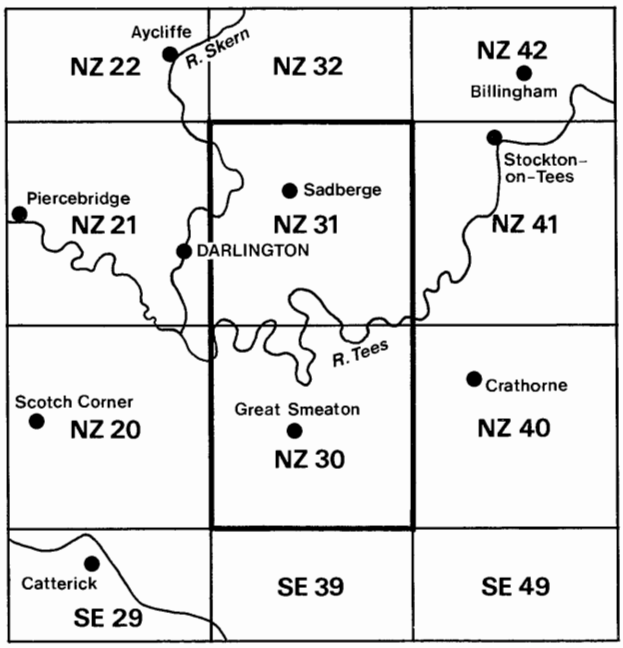
INSTITUTE OF GEOLOGICAL SCIENCES

Natural Environment Research Council

Mineral Assessment Report 111



The sand and gravel resources of the country east and south-east of Darlington, Durham

Description of 1:25 000 sheet NZ 30 and 31

J. R. Gozzard and D. Price

Contributors
J. G. O. Smart, J. W. C. James and A. Smith

ISBN 0 11 884311 7*

London Her Majesty's Stationery Office 1982

PREFACE

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

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

This report describes the sand and gravel resources of an area east and south-east of Darlington, Durham, shown on the accompanying 1:25 000 resource map NZ 31 and 30. The field work for the survey was conducted byMessrs A. Smith, J. W. C. James and R. G. Crofts. Mr J. G. O. Smart has contributed the geology section of the report and the remainder has been compiled by Messrs J. R. Gozzard and D. Price, incorporating contributions from Messrs James and Smith. The work is based on geological surveys by Institute field staff in 1967-73 and 1977-79.

Mr T. D. Hillyard (Land Agent, Property Services Agency) was responsible for negotiating access to land for drilling. The ready cooperation of landowners and tenants in this work is gratefully acknowledged.

G. M. Brown
Director

Institute of Geological Sciences
Exhibition Road
London SW7 2DE

15 October 1981

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

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

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

CONTENTS

FIGURES

MAP

TABLES

The sand and gravel resources of the country east and south-east of Darlington, Durham

Description of 1:25 000 sheet NZ 30 and 31

J. R. GOZZARD and D. PRICE

SUMMARY

The geological maps of the Institute of Geological Sciences, pre-existing borehole information, and 120 boreholes drilled for the Industrial Minerals Assessment Unit form the basis of the assessment of the sand and gravel resources of the country east and south-east of Darlington, Durham.

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

The mineral bearing ground is divided into six resource blocks, containing between 2.3 and 14.3 km^2 of potentially workable sand and gravel. For each block the geology of the deposits is described, and the mineral-bearing area, the mean thickness of overburden and mineral and the mean gradings are stated. Detailed borehole data are also given. The geology, the position of the boreholes and the outlines of the resource blocks are shown on the accompanying map.

Notes

Each borehole registered with the Institute is identified by a four-element code (e.g. NZ 30 NW 16). The first two elements define the 10-km square (of the National Grid) in which the borehole is situated; the third element defines a quadrant of that square, and the fourth is the accession number of the borehole. In the text of the report the letters NZ are normally omitted.

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

Bibliographical reference

GOZZARD, J. R. and PRICE, D. 1982. The sand and gravel resources of the country east and south-east of Darlington, Durham: Description of 1:25 000 resource sheet NZ 31 and 30. **Miner. Assess. Rep. Inst. Geol. Sci.,** No.111.

Authors and contributors

D. Price, BSc, J. W. C. James, BSc, and A Smith, BSc,
Institute of Geological Sciences,
Keyworth, Nottingham NG12 5GG.

J. R. Gozzard, BSc,
Geological Survey (Department of Mines),
Perth, W. Australia.

J. G. O. Smart, BSc,
Institute of Geological Sciences,
Windsor Terrace,
Newcastle-upon-Tyne.

INTRODUCTION

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

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

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

a The deposit should average at least 1 m in thickness.
b The ratio of overburden to sand and gravel should be no more than 3:1.
c The proportion of fines (particles passing a 0.063 mm B.S. sieve, about $\frac{1}{16}$ mm) should not exceed 40 per cent.
d The deposit should lie within 25 m of the surface, this being taken as the likely maximum working depth under most circumstances. It follows from the second criterion that boreholes are drilled no deeper than 18 m if no sand and gravel has been proved.

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

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

For the particular needs of assessing sand and gravel resources, a grain-size classification based on the geometric scale $\frac{1}{16}$ mm, $\frac{1}{4}$ mm, 1 mm, 4 mm, 16 mm, 64 mm has been adopted. The boundaries between fines (that is,

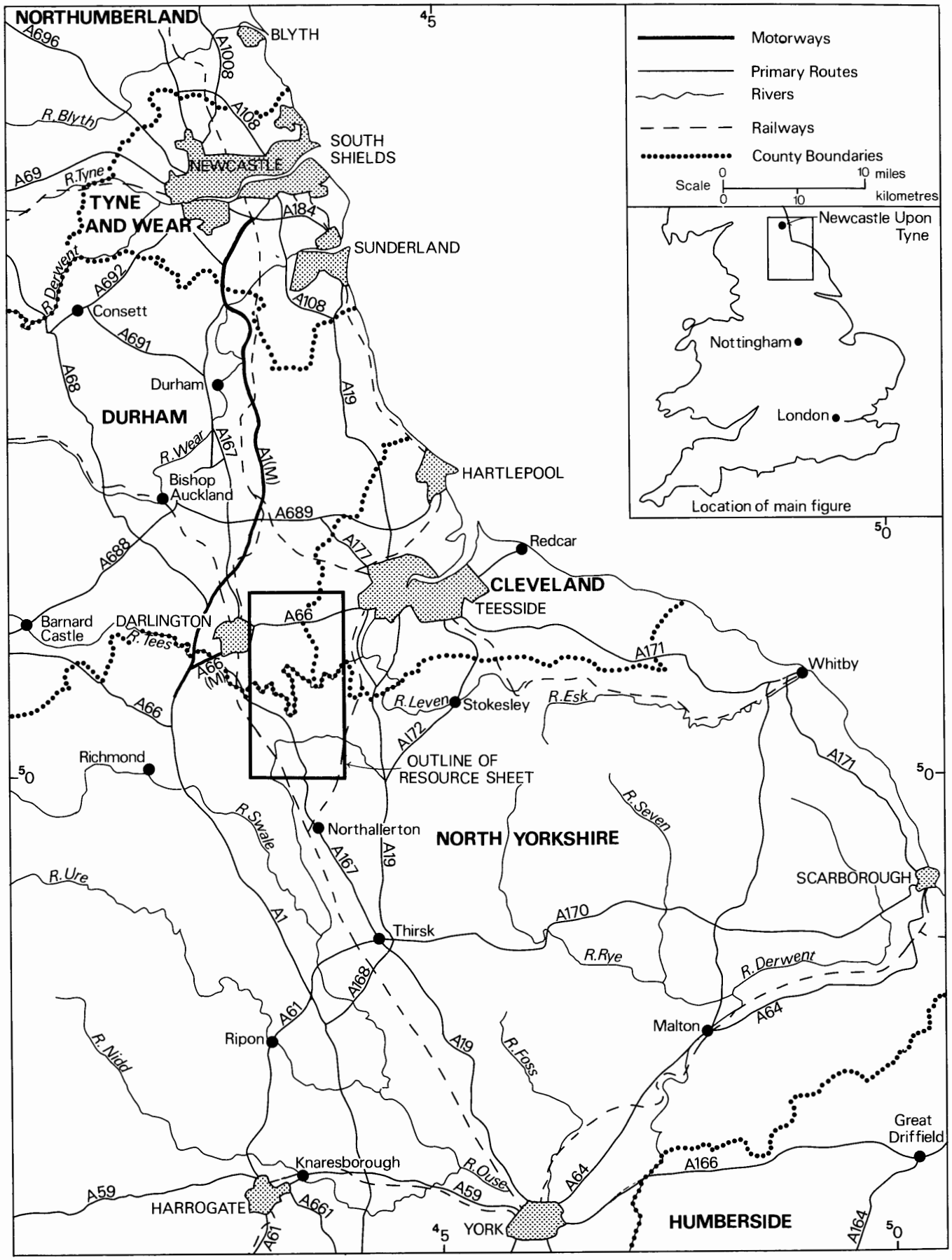


Figure 1 Sketch map showing the locations of the district.

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 or land of high agricultural or landscape value, which might stand in the way of sand and gravel being exploited, although towns are excluded. The estimated total volume therefore bears no simple relationship to the amount that could be extracted in practice.

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

DESCRIPTION OF THE DISRICT

General

The district (Figure 1) lies to the east and south-east of Darlington, forming parts of the counties of Durham, North Yorkshire and Cleveland. It is for the most part an area of mixed farming but Darlington provides a focus for light industry. Sand and gravel is worked in the valley of the River Skerne and a brick works at Skip Bridge [314 113] utilises local material.

The district is one of moderate relief, falling from about 85 m above OD in the north-west and south-east to about 7 m above OD along the lower reaches of the River Tees. The Tees flows towards the east in a series of pronounced meander loops and is tidal to near Holme Farm [384 102]. The River Skerne drains the north-west of the district and joins the Tees south of Darlington.

The main 'east coast' railway crosses the district, as does the rail link between Darlington and Middlesbrough. The A1 trunk road and the A1(M) motorway lie a few miles to the west. Teesside Airport is situated at Middleton St George.

Geology

The geological sequence is summarised in Table 1, where deposits are listed as far as possible in order of increasing age, and described briefly below.

Table 1 Geological sequence.

DRIFT	
Recent and Pleistocene	Landslip
	Foundered Ground
	Lacustrine Alluvium
	Alluvium and Alluvial Cone
	River Terraces, undifferentiated
	Calcareous Tufa
	Head
	Glacial Lake Deposits
	Laminated Clay
	Till (Boulder Clay)
	Glacial Sand and Gravel
SOLID	
Tertiary (Intrusive)	Cleveland Dyke
Triassic	Mercia Mudstone (Keuper Marl)
	Sherwood (Bunter) Sandstone
Permian	Permian Upper Marls
	Upper Magnesian Limestone
	Permian Middle Marls
	Middle Magnesian Limestone

Solid

The solid rocks are known from a few boreholes only and from small exposures in the banks of the River Tees. The strata dip gently eastwards with minor folding and faulting. Both the Middle Magnesian Limestone and the Permian Middle Marls vary in thickness due to local variations in sedimentation. Anhydrite in the Permian Marls is hydrated to gypsum near crop and partially dissolved with the development of solution -collapse hollows in the overlying strata and drift.

The base of the Triassic cannot be identified in this district, but is taken to lie about the bottom of the Sherwood Sandstone some 50 m above the base of the Permian Upper Marl, where red mudstones with thin sandstones grade up into red sandstones with thin mudstones.

Permian The Middle Magnesian Limestone crops out beneath drift in the north-west corner of the district and comprises up to 60 m of pale grey to pale buff dolomite, oolitic in places and with abundant patches of anhydrite. The succeeding Permian Middle Marls consist of reddish brown mudstones and siltstones with anhydrite (hydrated near crop) and some dolomite and are about 30 m thick.

The Upper Magnesian Limestone (Seaham Beds), about 20 m thick, comprises pale buff, flaggy, cross-bedded dolomite with *Schizodus obscurus*, *Liebea squamosa* and *Calcinema permiana*, and with small patches of anhydrite. The overlying Permian Upper Marls have at their base the Billingham Main Anhydrite, which is about 8 m thick but is hydrated and dissolved towards crop. The marls are red mudstones with thin sandstone partings which become thicker upwards in the sequence until, about 50 m above the base, the rock is more sandstone than mudstone and passes upwards into the Sherwood Sandstone.

Triassic The Sherwood Sandstone (Bunter Sandstone) consists for the most part of reddish brown, fine-grained sandstone with very thin mudstone partings. It is some 250 m thick. Small exposures are present in the banks of the Tees, for example at Fish Lock [3520 0983].

The Mercia Mudstone (Keuper Marl) consists of red and greenish grey mudstone and silty mudstone; only the lowest 120 m (approximately) of the sequence are present.

Tertiary (Intrusive) The Cleveland Dyke of tholeiitic dolerite is about 25 m wide and nearly vertical. It crops out in the east but does not appear to reach rockhead elsewhere in this district, being next known at crop some 5 km to the west.

Drift

Glacial deposits, which cover almost the whole district, are the product of a late-Devensian ice sheet which melted somewhat before 12,000 years ago. The deposits are 30 to 70 m thick except where removed by erosion in the Tees valley. Several pre-glacial drift-filled valleys cross the district, the most notable being an easterly-trending valley in the north and an east-north-east-trending valley crossing the middle of the district. These valleys unite near the north-east corner, rockhead here descending to 18 m below sea level.

Glacial Till and Glacial Sand and Gravel There is no general sequence in the glacial deposits, although in most areas the lowest deposit is a grey lodgement till with many large Carboniferous limestone erratics, and the highest deposit is a relatively stoneless flow till. The bulk of the tills contain some interbedded sands and laminated clays. Sands of any thickness or continuity are confined to a belt in the north-west, running from north of Barmpton to Neasham. It seems likely that the River Skerne (entering the district in the north-west) is a

direct descendant of an original glacial meltwater stream, and the associated sands were deposited by this river at and beyond the ice edge as the ice sheet melted back. The sand thins out quite rapidly east of a line through Sadberge and Neasham Hill [332 104]. West of a line through Haughton le Skern and Neasham Springs [321 104] it also thins out, and appears to pass beneath laminated clay which is and has been quarried for brick clay in several places. The north-south continuity of the sand may be interrupted between Sadberge Hall [3413 1574] and Red Hall [3100 1563]. A noteworthy feature of the sand, in places, is its variability in grade and bedding, both horizontally and vertically. In the remaining parts of the district sands are apparently haphazardly disposed within till and are best exposed in Girsby Scar [3553 0809]. Gravel is locally associated with them, as in Eyrholme Scar [3161 0905]. Glacial Sand and Gravel mapped north-east of East Cowton is partially overlain by the adjacent Glacial Lake Deposits and may be en-glacial or outwash deposits.

Till is generally reddish brown near surface but darker brown at depth. It consists mostly of massive, partly silty, variably stony clay. Erratics, the content of which in general increases with depth, are usually smaller than 10 mm in size. Carboniferous sandstone and limestone and Permian limestone and dolomite predominate but also present are mudstone, siltstone, quartz, coal, greywacke, red Permo-Triassic sandstone and, less commonly, igneous rocks from the Cheviots, Scotland and the Lake District. The best exposure of till is in Rockcliffe Scar [3134 0860].

Laminated Clay Bluish grey, sometimes reddish clay with fine silt laminae, probably deposited in a sub-glacial lake, has a wide distribution north of the Tees where it can be covered by thin sand and superficial till.

Glacial Lake Deposits Partly laminated silts, sands and clays fill a broad valley north-east of East Cowton and lap onto adjacent gravel and till.

Head Head is a clayey solifluction deposit resembling flow till which has been mapped in some valleys near Ketton, in the north-west corner of the district.

Calcareous Tufa Calcareous deposits precipitated around some springs, notably Spa Wells [3493 1025] and Rock Well [3004 1628] have been mapped as Calcareous Tufa.

River Terraces, undifferentiated The broad terrace deposits of the Tees tend to be thin (maximum thickness 4.5 m) and have variable lithology from coarse gravel to 'clayey' sand. There are at least four separate levels of terrace deposits above the level of the alluvium.

There are small areas of terrace at Great Burdon, Haughton le Skern and along the Wiske and its tributary, north-east of East Cowton. The terrace deposits south of the Tees tend to be 'clayey' sand and 'clayey' gravel. Other terrace deposits bordering Lacustrine Alluvium are composed of clays.

Alluvium and Alluvial Cone The alluvium is generally clayey silt in the upper part with sand and gravel below; the whole may reach 5 m in thickness. A narrow belt of alluvium borders the Skerne and in its upper layers in places it is black with coal dust from colliery washeries and tips.

Where the debris carried by tributary streams is dumped at the union with major rivers the resultant mound of alluvium is mapped, on morphological grounds, as Alluvial Cone.

Lacustrine Alluvium Lake deposits comprising a variable suite of sands, clays, peat and shell-marl partially infill hollows on the surface of the glacial deposits which have been left by the ice or which have collapsed because evaporites in the underlying solid rocks have been dissolved.

Foundered Ground Small areas of foundered ground have been mapped. These are depressions caused by solution of gypsum in the underlying Permian rocks with subsequent collapse.

Landslip Steep valley sides, especially where the rivers are undercutting glacial deposits, are subject to landslip.

Composition of the sand and gravel deposits

The potentially workable deposits within the district consist of glacial sand and gravel, river terrace deposits and possibly some alluvium. Details of grading and composition are given in Figures 2 to 8, Tables 2 to 8 and in Appendix E; they are summarised below.

Glacial Sand and Gravel These deposits most commonly consist of 'clayey' to 'very clayey' sands (Appendix C), with silt and clay content ranging up to 30 per cent. Gravel is present in amounts exceeding a few per cent only in areas north-east of Darlington, west of Great Smeaton and, as recorded in a single borehole, east of Little Smeaton; in these areas up to 57 per cent has been recorded.

The sand fraction is generally fine-grained but where appreciable amounts of gravel are present it tends to be medium-grained and may include a high proportion of coarse grade. Quartz predominates in the finer sands but lithic fragments are common in the coarser types. Where represented, the gravel fraction is fine- to coarse-grained and in places it includes some cobbles. Carboniferous sandstone pebbles are most common, accounting for up to 60 per cent of the fraction, and Carboniferous limestone ranges up to 35 per cent. Subordinate rock types which generally each make up less than 10 per cent of the fraction include Permian dolomites and dolomitic limestones, quartzite, igneous rocks and chert. Ironstone and quartz comprise less than 5 per cent and mudstone, siltstone and coal usually less than one per cent.

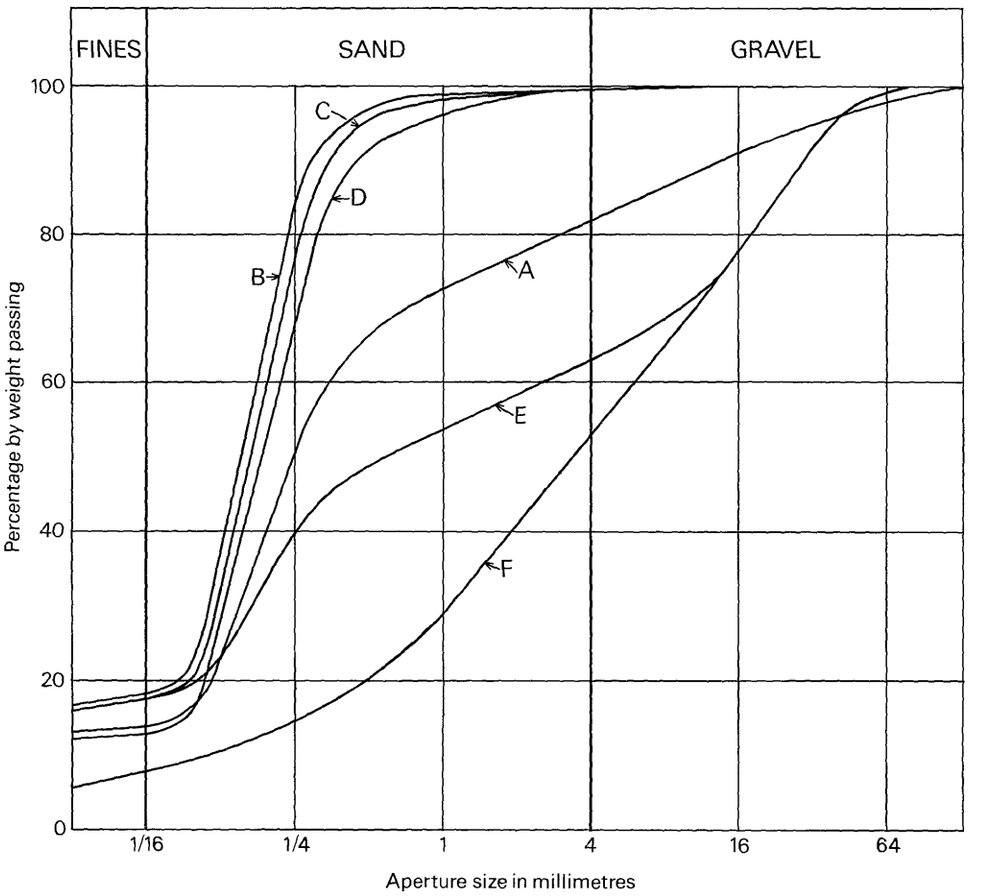
River Terrace Deposits and Alluvium Samples from these deposits have a mean grading of 16 per cent fines, 39 per cent sand and 45 per cent gravel. Fines content in four of the boreholes drilled for the assessment was low, averaging 7 per cent but in the other five exceeded 18 per cent - possibly due to the presence of thin waste partings. Mean gravel content of individual boreholes ranges from 14 to 80 per cent and generally exceeds 40 per cent.

The sand fraction is fine- to medium-grained but up to a third of it may fall in the coarse grade. The gravel is fine to coarse with some cobbles. The deposits have a lithological composition similar to that of the glacial sands and gravels except that they tend to contain less dolomite and slightly more quartzite and chert. The components are generally more rounded than those in the glacial deposits.

The Map

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

Geological data The geological boundary lines, symbols, etc., shown are taken from the geological map of this area, which was surveyed recently at the scale of 1:10 000. This information was obtained by detailed application of field mapping techniques by the Institute's field staff. The geological boundaries are the best interpretation of the information available at the time of survey. However, it is inevitable that local



Block	Percentage by weight passing					
	$\frac{1}{16}$ mm	$\frac{1}{4}$ mm	1 mm	4 mm	16 mm	64 mm
A	14	50	73	82	91	98
B	18	84	99	100	100	
C	17	76	98	99	100	100
D	13	67	96	99	100	
E	18	40	54	63	78	99
F	8	15	29	54	78	98

Figure 2 Mean particle-size distributions for the assessed mineral in the resource blocks.

Table 2 The sand and gravel resources of the district.

Block	Area		Mean thickness			Volume of sand and gravel			Mean grading percentage		
	Block	Mineral	Over-burden	Mineral	Waste		Limits at the 95% probability level		Fines $-\frac{1}{16}$ mm	Sand $+\frac{1}{16}-4$ mm	Gravel +4 mm
	km^2	km^2	m	m	m	$m^3 \times 10^6$	± %	± $m^3 \times 10^6$			
A	13.4	12.8	5.0	9.2	1.8	118	58	68	14	68	18
B	14.4	14.3	4.3	7.8	2.1	112	57	64	18	81	1
C	13.5	12.9	6.0	11.9	1.5	154	36	55	17	82	1
D	13.3	11.5	5.5	3.2	nil	37	22	8	13	86	1
E	16.4	13.5	1.4	2.3	0.3	31	38	12	18	45	37
F	87.4	2.3	1.4	3.5	nil	8	Speculative		8	45	47
A-F	158.4	67.3	4.3	6.8	1.1	460	25	115	16	75	9

irregularities and discrepancies will be revealed as new evidence from boreholes and excavations becomes available.

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

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

Areas where bedrock crops out, where boreholes indicate absence of sand and gravel beneath cover and where sand and gravel beneath cover is interpreted to be not potentially workable, are uncoloured on the map; where appropriate, the relevant criterion is noted. In such cases it has been assumed that mineral is absent except in infrequent and relatively minor patches that can neither be outlined nor assessed quantitatively in the context of this survey. Areas of unassessed sand and gravel, for example in built-up areas, are indicated by a red stipple.

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

Results

The statistical results are summarised in Table 2. Fuller grading particulars are shown in Figures 2 to 8 and Tables 3 to 8.

