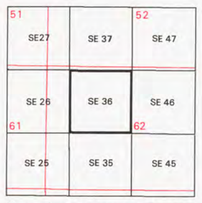


Diagram showing the relationship of this sheet to the National Grid 1:25,000 sheets and the New Series One-inch Geological Sheets 51, 52, 61 and 62

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.

Contour values are in feet

1 square inch on this map represents 99·639 acres on the ground.

Compiled from 6" sheets last fully revised 1907–32.
Other partial systematic revision 1938–51 has been incorporated.
Major roads and railways revised 1966.

Made and published by the Ordnance Survey, Southampton.
Reprinted with the addition of new major roads 1967.

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, particulary 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.

Original geological survey on the six-inch scale by C. Fox-Strangways and A.G. Cameron. Published as part of one-inch Old Series Sheet 93NW in 1874 (subsequently New Series Sheet 62).

Re-surveyed by R. Anderton, A.H. Cooper and J.S.C. Sceal between 1973 and 1978. D.R.A. Ponsford and E.G. Smith, District Geologists.

Sand and gravel survey by D.A. Abraham, B.J. Taylor, J.W.C. James, A.R. Clayton, D.F. Best, J.R. Gozzard, and R. Stanczyszyn , 1975-78 R.G. Thurrell, Head, Industrial Minerals Assessment Unit.

1:25,000 Sand and Gravel Resource Sheet published 1981.
G.M. Brown, FRS, *Director, Institute of Geological Sciences.*

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