Accuracy of results For the five blocks assessed statistically, the accuracy of the results at the 95 per cent probability level (that is, on average nineteen out of every twenty sets of limits constructed in this way contain the true value for the volume of mineral) varies between 22 per cent and 58 per cent (Appendix B). However, the true volumes are more likely to be nearer the figures estimated than either of the limits. Moreover, it is probable that roughly the same percentage limits would apply for the statistical estimate of mineral volume within a very much smaller parcel of ground (say 100 hectares) containing similar sand and gravel deposits, if the results from the same number of sample points (as provided by, say, ten boreholes) were used in the calculation. Thus, if closer limits are needed for quotation of reserves, data from more sample points would be required, even if the area were quite small. This point can be illustrated by considering the whole of the potentially workable sand and gravel in the district. The total volume (460 million m^3) can be estimated to limits of $\pm$ 25 per cent at the 95 per cent probability level by a calculation based on the data from the 58 sample points spread across the six resource blocks. However, it must be emphasised that the quoted volume of mineral has no simple relationship with the amount that could be extracted in practice, as no allowance has been made in the calculations for any restraints (such as existing buildings and roads) on the use of the land for mineral working.

Notes on the resource blocks

Boreholes in an area around Elton, Long Newton and Middleton St George and in a narrow strip extending to the Tees valley at Sockburn found sand and gravel to be absent or too thin or deeply buried to be potentially workable; this area is not included in any resource block. The remaining ground, excluding the Darlington urban area, is divided between six blocks. Block A, to the north and east of Darlington, encompasses glacial sand and gravel, partly 'exposed', together with minor amounts of fluvial mineral, and in places yields a high proportion of gravel. The mineral of blocks B, C and D consists almost entirely of glacial 'clayey' to 'very clayey' sand which is largely buried beneath overburden and is thus of uncertain extent. Block E includes the fluvial sand and gravel of the Tees valley. Block F comprises a large area south of the Tees valley which is largely devoid of sand and gravel.

Block A (Table 3, Figure 3)

This block occupies the north-west corner of the district. Mineral is present mainly in the Glacial Sand and Gravel

Table 3 Block A: data from IMAU boreholes and section.

Borehole or section	Recorded thickness (m)			Mean grading percentage						
	Over-burden	Mineral	Waste*	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$ -1 mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 -64 mm	Cobbles +64 mm
31 NW 17	3.4	8.2	9.8	29	47	12	5	5	2	0
31 NW 18	18.0	6.2		27	52	20	1	0	0	0
31 NW 19	0.6	7.6	0.2	15	41	24	6	5	7	2
31 NW 21		Absent								
31 NW 22	1.8	23.2		15	53	30	1	0		0
31 NW 23		Absent								
31 NW 24	7.5	16.0	1.5	18	52	25	2	1	2	0
31 NW 25	8.3	5.4		10	8	17	18	24	19	4
31 NW 26	2.9	1.2		10	13	9	14	26	28	0
31 NW 27	2.2	8.0	9.7	19	61	10	3	3	4	0
31 NW 29	0.7	9.1		10	19	33	13	11	13	1
E31 NW 1	2.0	24.0+		3	5	22	25	23	15	7

* Between mineral deposits

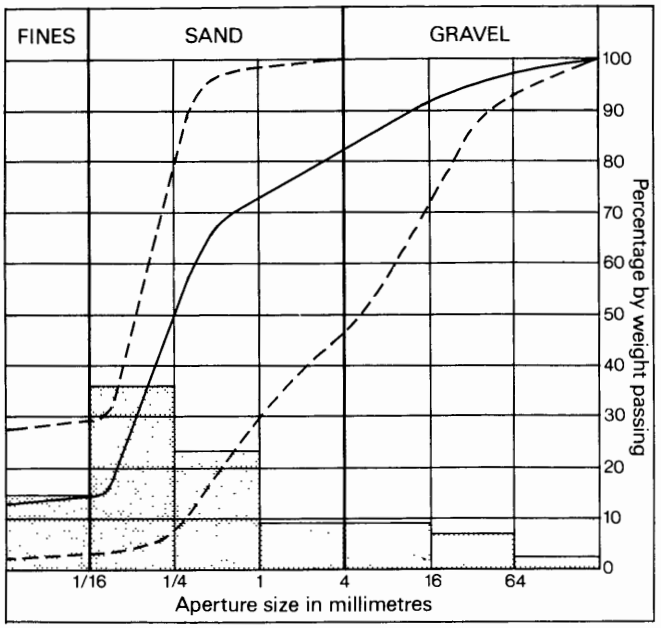


Figure 3 Grading characteristics of the mineral in Block A. (The continuous line is the cumulative frequency curve of the mean grading of the block as a whole: the broken lines denote the envelope within which the mean grading curves for individual boreholes fall. The mean grading of the block is also shown as a histogram.)

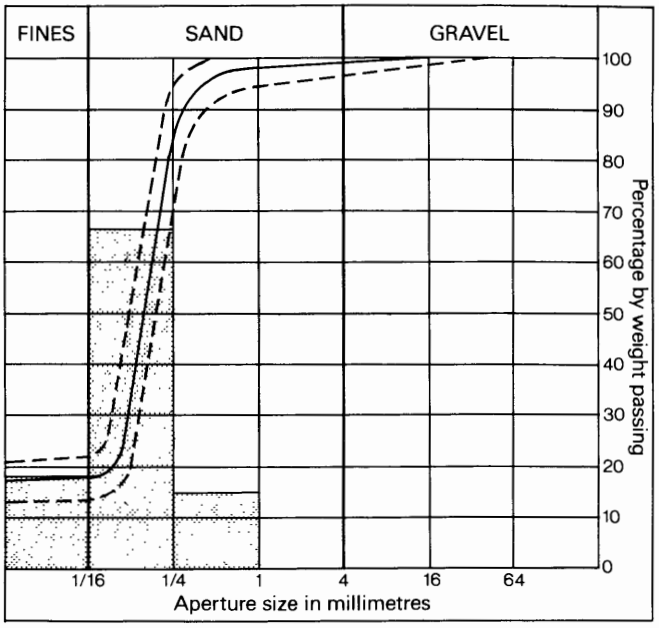


Figure 4 Grading characteristics of the mineral in Block B (for explanation see Figure 3).

but is also found in river terrace deposits associated with the River Skerne.

The estimated volume of mineral in the block is 118 million m^3 ±58 per cent, the broad confidence limits being an indication of the variability in thickness of the sand and gravel. Within the glacial deposits this variability may be illustrated by reference to the gravel pit at Barmpton and boreholes in the surrounding area. A section (E31 NW 1) showed, in 1977, 24.0 m of workable sand and gravel but boreholes 31 NW 21, 25 and 26, all less than a kilometre distant, found only 0.7 m, 5.4 m and 1.2 m of mineral respectively. Gravel content is equally variable: the section in the pit yielded 45 per cent of gravel but a borehole (31 NW 22) a kilometre to the north-east proved 23.2 m of 'clayey' sand. In the south-western part of the block the gravel content of the glacial sand and gravel is generally high but elsewhere it is up to 8 per cent. Where gravel is sparse, the fines content is usually high.

River terrace deposits, of limited extent, have been investigated by only one borehole (31 NW 29); it found 9.1 m of mineral with a mean grading of 10 per cent fines, 65 per cent sand and 25 per cent gravel.

Much of the mineral is concealed beneath overburden, largely till, ranging up to 18 m in thickness but commonly not exceeding 3.4 m. Thick partings of till separate mineral deposits in boreholes 31 NW 17 and 27.

Block B (Table 4, Figure 4)

The mineral of this block lies exclusively within the Glacial Sand and Gravel. It consists almost entirely of 'clayey' to 'very clayey' sand, although thin pebbly bands were found in boreholes 31 NE 11 and 17. IMAU boreholes 31 NE 12 and 31 NW 20 and three confidential commercial boreholes encountered no potentially workable sand and gravel. The areas of barren ground cannot be delineated but are probably small; the findings of these boreholes are taken into account in assessing the resources. Elsewhere, proved mineral thicknesses range up to 20.5 m (in a commercial borehole) although a number of IMAU bores had to be abandoned because of difficult ground conditions before penetrating the full

Table 4 Block B: data from IMAU boreholes.

Borehole	Recorded thickness (m)			Mean grading percentage					
	Over-burden	Mineral	Waste*	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$ -1 mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 mm
31 NW 20		Absent							
31 NW 28	3.9	8.0	0.5	21	47	28	3	1	0
31 NW 30	0.8	15.3	2.1	17	64	18	1	0	0
31 NW 31	3.8	15.7		18	77	5	0	0	0
31 NE 11	13.2	8.1+		13	60	24	1	1	1
31 NE 12		Absent							
31 NE 13	11.4	11.6	2.0	20	73	7	0	0	0
31 NE 15	2.5	1.9		16	54	29	1	0	0
31 NE 17	1.6	5.8+	11.8	23	61	11	2	2	1

* Between mineral deposits.

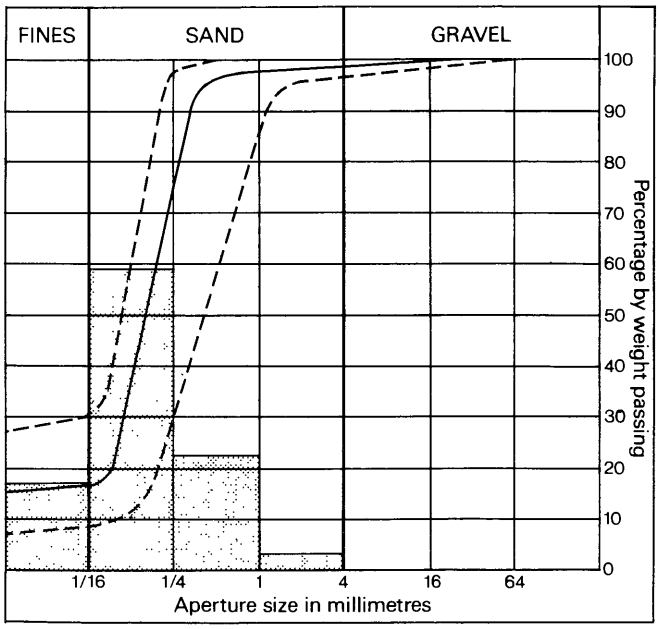


Figure 5 Grading characteristics of the mineral in Block C (for explanations see Figure 3).

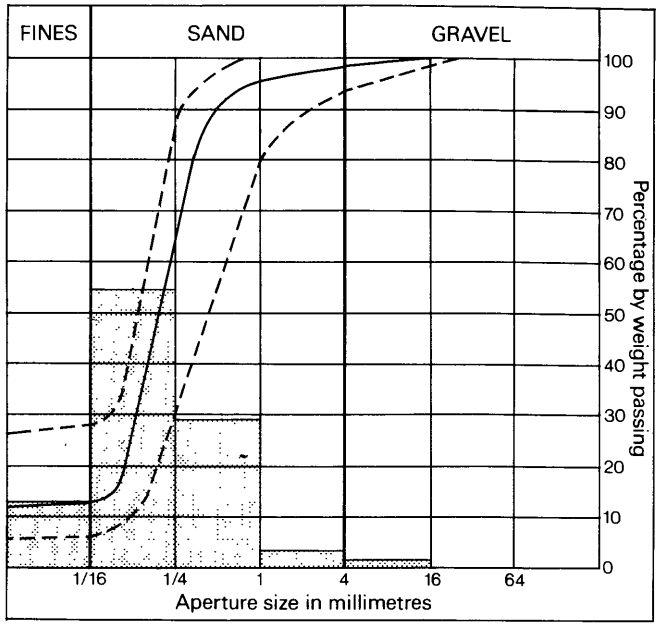


Figure 6 Grading characteristics of the mineral in Block D (for explanation see Figure 3).

thickness of potentially workable material. The mean proved mineral thickness for the block is 7.8 m. Mineral volume is estimated at 112 million m^3 ± 57 per cent and mean grading as 18 per cent fines, 81 per cent sand and one per cent gravel.

Overburden, almost entirely till or lacustrine alluvium, conceals most of the mineral; it ranges up to 13.2 m and has a mean proved thickness of 4.6 m. A number of boreholes found silt or clay partings (exceptionally 11.8 m thick in borehole 31 NE 17) between mineral deposits. The mean thickness of such partings for the block as a whole is about 1.9 m.

Block C (Table 5, Figure 5)
Mineral of this block, again, lies entirely within the Glacial Sand and Gravel. It consists, for the most part of 'clayey' to 'very clayey' fine sand but medium sand predominates in places. The highest part of the mineral in borehole 31 SW 10 and the lowest part in borehole 31 SW 11 yielded 19 per cent and 11 per cent of gravel respectively. Boreholes 31 SW 15 and 20 found no sand and gravel; barren areas around these holes cannot be delineated but 'nil' values have been incorporated in the statistical assessment. Sand and gravel found in borehole 31 SW 21 was too deeply buried to be potentially workable and a small barren area around the site is inferred.

Elsewhere proved mineral thicknesses range up to 20.8 m, giving a mean for the block of 11.9 m. The estimated mineral volume is 154 million m^3 ± 36 per cent and the mean grading 17 per cent fines, 82 per cent sand and one per cent gravel.

Sand crops out in the sides of the valleys of the Tees and its tributary Neasham Stell but is generally buried beneath overburden, largely till, up to 7.6 m having been proved by boreholes. Partings of silt, up to 3 m thick, occur between mineral in places and the mean thickness of waste partings for the block is 1.5 m.

Block D (Table 6, Figure 6)
This block, which is divided into two parts by block E, encompasses glacial sand bordering the Tees valley downstream from Sockburn and along the eastern margin of the district around Aislaby. For the most part, mineral comprises 'clayey', mainly fine sand although some boreholes have found minor amounts of gravel. The mineral is generally thinner and less variable than in blocks B and C, ranging from 2.0 m to 4.4 m. Exceptionally, the log of a water bore (30 NE 7) at Girsby Green Farm records a total of 11.9 m of potentially workable material but in view of its doubtful reliability, this record is not taken into account in the assessment. The estimated volume of mineral present is

Table 5 Block C: data from IMAU boreholes.

Borehole	Recorded thickness (m)			Mean grading percentage					
	Over-burden	Mineral	Waste*	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$ -1 mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 mm
31 SW 10	4.2	20.8+		16	58	23	2	1	0
31 SW 11	7.6	10.3	4.0	16	46	31	4	2	1
31 SW 12	7.5	17.5		9	60	29	1	1	0
31 SW 13	5.0	14.0		13	49	36	2	trace	trace
31 SW 16	5.0	14.0	5.0	22	69	8	1	0	0
31 SW 17	4.5	15.0	5.0	30	69	1	0	0	0
31 SW 19	2.3	2.0		10	21	55	11	3	0
31 SW 21		Absent							

*Between mineral deposits

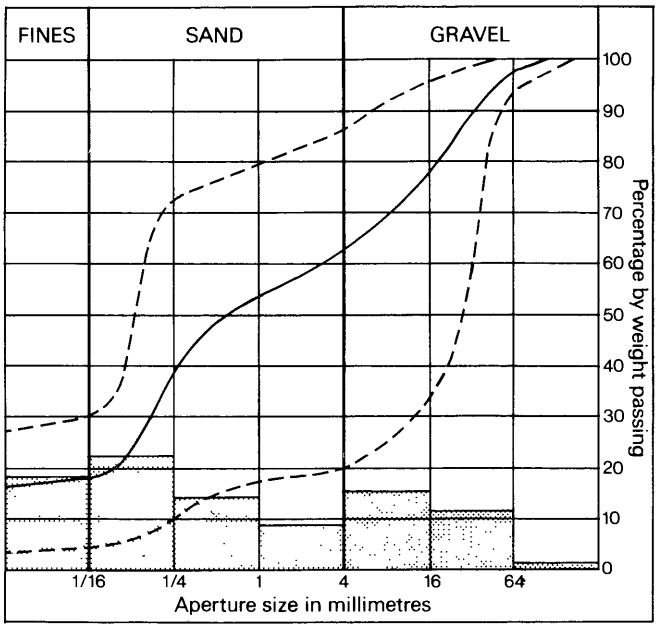


Figure 7 Grading characteristics of the mineral in Block E (for explanation see Figure 3).

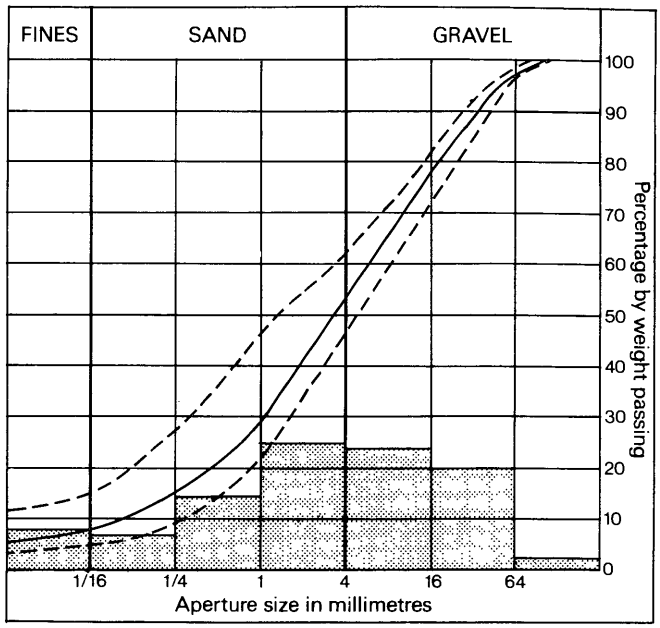


Figure 8 Grading characteristics of the assessed mineral in Block F (for explanation see Figure 3).

37 million m^3 ± 22 per cent and its mean grading, based on IMAU boreholes, 13 per cent fines, 86 per cent sand one per cent gravel.

As shown on the resource map, mineral crops out in the steep sides of the Tees valley and its tributaries but elsewhere lies beneath overburden of till which is up to at least 12.6 m thick.

Block E (Table 7, Figure 7)

This block encompasses the fluvial sediments of the Tees valley and includes mineral-bearing river terrace deposits. The latter may underlie alluvium but downstream from Middleton One Row, alluvial clays and silts in places rest directly on till or laminated clay. It is thought that, hereabouts, terrace deposits are absent or thin beneath alluvium, as in borehole 31 SE 25. To avoid any possibility of an over-optimistic assessment of resources, the alluvium-covered parts of this stretch of the valley are assumed to be barren except in the extreme east around borehole 31 SE 27. Borehole 31 SE 20, sited on a river terrace near Over Dinsdale Grange, found only thin sand and silt which is regarded as not potentially workable and, although the barren ground cannot be outlined, this finding is taken into account in assessing the resources.

The terrace deposits generally range up to 2.8 m in thickness and consist of partly 'clayey' gravel, sandy gravel and pebbly sand. However, borehole 30 NE 18 found 2.6 m of 'very clayey' sand on 1.2 m of sandy gravel. The deposits have a mean proved thickness of 2.1 m and a mean grading of 16 per cent fines, 44 per cent sand and 40 per cent gravel.

Potentially workable glacial sand and gravel was proved by 2 boreholes, 30 NE 14 and 31 SE 27, consisting of 1.0 m of 'very clayey' sand and 1.3 m of 'very clayey' sandy gravel, respectively, separated from the terrace deposits by till partings.

The total volume of mineral present in the block is estimated at 31 million m^3 ±38 per cent and its mean grading is 18 per cent fines, 45 per cent sand and 37 per cent gravel.

Where mineral is classified as 'exposed' (that is, it carries an average proved thickness of less than 1 m of overburden), overburden generally consists only of thin soil but at borehole 31 SW 24 it included clay and was 1.8 m thick. Elsewhere overburden comprises, exceptionally, up to 6.4 m of alluvial clay and silt.

Block F (Table 8, Figure 8)

This block occupies a wide area, 87.4 km^2, south of the Tees valley. It includes numerous small outcrops which might yield sand and gravel but most of them are considered to be too small to merit assessment. Of 35 IMAU boreholes drilled within the block only eight proved potentially workable sand and gravel. For the

Table 6 Block D: data from IMAU boreholes.

Borehole	Recorded thickness (m)		Mean grading percentage					
	Over-burden	Mineral	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}$ -1 mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 mm
30 NE 13	1.3	2.7	8	35	49	5	2	1
31 SE 11	7.0	3.0	6	62	32	0	0	0
31 SE 14	5.5	2.0	7	23	49	14	6	1
31 SE 15	3.5	3.0	28	58	14	0	0	0
31 SE 19	4.9	3.3	16	41	39	3	1	0
31 SE 22	12.6	4.4	15	67	15	3	0	0
31 SE 23	4.2	2.0	12	33	48	6	1	0
31 SE 24	10.4	4.3	9	78	13	0	0	0

Table 7 Block E: data from IMAU boreholes.

Borehole	Recorded thickness (m)			Mean grading percentage						
	Over-burden	Mineral	Waste*	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}-1$ mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 -64 mm	Cobbles +64 mm
30 NW 12	0.9	2.0		8	8	8	8	20	37	11
30 NW 17	0.6	3.6		8	8	14	12	27	30	1
30 NE 14	0.3	3.2	2.0	21	52	6	6	8	7	0
30 NE 18	1.5	3.8		25	36	18	7	7	6	1
31 SW 23	0.6	2.0		30	23	16	11	10	10	0
31 SW 24	1.8	2.8		4	8	27	10	25	25	1
31 SW 25	0.5	1.0		21	22	18	7	12	14	6
31 SW 26	3.0	1.8		6	4	7	3	12	68	0
31 SW 27	0.3	1.2		26	26	27	7	10	4	0
31 SE 21	0.4	1.9		18	13	18	10	19	22	0
31 SE 26		Absent								
31 SE 27	6.4	4.6	1.0	25	26	10	8	12	19	0

* Between mineral deposits

Table 8 Block F: data from IMAU boreholes proving mineral.

Borehole	Recorded thickness (m)			Mean grading percentage						
	Over-burden	Mineral	Waste*	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$ mm	Medium sand $+\frac{1}{4}-1$ mm	Coarse sand +1 -4 mm	Fine gravel +4 -16 mm	Coarse gravel +16 -64 mm	Cobbles +64 mm
30 NW 14	3.5	1.5		13	73	14	0	0	0	0
30 NW 19	0.3	6.0		20	53	24	1	1	1	0
30 NE 24	6.2	17.9+	0.9	21	52	26	1	trace	0	0
30 SW 16	0.3	6.2		5	6	10	31	28	18	2
30 SW 17	2.9	3.6		5	4	13	26	23	28	1
30 SW 20	1.1	3.9		15	12	19	16	19	18	1
30 SW 23	3.8	4.5		20	65	14	1	trace	0	0
30 SE 6	3.4	1.7		4	6	15	24	33	18	0

* Between mineral deposits

most part these are widely scattered and mineral-bearing areas around them cannot be outlined on the basis of available information. Only in a small area west of Great Smeaton can a mineral bearing area be delineated with any degree of confidence. Here three boreholes, 30 SW 16, 17 and 20, found potentially workable sand and gravel with a mean grading of 8 per cent fines, 45 per cent sand and 47 per cent gravel. Mineral extends beneath an area of about 2.3 km^2 and has an estimated mean thickness of about 3.5 m. The presence of about 8 million m^3 of potentially workable sand and gravel is inferred.

Much of the mineral is concealed beneath glacial lake deposits which were 2.9 m thick in borehole 30 SW 17.

REFERENCES

ALLEN, V. T. 1936. Terminology of medium-grained sediments. **Rep. Natl. Res. Counc., Washington, 1935-1936, App. 1, Rep. Comm. Sediment.**, 18-47.

ARCHER, A. A. 1969. Background and problems of an assessment of sand and gravel resources in the United Kingdom. **Proc. 9th Commonw. Min. & Metall. Congr., 1969**, Vol. 2: Mining and petroleum geology, 495-508.

— 1970a. Standardisation of the size classification of naturally occurring particles. **Geotechnique**, Vol. 20, 103-107.

— 1970b. Making the most of metrication. **Quarry Managers' J.**, Vol. 54, No. 6, 223-227.

ATTERBERG, A. 1905. Die rationelle Klassifikation der Sande und Kiese. **Chem. Z.**, Vol. 29, 195-198.

BRITISH STANDARDS INSTITUTION. 1967. **B.S.1377: Methods of testing soils for civil engineering purposes.** (London: British Standards Institution.)

BUREAU OF MINES AND GEOLOGICAL SURVEY. 1948. **Pp. 14-17** in **Mineral resources of the United States.** (Washington, DC: Public Affairs Press.)

HARRIS, P. M., THURRELL, R. G., HEALING, R. A., and ARCHER, A. A. 1974. Aggregates in Britain. **Proc. R. Soc.**, Ser. A, Vol. 339, 329-353.

HULL, J. H. 1981. Methods of calculating the volume of resources of sand and gravel. **Appendix** (pp. 192-193) to **THURRELL, R. G.** 1981. Quarry resources and reserves: the identification of bulk mineral resources: the contribution of the Institute of Geological Sciences. **Quarry Management,** for March 1981, 181-193.

LANE, E. W., and others. 1947. Report of the sub-committee on sediment terminology. **Trans. Am. Geophys. Union,** Vol. 28, 936-938.

PETTIJOHN, F. J. 1975. **Sedimentary rocks.** 3rd edition. (London: Harper and Row.)

THURRELL, R. G. 1971. The assessment of mineral resources with particular reference to sand and gravel. **Quarry Managers' J.,** Vol. 55, 19-25.

— 1981. Quarry resources and reserves: the identification of bulk mineral resources: the contribution of the Institute of Geological Sciences. **Quarry Management,** for March 1981, 181-193.

TWENHOFEL, W. H. 1937. Terminology of the fine-grained mechanical sediments. **Rep. Natl. Res. Counc., Washington, 1936-37,** App. 1, Rep. Comm. Sediment., 81-104.

UDDEN, J. A. 1914. Mechanical composition of clastic sediments. **Bull. Geol. Soc. Am.,** Vol. 25, 655-744.

WENTWORTH, C. K. 1922. A scale of grade and class terms for clastic sediments. **J. Geol.,** Vol. 30, 377-392.

— 1935. The terminology of coarse sediments. **Bull. Natl. Res. Counc. Washington,** No. 98, 225-246.

WILLMAN, H. B. 1942. Geology and mineral resources of the Marseilles, Ottawa and Streator quadrangles. **Bull. Illinois State Geol. Surv.,** No. 66, 343-344.

APPENDIX A

FIELD AND LABORATORY PROCEDURES

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

The mineral shown on each 1:25 000 sheet is divided into resource blocks. The arbitrary size selected is a compromise to meet the aims of the survey by providing sufficient sample points in each block. As far as possible the block boundaries are determined by geological boundaries so that, for example, glacial and river terrace gravels are separated. Otherwise division is by arbitrary lines, which may bear no relationship to the geology. The blocks are drawn provisionally before drilling begins.

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

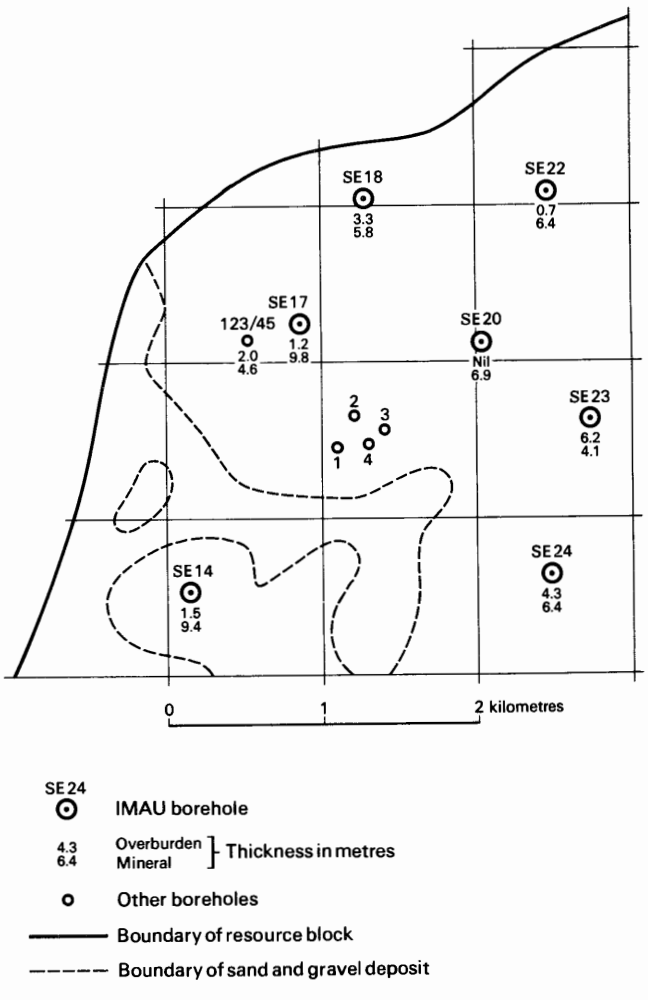
The drilling machine employed should be capable of providing a continuous sample representative of all unconsolidated deposits, so that the in-situ grading can be determined, if necessary, to a depth of 30 m (100 ft) at a diameter of about 200 mm (8 in), beneath different types of overburden. It should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

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

A continuous series of bulk samples is taken throughout the sand and gravel. Ideally samples are composed exclusively of the whole of the material encountered in the borehole between stated depths. However, care is taken to discard, as far as possible, material which has caved or has been pumped from the bottom of the hole. A new sample is commenced whenever there is an appreciable lithological change within the sand and gravel, or at every 1 m (3.3 ft) depth. The samples, each weighing between 25 and 45 kg (55 and 100 lb), are despatched in heavy-duty polythene bags to a laboratory for grading. The grading procedure is based on B.S. 1337 (British Standards Institution, 1967). Random checks of the accuracy of the grading are made in the Institute's laboratories.

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

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



Example of resource block assessment: map of a fictitious block

APPENDIX B

STATISTICAL PROCEDURE

Statistical assessment

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

2 The simple methods used in the calculations are consistent with the amount of data provided by the survey (Hull, 1981). Conventional symmetrical confidence limits are calculated for the 95 per cent probability level, that is, on average nineteen out of every twenty sets of limits constructed in this way contain the true value for the volume of mineral.

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

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

4 The above relationship may be transposed such that

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

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

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

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

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

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

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

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

6 The sampled area in each resource block is coloured pink on the map. Wherever possible, calculations relate to the mineral within mapped geological boundaries (which may not necessarily correspond to the limits of a deposit). Where the area is not defined by a mapped boundary, that is, where the boundary is inferred, a distinctive symbol is used. Experience suggests that the errors in determining area are small relative to those in thickness. The relationship $S_A / S_{\bar{l}_m} \leqq 0.\dot{3}$ is assumed in all cases. It follows from Equation [2] that

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

7 The limits on the estimate of mean thickness of mineral, $L_{\bar{l}_m}$, may be expressed in absolute units $\pm (t/\sqrt{n}) \times S_{\bar{l}_m}$ or as a percentage $\pm (t/\sqrt{n}) \times S_{\bar{l}_m} \times (100/\bar{l}_m)$ per cent, where t is Student's t at the 95 per cent probability level for $(n-1)$ degrees of freedom, evaluated by reference to statistical tables. (In applying Student's t it is assumed that the measurements are distributed normally).

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

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

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

9 In calculating confidence limits for volume, L_V, the following inequality, corresponding to Equation [3], is applied:

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

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

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

per cent,

and when n is greater than 20, as

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

per cent.

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

Inferred assessment

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

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

14 No assessment is attempted for an isolated area of mineral less than 0.25 km^2.

15 Note on weighting The thickness of a deposit at any point may be governed solely by the position of the point in relation to a broad trend. However, most sand and gravel deposits also exhibit a random pattern of local, and sometimes considerable, variation in thickness. Thus the distribution of sample points needs to be only approximately regular and in estimating the mean thickness only simple weighting is necessary. In practice, equal weighting can often be applied to thicknesses at all sample points. If, however, there is a distinctly unequal distribution of points, bias is avoided by dividing the sampled area into broad zones, to each of which a value roughly proportional to its area is assigned. This value is then shared between the data points with the zone as the weighting factor.

Block calculation

Scale: 1:25 000
Block: Fictitious

Area
Block: 11.08 km²
Mineral: 8.32 km²

Mean thickness
Overburden: 2.5 m
Mineral: 6.5 m

Volume
Overburden: 21 million m³
Mineral: 54 million m³

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

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

Sample point	Weighting w	Overburden l_o	Overburden wl_o	Mineral l_m	Mineral wl_m	Remarks
SE 14	1	1.5	1.5	9.4	9.4	IMAU boreholes
SE 18	1	3.3	3.3	5.8	5.8	
SE 20	1	nil	-	6.9	6.9	
SE 22	1	0.7	0.7	6.4	6.4	
SE 23	1	6.2	6.2	4.1	4.1	
SE 24	1	4.3	4.3	6.4	6.4	
SE 17	½	1.2	1.6	9.8	7.2	Hydrogeology Unit record
123/45	½	2.0		4.6		
1	¼	2.7	2.6	7.3	5.8	Close group of four boreholes (commercial)
2	¼	4.5		3.2		
3	¼	0.4		6.8		
4	¼	2.8		5.9		
Totals	$\Sigma w = 8$	$\Sigma wl_o = 20.2$		$\Sigma wl_m = 52.0$		
Means		$\overline{wl}_o = 2.5$		$\overline{wl}_m = 6.5$		

Calculation of confidence limits

wl_m	$\lvert(wl_m - \overline{wl}_m)\rvert$	$(wl_m - \overline{wl}_m)^2$
9.4	2.9	8.41
5.8	0.7	0.49
6.9	0.4	0.16
6.4	0.1	0.01
4.1	2.4	5.76
6.4	0.1	0.01
7.2	0.7	0.49
5.8	0.7	0.49

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

$n = 8$

$t = 2.365$

L_V is calculated as

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

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

$= 20.3$

$\simeq 20$ per cent.

APPENDIX C

CLASSIFICATION AND DESCRIPTION OF SAND AND GRAVEL

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

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

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

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

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

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

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

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

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

The fairly wide intervals in the scale are consistent with the general level of accuracy of the qualitative assessments of the resource blocks. Three sizes of sand are recognised, fine (+$\frac{1}{16}$ -$\frac{1}{4}$ mm), medium (+$\frac{1}{4}$ -1 mm) and coarse (+1 -4 mm). The boundary at 16 mm distinguishes a range of finer gravel (+4 -16 mm), often characterised by abundance of worn tough pebbles of vein quartz, from larger pebbles, often of notably different materials. The boundary at 64 mm distinguishes pebbles from cobbles. The term 'gravel' is used loosely to denote both pebble-sized and cobble-sized material.

The size distribution of borehole samples is determined by sieve analysis, which is presented by the laboratory as logarithmic cumulative curves (see, for example, British Standards Institution, 1967). In this report the grading is tabulated on the borehole record sheets (Appendix E), the intercepts corresponding with the simple geometric scale $\frac{1}{16}$ mm, $\frac{1}{4}$ mm, 1 mm, 4 mm, 16 mm and so on as required. Original sample grading curves are available for reference at the appropriate office of the Institute.

Each bulk sample is described, subjectively, by a geologist at the borehole site. Being based on visual examination, the description of the grading is inexact, the accuracy depending on the experience of the observer. The descriptions recorded are modified, as necessary, when the laboratory results become available.

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

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

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

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

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

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

Well rounded: not original faces, edges or corners left. The entire surface consists of broad curves; flat areas are absent. The original shape is suggested by the present form of the grain.

Classification of gravel, sand and fines

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

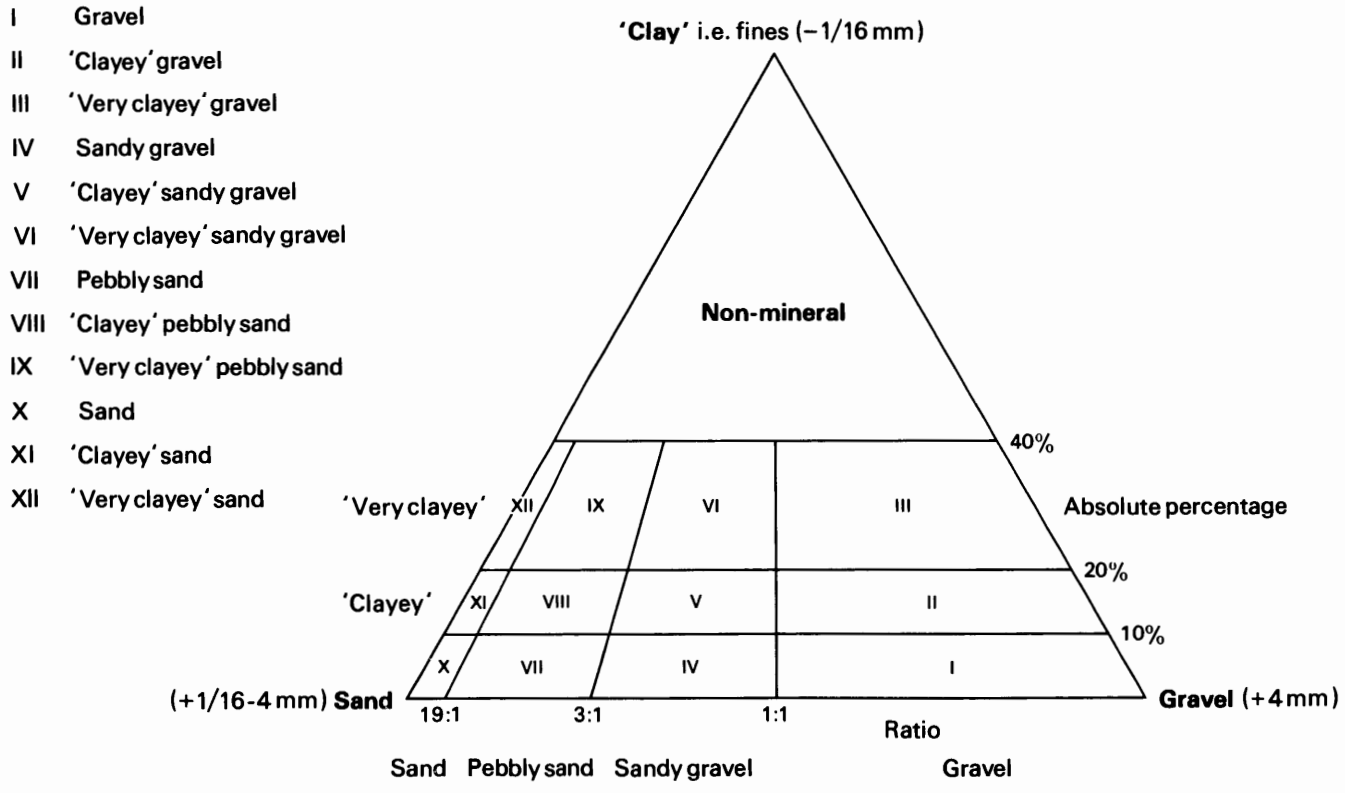


Diagram showing the descriptive categories used in the classification of sand and gravel

APPENDIX D

EXPLANATION OF THE BOREHOLE RECORDS

Annotated fictitious example

CK 66 NW 5[1] **6191 6962**[2] **Northfields**[3] **Block B**

Surface level (+49.7 m) +163 ft[4]
Water struck at +45.9 m[5]
October 1972[6]

Overburden[7] 2.8 m
Mineral 5.4 m
Waste 1.1 m
Mineral 1.4 m
Bedrock 0.7 m+[8]

LOG

Geological classification	Lithology[9]	Thickness m	Depth m
	Soil	0.2	0.2
Alluvium	Clay, silty, dark brown	2.6	2.8
River Terrace Deposits	**a** Gravel Gravel: fine to coarse, with cobbles towards base, angular to rounded flint and limestone with ironstone and some quartz and chalk Sand: medium with coarse and some fine, quartz and limestone	5.4	8.2
Boulder Clay	Clay, sandy and pebbly, red-brown	1.1	9.3
Glacial Sand and Gravel	**b** Sand, 'clayey' in part: fine, subangular to rounded, quartz with some coal	1.4	10.7
Lias	Mudstone, blue-grey, fossiliferous	0.7+	11.4

GRADING[10]

	Mean for deposit percentages			Depth below[11] surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	5	46	49	2.8-3.9	20	14	62	2	2	0	0
				3.8-4.8	2	2	12	18	42	24	0
				4.8-5.8	1	3	24	13	35	24	0
				5.8-6.8	0	4	21	20	26	29	0
				6.8-8.2	4	3	23	10	23	30	7
				Mean	**5**	**5**	**28**	**13**	**25**	**22**	**2**
b	5	95	0	9.3-10.3	3	73	23	1	0	0	0
				10.3-10.7	9	85	5	1	0	0	0
				Mean	**5**	**77**	**17**	**1**	**0**	**0**	**0**
a+b	**5**	**56**	**39**	**Mean**	**5**	**20**	**26**	**10**	**20**	**17**	**2**

COMPOSITION[12]

Depth below surface (m)	percentages by weight in the 8-16 mm fraction				
	Flint	Quartz	Limestone	Chalk	Ironstone
3.8-4.8	41	5	50	1	3
4.8-5.8	39	3	45	5	8
5.8-6.8	45	2	42	5	6
6.8-8.2	19	6	61	3	11
Mean	**35**	**4**	**51**	**3**	**7**

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

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

a The number of the 1:25 000 sheet on which the borehole lies, here CK 66.
b The quarter of the 1:25 000 sheet on which the borehole lies and the number of the borehole in a series for that quarter, here NW 5.

Thus the full Registration Number is CK 66 NW 5.

2 National Grid Reference
All National Grid References fall in the 100 km square identified by the first two letters of the Registration Number. Grid references are given to eight figures, accurate to within 10 m.

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 the borehole 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 feet; approximate conversions to metres are given in brackets.

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

6 Type of drill and date of drilling
Unless otherwise stated the borehole was drilled by a shell and auger rig using 152 mm diameter casing. The month and year of completion of drilling 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. Where waste occurs between the surface and mineral it is classified as overburden.

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

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

10 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 and cobble gravel (+16 mm) are stated.

The mean grading of groups of samples making up an identified bed of mineral are also given in detail and in summary. Where more than one bed is recognised the mean grading for the whole of the mineral in the borehole may be given. Where necessary, in calculating mean gradings, data for individual samples are weighted by the thickness represented.

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

11 Sampling
A continuous series of bulk samples is taken throughout the thickness of sand and gravel. A new sample is taken wherever there is an appreciable lithological change within the sand and gravel or at every 1 m of depth. Samples obtained by bailing are indicated by an asterisk.

12 Composition
Details of the composition of selected samples or groups of samples may be given. Where appropriate the calculated weighted mean composition of groups of samples may be quoted.

APPENDIX E

INDUSTRIAL MINERALS ASSESSMENT UNIT BOREHOLE, SECTION RECORDS AND OTHER PRE-EXISTING BOREHOLE RECORDS

NZ 30 NW 12 **3184 0986** **Newbus Grange** **Block E**

Surface level +25.6 m
Groundwater conditions not recorded
December 1976

Overburden	0.9 m
Mineral	2.0 m
Waste	8.9 m
Bedrock	0.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.9	0.9
River Terrace Deposits, undifferentiated	Gravel, 'clayey' at top Gravel: fine to coarse with cobbles, subrounded; sandstone and limestone with some quartzite, dolomite, volcanic and basic igneous rocks Sand: fine to coarse, subangular to subrounded; quartz with lithic grains as in gravel	2.0	2.9
Till	Clay, greyish brown to 9.9 m, reddish brown below, massive, sandy and stony	8.9	11.8
Sherwood Sandstone	Sandstone, red, medium-grained	0.7+	12.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
8	24	68	0.9-1.9	12	11	10	8	18	31	10
			1.9-2.9	4	4	5	9	23	43	12
			Mean	**8**	**8**	**8**	**8**	**20**	**37**	**11**

NZ 30 NW 13 **3422 0944** **Black Wood, Sockburn**

Surface level +46.0 m
Water not encountered
March 1978

Waste	10.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, reddish brown to brown, stony; rare lenses of sand and silty laminae, poorly laminated silt from 2.6 m to 3.1 m	10.3+	10.6
	Borehole abandoned		

NZ 30 NW 14 **3054 0769** **Tewit Castle, Dalton on Tees** **Block F**

Surface level +47.2 m
Water not encountered
March 1978

Overburden 3.5 m
Mineral 1.5 m
Waste 15.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, yellowish brown and reddish brown; some stones	3.3	3.5
Glacial Sand and Gravel	'Clayey' sand; fine, subangular to subrounded quartz	1.5	5.0
	Silty clay, reddish brown, laminated, with thin sand partings	1.2	6.2
Till	Clay, brown, sandy, stony; some thin silty bands below 12.0 m	13.8+	20.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
13	87	0	3.5-5.0	13	73	14	0	0	0	0

NZ 30 NW 15 **3477 0814** **White Houses, Sockburn**

Surface level +44.2 m
Water not encountered
July 1977

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, reddish brown, stony, poorly laminated in part; 0.2 m band of fine sand at 16.6 m	17.8+	18.0

NZ 30 NW 16 **3121 0672** **Thorntree Farm, Dalton on Tees** **Block F**

Surface level +46.9 m
Water struck at +32.4 m
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial Drift, undifferentiated	Clay, reddish brown, massive, mainly stony but silty and stoneless with thin sand bands from 10.7 m to 12.4 m	17.8+	18.0

NZ 30 NW 17 **3478 0684** **Sockburn** **Block E**

Surface level +19.5 m
Water struck at +16.1 m
March 1978

Overburden 0.6 m
Mineral 3.6 m
Waste 15.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
River Terrace Deposits, undifferentiated	Gravel, 'clayey' at top Gravel: fine and coarse with some cobbles near top, subangular to subrounded; Carboniferous sandstone, limestone, mudstone, siltstone and Magnesian Limestone with trace of red sandstone Sand: fine to coarse, subangular to rounded; quartz with lithic grains as in gravel and some coal	3.6	4.2
Till	Clay, brown, massive, stony	15.6+	19.8

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
8	34	58	0.6-1.6	16	11	13	6	16	33	5
			1.6-2.6	11	12	19	8	23	27	0
			2.6-3.6	1	3	8	15	40	33	0
			3.6-4.2	4	4	13	24	34	21	0
			Mean	**8**	**8**	**14**	**12**	**27**	**30**	**1**

NZ 30 NW 18 **3423 0570** **High Entercommon, Great Smeaton** **Block F**

Surface level +49.1 m
Water struck at +40.1 m
March 1978

Waste 20.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, brown, stony; thin sandy lenses and silt bands in lower part	9.0	9.2
Glacial Sand and Gravel	'Clayey' to 'very clayey' sand, fine to medium; traces of coal	2.8	12.0
Till	Clay, brown, massive, stony	8.0+	20.0

NZ 30 NW 19 **3351 0537** **High Magdalen, Great Smeaton** **Block F**

Surface level +71.3 m
Water struck at +67.1 m
March 1978

Overburden 0.3 m
Mineral 6.0 m
Waste 14.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	'Very clayey' sand, pebbly near top Sand: fine to medium quartz Fines: yellowish brown, laminated silty clay bands	6.0	6.3
	Silt, brown, sandy, with reddish brown clay and sand partings	3.4	9.7
Till	Clay, reddish brown, massive, stony; some silt bands towards base	11.3+	21.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
20	78	2	0.3-1.3	25	41	28	2	1	3	0
			1.3-2.3	28	50	14	2	2	4	0
			2.3-3.3	10	44	44	1	1	0	0
			3.3-4.3	12	43	44	1	0	0	0
			4.3-5.3	18	73	9	trace	0	0	0
			5.3-6.3	28	64	7	1	0	0	0
			Mean	**20**	**53**	**24**	**1**	**1**	**1**	**0**

NZ 30 NE 13 **3545 0939** **White House, Girsby** **Block D**

Surface level +39.9 m
Water struck at +38.6 m
January 1977

Overburden	1.3 m
Mineral	2.7 m
Waste	16.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, reddish brown, weathered; some stones	1.0	1.3
Glacial Sand and Gravel	Sand, pebbly near top: medium to fine, subangular to subrounded; quartz and quartzite with sandstone, limestone, Magnesian Limestone and igneous grains, and trace of red sandstone	2.7	4.0
Till	Clay, reddish brown to brown, silty near top, mainly stony, poorly laminated fronm 7.0 m to 8.0 m	16.0+	20.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
8	89	3	1.3-2.3	9	29	45	9	6	2	0
			2.3-4.0	8	39	51	2	trace	0	0
			Mean	**8**	**35**	**49**	**5**	**2**	**1**	**0**

NZ 30 NE 14 **3760 0980** **Bowlhole Wood, Newsham** **Block E**

Surface level +25.6 m
Groundwater conditions not recorded
December 1976

Overburden	0.3 m
Mineral	2.2 m
Waste	2.0 m
Mineral	1.0 m
Waste	13.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
River Terrace Deposits, undifferentiated	**a** 'Clayey' gravel on 'very clayey' sand Gravel: fine and coarse, subangular to subrounded; sandstone with limestone and some quartzite Sand: mainly fine; quartz with lithic grains as in gravel	2.2	2.5
Laminated Clay	Clay, greyish brown, silty, stoneless and poorly laminated	2.0	4.5
Glacial Sand and Gravel	**b** 'Very clayey' sand, grey: fine; quartz with some lithic grains	1.0	5.5
Till	Clay, brown and reddish brown, massive, stony and sandy; poorly laminated silt, clay and sand from 16.5 m to 17.5 m	13.0+	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 mm
a	17	61	22	0.3-1.3	10	12	13	17	27	21	0
				1.3-2.5	23	73	3	1	0	0	0
				Mean	**17**	**45**	**8**	**8**	**12**	**10**	**0**
b	31	69	0	4.5-5.5	31	67	2	trace	0	0	0
a+b	**21**	**64**	**15**	**Mean**	**21**	**52**	**6**	**6**	**8**	**7**	**0**

NZ 30 NE 15 **3933 0942** **Low Worsall** **Block F**

Surface level +24.4 m
Water struck at +8.4 m
December 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, mainly dark brown, sandy (especially at top), mainly stony; thin bands of sand from 2.8 m to 4.0 m and near base	17.7+	18.0

NZ 30 NE 16 **3614 0856** **Girsby Grange** **Block F**

Surface level +46.0 m
Water struck at +32.5 m
December 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown, massive, stony, silty from 4.3 m to 11.3 m; thin bands of sand at 5.0 m and 13.5 m	17.7+	18.0

NZ 30 NE 17 **3841 0848** **Viewley Hill, High Worsall** **Block F**

Surface level +35.4 m
Water not encountered
January 1977

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Till	Clay, brown, massive, stony in part, silty from 4.5 m to 5.5 m; scattered sand laminae	17.5+	18.0

NZ 30 NE 18 **3518 0737** **East Sockburn Farm** **Block E**

Surface level +15.5 m
Water struck at -4.3 m, artesian flow
March 1978

Overburden 1.5 m
Mineral 3.8 m
Waste 14.5 m
Bedrock 0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Alluvium	Clay, yellowish brown, silty and sandy	1.0	1.5
River Terrace Deposits, undifferentiated	**a** 'Very clayey' sand: mainly fine quartz	2.6	4.1
	b Sandy gravel Gravel: fine and coarse with some cobbles, rounded to well rounded; sandstone and limestone with igneous rock, quartzite, quartz and dolomite, and some silicified limestone, mudstone, ironstone and greywacke Sand: mainly medium and coarse, subangular to subrounded; quartz with lithic grains as gravel	1.2	5.3
Till	Clay, greyish brown, massive, stony; red sandstone pebbles common below 11.3 m	14.5	19.8
Sherwood Sandstone	Sandstone, red, fine-grained	0.2+	20.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	34	66	0	1.5-2.5	39	46	15	0	0	0	0
				2.5-3.5	35	51	14	0	0	0	0
				3.5-4.1	26	45	29	0	0	0	0
				Mean	**34**	**48**	**18**	**0**	**0**	**0**	**0**
b	5	51	44	4.1-5.3	5	11	19	21	22	20	2
a+b	**25**	**61**	**14**	**Mean**	**25**	**36**	**18**	**7**	**7**	**6**	**1**

COMPOSITION

Depth below surface (m)	percentages by weight in gravel fraction								
	Sandstone	Limestone	Dolomite	Quartz/ Quartzite	Igneous	Chert	Mudstone/ Siltstone	Ironstone	Coal
4.1-5.3	45	29	6	7	9	2	1	1	0

NZ 30 NE 19 **3619 0749** **Girsby Green** **Block F**

Surface level +43.3 m
Groundwater conditions not recorded
December 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Till	Clay, brown, massive, mainly stony, silty in part, poorly laminated from 7.1 m to 8.1 m	17.9+	18.0

NZ 30 NE 20 **3818 0754** **High Worsall Moor** **Block F**

Surface level +46.3 m
Groundwater conditions not recorded
January 1977

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown, massive with some stones; thin bands of sand and scattered silty laminae	17.7+	18.0

NZ 30 NE 21 **3601 0642** **Staindale Grange, Hornby** **Block F**

Surface level +43.9 m
Water struck at +34.9 m
January 1977

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, mainly red and brown, generally massive and stony but mainly stoneless from 9.3 m to 15.3 m and poorly laminated in places; thin band of sand at 9.3 m	17.7+	18.0

NZ 30 NE 22 **3827 0633** **Low Field Farm** **Block F**

Surface level +46.3 m
Groundwater conditions not recorded
December 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown, stony, mainly massive but poorly laminated in part, sandy below 5.6 m; 0.4 m of pebbly sand at 5.6 m	17.7+	18.0

NZ 30 NE 23 **3925 0674** **Staindale, Appleton Wiske** **Block F**

Surface level +49.7 m
Groundwater conditions not recorded
January 1977

Waste 19.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, mainly brown, massive, stony	9.1	9.3
Glacial Sand and Gravel	'Clayey' sand, fine	1.5	10.8
Till	Clay, dark brown, silty; scattered pebbles	1.0	11.8
Glacial Sand and Gravel	'Very clayey' sand, fine; few pebbles	1.2	13.0
Till	Clay, dark brown, massive, pebbly	6.0+	19.0

NZ 30 NE 24 **3900 0563** **Prospect House, Appleton Wiske** **Block F**

Surface level +61.2 m
Water struck at +55.6 m
March 1978

Overburden 6.2 m
Mineral 6.2 m
Waste 0.9 m
Mineral 11.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, reddish brown, sandy in part, mainly stony but stoneless and poorly laminated below 5.2 m; some thin sand lenses below 1.5 m	6.0	6.2
Glacial Sand and Gravel	**a** 'Very clayey' sand Sand: mainly fine; quartz with trace of coal and lithic grains Fines: thin yellowish brown silty clays	6.2	12.4
Till	Clay, reddish brown, stony	0.9	13.3
Glacial Sand and Gravel	**b** 'Very clayey' sand: sand as above, with brown laminated clays up to 0.2 m thick below 21.0 m	11.7+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	20	80	trace	6.2-7.2	26	48	25	1	0	0	0
				7.2-8.2	31	56	13	0	0	0	0
				8.2-9.2	11	47	40	1	1	0	0
				9.2-10.2	13	44	40	2	1	0	0
				10.2-11.2	14	61	24	1	0	0	0
				11.2-12.4	24	62	14	0	0	0	0
				Mean	**20**	**53**	**26**	**1**	**trace**	**0**	**0**
b	21	79	trace	13.3-14.3	11	63	26	trace	0	0	0
				14.3-15.3	16	74	10	trace	trace	0	0
				15.3-18.3	25	42	33	trace	trace	0	0
				18.3-21.3	23	58	19	trace	0	0	0
				21.3-23.3	18	33	48	1	0	0	0
				23.3-25.0	25	62	13	trace	0	0	0
				Mean	**21**	**52**	**26**	**1**	**trace**	**0**	**0**
a+b	**21**	**79**	**trace**	**Mean**	**21**	**52**	**26**	**1**	**trace**	**0**	**0**

NZ 30 NE 25 **3639 0510** **Grange Farm, Hornby** **Block F**

Surface level +59.4 m
Water not encountered
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, brown, stony; silty from 12.0 m to 13.0 m	17.8+	18.0

NZ 30 SW 15 **3056 0485** **Firtree House, East Cowton** **Block F**

Surface level +53.0 m
Groundwater conditions not recorded
January 1977

Waste 21.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, dark grey to reddish brown, partly sandy, massive; pebbles scattered in upper part, more common towards base	6.2	6.5
Glacial Sand and Gravel	'Clayey' sandy gravel	1.0	7.5
Till	Clay, reddish brown, massive; some pebbles	4.5	12.0
Glacial Sand and Gravel	Sand with thin bands of silty clay	3.8	15.8
	Clay, soft, silty, pale to dark brown, laminated	1.0	16.8
	Clay, dark brown, massive, stony	4.2+	21.0

NZ 30 SW16 **3223 0467** **Stones Rigg, East Cowton** **Block F**

Surface level +46.3 m
Groundwater conditions not recorded
January 1977

Overburden	0.3 m
Mineral	6.2 m
Waste	13.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Sand and Gravel	Gravel Gravel: fine with coarse and some cobbles, subangular; sandstone and limestone with some quartz, quartzite, tuff and basic igneous rock and traces of coal and mudstone Sand: mainly coarse, subangular; composition as gravel	6.2	6.5
Till	Clay, reddish brown to brown, mainly massive but laminated from 14.5 m to 15.5 m; pebbles scattered to 15.5 m, more common below	13.5+	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 mm
5	47	48	0.3-1.3	9	7	11	29	26	15	3
			1.3-2.3	3	3	10	39	34	11	0
			2.3-3.3	4	5	15	29	28	19	0
			3.3-4.3	3	7	10	35	31	14	0
			4.3-5.3	1	1	4	21	19	42	12
			5.3-6.5	7	13	11	32	27	10	0
			Mean	**5**	**6**	**10**	**31**	**28**	**18**	**2**

NZ 30 SW 17 **3308 0445** **Low Magdalen, Great Smeaton** **Block F**

Surface level +43.6 m
Water struck at +40.7 m
January 1977

Overburden	2.9 m
Mineral	3.6 m
Waste	14.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial Lake Deposits	Clay, mainly dark brown, sandy to silty; plant fragments near base	2.5	2.9
Glacial Sand and Gravel	Gravel, 'clayey' at top Gravel: fine and coarse with cobbles near base, subangular to subrounded; sandstone (including some of soft red variety) and limestone with basic igneous rocks, quartzite, quartz and traces of tuff and coal Sand: mainly coarse, subangular; quartz with lithic fragments as in gravel	3.6	6.5
Till	Clay, dark reddish brown, part sandy, mainly massive but poorly laminated at top; some stones	14.5+	21.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
5	43	52	2.9-3.9	13	9	14	21	23	20	0
			3.9-4.9	3	2	8	28	26	33	0
			4.9-5.9	1	2	13	29	24	31	0
			5.9-6.5	2	4	20	24	17	25	8
			Mean	**5**	**4**	**13**	**26**	**23**	**28**	**1**

NZ 30 SW 18 **3414 0443** **Smeaton Manor, Great Smeaton** **Block F**

Surface level +54.6 m
Water not encountered
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial Drift, undifferentiated	Clay, reddish brown; generally poorly laminated and with few stones to 11.2 m, massive and stony below; thin band of 'clayey' sand at 11.3 m and sandy and silty laminae below 14.0 m	17.7+	18.0

NZ 30 SW 19 **3114 0417** **Raby Lane, East Cowton** **Block F**

Surface level +46.9 m
Water struck at +43.0 m
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown, stony; silty and sandy laminae and lenses from 9.0 m to 12.0 m, 0.1 m of gravel at 4.0 m	17.7+	18.0

NZ 30 SW 20 **3233 0381** **Frigidale Wood, East Cowton** **Block F**

Surface level +43.9 m
Water struck at +39.9 m and +36.7 m
March 1978

Overburden 1.1 m
Mineral 3.9 m
Waste 13.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial Sand and Gravel	Clay, brown, silty, sandy and stony	0.9	1.1
	'Clayey' sandy gravel Gravel: fine and coarse, angular to subrounded; Carboniferous sandstone, limestone and mudstone and Magnesian Limestone with some coal Sand: fine to coarse, subangular to subrounded; quartz with lithic grains as in gravel	3.9	5.0
Glacial Drift, undifferentiated	Clay, brown, poorly laminated in part, stony towards base; thin bands of sandy gravel near top, lenses and laminae of fine sand, 0.3 m of sand at 7.5 m	4.0	9.0
Till	Clay, reddish brown, massive, stony	9.0+	18.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
15	47	38	1.1-2.1	19	10	12	9	17	30	3
			2.1-3.1	16	11	16	14	19	24	0
			3.1-4.1	13	13	18	18	26	12	0
			4.1-5.0	10	14	32	24	14	6	0
			Mean	**15**	**12**	**19**	**16**	**19**	**18**	**1**

NZ 30 SW 21 **3345 0343** **Birkby Farm** **Block F**

Surface level +44.5 m
Groundwater conditions not recorded
December 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, reddish brown and grey, massive, mainly stony, sandy and silty in part; thin laminated stoneless band at 15.4 m	17.6+	18.0

NZ 30 SW 22 **3450 0315** **Westhorpe Hall, Little Smeaton** **Block F**

Surface level +41.3 m
Water struck at +30.8 m
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Lacustrine Alluvium	Silt and peat, greyish brown to black	5.0	5.6
Till	Clay, brown, massive, stony	4.9	10.5
Glacial Sand and Gravel	Gravel, mainly coarse	2.0	12.5
Till	Clay, brown, massive, stony	5.5+	18.0

NZ 30 SW 23 **3087 0301** **East Cowton** **Block F**

Surface level +41.8 m
Water struck at +38.0 m
December 1976

Overburden 3.8 m
Mineral 4.5 m
Waste 13.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, reddish brown to brown, stony; some fine sand laminae towards base	3.5	3.8
Glacial Sand and Gravel	'Very clayey' sand, greyish brown, with thin bands of sandy silt towards base: fine; quartz with some sandstone, limestone, Magnesian Limestone and coal	4.5	8.3
Till	Clay, brown to reddish brown, massive, stony	13.7+	22.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
20	80	trace	3.8-4.8	15	72	12	1	0	0	0
			4.8-5.8	11	80	9	trace	0	0	0
			5.8-6.8	16	60	24	0	0	0	0
			6.8-8.3	31	54	12	2	1	0	0
			Mean	**20**	**65**	**14**	**1**	**trace**	**0**	**0**

NZ 30 SW 24 **3110 0236** **Manor House, East Cowton** **Block F**

Surface level +36.4 m
Water struck at +27.4 m
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, brown, massive, soft, stony, silty and with some sandy lenses from 10.0 m to base	17.8+	18.0

NZ 30 SW 25 **3327 0248** **Birkby Manor** **Block F**

Surface level +42.7 m
Water struck at +29.7 m
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, brown and grey, mainly stony, silty in parts	17.8+	18.0

NZ 30 SW 26 **3056 0076** **High Whinholme, South Cowton** **Block F**

Surface level +46.6 m
Water not encountered
March 1978

Waste 18.0 +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, brown, massive, stony, especially below 13.0 m	17.8+	18.0

NZ 30 SW 27 **3254 0105** **Wiske House Farm, Birkby** **Block F**

Surface level +37.0 m
Water not encountered
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Alluvium	Clay, grey-green, generally stoneless, with plant debris	1.9	2.2
Till	Clay, dark brown, massive, stony	15.8+	18.0

NZ 30 SW 28 **3490 0110** **Cock Holme, Birkby** **Block F**

Surface level +55.5 m
Water struck at +50.9 m
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, brown, mainly massive and stony but stoneless and poorly laminated from 4.6 m to 6.1 m	17.8+	18.0

NZ 30 SE 5 **3745 0452** **Hornby Green, Hornby** **Block F**

Surface level +58.0 m
Water struck at +51.0 m
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown, mainly stony, silty in part; some sand lenses from 6.5 m to 8.2 m	17.7+	18.0

NZ 30 SE 6 **3616 0347** **Stell Plantation, Little Smeaton** **Block F**

Surface level +45.6 m
Water struck at +42.2 m
March 1978

Overburden 3.4 m
Mineral 1.7 m
Waste 14.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, brown, with blue-grey mottling to 2.0 m, massive, sandy and stony	3.2	3.4
Glacial Sand and Gravel	Gravel Gravel: fine to coarse, subrounded to well rounded; sandstone and limestone with some dolomite, igneous and metamorphic rocks, quartzite, greywacke, silicified limestone and red sandstone and trace of siltstone, ironstone and *Gryphaea* Sand: mainly medium and coarse, subangular to subrounded; quartz and lithic grains as gravel	1.7	5.1
Till	Clay, brown, massive, stony - especially towards base	14.9+	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 mm
4	45	51	3.4-4.4	4	4	7	20	41	24	0
			4.4-5.1	5	8	26	29	23	9	0
			Mean	**4**	**6**	**15**	**24**	**33**	**18**	**0**

COMPOSITION

Depth below surface (m)	percentages by weight in gravel fraction								
	Sandstone	Limestone	Dolomite	Quartz/ Quartzite	Igneous	Chert	Mudstone/ Siltstone	Ironstone	Coal
3.4-5.1	56	33	5	2	3	1	0	0	0

NZ 30 SE 7 **3823 0363** **Roman Road, Welbury** **Block F**

Surface level +56.3 m
Water not encountered
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, brown to reddish brown, stony, sandy to 1.5 m	17.8+	18.0

NZ 30 SE 8 **3987 0355** **Hill House, Welbury** **Block F**

Surface level +58.8 m
Water struck at +48.0 m
January 1977

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Till	Clay, brown, massive, with scattered stones, sandy to 2.5 m	10.3	10.8
Glacial Sand and Gravel	Gravel and sandy gravel	1.5	12.3
Till	Clay, dark brown, mainly massive; scattered stones, silt laminae in top metre	5.7+	18.0

NZ 30 SE 9 **3605 0220** **Birkby Gate House, Birkby** **Block F**

Surface level +60.4 m
Water not encountered
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, brown, stony; 1.2 m stoneless silty clay at 6.0 m	17.8+	18.0

NZ 30 SE 10 **3757 0090** **Deighton Grange, Deighton** **Block F**

Surface level +75.0 m
Water not encountered
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, brown to reddish brown, stony, sandy from 12.0 m to 12.5 m	17.8+	18.0

NZ 30 SE 11 **3881 0153** **Greenhills, Deighton** **Block F**

Surface level +80.3 m
Water not encountered
March 1978

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown, stony; 0.8 m reddish brown, silty stoneless clay at 6.5 m	17.7+	18.0

NZ 31 NW 17 **3113 1934** **Little Ketton, Barmpton** **Block A**

Surface level +77.7 m
Water struck at +63.3 m
October 1976

Overburden	3.4 m
Mineral	7.0 m
Waste	9.8 m
Mineral	4.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, reddish brown to brown,poorly laminated with few stones to 1.8 m, massive and stony below	3.2	3.4
Glacial Sand and Gravel	**a** 'Very clayey' sand Sand: fine, subangular to subrounded; quartz with some coal Fines: thin reddish brown silty clay bands	7.0	10.4
Till	Clay, brown and reddish brown with some stones; 1.3 m of sandy silt at 20.2 m	9.8	20.2
Glacial Sand and Gravel	**b** 'Very clayey' sand on 'very clayey' sandy gravel; 0.1 m silt at 21.3 m Gravel: mainly fine, angular to rounded; sandstone with limestone, igneous rocks, dolomite, quartzite and chert and some quartz, siltstone and ironstone and trace of coal Sand: mainly fine; quartz and quartzite with other lithic grains as in gravel Fines: thin bands of reddish brown silt and silty clay	4.8+	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 mm
a	30	70	0	3.4-4.4	23	50	26	1	0	0	0
				4.4-5.4	35	52	9	1	1	2	0
				5.4-6.4	25	70	5	0	0	0	0
				6.4-7.4	26	70	4	0	0	0	0
				7.4-8.4	29	70	1	0	0	0	0
				8.4-9.4	38	57	4	1	0	0	0
				9.4-10.4	32	49	18	0	1	0	0
				Mean	**30**	**60**	**10**	**trace**	**trace**	**trace**	**0**
b	27	56	17	20.2-21.2	37	45	12	4	1	1	0
				21.2-21.3	Silt band						
				21.3-22.3	19	20	15	17	17	12	0
				22.3-23.3	20	20	16	17	18	9	0
				23.3-25.0	25	32	15	12	10	6	0
				Mean*	**27**	**30**	**14**	**12**	**11**	**6**	**0**
a+b	**29**	**64**	**7**	**Mean***	**29**	**47**	**12**	**5**	**5**	**2**	**0**

*Assuming ungraded silt comprises 100% fines

COMPOSITION

Depth below surface (m)	percentages by weight in gravel fraction								
	Sandstone	Limestone	Dolomite	Quartz/ Quartzite	Igneous	Chert	Mudstone/ Siltstone	Ironstone	Coal
21.3-25.0	60	11	6	7	8	6	1	1	trace

NZ 31 NW 18 **3237 1944** **Moor House, Barmpton** **Block A**

Surface level +78.0 m
Water level +72.7 m
September 1976

Overburden	18.0 m
Mineral	6.2 m
Waste	0.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, red-brown and grey, soft, silty, mainly stone-free; scattered thin sand partings	5.2	5.5
Glacial Sand and Gravel	'Clayey' fine sand	1.8	7.3
Till	Clay, red-brown to brown, silty, poorly laminated and stone-free to 9.3 m, massive and stony below	5.9	13.2
Glacial Sand and Gravel	'Very clayey' fine sand with 0.2 m pebbly clay at 14.2 m	3.3	16.5
	Silt, red brown, mainly very sandy; 0.2 m pebbly clay at top	1.5	18.0
	'Clayey' sand with scattered thin clay bands: fine quartz	6.2	24.2
Till	Clay, red-brown, firm silty	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 mm	
27	73	0	18.0-19.0	29	53	17	1	0	0	0	
			19.0-20.0	22	48	28	2	0	0	0	
			20.0-21.0	24	55	20	1	0	0	0	
			21.0-22.0	31	52	16	1	0	0	0	
			22.0-23.0	30	53	16	1	0	0	0	
			23.0-24.2	29	50	20	1	0	0	0	
			Mean	**27**	**52**	**20**	**1**	**0**	**0**	**0**	

NZ 31 NW 19 **3392 1894** **Petty's Nook, Barmpton** **Block A**

Surface level +51.5 m
Water level +49.8 m
January 1976

Overburden	0.6 m
Mineral	6.1 m
Waste	0.2 m
Mineral	1.5 m
Waste	16.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Glacial Sand and Gravel	**a** 'Clayey' sandy gravel and pebbly sand on sand Gravel: fine and coarse with some cobbles at top, subangular to subrounded; sandstone and limestone with dolomite Sand: fine and medium; quartz and lithic grains as in gravel with a trace of coal	6.1	6.7
	Clay, purplish brown, with thin bands of sand	0.2	6.9
	b 'Clayey' sand: fine; quartz with sandstone, limestone and dolomite	1.5	8.4
	Sandy silt, greyish brown, slightly micaceous	1.9	10.3
Till	Clay, greyish brown to reddish brown, massive, stony from 14.0 m to 16.0 m; some thin sand and silt laminae	14.7+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	15	67	18	0.6-2.0	26	20	15	7	9	14	9
				2.0-3.1	17	15	13	12	15	28	0
				3.1-4.0	19	34	20	12	10	5	0
				4.0-5.0	7	44	44	4	1	0	0
				5.0-6.7	8	54	34	3	1	0	0
				Mean	**15**	**35**	**25**	**7**	**7**	**9**	**2**
b	13	87	0	6.9-8.4	13	67	19	1	0	0	0
a+b	**15**	**71**	**14**	**Mean**	**15**	**41**	**24**	**6**	**5**	**7**	**2**

NZ 31 NW 20 **3459 1893** **Longpasture House, Sadberge** **Block B**

Surface level +49.7 m
Water struck at +43.8 m
September 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, red-brown, mainly massive; some stones, patches of sand and silt laminae	5.5	5.9
Glacial Sand and Gravel	'Very clayey' pebbly sand	1.0	6.9
	Silt, red, soft, clayey and micaceous; some sand laminae	3.1	10.0
Glacial Drift, undifferentiated	Clay and sand: brown and grey, partly massive and partly poorly laminated clay with some stones, interbedded with 'very clayey' sands up to 0.5 m thick	8.0+	18.0

NZ 31 NW 21 **3055 1844** **Skerningham** **Block A**

Surface level +76.2 m
Groundwater conditions not recorded
October 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, red-brown, mainly massive, stony; scattered thin bands of sand	7.5	7.9
Glacial Sand and Gravel	'Very clayey' pebbly sand	0.7	8.6
Glacial Drift, undifferentiated	Clay, red-brown to dark brown, sandy and stony near top; laminae and thin bands of sand, 0.8 m very sandy silt at 17.5 m	9.4+	18.0

NZ 31 NW 22 **3207 1831** **Barmpton Grange Farm** **Block A**

Surface level +59.4 m
Groundwater conditions not recorded
February 1976

Overburden 1.8 m
Mineral 23.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
?Head	Clay, reddish brown, silty with some stones	1.5	1.8
Glacial Sand and Gravel	'Clayey' sand with some pebbles in parts, reddish brown; fine to medium; quartz with some Carboniferous limestone, sandstone, Magnesian Limestone and coal	23.2+	25.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
15	84	1	1.8-2.8	18	43	30	4	5	0	0
			2.8-3.8	18	58	23	1	0	0	0
			3.8-4.8	12	32	51	5	0	0	0
			4.8-5.8	12	31	56	1	0	0	0
			5.8-6.8	9	27	62	1	0	1	0
			6.8-7.8	12	23	65	0	0	0	0
			7.8-8.8	12	29	59	0	0	0	0
			8.8-9.8	12	35	53	0	0	0	0
			9.8-10.8	13	38	49	0	0	0	0
			10.8-11.8	16	45	39	0	0	0	0
			11.8-12.8	14	46	40	0	0	0	0
			12.8-13.8	10	50	40	0	0	0	0
			13.8-14.8	11	53	36	0	0	0	0
			14.8-15.8	14	62	24	0	0	0	0
			15.8-16.8	16	70	14	0	0	0	0
			16.8-17.8	12	73	8	1	0	6	0
			17.8-18.8	19	74	5	1	0	1	0
			18.8-19.8	22	71	5	1	0	1	0
			19.8-20.8	18	76	6	0	0	0	0
			20.8-21.8	20	70	7	1	1	1	0
			21.8-22.8	23	74	3	0	0	0	0
			22.8-23.8	17	75	8	0	0	0	0
			23.8-24.8	16	76	8	0	0	0	0
			Mean	**15**	**53**	**30**	**1**	**trace**	**1**	**0**

NZ 31 NW 23 **3309 1808** **Burdon Hall** **Block A**

Surface level +48.5 m
Water struck at +36.4 m
February 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Lacustrine Alluvium	Silty clay, pale brown and grey; irregular fine sand laminae	1.7	2.0
	Sandy silt, grey-brown to brown; some bands of stony silty clay up to 5 cm thick	2.1	4.1
?Glacial Sand and Gravel	Gravel: fine gravel and medium to coarse sand	0.9	5.0
Till	Clay, brown to red-brown, mainly massive; some stones, sand and silty clay laminae, 0.2 m sandy silt at base	7.3	12.3
	Clay, grey-green to grey-brown, stoneless; fine sand laminae	5.7+	18.0

NZ 31 NW 24 **3415 1810** **Hill House, Sadberge** **Block A**

Surface level +63.1 m
Water struck at +55.6 m
September 1976

Overburden	7.5 m
Mineral	9.0 m
Waste	1.5 m
Mineral	7.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, reddish brown, massive with some stones	7.2	7.5
Glacial Sand and Gravel	**a** 'Very clayey' sand Sand: fine, quartz with some lithic grains Fines: thin bands of reddish brown silty clay	9.0	16.5
Till	Clay, blue-grey to brown; silty and sandy laminae, some stones at base	1.5	18.0
Glacial Sand and Gravel	**b** 'Clayey' partly pebbly sand Gravel: fine and coarse, subangular to subrounded; sandstone with limestone, dolomite, igneous rocks and some chert, quartzite and quartz Sand: fine and medium; quartz with lithic grains as in gravel	7.0+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	23	77	0	7.5-8.5	22	50	27	1	0	0	0
				8.5-9.5	27	50	22	1	0	0	0
				9.5-10.5	31	55	14	0	0	0	0
				10.5-11.5	36	53	11	0	0	0	0
				11.5-12.5	16	76	8	0	0	0	0
				12.5-13.5	16	77	7	0	0	0	0
				13.5-14.5	14	80	6	0	0	0	0
				14.5-15.5	18	73	9	0	0	0	0
				15.5-16.5	25	69	6	0	0	0	0
				Mean	**23**	**65**	**12**	**trace**	**0**	**0**	**0**
b	11	83	6	18.0-19.0	19	74	7	0	0	0	0
				19.0-20.0	12	41	42	4	1	0	0
				20.0-21.0	12	28	49	4	4	3	0
				21.0-22.0	6	33	59	1	1	0	0
				22.0-23.0	8	35	55	2	0	0	0
				23.0-24.0	12	32	37	3	3	13	0
				24.0-25.0	4	10	47	18	7	14	0
				Mean	**11**	**36**	**42**	**5**	**2**	**4**	**0**
a+b	**18**	**79**	**3**	**Mean**	**18**	**52**	**25**	**2**	**1**	**2**	**0**

COMPOSITION

Depth below surface (m)	percentages by weight in gravel fraction								
	Sandstone	Limestone	Dolomite	Quartz/ Quartzite	Igneous	Chert	Mudstone/ Siltstone	Ironstone	Coal
20.0-25.0	54	20	8	5	7	5	trace	trace	trace

NZ 31 NW 25 **3018 1775** **Haughton Moor House** **Block A**

Surface level +66.8 m
Water struck at +46.3 m
October 1976

Overburden	8.3 m
Mineral	5.4 m
Waste	11.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, reddish brown, massive, stony; 1.0 m sandy silt at top	8.0	8.3
Glacial Sand and Gravel	'Clayey' gravel, sandy in upper part Gravel: fine and coarse with some cobbles, angular to subrounded; sandstone and limestone with chert, quartzite, dolomite and igneous rock and some siltstone, ironstone and trace of coal Sand: mainly medium and coarse; quartz with lithic grains as gravel	5.4	13.7
Till	Clay, dark brown and grey, stony and silty	6.3	20.0
	Sandy silt	2.8	22.8
	Clay, brown to red brown, pebbly; thin silt and sand partings	2.2+	25.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
10	43	47	8.3-9.3	21	19	20	11	18	11	0
			9.3-10.3	21	14	15	14	23	13	0
			10.3-11.3	4	3	15	21	28	19	10
			11.3-12.3	4	4	17	22	23	30	0
			12.3-13.7	3	4	17	19	27	22	8
			Mean	**10**	**8**	**17**	**18**	**24**	**19**	**4**

COMPOSITION

Depth below surface (m)	percentages by weight in gravel fraction								
	Sandstone	Limestone	Dolomite	Quartz/ Quartzite	Igneous	Chert	Mudstone/ Siltstone	Ironstone	Coal
9.3-10.3	37	28	8	8	6	11	1	1	0
12.3-13.7	38	26	3	12	9	8	1	3	trace

NZ 31 NW 26 **3155 1763** **Elly Hill, Barmpton** **Block A**

Surface level +60.0 m
Water struck at +57.1 m
November 1976

Overburden	2.9 m
Mineral	1.2 m
Waste	9.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.9	0.9
Till	Clay, reddish brown, sandy and silty, with some stones	2.0	2.9
Glacial Sand and Gravel	'Clayey' gravel Gravel: fine and coarse, angular to rounded; sandstone with limestone, quartzite, igneous rock, dolomite, ironstone and chert Sand: fine to coarse, angular to rounded; lithic grains as in gravel with quartz	1.2	4.1
Till	Clay, dark brown and greyish brown, silty and sandy with stones; sand partings from 4.5 m to 5.5 m	9.9+	14.0
	Borehole abandoned due to obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm	
10	36	54	2.9-4.1	10	13	9	14	26	28	0	

COMPOSITION

Depth below surface (m)	percentages by weight in gravel fraction								
	Sandstone	Limestone	Dolomite	Quartz/ Quartzite	Igneous	Chert	Mudstone/ Siltstone	Ironstone	Coal
2.9-4.1	51	22	4	11	7	2	trace	3	0

NZ 31 NW 27 **3237 1719** **Burdon Gardens, Great Burdon** **Block A**

Surface level +49.1 m
Groundwater conditions not recorded
February 1976

Overburden	2.2 m
Mineral	3.3 m
Waste	9.7 m
Mineral	4.7 m
Waste	5.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.9	0.9
Glacial Sand and Gravel	Sandy silt, brown and reddish brown	1.3	2.2
	a 'Clayey' pebbly sand and sandy gravel Gravel: fine to coarse, angular to subrounded; sandstone, limestone and dolomite Sand: mainly fine; quartz with lithic grains as gravel Fines: brown silt bands near top	3.3	5.5
Till	Clay, brown and reddish brown, stony and silty, laminated in part, thin bands of sand at 8.7 m and 9.5 m	9.7	15.2
Glacial Sand and Gravel	**b** 'Very clayey' sand: fine; quartz with sandstone, limestone, dolomite and some coal	4.7	19.9
Till	Clay, brown, massive, stony	4.3	24.2
Glacial Sand and Gravel	'Very clayey' sand: fine to medium; quartz with rock fragments including much coal; some pebbles	0.8+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
a	17	67	16	2.2-3.2	23	54	13	2	2	6	0
				3.2-4.2	17	26	10	17	12	18	0
				4.2-5.5	12	50	22	5	7	4	0
				Mean	**17**	**43**	**16**	**8**	**7**	**9**	**0**
b	21	79	0	15.2-16.2	33	65	2	0	0	0	0
				16.2-17.2	27	68	5	0	0	0	0
				17.2-18.2	16	78	6	0	0	0	0
				18.2-19.2	14	80	6	0	0	0	0
				19.2-19.9	16	75	8	1	0	0	0
				Mean	**21**	**74**	**5**	**trace**	**0**	**0**	**0**
a+b	**19**	**74**	**7**	**Mean**	**19**	**61**	**10**	**3**	**3**	**4**	**0**

NZ 31 NW 28 **3340 1727** **Sadberge** **Block B**

Surface level +47.5 m
Water struck at +43.6 m
September 1976

Overburden	3.9 m
Mineral	6.0 m
Waste	0.5 m
Mineral	2.0 m
Waste	12.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Lacustrine Alluvium	Clay, brown; some sandy and silty laminae	3.7	3.9
Glacial Sand and Gravel	**a** 'Clayey' to 'very clayey' sand: mainly fine; quartz with sandstone, limestone, dolomite, coal and igneous grains	6.0	9.9
	Clay, brown, silty, with some stones	0.5	10.4
Glacial Sand and Gravel	**b** 'Very clayey' sand: as above with thin layers of brown stony clay	2.0	12.4
Laminated Clay	Clay, grey and reddish brown, silty, poorly laminated	2.7	15.1
	Silt and sand, brown; thin bands of laminated stoneless clay	7.9	23.0
Till	Clay, brown, massive, stony	2.0+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	19	81	0	3.9-4.9	36	51	10	2	1	0	0
				4.9-5.9	23	69	8	0	0	0	0
				5.9-6.9	13	59	27	1	0	0	0
				6.9-7.9	23	56	19	2	0	0	0
				7.9-8.9	11	33	52	4	0	0	0
				8.9-9.9	6	19	70	5	0	0	0
				Mean	**19**	**48**	**31**	**2**	**trace**	**0**	**0**
b	28	70	2	10.4-11.4	31	41	20	7	1	0	0
				11.4-12.4	25	46	21	5	1	2	0
				Mean	**28**	**44**	**20**	**6**	**1**	**1**	**0**
a+b	**21**	**78**	**1**	**Mean**	**21**	**47**	**28**	**3**	**1**	**trace**	**0**

NZ 31 NW 29 **3190 1645** **Great Burdon** **Block A**

Surface level +46.6 m
Water struck at +43.6 m
September 1976

Overburden	0.7 m
Mineral	9.1 m
Waste	5.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.7	0.7
River Terrace Deposits, undifferentiated	'Clayey' sandy gravel and pebbly sand Gravel: fine to coarse, subangular to rounded; sandstone with limestone, chert, quartzite, igneous rock, dolomite and some siltstone, ironstone and coal Sand: medium with fine and coarse, angular to subangular; quartz and lithics as in gravel	9.1	9.8
Till	Clay, reddish brown and greyish brown, sandy and silty at top; some stones especially towards base	5.5+	15.3
	Borehole abandoned		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
10	65	25	0.7-1.7	22	35	36	5	1	1	0
			1.7-3.0	17	24	41	9	7	2	0
			3.0-4.0	17	2	11	19	23	28	0
			4.0-5.0	2	4	21	20	18	29	6
			5.0-6.0	6	20	19	12	13	30	0
			6.0-7.0	10	42	33	12	3	0	0
			7.0-8.0	4	21	45	9	10	11	0
			8.0-9.0	3	11	45	17	15	9	0
			9.0-9.8	4	14	44	13	12	13	0
			Mean	**10**	**19**	**33**	**13**	**11**	**13**	**1**

COMPOSITION

Depth below surface (m)	percentages by weight in gravel fraction								
	Sandstone	Limestone	Dolomite	Quartz/ Quartzite	Igneous	Chert	Mudstone/ Siltstone	Ironstone	Coal
3.0-6.0	44	19	9	4	6	15	trace	2	trace
7.0-9.8	55	13	3	8	7	10	3	0	1

NZ 31 NW 30 **3293 1650** **Little Burdon** **Block B**

Surface level +52.1 m
Water struck at +46.0 m
September 1976

Overburden	0.8 m
Mineral	4.2 m
Waste	1.1 m
Mineral	7.0 m
Waste	1.0 m
Mineral	4.1 m
Waste	6.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.8	0.8
Glacial Sand and Gravel	**a** 'Very clayey' sand, pebbly in part Sand: fine; quartz with some dark lithic fragments including coal Fines: grey clay and reddish brown silt	4.2	5.0
Till	Clay, dark grey, sandy and stony	1.1	6.1
Glacial Sand and Gravel	**b** 'Clayey' sand: as above	7.0	13.1
	Sandy silt, brown	1.0	14.1
	c 'Clayey' sand: as above	4.1	18.2
Till	Clay, brown, sandy in part; some stones	6.8+	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 mm
a	28	70	2	0.8-1.8	35	49	15	1	0	0	0
				1.8-2.8	29	54	16	1	0	0	0
				2.8-3.8	14	50	25	5	5	1	0
				3.8-5.0	35	53	9	2	1	0	0
				Mean	**28**	**52**	**16**	**2**	**2**	**trace**	**0**
b	14	86	0	6.1-7.1	11	69	19	1	0	0	0
				7.1-8.1	14	53	32	1	0	0	0
				8.1-9.1	14	72	13	1	0	0	0
				9.1-10.1	13	77	10	0	0	0	0
				10.1-11.1	13	74	13	0	0	0	0
				11.1-12.1	17	69	14	0	0	0	0
				12.1-13.1	13	71	15	1	0	0	0
				Mean	**14**	**69**	**16**	**1**	**0**	**0**	**0**
c	11	89	0	14.1-15.1	17	66	17	0	0	0	0
				15.1-16.1	6	70	24	0	0	0	0
				16.1-17.1	8	67	25	0	0	0	0
				17.1-18.2	13	67	20	0	0	0	0
				Mean	**11**	**68**	**21**	**0**	**0**	**0**	**0**
a+b+c	**17**	**83**	**0**	**Mean**	**17**	**64**	**18**	**1**	**trace**	**trace**	**0**

NZ 31 NW 31 **3425 1679** **Roman Road, Sadberge** **Block B**

Surface level +64.3 m
Water level +63.1 m
February 1976

Overburden 3.8 m
Mineral 15.7 m
Waste 5.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown and reddish brown, massive to poorly laminated; few stones	3.5	3.8
Glacial Sand and Gravel	'Clayey' to 'very clayey' sand: fine; quartz with some coal and other lithic grains	15.7	19.5
	Sandy silt, red-brown to brown; some thin clay bands and coaly laminae	4.2	23.7
Till	Silty clay, brown, some stones	1.3+	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 mm
18	82	0	3.8-4.8	15	68	17	0	0	0	0
			4.8-5.8	12	78	10	0	0	0	0
			5.8-6.8	21	73	6	0	0	0	0
			6.8-7.8	9	81	10	0	0	0	0
			7.8-8.8	9	80	10	1	0	0	0
			8.8-9.8	19	75	6	0	0	0	0
			9.8-10.8	10	87	3	0	0	0	0
			10.8-11.8	9	88	3	0	0	0	0
			11.8-12.8	11	85	4	0	0	0	0
			12.8-13.8	24	74	2	0	0	0	0
			13.8-14.8	33	65	2	0	0	0	0
			14.8-15.8	20	78	2	0	0	0	0
			15.8-16.8	23	75	2	0	0	0	0
			16.8-17.8	23	75	2	0	0	0	0
			17.8-19.5	23	75	2	0	0	0	0
			Mean	**18**	**77**	**5**	**0**	trace	**0**	**0**

NZ 31 NW 32 **3245 1564** **Buess Lane, Great Burdon** **Block A**

Surface level +52.4 m
Water not encountered
September 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown, massive, stony except near base; 0.3 m gravel at 5.6 m and thin sands at 6.0 m and 16.0 m. Becomes stone-free towards base	17.7+	18.0

NZ 31 NW 33 **3366 1571** **Sadberge Hall**

Surface level +51.5 m
Water not encountered
November 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, brown and greyish brown, part silty, stony; poorly laminated from 3.2 m to 4.2 m	17.8+	18.0

NZ 31 NW 34 **3465 1555** **Street House, Sadberge**

Surface level +53.6 m
Water not encountered
February 1976

Waste 18.0 +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Sandy silt, with clay partings	2.7	3.0
	Clay, brown, mainly stony; thin bands and lenses of fine sand below 14.0 m	15.0+	18.0

E NZ 31 NW 1 **3105 1795** **Barmpton** **Block A**

Surface level +c76 m
February 1977

Overburden 2.0 m
Mineral 24.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil and stony clay	2.0	2.0
Glacial Sand and Gravel	Sandy gravel Gravel: fine and coarse with some cobbles, subangular to subrounded; sandstone with quartzite, limestone and dolomite, some basic igneous and Borrowdale Volcanic Group rocks, chert, quartz and siltstone and traces of coal and ironstone Sand: medium and coarse, subangular to subrounded; lithic fragments as in gravel Fines: scattered lumps of red clay	24.0+	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 mm
3	52	45	2.0-6.0	9	3	17	29	32	10	0
			6.0-10.0	2	4	5	8	23	38	20
			10.0-18.0	2	2	14	28	26	18	10
			18.0-22.0	3	15	59	17	6	0	0
			22.0-26.0	2	4	25	37	25	7	0
			Mean	**3**	**5**	**22**	**25**	**23**	**15**	**7**

COMPOSITION

Depth below surface (m)	percentages by weight in gravel fraction								
	Sandstone	Limestone	Dolomite	Quartz/ Quartzite	Igneous	Chert	Mudstone/ Siltstone	Ironstone	Coal
2.0-6.0	21	15	15	33	10	4	1	trace	trace
6.0-10.0	45	10	26	8	6	4	trace	1	0

NZ 31 NE 11 **3597 1933** **Gilly Flat Farm, Bishopton** **Block B**

Surface level +55.2 m
Grounderwater conditions not recorded
September 1976

Overburden 13.2 m
Mineral 8.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown and reddish brown, some stones, sandy and silty towards base	12.9	13.2
Glacial Sand and Gravel	'Clayey' sand with thin gravel and clay partings at top Gravel: fine and coarse, subrounded; Carboniferous limestone and sandstone with Triassic sandstone, and Permian dolomite and some igneous rocks Sand: fine, subangular to subrounded; quartz and lithic grains Fines: silt and clay bands, especially in lower part	8.1+	21.3
	Borehole abandoned		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
13	85	2*	13.2-13.6	24	18	12	5	20	21	0
			13.6-13.7	Silty clay band						
			13.7-14.7	7	41	51	1	0	0	0
			14.7-15.7	6	48	45	1	0	0	0
			15.7-16.7	6	47	46	1	0	0	0
			16.7-17.7	5	67	27	1	0	0	0
			17.7-18.7	9	79	12	0	0	0	0
			18.7-19.7	16	77	7	0	0	0	0
			19.7-20.7	17	80	3	0	0	0	0
			20.7-21.3	30	68	2	0	0	0	0
			Mean*	**13**	**60**	**24**	**1**	**1**	**1**	**0**

* Assuming ungraded clay comprises 100 per cent fines

NZ 31 NE 12 **3697 1891** **Newbiggin East** **Block B**

Surface level +50.3 m
Water not encountered
January 1976

Waste	18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, reddish brown and brown, stone-free in part with some sandy laminae from 6.0 m to 11.0 m	17.7+	18.0

NZ 31 NE 13 **3807 1908** **Ox Hill, Newbiggin** **Block B**

Surface level +55.2 m
Water not encountered
January 1976

Overburden	11.4 m
Mineral	6.6 m
Waste	2.0 m
Mineral	5.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, reddish brown with some stones	11.1	11.4
Glacial Sand and Gravel	a 'Clayey' sand: fine; quartz with some sandstone, limestone and coal	6.6	18.0
	Sandy silt with laminae and lenses of coal debris	2.0	20.0
	b 'Very clayey' sand: as above	5.0+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
a	16	84	0	11.4-12.4	16	70	14	0	0	0	0
				12.4-13.4	28	65	7	0	0	0	0
				13.4-14.4	17	77	6	0	0	0	0
				14.4-15.4	12	77	10	1	0	0	0
				15.4-16.4	11	73	15	1	0	0	0
				16.4-18.0	13	72	14	1	0	0	0
				Mean	**16**	**72**	**11**	**1**	**0**	**0**	**0**
b	26	74	0	20.0-21.0	32	66	2	0	0	0	0
				21.0-22.0	25	74	1	0	0	0	0
				22.0-23.0	22	76	2	0	0	0	0
				23.0-24.0	22	77	1	0	0	0	0
				24.0-25.0	30	69	1	0	0	0	0
				Mean	**26**	**73**	**1**	**0**	**0**	**0**	**0**
a+b	**20**	**80**	**0**	**Mean**	**20**	**73**	**7**	**0**	**0**	**0**	**0**

NZ 31 NE 14 **3900 1923** **Gooseberry Farm, Redmarshall**

Surface level +44.5 m
Water struck at +32.5 m
January 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, brown and reddish brown, massive, stony; clayey silt with some sand laminae from 2.2 m to 3.0 m	4.2	4.6
	Clayey silt, grey to grey-brown; sand laminae	4.2	8.8
	Clay, brown to red-brown, massive, stony	9.2+	18.0

NZ 31 NE 15 **3533 1814** **Newbiggin West** **Block B**

Surface level +55.2 m
Water level +53.8 m
February 1976

Overburden 2.5 m
Mineral 1.9 m
Waste 13.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown and grey, silty to sandy; sand laminae in lower part	2.2	2.5
Glacial Sand and Gravel	'Clayey' sand, greyish brown: mainly fine; quartz with coal and some sandstone, limestone and dolomite	1.9	4.4
Till	Clay, brown and reddish brown, silty from 8.0 m to 10.4 m, stoneless and laminated from 16.0 m to 16.5 m	13.6+	18.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
16	84	0	2.5-3.5	20	46	33	1	0	0	0
			3.5-4.4	12	62	25	1	0	0	0
			Mean	**16**	**54**	**29**	**1**	**0**	**0**	**0**

NZ 31 NE 16 **3642 1813** **Fox Hill, Long Newton**

Surface level +50.3 m
Water struck at +35.3 m
January 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, reddish brown, mainly massive and stony but laminated and stone-free from 8.0 m to 15.0 m and silty and laminated from 15.0 m to 17.0 m	17.8+	18.0

NZ 31 NE 17 **3755 1832** **Long Newton Grange** **Block B**

Surface level +49.4 m
Water level +46.8 m
January 1976

Overburden 1.6 m
Mineral 1.8 m
Waste 11.8 m
Mineral 4.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Silt, greyish brown, clayey at top, sandy at base; some stones	1.4	1.6
Glacial Sand and Gravel	**a** 'Very clayey' pebbly sand Gravel: fine and coarse; sandstone, limestone and dolomite Sand: mainly fine; quartz and lithic grains as in gravel Fines: silt and clay partings	1.8	3.4
Till	Clay, brown to red-brown, stony, generally massive but irregular sand laminae in parts	6.5	9.9
Glacial Sand and Gravel	Sandy gravel	0.9	10.8
Till	Clay, red-brown to dark brown, stony in upper part, generally massive but with sand laminae from 12.0 m to 14.0 m	4.4	15.2
Glacial Sand and Gravel	**b** 'Clayey' to 'very clayey' sand, grey-brown: fine; quartz with coal and some sandstone and limestone	4.0+	19.2
	Borehole abandoned		

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	30	63	7	1.6-2.6	32	47	15	3	3	0	0
				2.6-3.4	28	35	15	10	5	7	0
				Mean	**30**	**42**	**15**	**6**	**4**	**3**	**0**
b	19	80	1	15.2-16.2	37	57	3	1	1	1	0
				16.2-17.2	14	74	12	0	0	0	0
				17.8-18.2	10	77	13	0	0	0	0
				18.2-19.2	18	71	11	0	0	0	0
				Mean	**19**	**70**	**10**	**trace**	**trace**	**trace**	**0**
a+b	**23**	**74**	**3**	**Mean**	**23**	**61**	**11**	**2**	**2**	**1**	**0**

NZ 31 NE 18 3865 1817 Sandy Leas Lane, Elton

Surface level +38.4 m
Water not encountered
January 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, mainly reddish brown, stony to 7.0 m, scattered stones below, laminated in part	17.6+	18.0

NZ 31 NE 19 3979 1808 Smith House Farm, Elton

Surface level +33.8 m
Water struck at +26.2 m
January 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, red to dark brown, stony; thin grey slightly micaceous clay bands near base	7.2	7.6
Glacial Sand and Gravel	'Clayey' sand	1.9	9.5
Till	Clay, greyish to reddish brown; some silt laminae, scattered stones to 12.0 m	8.5+	18.0

NZ 31 NE 20 **3669 1725** **Bewley Hill, Long Newton**

Surface level +58.5 m
Water not encountered
February 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, reddish brown and brown, stony; silty with sand laminae to 3.4 m	17.6+	18.0

NZ 31 NE 21 **3790 1720** **Larberry Pasture, Long Newton**

Surface level +42.1 m
Water struck at +36.9 m
October 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.7	0.7
Till	Clay, reddish brown and grey, silty, laminated in parts; pebbles scattered to 11.0 m but more common below; 0.5 m 'very clayey' sand at 11.0 m and sandy silt from 14.0 m to 16.0 m	17.3+	18.0

NZ 31 NE 22 **3906 1707** **Viewley Hill, Elton**

Surface level +34.1 m
Water level +32.5 m
January 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown and reddish brown, stony and silty, laminated from 1.6 m to 2.7 m and in places elsewhere; 0.2 m gravel at 5.7 m	17.7+	18.0

NZ 31 NE 23 **3527 1640** **Newton South Grange, Sadberge**

Surface level +51.2 m
Water struck at +43.8 m
January 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown, stony, mainly massive but poorly laminated in part; some thin sand laminae and 0.6 m of 'very clayey' sand at 9.2 m	17.7+	18.0

NZ 31 NE 24 **3643 1637** **Long Newton Reservoir**

Surface level +51.8 m
Water level +47.7 m
February 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, reddish brown and brown, stony, poorly laminated in part; some lenses of fine sand from 15.6 m to base and 0.7 m of 'very clayey' sand at 10.9 m	17.7+	18.0

NZ 31 NE 25 **3762 1639** **Fairfields Farm, Long Newton**

Surface level +41.8 m
Water not encountered
January 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, reddish brown and brown; some stones; few sand lenses and poor silty laminae in places, 0.5 m 'clayey' gravel at 4.3 m	17.6+	18.0

NZ 31 NE 26 **3852 1634** **Long Newton**

Surface level +35.1 m
Water not encountered
October 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Till and Laminated Clay	Clay, brown and reddish brown, sandy and silty in part, mainly massive and stony but well laminated and stoneless from 5.6 m to 6.6 m	17.4+	18.0

NZ 31 NE 27 **3960 1653** **Moor Plantation, Long Newton**

Surface level +30.8 m
Groundwater conditions not recorded
October 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, reddish brown and brown, stony, sandy and silty in parts; 0.8 m sand at 4.3 m	17.8+	18.0

NZ 31 NE 28 **3570 1541** **Spring House, Sadberge**

Surface level +47.5 m
Water struck at +31.5 m
February 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown and reddish brown, partly stony; some thin lenses and laminae of sand, 0.4 m sandy silt at 8.2 m	15.7	16.0
	Poor recovery: ?silty sands	2.0+	18.0

NZ 31 NE 29 **3700 1537** **Mill Hill Farm, Long Newton**

Surface level +41.5 m
Groundwater conditions not recorded
November 1976

Waste 22.0 +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown, sandy to silty, massive and stony near base; sand laminae from 3.0 m to 5.3 m	6.3	6.6
Glacial Sand and Gravel	Very sandy silt and very clayey sand	3.7	10.3
Till	Clay, dark brown, silty, stony	11.7+	22.0

NZ 31 NE 30 **3786 1551** **Long Newton**

Surface level +35.1 m
Water level +32.1 m
October 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, red-brown, sandy and silty; scattered stones	4.0	4.2
Laminated Clay	Clay, dark brownish grey and red, stoneless, well laminated to 6.2 m	3.0	7.2
Till	Clay, dark brown, mainly massive and stony; thin sand at 13.3 m	10.8+	18.0

NZ 31 NE 31 **3925 1520** **East Gate, Long Newton**

Surface level +32.2 m
Groundwater conditions not recorded
October 1976

Waste 22.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, dark brown, mainly massive and stony	6.0	6.4
Glacial Sand and Gravel	Sand, 'clayey' in upper part	2.0	8.4
Laminated Clay	Clayey silt, mainly dark grey, very sandy at top, well laminated below 9.6 m	5.2	13.6
Till	Clay, dark red-brown, silty, massive and stony	8.4+	22.0

NZ 31 SW 10 **3289 1463** **Morton Palms Farm** **Block C**

Surface level +52.7 m
Groundwater conditions not recorded
October 1976

Overburden 4.2 m
Mineral 20.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, reddish brown, silty; few stones and sand laminae	3.9	4.2
Glacial Sand and Gravel	'Clayey' sand, pebbly at top Gravel: fine, subangular sandstone Sand: mainly fine, subangular to subrounded; quartz with coal, sandstone, limestone dolomite and some igneous rock	20.8+	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 mm
16	83	1	4.2-5.2	17	16	27	21	15	4	0
			5.2-6.2	18	27	51	4	0	0	0
			6.2-7.2	11	25	63	1	0	0	0
			7.2-8.2	6	22	69	1	1	1	0
			8.2-9.2	10	26	62	2	0	0	0
			9.2-10.2	25	68	7	0	0	0	0
			10.2-11.2	21	63	15	1	0	0	0
			11.2-12.2	20	63	16	1	0	0	0
			12.2-13.2	25	71	4	0	0	0	0
			13.2-14.2	22	74	4	0	0	0	0
			14.2-15.2	19	75	6	0	0	0	0
			15.2-16.2	13	74	13	0	0	0	0
			16.2-17.2	7	77	16	0	0	0	0
			17.2-18.2	7	63	30	0	0	0	0
			18.2-19.2	7	67	26	0	0	0	0
			19.2-20.2	7	71	21	1	0	0	0
			20.2-21.2	7	72	20	1	0	0	0
			21.2-22.2	10	78	11	1	0	0	0
			22.2-23.2	20	73	7	0	0	0	0
			23.2-25.0	36	60	4	0	0	0	0
			Mean	**16**	**58**	**23**	**2**	**1**	**trace**	**0**

COMPOSITION

Depth below surface (m)	percentages by weight in gravel fraction								
	Sandstone	Limestone	Dolomite	Quartz/ Quartzite	Igneous	Chert	Mudstone/ Siltstone	Ironstone	Coal
4.2-5.2	58	17	11	7	3	4	0	trace	0

NZ 31 SW 11 **3425 1460** **Highfield Farm, Fighting Cocks** **Block C**

Surface level +51.8 m
Water struck at +48.3 m
November 1976

Overburden	7.6 m
Mineral	3.0 m
Waste	3.0 m
Mineral	1.0 m
Waste	1.0 m
Mineral	6.3 m
Waste	3.1 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Till	Clay, reddish brown, silty; scattered stones, thin gravel at 3.5 m and 0.5 m sand at 7.3 m	7.0	7.6
Glacial Sand and Gravel	**a** 'Very clayey' sand: fine, subangular to subrounded; quartz with some sandstone, dolomite, limestone and trace of coal	3.0	10.6
	Sandy silt, reddish brown	3.0	13.6
	b 'Very clayey' sand: as above	1.0	14.6
	Sandy silt, reddish brown	1.0	15.6
	c Sand, 'clayey' in upper part, pebbly below Gravel: fine and coarse with few cobbles, subrounded; sandstone and limestone with igneous rock, dolomite, mudstone and quartz Sand: medium and fine; quartz and lithic grains as in gravel Fines: thin clay partings	6.3	21.9
Till	Clay, reddish brown, silty; some stones	3.1+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
a	26	74	0	7.6-8.6	12	68	18	2	0	0	0
				8.6-9.6	34	61	5	0	0	0	0
				9.6-10.6	33	64	3	0	0	0	0
				Mean	**26**	**64**	**9**	**1**	**0**	**0**	**0**
b	27	73	0	13.6-14.6	27	56	15	2	0	0	0
c	9	85	6	15.6-16.6	19	42	37	2	0	0	0
				16.6-17.6	10	40	50	0	0	0	0
				17.6-18.6	10	38	49	3	0	0	0
				18.6-19.6	4	24	35	15	13	9	0
				19.6-20.6	7	37	46	5	2	3	0
				20.6-21.9	7*	35	45	5	2	3	3*
				Mean	**9**	**36**	**44**	**5**	**3**	**3**	**trace**
a+b+c	**16**	**81**	**3**	**Mean**	**16**	**46**	**31**	**4**	**2**	**1**	**trace**

* Estimated grading

NZ 31 SW 12 **3223 1380** **Maidendale, Morton Palms** **Block C**

Surface level +53.0 m
Groundwater conditions not recorded
October 1976

Overburden 7.5 m
Mineral 17.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, reddish brown and brown, with stones	7.3	7.5
Glacial Sand and Gravel	Sand, 'very clayey' at base: mainly fine; quartz with some sandstone and limestone and traces of coal and dolomite	17.5+	25.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
9	90	1	7.5-8.5	9	53	27	3	4	4	0
			8.5-9.5	6	49	44	1	0	0	0
			9.5-10.5	7	49	41	3	0	0	0
			10.5-11.5	5	34	56	4	1	0	0
			11.5-12.5	7	65	27	1	0	0	0
			12.5-13.5	6	46	46	1	1	0	0
			13.5-14.5	5	52	42	1	0	0	0
			14.5-15.5	4	66	30	0	0	0	0
			15.5-16.5	6	63	30	1	0	0	0
			16.5-17.5	4	61	35	0	0	0	0
			17.5-18.5	5	62	33	0	0	0	0
			18.5-19.5	13	73	14	0	0	0	0
			19.5-20.5	6	57	37	0	0	0	0
			20.5-21.5	7	69	24	0	0	0	0
			21.5-22.5	12	73	14	1	0	0	0
			22.5-23.5	20	79	1	0	0	0	0
			23.5-25.0	33	60	5	2	0	0	0
			Mean	**9**	**60**	**29**	**1**	**1**	**trace**	**0**

NZ 31 SW 13 **3362 1367** **High Stodhoe, Middleton St. George** **Block C**

Surface level +48.2 m
Water struck at +37.2 m
October 1976

Overburden 5.0 m
Mineral 14.0 m
Waste 4.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, reddish brown, silty; sand and silt laminae	4.8	5.0
Glacial Sand and Gravel	Sand, 'very clayey' near top, few pebbles: fine and medium, subangular to subrounded; quartz with sandstone, limestone, dolomite, coal and igneous grains	14.0	19.0
Till	Clay, brown, massive, stony; few silt and sand laminae	4.0+	23.0
	Borehole abandoned		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
13	87	trace	5.0-6.0	25	72	3	0	0	0	0
			6.0-7.0	46	47	6	1	0	0	0
			7.0-8.0	29	50	18	3	0	0	0
			8.0-9.0	19	43	35	3	0	0	0
			9.0-10.0	5	22	66	5	1	1	0
			10.0-11.0	11	19	64	5	1	0	0
			11.0-12.0	11	37	49	3	0	0	0
			12.0-13.0	7	67	19	2	0	5	0
			13.0-14.0	7	59	31	3	0	0	0
			14.0-15.0	3	54	42	1	0	0	0
			15.0-16.0	5	48	46	1	0	0	0
			16.0-17.0	6	48	45	1	0	0	0
			17.0-19.0	3	59	37	1	0	0	0
			Mean	**13**	**49**	**36**	**2**	**trace**	**trace**	**0**

NZ 31 SW 14 **3495 1355** **Killinghall**

Surface level +37.8 m
Groundwater conditions not recorded
November 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.7	0.7
Till	Clay, mainly dark brown, massive; scattered stones	5.3	6.0
Glacial Sand and Gravel	'Clayey' fine sand	1.3	7.3
Laminated Clay	Clay, dark brown, silty, well laminated	4.0	11.3
Till	Clay, red-brown, massive to 14.3 m but poorly laminated below; some stones	6.7+	18.0

NZ 31 SW 15 **3056 1263** **Creebeck House, Darlington** **Block C**

Surface level +37.2 m
Groundwater conditions not recorded
November 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till and Laminated Clay	Clay, dark grey-brown to brown, mainly massive but well laminated from 6.3 m to 7.3 m and 12.3 m to 13.3 m, mainly stoneless to 13.3 m	17.7+	18.0

NZ 31 SW 16 **3214 1297** **Maidendale, Morton Palms** **Block C**

Surface level +46.0 m
Water struck at +41.6 m
November 1976

Overburden	5.0 m
Mineral	2.0 m
Waste	3.0 m
Mineral	1.0 m
Waste	2.0 m
Mineral	11.0 m
Waste	1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.8	0.8
Till	Clay, reddish brown and brown, silty; some stones at top	4.2	5.0
Glacial Sand and Gravel	**a** 'Very clayey' sand: fine, quartz with some lithic grains	2.0	7.0
	Sandy silt with scattered bands of silty clay	3.0	10.0
	b 'Very clayey' sand: as above	1.0	11.0
	Sandy silt	2.0	13.0
	c 'Very clayey' sand: fine; quartz with coal and other lithic grains	11.0	24.0
	Sandy silt	1.0+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
a	22	78	0	5.0-6.0	22	77	1	0	0	0	0
				6.0-7.0	22	77	1	0	0	0	0
				Mean	**22**	**77**	**1**	**0**	**0**	**0**	**0**
b	38	62	0	10.0-11.0	38	61	1	0	0	0	0
c	20	80	trace	13.0-14.0	39	60	1	0	0	0	0
				14.0-15.0	18	80	2	0	0	0	0
				15.0-16.0	13	71	15	1	0	0	0
				16.0-17.0	16	69	14	1	0	0	0
				17.0-18.0	16	64	19	1	0	0	0
				18.0-19.0	14	67	18	1	0	0	0
				19.0-20.0	16	68	14	2	0	0	0
				20.0-21.0	12	74	11	3	0	0	0
				21.0-22.0	12	64	13	8	3	0	0
				22.0-23.0	30	68	2	0	0	0	0
				23.0-24.0	37	62	1	0	0	0	0
				Mean	**20**	**68**	**10**	**2**	**trace**	**0**	**0**
a+b+c	**22**	**78**	**trace**	**Mean**	**22**	**69**	**8**	**1**	**trace**	**0**	**0**

NZ 31 SW 17 **3300 1280** **Morton Farm, Morton Palms** **Block C**

Surface level +46.6 m
Water struck at +36.1 m
November 1976

Overburden	4.5 m
Mineral	2.0 m
Waste	1.0 m
Mineral	11.0 m
Waste	2.0 m
Mineral	1.0 m
Waste	2.0 m
Mineral	1.0 m
Waste	0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, reddish brown to brown, silty and sandy; stones in places	4.3	4.5
Glacial Sand and Gravel	**a** 'Very clayey' sand: fine; quartz with some lithic grains and traces of coal	2.0	6.5
	Sandy silt and clay	1.0	7.5
	b 'Very clayey' sand: as above	11.0	18.5
	Silty clay	2.0	20.5
	c 'Very clayey' sand: as above	1.0	21.5
	Very sandy silt	2.0	23.5
	d 'Very clayey' sand: as above	1.0	24.5
	Very sandy silt	1.5+	25.0

GRADING

	Mean for deposit percentages			Depth below surface (m)	percentages						
	Fines	Sand	Gravel		Fines	Sand			Gravel		
					$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}$ -1	+1 -4	+4 -16	+16 -64	+64 mm
a	37	63	0	4.5-5.5	39	61	0	0	0	0	0
				5.5-6.5	36	64	0	0	0	0	0
				Mean	**37**	**63**	**0**	**0**	**0**	**0**	**0**
b	28	72	0	7.5-8.5	11	88	1	0	0	0	0
				8.5-9.5	43	57	0	0	0	0	0
				9.5-10.5	37	63	0	0	0	0	0
				10.5-11.5	23	77	0	0	0	0	0
				11.5-12.5	36	63	1	0	0	0	0
				12.5-13.5	19	80	1	0	0	0	0
				13.5-14.5	22	77	1	0	0	0	0
				14.5-15.5	21	78	1	0	0	0	0
				15.5-16.5	19	80	1	0	0	0	0
				16.5-17.5	35	65	0	0	0	0	0
				17.5-18.5	37	63	0	0	0	0	0
				Mean	**28**	**71**	**1**	**0**	**0**	**0**	**0**
c	32	68	0	20.5-21.5	32	67	1	0	0	0	0
d	37	63	0	23.5-24.5	37	62	1	0	0	0	0
a-d	**30**	**69**	**1**	**Mean**	**30**	**69**	**1**	**0**	**0**	**0**	**0**

NZ 31 SW 18 **3387 1271** **Hunger Hill, Middleton St. George**

Surface level +48.5 m
Groundwater conditions not recorded
October 1976

Waste 25.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, red-brown, mainly massive, stony to 4.3 m	11.8	12.1
Glacial Sand and Gravel	'Very clayey' fine sand with thin clay bands	2.0	14.1
	Very sandy silt	2.7	16.8
Till	Clay, dark brown, mainly massive and stony but poorly laminated and stone-free in part below 17.8 m	8.2+	25.0

NZ 31 SW 19 **3050 1172** **Round Hill, Hurworth** **Block C**

Surface level +36.0 m
Groundwater conditions not recorded
November 1976

Overburden 2.3 m
Mineral 2.0 m
Waste 11.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	Clay, reddish brown; some stones	1.9	2.3
Glacial Sand and Gravel	'Clayey' sand, mainly medium; quartz with sandstone, dolomite, quartzite and coal	2.0	4.3
Laminated Clay	Clay, blue-grey to red-brown, poorly to well laminated	9.0	13.3
Till	Clay, dark brown, stony, sandy at base	2.7+	16.0
	Borehole abandoned		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
10	87	3	2.3-3.3	11	21	55	10	3	0	0
			3.3-4.3	9	21	55	12	3	0	0
			Mean	**10**	**21**	**55**	**11**	**3**	**0**	**0**

NZ 31 SW 20 **3158 1147** **Skip Bridge, Hurworth** **Block C**

Surface level +38.7 m
Water struck at +35.7 m
November 1976

Waste 19.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, red-brown to dark brown, mainly massive, stony in part	8.4	8.6
Laminated Clay	Clay, blue-grey, very silty in upper part, poorly to well laminated	10.4+	19.0

NZ 31 SW 21 **3261 1135** **Cold Comfort, Neasham** **Block C**

Surface level +44.8 m
Groundwater conditions not recorded
November 1976

Waste 25.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, red-brown, massive; some pebbles, silt laminae	3.3	3.5
Glacial Drift, undifferentiated	Very sandy silt and 'very clayey' sand with bands of clay	16.0	19.5
Glacial Sand and Gravel	Gravel	5.5+	25.0

NZ 31 SW 22 **3342 1180** **Golf Course, Low Dinsdale**

Surface level +53.6 m
Groundwater conditions not recorded
November 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, reddish brown, silty and sandy near top, mainly massive but poorly laminated and with thin bands of sand below 14.0 m; scattered stones	17.7+	18.0

NZ 31 SW 23 **3467 1170** **Over Dinsdale Grange** **Block E**

Surface level +18.3 m
Water struck at +10.8 m
December 1976

Overburden	0.6 m
Mineral	2.0 m
Waste	5.9 m
Bedrock	1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
River Terrace Deposits, undifferentiated	'Very clayey' sandy gravel Gravel: fine and coarse, subangular to subrounded; sandstone with ironstone, quartzite, igneous rock and some chert, siltstone and trace of coal Sand: fine to coarse; quartz with some lithic grains as gravel	2.0	2.6
Till	Clay, brown, sandy; some stones, thin sand at about 7.5 m	5.9	8.5
Permian Upper Marl	Mudstone, soft, and sandstone; red	1.0+	9.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
30	50	20	0.6-2.6	30	23	16	11	10	10	0

COMPOSITION

Depth below surface (m)	percentages by weight in gravel fraction								
	Sandstone	Limestone	Dolomite	Quartz/ Quartzite	Igneous	Chert	Mudstone/ Siltstone	Ironstone	Coal
0.6-2.6	60	0	0	12	7	5	3	13	trace

NZ 31 SW 24 **3035 1059** **Garden House, Hurworth** **Block E**

Surface level +34.1 m
Water struck at +32.3 m
November 1976

Overburden	1.8 m
Mineral	2.8 m
Waste	11.2 m
Bedrock	0.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
River Terrace Deposits, undifferentiated	Clay, brown and grey, sandy in part	1.4	1.8
	Gravel, sandy at top Gravel: fine and coarse, rounded; sandstone with limestone, quartzite, dolomite, igneous rock and traces of quartz and siltstone Sand: mainly medium; quartz with lithic grains as in gravel	2.8	4.6
Till	Clay, brown and grey, massive and stony, silty and sandy near top; thin bands of sand	11.2	15.8
Sherwood Sandstone	Sandstone, red, medium	0.2+	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 mm
4	45	51	1.8-2.8	8	16	40	9	15	12	0
			2.8-3.8	1	4	17	9	32	37	0
			3.8-4.6	1	4	24	13	29	26	3
			Mean	**4**	**8**	**27**	**10**	**25**	**25**	**1**

COMPOSITION

Depth below surface (m)	percentages by weight in gravel fraction								
	Sandstone	Limestone	Dolomite	Quartz/ Quartzite	Igneous	Chert	Mudstone/ Siltstone	Ironstone	Coal
1.8-2.8	56	14	3	10	3	7	trace	6	0
3.8-4.6	49	18	4	8	3	16	trace	1	0

NZ 31 SW 25 **3151 1046** **Hilton House, Hurworth** **Block E**

Surface level +25.9 m
Water struck at +24.4 m
204 mm percussion
December 1976

Overburden	0.5 m
Mineral	1.0 m
Waste	5.5 m
Bedrock	0.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
River Terrace Deposits, undifferentiated	'Very clayey' sandy gravel Gravel: fine and coarse with cobbles, subangular to subrounded sandstone Sand: mainly fine and medium; quartz with sandstone, limestone and other lithic grains	1.0	1.5
Till	Clay, reddish brown, pebbly, sandy at top, thin sand at 5.0 m	5.5	7.0
Sherwood Sandstone	Sandstone, red, medium	0.5+	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 mm
21	47	32	0.5-1.5	21	22	18	7	12	14	6

NZ 31 SW 26 **3241 1046** **Neasham** **Block E**

Surface level +22.3 m
Groundwater conditions not recorded
November 1976

Overburden	3.0 m
Mineral	1.8 m
Waste	8.3 m
Bedrock	0.4 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.7	0.7
Alluvium	Clay and silt, sandy at top, some stones below 1.3 m	2.3	3.0
River Terrace Deposits, undifferentiated	Gravel Gravel: mainly coarse, subangular to rounded; sandstone and limestone with quartzite, some igneous rock, chert and siltstone and traces of quartz, ironstone and coal Sand: fine to coarse; quartz with lithic grains as in gravel	1.8	4.8
Till	Clay, brown and grey, sandy in part, massive; some stones	8.3	13.1
Sherwood Sandstone	Sandstone, red, fine	0.4+	13.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
6	14	80	3.0-4.0	5	4	8	4	14	65	0
			4.0-4.8	8	4	5	3	10	70	0
			Mean	**6**	**4**	**7**	**3**	**12**	**68**	**0**

COMPOSITION

Depth below surface (m)	percentages by weight in gravel fraction								
	Sandstone	Limestone	Dolomite	Quartz/ Quartzite	Igneous	Chert	Mudstone/ Siltstone	Ironstone	Coal
3.0-4.0	49	20	0	20	7	2	1	trace	trace
4.0-4.8	43	30	1	12	9	3	1	1	trace
Mean	**46**	**25**	**trace**	**16**	**8**	**2**	**1**	**1**	**trace**

NZ 31 SW 27 **3488 1071** **Manor House Farm, Low Dinsdale** **Block E**

Surface level +20.4 m
Water not encountered
November 1976

Overburden	0.3 m
Mineral	1.2 m
Waste	6.0 m
Bedrock	2.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
River Terrace Deposits, undifferentiated	'Very clayey' pebbly sand Gravel: mainly fine, subangular to subrounded; weathered sandstone Sand: mainly fine and medium; quartz with some lithic grains	1.2	1.5
Till	Clay, reddish brown and greyish brown, sandy, pebbly; sand laminae from 3.5 m to 4.5 m	6.0	7.5
Permian Upper Marl	Siltstone and mudstone, red	2.0+	9.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm	
26	60	14	0.3–1.5	26	26	27	7	10	4	0	

NZ 31 SE 7 **3542 1435** **West Hartburn, Middleton St. George**

Surface level +39.0 m
Groundwater conditions not recorded
November 1976

Waste	22.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, red-brown, silty to sandy, stony to 4.3 m; scattered sand laminae below 4.3 m	9.0	9.4
Glacial Drift, undifferentiated	Very sandy silt and clay and 'very clayey' sand	4.0	13.4
Till	Clay, brown, stony	8.6+	22.0

NZ 31 SE 8 **3627 1451** **High Goosepool, Middleton St. George**

Surface level +39.9 m
Groundwater conditions not recorded
November 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, reddish brown, and brown mainly stony and massive but laminated from 6.2 m to 7.2 m and below 15.2 m	17.8+	18.0

NZ 31 SE 9 **3773 1395** **West Gate, Midddleton St. George**

Surface level +34.1 m
Groundwater conditions not recorded
October 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, dark brown, red and grey, mainly massive and pebbly	5.9	6.2
Glacial Sand and Gravel	'Very clayey' pebbly sand	1.7	7.9
Laminated Clay	Clay, red-brown, silty, poorly laminated; scattered stones	2.0	9.9
Till	Clay, dark brown, massive, pebbly	8.1+	18.0

NZ 31 SE 10 **3854 1446** **Call Hill, Long Newton**

Surface level +32.0 m
Water struck at +7.0 m
October 1976

Waste 25.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, dark brown, silty, mainly massive; some stones	4.9	5.2
Glacial Sand and Gravel	'Very clayey' sand	1.0	6.2
	Silt and 'very clayey' sand, interbedded	2.0	8.2
Laminated Clay	Clay, red-brown, silty, laminated, mainly stone-free; sand laminae	2.0	10.2
Till	Clay, brown, massive, stony	5.0	15.2
Laminated Clay	Clay, red-brown, silty, laminated	1.7	16.9
Glacial Sand and Gravel	Sandy clayey silt	2.0	18.9
	'Clayey' sand with thin silt partings	6.1+	25.0

NZ 31 SE 11 **3955 1446** **East Gate, Long Newton** **Block D**

Surface level +33.2 m
Water struck at +25.7 m
October 1976

Overburden 7.0 m
Mineral 3.0 m
Waste 12.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, brown to red-brown; scattered pebbles, thin sand at 4.5 m	5.0	5.3
Laminated Clay	Clay, red-brown, laminated	1.7	7.0
Glacial Sand and Gravel	Sand: mainly fine; quartz with lithic grains	3.0	10.0
Till	Clay and clayey silt, dark brown, mainly massive but laminated near top, stony below 15.0 m	12.0+	22.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
6	94	0	7.0-10.0	6	62	32	0	0	0	0

NZ 31 SE 12 **3582 1343** **Middleton Hall, Middleton St. George**

Surface level +38.7 m
Water struck at +25.5 m
October 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, dark brown and red-brown, silty, part pebbly, mainly massive but poorly laminated from 4.3 m to 5.3 m and towards base	12.9	13.2
Glacial Sand and Gravel	'Clayey' fine sand	1.8	15.0
Laminated Clay	Clay, dark grey, silty, laminated; thin sand partings	1.0	16.0
Till	Clay, dark brown, massive, pebbly, sandy in parts	2.0+	18.0

NZ 31 SE 13 **3708 1340** **Teesside Airport**

Surface level +36.0 m
Groundwater conditions not recorded
November 1976

Waste 23.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, dark brown, sandy, stony	6.2	6.4
Glacial Sand and Gravel	'Clayey' pebbly sand and sandy gravel	2.0	8.4
Laminated Clay	Clay, pale brown, silty, laminated	1.0	9.4
Till	Clay, dark grey-brown, mainly massive and pebbly, but laminated from 11.4 m to 12.4 m	13.6+	23.0

NZ 31 SE 14 **3872 1343** **White House, Aislaby** **Block D**

Surface level +32.9 m
Groundwater conditions not recorded
October 1976

Overburden 5.5 m
Mineral 2.0 m
Waste 13.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, dark brown, silty, stony with some sand laminae	3.0	3.3
Laminated Clay	Clay, dark brown, laminated	2.2	5.5
Glacial Sand and Gravel	Pebbly sand Gravel: fine, angular; sandstone with some dolomite, limestone, igneous rock and coal Sand: mainly medium, quartz with quartzite and other lithic grains as in gravel	2.0	7.5
Till	Clay, brown, sandy and silty, mainly massive and stony but stoneless and laminated from 7.5 m to 8.5 m and 9.5 m to 10.5 m	13.5+	21.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
7	86	7	5.5-6.5	7	20	49	17	6	1	0
			6.5-7.5	7	26	49	12	6	0	0
			Mean	**7**	**23**	**49**	**14**	**6**	**1**	**0**

NZ 31 SE 15 **3503 1254** **Middleton St. George** **Block D**

Surface level +35.4 m
Water struck at +31.9 m
November 1976

Overburden 3.5 m
Mineral 3.0 m
Waste 14.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Boulder Clay	Clay, reddish brown with some stones	3.1	3.5
Glacial Sand and Gravel	'Very clayey' sand Sand: fine; quartz with limestone, dolomite and sandstone and dark lithic grains Fines: silt and clay bands	3.0	6.5
	Silty clay and sand, interbedded	1.0	7.5
Laminated Clay	Clay, dark grey, laminated	1.0	8.5
Till	Clay, dark grey, poorly laminated from 9.5 m to 16.5 m; pebbles scattered to 9.5 m but more common below	12.5+	21.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
28	72	0	3.5-4.5	10	74	16	0	0	0	0
			4.5-5.5	36	45	18	1	0	0	0
			5.5-6.5	37	54	9	0	0	0	0
			Mean	**28**	**58**	**14**	**trace**	**0**	**0**	**0**

NZ 31 SE 16 **3598 1242** **Teesside Airport**

Surface level +35.1 m
Water struck at +22.3 m
November 1976

Waste 18.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, brown, silty and sandy, mainly massive; some stones, 0.3 m of 'clayey' sand at 13.1 m	18.3+	18.5

NZ 31 SE 17 **3711 1231** **Teesside Airport**

Surface level +35.4 m
Groundwater conditions not recorded
November 1976

Waste 18.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, red-brown to dark brown, massive, stony	5.0	5.3
Laminated Clay	Clay, dark brown, well laminated, stone-free; 0.4 m sand at 6.7 m	2.4	7.7
Till	Clay, dark brown, mainly massive but poorly laminated from 13.7 m to 14.7 m; scattered stones	10.3+	18.0

NZ 31 SE 18 **3858 1229** **Sloshmire Gate, Newsham**

Surface level +35.1 m
Water rising to surface
November 1976

Waste 25.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, dark brown to red-brown; some stones	5.0	5.2
Laminated Clay	Clay, pale brown, silty, laminated	1.2	6.4
Glacial Sand and Gravel	Sand, 'clayey' in upper part	1.6	8.0
	Clay, pale brown	0.8	8.8
	'Very clayey' sand and silt	2.7	11.5
Laminated Clay	Clay, grey to dark brown, laminated and stone-free	3.0	14.5
Till	Clay, red-brown to dark brown, massive, sandy and stony	4.3	18.8
Glacial Sand and Gravel	'Very clayey' sand and silt	2.7	21.5
Till	Clay, red-brown to dark brown, massive, sandy and stony	3.5+	25.0

NZ 31 SE 19 **3970 1257** **West Farm, Aislaby** **Block D**

Surface level +29.9 m
Groundwater conditions not recorded
October 1976

Overburden 4.9 m
Mineral 3.3 m
Waste 12.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, red-brown, dark brown and grey, stony to 3.3 m; silt and sand laminae below 3.3 m	4.6	4.9
Glacial Sand and Gravel	'Clayey' sand: fine to medium; quartz with lithic fragments including coal; thin clay bands towards base, scattered pebbles	3.3	8.2
Laminated Clay	Clay, dark grey-brown, laminated; scattered small sandstone fragments	3.0	11.2
Till	Clay, dark brown, stony; some sand partings from 13.2 m to 15.2 m	9.8+	21.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages							
Fines	Sand	Gravel		Fines	Sand			Gravel			
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm	
16	83	1	4.9-5.9	7	35	51	5	2	0	0	
			5.9-6.9	8	37	52	3	0	0	0	
			6.9-8.2	29	50	20	1	0	0	0	
			Mean	**16**	**41**	**39**	**3**	**1**	**0**	**0**	

NZ 31 SE 20 **3534 1138** **Over Dinsdale Grange** **Block E**

Surface level +25.3 m
Water struck at +14.3 m
December 1976

Waste 10.5 m
Bedrock 1.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
River Terrace Deposits	Pebbly sand and silt	0.6	1.2
Till	Clay, red-brown, mainly massive and stony but poorly laminated and stone-free from 2.2 m to 3.2 m	9.3	10.5
Sherwood Sandstone	Sandstone, red	1.0+	11.5

NZ 31 SE 21 **3647 1107** **Low Middleton Hall, Middleton St. George** **Block E**

Surface level +11.9 m
Groundwater conditions not recorded
Shell and auger, 152 mm and 204 mm diameter
December 1976

Overburden	0.4 m
Mineral	1.9 m
Waste	15.5 m
Bedrock	0.7 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
River Terrace Deposits	Gravel, sandy and 'very clayey' in upper part Gravel: coarse and fine, subrounded; sandstone and limestone with chert, quartzite, volcanic and basic igneous rocks, some dolomite and traces of quartz, mudstone and ironstone Sand: mainly medium; quartz with lithic grains as in gravel	1.9	2.3
Till	Clay, brown and grey, stony	13.0	15.3
?Glacial Sand and Gravel	Gravel with scattered cobbles	2.5	17.8
Sherwood Sandstone	Sandstone and mudstone, red	0.7+	18.5

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$ mm
18	41	41	0.4-1.4	31	21	23	9	10	6	0
			1.4-2.3	4	4	12	11	30	39	0
			Mean	**18**	**13**	**18**	**10**	**19**	**22**	**0**

COMPOSITION

Depth below surface (m)	percentages by weight in gravel fraction								
	Sandstone	Limestone	Dolomite	Quartz/ Quartzite	Igneous	Chert	Mudstone/ Siltstone	Ironstone	Coal
1.4-2.3	42	28	3	9	7	11	trace	trace	0

NZ 31 SE 22 **3773 1160** **Trafford Hill, Newsham** **Block D**

Surface level +36.0 m
Water struck at +25.0 m
November 1976

Overburden 12.6 m
Mineral 4.4 m
Waste 4.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, dark brown, silty and sandy, stony in part	5.0	5.3
Laminated Clay	Clay, dark brown, silty, poorly to well laminated; scattered stones, 0.8 m 'clayey' sand at 11.8 m	7.3	12.6
Glacial Sand and Gravel	'Clayey' to 'very clayey' sand: fine; quartz with lithic grains including coal	4.4	17.0
Laminated Clay	Clay, dark grey, silty; scattered small stones in lower part	2.0	19.0
Till	Clay, red-brown, massive, stony	2.0+	21.0
	Borehole abandoned		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
15	85	0	12.6-13.6	12	82	6	0	0	0	0
			13.6-14.6	11	75	13	1	0	0	0
			14.6-15.6	12	72	13	3	0	0	0
			15.6-16.6	18	48	26	7	1	0	0
			16.6-17.0	31	46	19	4	0	0	0
			Mean	**15**	**67**	**15**	**3**	**trace**	**0**	**0**

NZ 31 SE 23 **3914 1166** **Portknowle, Aislaby** **Block D**

Surface level +29.9 m
Groundwater conditions not recorded
November 1976

Overburden 4.2 m
Mineral 2.0 m
Waste 11.8 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.8	0.8
Till	Clay, brown to red, silty, pebbly in lower part	3.4	4.2
Glacial Sand and Gravel	'Clayey' sand: mainly fine; quartz with lithic grains including some coal	2.0	6.2
Laminated Clay	Clay, silty, poorly to well laminated and mainly stoneless	4.0	10.2
	Clay, red-brown to dark brown, mainly massive and pebbly but poorly laminated from 11.2 m to 12.2 m	7.8+	18.0
	Borehole abandoned because of obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
12	87	1	4.2-5.2	14	36	47	2	1	0	0
			5.2-6.2	10	30	49	10	1	0	0
			Mean	**12**	**33**	**48**	**6**	**1**	**0**	**0**

NZ 31 SE 24 **3576 1036** **Rose Hill, Over Dinsdale** **Block D**

Surface level +38.1 m
Groundwater conditions not recorded
December 1976

Overburden 10.4 m
Mineral 4.3 m
Waste 8.3 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, reddish brown, stony, sandy in part; scattered sand laminae towards base	10.1	10.4
Glacial Sand and Gravel	Sand, 'clayey' near top: fine; quartz with some lithic grains	4.3	14.7
Laminated Clay	Clay, dark brown, laminated, mainly stone-free; scattered sand laminae	3.0	17.7
Till	Clay, dark brown, massive, stony	5.3+	23.0

GRADING

Mean for deposit percentages			Depth below surface (m)	percentages						
Fines	Sand	Gravel		Fines	Sand			Gravel		
				$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1 -4	+4 -16	+16 -64	+64 mm
9	91	0	10.4-11.4	15	80	5	0	0	0	0
			11.4-12.4	9	73	18	0	0	0	0
			12.4-13.4	7	78	15	0	0	0	0
			13.4-14.7	7	81	12	0	0	0	0
			Mean	**9**	**78**	**13**	**0**	**0**	**0**	**0**

NZ 31 SE 25 **3716 1080** **Trafford Hill, Newsham** **Block E**

Surface level +8.3 m
Groundwater conditions not recorded
December 1976

Waste 8.8 m
Bedrock 1.2 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Alluvium	Clay, grey, soft, silty	1.8	2.3
River Terrace Deposits	Gravel, fine to coarse, with medium sand	0.5	2.8
Till	Clay, sandy to very sandy, red-brown to dark brown, pebbly	6.0	8.8
Sherwood Sandstone	Sandstone and mudstone, red	1.2+	10.0

NZ 31 SE 26 **3890 1054** **The Holmes, Low Worsall** **Block E**

Surface level +7.0 m
Groundwater conditions not recorded
December 1976

Waste 13.5 m
Bedrock 1.5 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Alluvium, ?on Till	Clay, dark brown, sandy, stony	1.5	1.9
?Glacial Sand and Gravel	Sandy clayey silt	1.6	3.5
	Gravel, coarse, with medium sand	1.0	4.5
Glacial Drift, undifferentiated	Clay, dark grey to red-brown, laminated at top and from 5.5 m to 9.3 m, massive and stony elsewhere; 0.3 m gravel at 9.6 m and 1.0 m gravel at 11.4 m	9.0	13.5
Sherwood Sandstone	Sandstone, red, with some mudstone	1.5+	15.0

NZ 31 SE 27 **3982 1045** **Aislaby Grange** **Block E**

Surface level +7.0 m
Groundwater conditions not recorded
November 1976

Overburden	6.4 m
Mineral	3.3 m
Waste	1.0 m
Mineral	1.3 m
Bedrock	3.0 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Alluvium	Clay, greyish brown, silty; plant debris at top	6.0	6.4
River Terrace Deposits, undifferentiated	**a** 'Very clayey' sand: fine; quartz with some lithic grains	1.0	7.4
	b 'Clayey' gravel Gravel: coarse and fine, subangular to subrounded; sandstone with quartzite, limestone, dolomite, chert, ironstone, igneous rock and trace of mudstone Sand: fine to coarse; quartz with lithic grains as in gravel	2.3	9.7
Till	Clay, dark brown, sandy, stony	1.0	10.7
Glacial Sand and Gravel	**c** 'Very clayey' sandy gravel Gravel: as above Sand: fine; quartz with some lithic grains as in gravel	1.3	12.0
Sherwood Sandstone	Sandstone, red, fine grained	3.0+	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 mm
a	36	64	0	6.4-7.4	36	52	10	2	0	0	0
b	11	36	53	7.4-8.4	22	17	10	7	16	28	0
				8.4-9.7	2	4	16	18	28	32	0
				Mean	**11**	**10**	**13**	**13**	**23**	**30**	**0**
c	38	39	23	10.7-12.0	38	30	5	4	5	18	0
a+b+c	**25**	**44**	**31**	**Mean**	**25**	**26**	**10**	**8**	**12**	**19**	**0**

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

Reports of the Institute of Geological Sciences

Assessment of British Sand and Gravel Resources

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

2 The sand and gravel resources of the country around Witham, Essex: Resource sheet TL 81. H. J. E. Haggard.
Report 72/6 ISBN 0 11 880588 6 £1.20

3 The sand and gravel resources of the area south and west of Woodbridge, Suffolk: Resource sheet TM 24.
R. Allender and S. E. Hollyer.
Report 72/9 ISBN 0 11 880596 7 £1.70

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

5 The sand and gravel resources of the country around Hethersett, Norfolk: Resource sheet TG 10.
E. F. P. Nickless.
Report 73/4 ISBN 0 11 880606 8 £1.60

6 The sand and gravel resources of the country around Terling, Essex: Resource sheet TL 71. C. H. Eaton.
Report 73/5 ISBN 0 11 880608 4 £1.20

7 The sand and gravel resources of the country around Layer Breton and Tolleshunt D'Arcy, Essex: Resource sheet TL 91 and part of TL 90. J. D. Ambrose.
Report 73/8 ISBN 0 11 880614 9 £1.30

8 The sand and gravel resources of the country around Shotley and Felixstowe, Suffolk: Resource sheet TM 23.
R. Allender and S. E. Hollyer.
Report 73/13 ISBN 0 11 880625 4 £1.60

9 The sand and gravel resources of the country around Attlebridge, Norfolk: Resource sheet TG 11.
E. F. P. Nickless.
Report 73/15 ISBN 0 11 880658 0 £1.85

10 The sand and gravel resources of the country west of Colchester, Essex: Resource sheet TL 92. J. D. Ambrose.
Report 74/6 ISBN 0 11 880671 8 £1.45

11 The sand and gravel resources of the country around Tattingstone, Suffolk: Resource sheet TM 13. S. E. Hollyer.
Report 74/9 ISBN 0 11 880675 0 £1.95

12 The sand and gravel resources of the country around Gerrards Cross, Buckinghamshire: Resource sheet SU 99, TQ 08 and TQ 09. H. C. Squirrell.
Report 74/14 ISBN 0 11 880710 2 £2.20

Mineral Assessment Reports

13 The sand and gravel resources of the country east of Chelmsford, Essex: Resource sheet TL 70. M. R. Clarke.
ISBN 0 11 880744 7 £3.50

14 The sand and gravel resources of the country east of Colchester, Essex: Resource sheet TM 02. J. D. Ambrose.
ISBN 0 11 880745 5 £3.25

15 The sand and gravel resources of the country around Newton on Trent, Lincolnshire: Resource sheet SK 87.
D. Price.
ISBN 0 11 880746 3 £3.00

16 The sand and gravel resources of the country around Braintree, Essex: Resource sheet TL 72. M. R. Clarke.
ISBN 0 11 880747 1 £3.50

17 The sand and gravel resources of the country around Besthorpe, Nottinghamshire: Resource sheet SK 86 and part of SK 76. J. R. Gozzard.
ISBN 0 11 880748 X £3.00

18 The sand and gravel resources of the Thames Valley, the country around Cricklade, Wiltshire: Resource sheet SU 09/19 and parts of SP 00/10. P. R. Robson.
ISBN 0 11 880749 8 £3.00

19 The sand and gravel resources of the country south of Gainsborough, Lincolnshire: Resource sheet SK 88 and part of SK 78. J. H. Lovell.
ISBN 0 11 880750 1 £2.50

20 The sand and gravel resources of the country east of Newark upon Trent, Nottinghamshire: Resource sheet SK 85.
J. R. Gozzard.
ISBN 0 11 880751 X £2.75

21 The sand and gravel resources of the Thames and Kennet Valleys, the country around Pangbourne, Berkshire: Resource sheet SU 67. H. C. Squirrell.
ISBN 0 11 880752 8 £3.25

22 The sand and gravel resources of the country north-west of Scunthorpe, Humberside: Resource sheet SE 81.
J. W. C. James.
ISBN 0 11 880753 6 £3.00

23 The sand and gravel resources of the Thames Valley, the country between Lechlade and Standlake: Resource sheet SP 30 and parts of SP 20, SU 29 and SU 39. P. Robson.
ISBN 0 11 881252 1 £7.25

24 The sand and gravel resources of the country around Aldermaston, Berkshire: Resource sheet SU 56 and SU 66. H. C. Squirrell.
ISBN 0 11 881253 X £5.00

25 The celestite resources of the area north-east of Bristol: Resource sheet ST 68 and parts of ST 59, 69, 79, 58, 78, 68 and 77. E. F. P. Nickless, S. J. Booth and P. N. Mosley.
ISBN 0 11 881262 9 £5.00

26 The limestone and dolomite resources of the country around Monyash, Derbyshire: Resource sheet SK 16.
F. C. Cox and D. McC. Bridge.
ISBN 0 11 881263 7 £7.00

27 The sand and gravel resources of the country west and south of Lincoln, Lincolnshire: Resource sheets SK 95, SK 96 and SK 97. I. Jackson.
ISBN 0 11 884003 7 £6.00

28 The sand and gravel resources of the country around Eynsham, Oxfordshire: Resource sheet SP 40 and part of SP 41. W. J. R. Harries.
ISBN 0 11 884012 6 £3.00

29 The sand and gravel resources of the country south-west of Scunthorpe, Humberside: Resource sheet SE 80.
J. H. Lovell.
ISBN 0 11 884013 4 £3.50

30 Procedure for the assessment of limestone resources.
F. C. Cox, D. McC. Bridge and J. H. Hull.
ISBN 0 11 884030 4 £1.25

31 The sand and gravel resources of the country west of Newark upon Trent, Nottinghamshire: Resource sheet SK 75.
D. Price and P. J. Rogers.
ISBN 0 11 884031 2 £3.50

32 The sand and gravel resources of the country around Sonning and Henley, Berkshire, Oxfordshire and Buckinghamshire: Resource sheet SU 77 and SU 78.
H. C. Squirrell.
ISBN 0 11 884032 0 £5.25

33 The sand and gravel resources of the country north of Gainsborough, Lincolnshire: Resource sheet SK 89.
J. R. Gozzard and D. Price
ISBN 0 11 884033 9 £4.50

34 The sand and gravel resources of the Dengie Peninsula, Essex: Resource sheet TL 90, etc. M. B. Simmons.
ISBN 0 11 884081 9 £5.00

35 The sand and gravel resources of the country around Darvel, Strathclyde: Resource sheet NS 53, 63, etc.
E. F. P. Nickless, A. M. Aitken and A. A. McMillan.
ISBN 0 11 884082 7 £7.00

36 The sand and gravel resources of the country around Southend-on-Sea, Essex: Resource sheets TQ 78, 79 etc. S. E. Hollyer and M. B. Simmons.
ISBN 0 11 884083 5 £7.50

37 The sand and gravel resources of the country around Bawtry, South Yorkshire: Resource sheet SK 69. A. R. Clayton
ISBN 0 11 884053 3 £5.75

38 The sand and gravel resources of the country around Abingdon, Oxfordshire: Resource sheet SU 49, 59, SP 40, 50. C. E. Corser.
ISBN 0 11 884084 5 £5.50

39 The sand and gravel resources of the Blackwater Valley (Aldershot) area: Resource sheet SU 85, 86, parts SU 84, 94, 95, 96. M. R. Clarke, A. J. Dixon and M. Kubala.
ISBN 0 11 884085 1 £7.00

40 The sand and gravel resources of the country west of Darlington, County Durham: Resource sheet NZ 11, 21. A. Smith.
ISBN 0 11 884086 X £5.00

41 The sand and gravel resources of the country around Garmouth, Grampian Region: Resource sheet NJ 36. A. M. Aitken, J. W. Merritt and A. J. Shaw.
ISBN 0 11 884090 8 £8.75

42 The sand and gravel resources of the country around Maidenhead and Marlow: Resource sheet SU 88, parts SU 87, 97, 98. P. N. Dunkley.
ISBN 0 11 884091 6 £5.00

43 The sand and gravel resources of the country around Misterton, Nottinghamshire: Resource sheet SK 79. D. Thomas and D. Price.
ISBN 0 11 884092 4 £5.25

44 The sand and gravel resources of the country around Sedgefield, Durham: Resource sheet NZ 32. M. D. A. Samuel.
ISBN 0 11 884093 2 £5.75

45 The sand and gravel resources of the country around Brampton, Cumbria: Resource sheet NY 55, part 56. I. Jackson.
ISBN 0 11 884094 0 £6.75

46 The sand and gravel resources of the country around Harlow, Essex: Resource sheet TL 41. P. M. Hopson.
ISBN 0 11 884107 6 £9.50

47 The limestone and dolomite resources of the country around Wirksworth, Derbyshire: Resource sheet SK 25, part 35. F. C. Cox and D. J. Harrison.
ISBN 0 11 884108 4 £15.00

48 The sand and gravel resources of the Loddon Valley area: Resource sheet SU 75, 76, parts 64, 65, 66 and 74. M. R. Clarke, E. J. Raynor and R. A. Sobey.
ISBN 0 11 884109 2 £8.75

49 The sand and gravel resources of the country around Lanark, Strathclyde Region: Resource sheet NS 94, part 84. J. L. Laxton and E. F. P. Nickless.
ISBN 0 11 884112 2 £11.00

50 The sand and gravel resources of the country around Fordingbridge, Hampshire: Resource sheet SU 11 and parts of SU 00, 01, 10, 20 and 21. M. Kubala.
ISBN 0 11 884111 4 £7.75

51 The sand and gravel resources of the country north of Bournemouth, Dorset: Resource sheet SU 00, 10, 20, SZ 09, 19 and 29. M. R. Clarke.
ISBN 0 11 884110 6 £9.75

52 The sand and gravel resources of the country between Hatfield Heath and Great Waltham, Essex: Resource sheet TL 51 and 61. R. J. Marks.
ISBN 0 11 884113 0 £8.00

53 The sand and gravel resources of the country around Cottenham, Cambridgeshire: Resource sheet TL 46 and 47. A. J. Dixon.
ISBN 0 11 884114 9 £9.25

54 The sand and gravel resources of the country around Huntingdon and St Ives. Cambridgeshire: Resource sheets TL 16, 17, 26, 27, 36 and 37. R. W. Gatliff.
ISBN 0 11 884115 7 £8.75

55 The sand and gravel resources of the country around Ipswich, Suffolk: Resource sheet TM 14. R. Allender and S. E. Hollyer.
ISBN 0 11 884116 5 £10.00

56 Procedure for the assessment of the conglomerate resources of the Sherwood Sandstone Group. D. P. Piper and P. J. Rogers.
ISBN 0 11 884143 2 £1.25

57 The conglomerate resources of the Sherwood Sandstone Group of the country around Cheadle, Staffordshire: Resource sheet SK 04. P. J. Rogers, D. P. Piper and T. J. Charsley.
ISBN 0 11 884144 0 £7.75

58 The sand and gravel resources of the country west of Peterhead, Grampian Region: Resource sheet NK 04 and parts of NJ 94 and 95, NK 05, 14 and 15. A. A. McMillan and A. M. Aitken.
ISBN 0 11 884145 9 £12.00

59 The sand and gravel resources of the country around Newbury, Berkshire: Resource sheet SU 46 and 57, parts of SU 36, 37 and 47. J. R. Gozzard.
ISBN 0 11 884146 7 £11.50

60 The sand and gravel resources of the country south-west of Peterborough, in Cambridgeshire and east Northamptonshire: Resource sheet TL 09 and 19 and SP 98 and TL 08. A. M. Harrisson.
ISBN 0 11 884147 5 £15.50

61 The sand and gravel resources of the country north of Wrexham, Clwyd: Resource sheet SJ 35 and part of SJ 25. P. N. Dunkley.
ISBN 0 11 884148 3 £11.75

62 The sand and gravel resources of the country around Dolphinton, Strathclyde Region, and West Linton, Borders Region: Resource sheet NT 04 and 14, parts of NT 05 and 15. A. A. McMillan, J. L. Laxton and A. J. Shaw.
ISBN 0 11 884149 1 £8.00

63 The sand and gravel resources of the valley of the Douglas Water, Strathclyde Region: Resource sheet NS 83 and parts of NS 82, 92 and 93. A. J. Shaw and E. F. P. Nickless.
ISBN 0 11 884150 5 £11.50

64 The sand and gravel resources of the country between Wallingford and Goring, Oxfordshire: Resource sheet SU 68 and part of SU 58. C. E. Corser.
ISBN 0 11 884151 3 £11.50

65 The sand and gravel resources of the country around Hexham, Northumberland: Resource sheet NY 86 and 96. J. H. Lovell.
ISBN 0 11 884152 1 £7.50

66 The sand and gravel resources of the country west of Chelmsford, Essex: Resource sheet TL 60. P. M. Hopson.
ISBN 0 11 884153 X £8.50

67 The sand and gravel resources of the country around Hatfield and Cheshunt, Hertfordshire: Resource sheet TL 20 and 30, and parts of TQ 29 and 39. J. R. Gozzard.
ISBN 0 11 884167 X £10.00

68 The sand and gravel resources of the country north-east of Halstead, Essex: Resource sheet TL 83. R. J. Marks and J. W. Merritt.
ISBN 0 11 884168 8 £13.25

69 The sand and gravel resources of the country around Welwyn Garden City. Hertfordshire: Resource sheet TL 11 and 21. J. R. Gozzard.
ISBN 0 11 884169 6 £10.50

70 The sand and gravel resources of the country east of Harrogate, North Yorkshire: Resource sheet SE 35. D. L. Dundas.
ISBN 0 11 884170 7 £15.50

71 The sand and gravel resources of the country around Hemel Hempstead, St Albans and Watford: Resource sheet TL 00, 10, and parts TQ 09, 19.
W. J. R. Harries, S. E. Hollyer and P. M. Hopson.
ISBN 0 11 884171 8 *not yet priced*

72 The sand and gravel resources of the country around Bury St Edmunds Suffolk: Resource sheet TL 86.
M. P. Hawkins.
ISBN 0 11 884172 6 £10.50

73 The sand and gravel resources of the country between Ely and Cambridge, Cambridgeshire: Resource sheet TL 56, 57. A. R. Clayton.
ISBN 0 11 884173 4 £9.50

74 The sand and gravel resources of the country around Blaydon, Tyne and Wear: Resource sheet NZ 06, 16.
J. R. A. Giles.
ISBN 0 11 884174 2 £10.50

75 The sand and gravel resources of the country around Stokesley, North Yorkshire: Resource sheet NZ 40, 50 and parts 41, 51. R. G. Crofts.
ISBN 0 11 884175 0 £11.50

76 The sand and gravel resources of the country around Ellon, Grampian Region: Resource sheets NJ 93 with parts 82, 83, 92, and NK 03 with parts 02, 13. J. W. Merrit.
ISBN 0 11 884176 9 £15.00

77 The limestone and dolomite resoures of the country around Buxton, Derbyshire: Resource sheet SK 07 and parts 06, 08. D. J. Harrison.
ISBN 0 11 884177 7 £13.50

78 The sand and gravel resources of the country west of Boroughbridge, North Yorkshire: Resource sheet SE 36.
D. A. Abraham.
ISBN 0 11 884178 5 £12.75

79 The limestone and dolomite resources of the country around Bakewell, Derbyshire: Resource sheet SK 26 and part 27. D. McC. Bridge and J. R. Gozzard.
ISBN 0 11 884179 3 £10.50

80 The sand and gravel resources of the country between Stamford, Lincolnshire, and Peterborough, Cambridgeshire: Resource sheet TF 00, 10. S. J. Booth.
ISBN 0 11 884180 7 £14.50

81 The sand and gravel resources of the country of the Thames and Thame valleys, the country around Dorchester and Watlington, Oxfordshire: Resource sheet SU 69 and part 59. C. E. Corser.
ISBN 0 11 884204 8 £14.25

82 The sand and gravel resources of the country around Sible Hedingham, Essex: Resource sheet TL 73.
R. J. Marks and D. W. Murray.
ISBN 0 11 884205 6 £10.75

83 The sand and gravel resources of the country around Hollesley, Suffolk: Resource sheet TM 34. S. E. Hollyer and R. Allender.
ISBN 0 11 884206 4 £13.25

84 The sand and gravel resources of the country around Kirk Hammerton, North Yorkshire: Resource sheet SE 45.
J. R. A. Giles.
ISBN 0 11 884207 2 £10.00

85 The sand and gravel resources of the country around Nayland, Suffolk: Resource sheet TL 93. P. M. Hopson.
ISBN 0 11 884208 0 £11.25

86 The sand and gravel resources of the country around Wem, Shropshire: Resource sheet SJ 42, 52. B. Cannell and W. J. R. Harries.
ISBN 0 11 884209 9 £15.50

87 The sand and gravel resources of the country around Ranskill and East Retford, Nottinghamshire: Resource sheet SK 68 and part 78. D. Thomas.
ISBN 0 11 884210 2 £8.50

88 The sand and gravel resources of the country around Tholthorpe, North Yorkshire: Resource sheet SE 46.
R. Stanczyszyn.
ISBN 0 11 884211 0 *not yet priced*

89 The sand and gravel resources of the country around Newport-on-Tay, Fife Region: Resource sheet NO 42 and parts 32, 52. J. L. Laxton and D. L. Ross.
ISBN 0 11 887413 6 £12.75

90 The sand and gravel resources of the country around Shrewsbury, Shropshire: Resource sheet SJ 41, 51.
B. Cannell.
ISBN 0 11 884213 7 £17.00

91 The conglomerate resources of the Sherwood Sandstone Group of the country east of Stoke-on-Trent, Staffordshire: Resource sheet SJ 94. D. Piper.
ISBN 0 11 884214 5 *not yet priced*

92 The sand and gravel resources of the country around Armthorpe, South Yorkshire: Resource sheet SE 60.
D. Price and D. P. Best.
ISBN 0 11 884215 3 £10.00

93 The sand and gravel resources of the country aound Whittlesey, Cambridgeshire: Resource sheet TF 20, TL 29.
S. J. Booth.
ISBN 0 11 884216 1 £12.50

94 The sand and gravel resources of the country north and west of Woodhall Spa, Lincolnshire: Resource sheet TF 16 and part 17. I. Jackson.
ISBN 0 11 884217 X £14.75

95 The sand and gravel resources of the country around Biggar, Strathclyde Region: Resource sheet NS 93, NT 03, and parts NS 92, NT 02. A. J. Shaw and J. W. Merritt.
ISBN 0 11 887414 4 £15.00

96 The sand and gravel resources of the country around Potter Hanworth and Reepham, Lincolnshire: Resource sheet TF 06, 07. R. G. Crofts.
ISBN 0 11 884216 6 £9.75

97 The sand and gravel resources of the country around Clare, Suffolk: Resource sheet TL 74. R. Marks.
ISBN 0 11 884297 8 £10.00

98 The limestone and dolomite resources of the country around Tideswell, Derbyshire: Resource sheet SK 17 and parts 18, 27. R. W. Gatliff.
ISBN 0 11 884298 6

99 The sand and gravel resources of the country north and west of Billingham, Cleveland: Resource sheet NZ 42 and part 52. J. W. C. James.
ISBN 0 11 884299 4 £10.50

100 The sand and gravel resources of the country around Billinghay, Lincolnshire: Resource sheet TF 15 and part 05.
J. B. L. Wild.
ISBN 0 11 884300 1 £13.75

101 The sand and gravel resources of the country around Glenrothes, Fife Region: Resource sheet NO 20 and parts 21, 30, 31. A. M. Aitken.
ISBN 0 11 8847415 2 £15.00

102 The sand and gravel resources of the country around Coggeshall, Essex: Resource sheet TL 82. S. J. Booth and J. W. Merritt.
ISBN 0 11 887416 0 £16.00

103 The sand and gravel resources of the country between Dorchester and Wareham, Dorset: Resource sheets comprising parts of SY 68, 69, 78, 79, 88, 89, 98, 99.
S. J. Mathers.
ISBN 0 11 884303 6 £17.00

104 The sand and gravel resources of the country around Stansted Mountfitchet, Essex: Resource sheet TL 52.
P. M. Hopson.
ISBN 0 11 884304 4 £11.75

105 The sand and gravel resources of the Welshampton area, Shropshire and Clwyd: Resource sheet SJ 43.
S. J. Mathers and A. C. Wilson.
ISBN 0 11 884305 2 *not yet priced*

106 The sand and gravel resources of the country south of Wrexham, Clwyd: Resource sheet SJ 34, and part 24.
D. F. Ball.
ISBN 0 11 884306 0 £11.00

107 The sand and gravel resources of the country between Rugby and Northampton, Warwickshire and Northamptonshire: Resource sheet SP 66 and parts 56, 57, 65, 67, 75 and 76.
M. R. Clarke and E. R. Moczarski.
ISBN 0 11 884307 9 £20.00

108 The sand and gravel resources of the country south of Horncastle, Lincolnshire: Resource sheet TF 26.
G. Power and J. B. L. Wild.
ISBN 0 11 884308 7 £9.75

109 The sand and gravel resources of the country around Great Dunmow, Essex: Resource sheet TL 62.
C. W. Thomas.
ISBN 0 11 884309 5 £12.75

110 The sand and gravel resources of the country north of Newmarket, Cambridgeshire and Suffolk: Resource sheet TL 67 and part 66. C. E. Corser.
ISBN 0 11 884310 9 £14.50

111 The sand and gravel resources of the country east and south-east of Darlington, Durham: Resource sheet NZ 30, 31. J. R. Gozzard and D. Price.
ISBN 0 11 884311 7 £14.25

112 The sand and gravel resources of the country around Hertford, Hertfordshire: Resource sheet TL 31.
P. M. Hopson and M. D. A. Samuel.
ISBN 0 11 884312 5 £11.75

113 The sand and gravel resources of the country around Mold, Clwyd: Resource sheet SJ 26 and part 16.
D. F. Ball and K. A. McL. Adlam.
ISBN 0 11 884313 3 *not yet priced*

114 The sand and gravel resources of the country around Kettering and Wellingborough, Northamptonshire: Resource sheets SP 86, 96, and SP 97 and parts of SP 87, TF 07.
A. M. Harrison.
ISBN 0 11 884314 1 *not yet priced*

115 The sand and gravel resources of the country east of Solihull, Warwickshire: Resource sheet comprising parts of SP 17, 18, 27, 28.
B. Cannell.
ISBN 0 11 884315 X *not yet priced*

Reports of the Institute of Geological Sciences

Other Reports

69/9 Sand and gravel resources of the Inner Moray Firth.
A. L. Harris and J. D. Peacock.
ISBN 0 11 880106 6 35p

70/4 Sands and gravels of the southern counties of Scotland.
G. A. Goodlet.
ISBN 0 11 880105 8 90p

72/8 The use and resources of moulding sand in Northern Ireland. R. A. Old.
ISBN 0 11 881594 0 30p

73/9 The superficial deposits of the Firth of Clyde and its sea lochs. C. E. Deegan, R. Kirby, I. Rae and R. Floyd.
ISBN 0 11 880617 3 95p

77/1 Sources of aggregate in Northern Ireland (2nd edition).
I. B. Cameron.
ISBN 0 11 881279 3 70p

77/2 Sand and gravel resources of the Grampian Region.
J. D. Peacock and others.
ISBN 0 11 881282 3 80p

77/5 Sand and gravel resources of the Fife Region.
M. A. E. Browne.
ISBN 0 11 884004 5 60p

77/6 Sand and gravel resources of the Tayside Region.
I. B. Paterson.
ISBN 0 11 884008 8 £1.40

77/8 Sand and gravel resources of the Strathclyde Region.
I. B. Cameron and others.
ISBN 0 11 884028 2 £2.50

77/9 Sand and gravel resources of the Central Region, Scotland. M. A. E. Browne.
ISBN 0 11 884016 9 £1.35

77/19 Sand and gravel resources of the Borders Region, Scotland. A. D. McAdam.
ISBN 0 11 884025 8 £1.00

77/22 Sand and gravel resources of the Dumfries and Galloway Region of Scotland. I. B. Cameron.
ISBN 0 11 884021 5 £1.20

78/1 Sand and gravels of the Lothian Region of Scotland.
A. D. McAdam.
ISBN 0 11 884042 8 £1.00

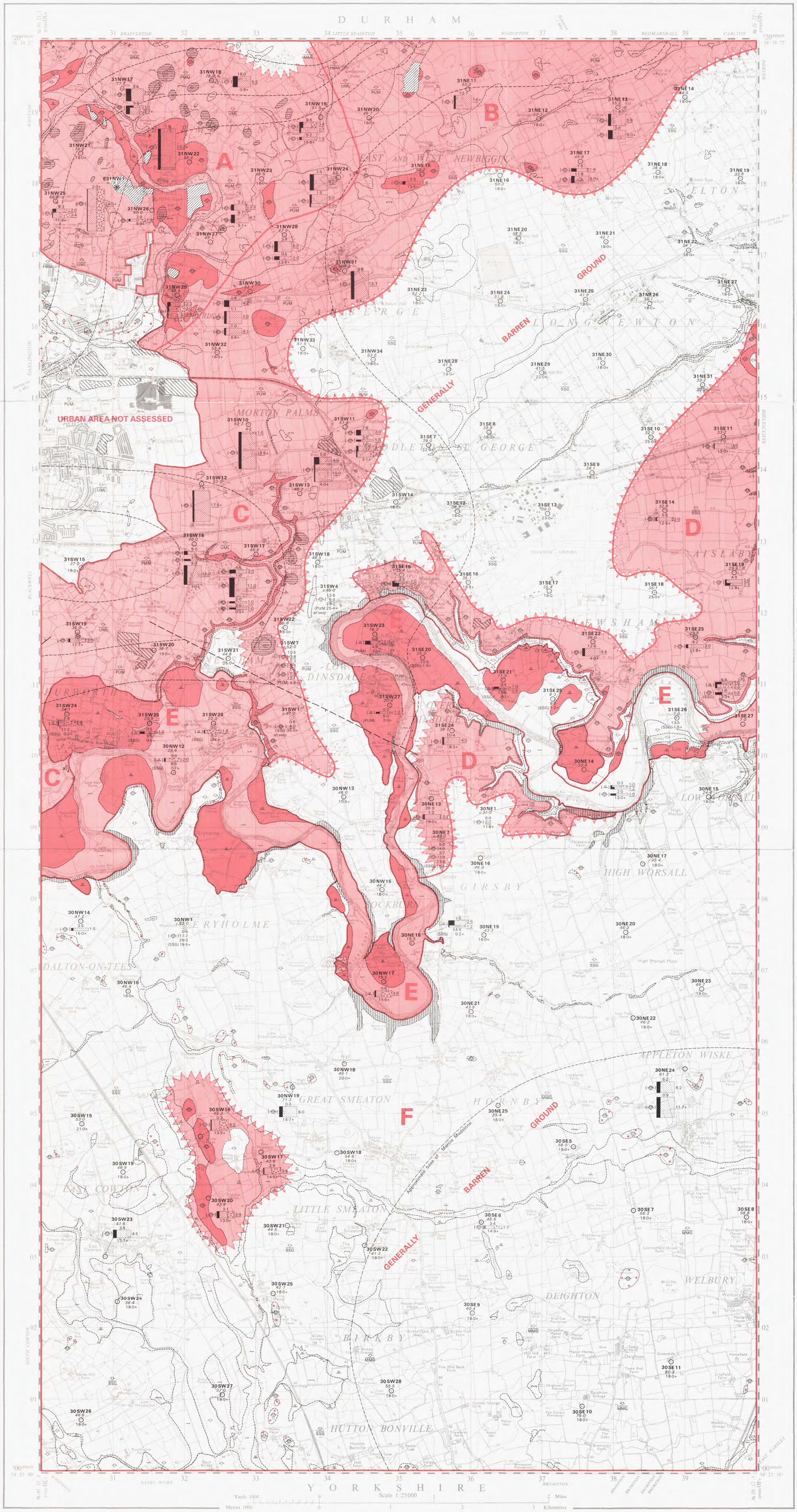
78/8 Sand and gravel resources of the Highland Region.
W. Mykura, D. L. Ross and F. May.
ISBN 0 11 884050 9 £3.00

Dd. 717411 K8

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

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

ORDNANCE SURVEY
SHEET NZ31 AND SHEET NZ30
PROVISIONAL EDITION — SECOND SERIES



MINERAL ASSESSMENT REPORT 111

INSTITUTE OF GEOLOGICAL SCIENCES

INDUSTRIAL MINERALS ASSESSMENT UNIT

THE SAND AND GRAVEL RESOURCES OF SHEETS NZ 31 & NZ 30 (EAST AND SOUTH-EAST OF DARLINGTON, DURHAM)

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

111

EXPLANATION OF SYMBOLS AND ABBREVIATIONS

Landslip L-1

Foundered ground F-1

DRIFT

RECENT AND PLEISTOCENE

- Lacustrine Alluvium – clay, silt and sand. LA-6
- Alluvium – clays, silts, sand and gravel. A-47
- Alluvial Cone – mainly gravel and sand. AC-4
- River Terrace Deposits, Undifferentiated – sand and gravel with some silt and clay. RT-10
- Calcareous Tufa CT-2
- Head – mainly of stony clay. H-45
- Glacial Lake Deposits – clay, silt and peat. GL-10
- Laminated Clay – pebble free clay. LC-1
- Till (Boulder Clay) – grey-brown and red-brown stiff stony clay with scattered lenses of sand and/or gravel and of laminated clay. TL-15
- Glacial Sand and Gravel – mainly sand with lenses of gravel and with beds of laminated clay and silt locally. GS-27

SOLID

PERMO-TRIASSIC

- MMG Mercia Mudstone (Keuper Marl) – mainly reddish brown mudstone and siltstone.
- SSG Sherwood (Bunter) Sandstone – soft red sandstone with mudstone beds.
- PUM Permian Upper Marl – red-brown mudstone and siltstone with Billingham Main Anhydrite or its residue at base.
- UML Upper Magnesian Limestone – grey thin-bedded fine-grained dolomite.
- PMM Permian Middle Marl – red and grey mudstones with anhydrite and some dolomite.
- MML Middle Magnesian Limestone – grey to buff mainly oolitic dolomite.

TERTIARY INTRUSIVE

- D Dolerite

Made Ground MG-2

Area worked for sand and gravel WO-20

BOUNDARY LINES

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

Broken lines denote uncertainty

BOREHOLE DATA
SITE LOCATIONS

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

I.M.A.U. BOREHOLES

Borehole Registration Number → 31SW24
Surface level in metres above O.D. (Newlyn) ← 34·1
Borehole site ○
Overburden ← 1·8
Mineral (sand and gravel) ← 11·2 (2·8)
Waste
Geological Classification (SSG) 0·2+ ← Bedrock

Grading Diagram
Thicknesses in metres

Notes
(i) Figures underlined denote thicknesses used in the assessment of resources.
(ii) The + sign indicates that the base of the deposit was not reached.
(iii) The figures in *italics* are the metric conversions of measurements recorded in feet.
(iv) The Geological Classification is given only for mineral and bedrock.
(v) Estimated surface levels are preceded by c.(circa).

Borehole Registration Number
Each I.M.A.U. borehole is identified by a Registration Number, e.g. **31SW24.** The initial letters and numbers refer to the quarter sheet and the final figures to the I.G.S. serial number for that quarter. The unique designation for borehole **31SW24** is **NZ31SW24.**

Grading Diagrams
Each grading diagram shows the mean particle-size distribution in a distinct deposit of mineral.

Sand (+1/16mm – 4mm)
Fines (– 1/16mm) Gravel (+ 4mm)

The height of the diagram is proportional to the mineral thickness.
The widths of the divisions show the proportions of **Fines, Sand** and **Gravel.**

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

EXPOSURE RECORDS
Information from the inspection of exposures is shown in the same way as for boreholes, but they are located by an asterisk, thus: ✳

CATEGORIES OF DEPOSITS

- Exposed mineral CAT-E6
- Continuous or almost continuous spreads of mineral beneath overburden CAT-C1
- Sand and gravel either not potentially workable (see Report) or absent CAT-A2
- Sand and gravel not assessed CAT-N1

RESOURCE BLOCKS

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

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

Geological lines from six-inch surveys by D.H. Land in 1967-73 (northern part), and by J.G.O. Smart, J.R. Davies, P.A. Rathbone and C.M. Jones in 1977-79; B.J. Taylor, D.H. Land and J.G.O. Smart District Geologists. Solid boundaries are provisional.

Sand and gravel survey by A. Smith, J.W.C. James and R.G. Crofts in 1976-78; R.G. Thurrell, Head, Industrial Minerals Assessment Unit.

1: 25000 Sand and Gravel Resource Sheet published 1982.
G.M. Brown, DSc, FRS, *Director, Institute of Geological Sciences incorporating the Geological Survey of Great Britain, the Museum of Practical Geology, and Overseas Geological Surveys.*

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

NZ 22	NZ 32	NZ 42
32 NZ 21	NZ 31	33 NZ 41
NZ 20	NZ 30	NZ 40
41 SE 29	SE 39	42 SE 49

Diagram showing the relationship of this sheet with the National Grid 1: 25000 sheets and One-Inch and 1: 50000 Geological Sheets 32, 33, 41 and 42.

Produced for the Institute of Geological Sciences by Engineering Surveys Reproduction Ltd, Printed by Impact Litho (Tolworth) 1981

The representation on this map of a Road, Track, or Footpath, is not evidence of the existence of a right of way.

The GRID Lines on this Sheet are at 1 Kilometre interval.
Surface heights are to the nearest metre above mean sea level.
Contour values are in metres
1 Square inch on this map represents 0·639 acres on the ground.

Northern half compiled from 6"sheets last fully revised 1913-14.
Other partial systematic revision 1938-50 has been incorporated.
Major roads and Airport revised 1969.
Southern half compiled from 1:10 560 or 1:10 000 scale maps surveyed 1970-73.
Revised for significant changes 1975.
Major roads revised 1976.