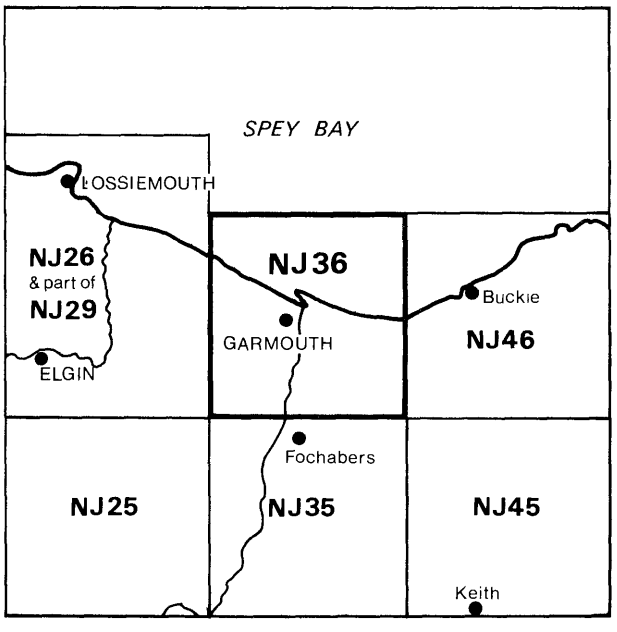
INSTITUTE OF GEOLOGICAL SCIENCES

Natural Environment Research Council

Mineral Assessment Report 41



The sand and gravel resources of the country around Garmouth, Grampian Region

Description of 1:25 000 resource sheet NJ 36

A. M. Aitken, J. W. Merritt and A. J. Shaw

ISBN 0 11 884090 8

London Her Majesty's Stationery Office 1979

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 onwards are appearing in the Mineral Assessment Report Series of the Institute.
Details of published reports appear at the end of this Report.

Any enquiries concerning this report may be addressed to Officer-in-Charge, Industrial Minerals Assessment Unit, Institute of Geological Sciences, Murchison House, West Mains Road, Edinburgh.

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 these mineral resources should be undertaken. 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 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. In 1968, following a short feasibility study initiated in 1966 by the Ministry of Land and National Resources, the Industrial Minerals Assessment Unit (formerly the Mineral Assessment Unit) began systematic surveys which have been extended progressively through Central and Northern England. Work in Scotland, which began in 1975 in the Darvel area of Strathclyde Region, is being financed by the Department of the Environment, acting through the Scottish Development Department, and is being undertaken with the cooperation of the Sand and Gravel Association of Great Britain.

This report describes the resources of sand and gravel of 54.4 km^2 of country around Garmouth, Grampian Region, shown on the accompanying resource map. The survey was conducted by J.W. Merritt and A.J. Shaw under the supervision of A.M. Aitken, assisted by A.M. Harrisson in the drilling and sampling programme. The work which was controlled from the sub-unit in Edinburgh (E.F.P. Nickless, Officer-in-Charge) is based on the one-inch geological survey of Sheet 95 published in 1886 and the six-inch to one mile resurvey conducted between 1961 and 1963. The geological lines now presented at the 1:25 000 scale are taken from the 1961–1963 resurvey, incorporating minor modifications made as a result of the assessment field programme.

J.W. Gardner, CBE (Land Agent) has been responsible for negotiating access to land for drilling. The ready cooperation of land owners and tenants and the assistance of officials of Moray District is gratefully acknowledged.

Austin W. Woodland
Director

31st May 1979

Institute of Geological Sciences
Exhibition Road
South Kensington
London SW7 2DE

CONTENTS

FIGURES

TABLES

TABLES continued

PLATES

Plate 1 River Spey Estuary and flood plain

Gravel bars and alluvial terraces of the Spey north of Fochabers. Margin of fluvioglacial terrace is in the foreground. Oblique aerial photograph taken near Redhall looking north (*MNS 2106*)

Plate 2 Mouth of the Spey and the village of Kingston

Mouth of the River Spey, showing westerly longshore drift. The beach consists of sub-parallel storm ridges composed of shingle. IMAU borehole is in progress in the foreground. Oblique aerial photograph from near Gladhill (*MNS 2109*)

Plate 3 Post-glacial storm beach deposits

Long parallel ridges of beach gravel, reaching 7 metres above OD. Oblique aerial photograph near Lower Auchenreath, looking west towards Binn Hill *(MNS 2113)*

The sand and gravel resources of the country around Garmouth, Grampian Region

Description of 1:25 000 resource sheet NJ 36

A. M. AITKEN, J. W. MERRITT and A. J. SHAW

SUMMARY

The geological maps of the Institute of Geological Sciences, fifty-seven boreholes and thirty shallow pits sunk for the Industrial Minerals Assessment Unit, together with data from three pits and one natural section, form the basis of the assessment of sand and gravel resources in the Garmouth area, Grampian Region.

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

The 1:25 000 map is divided into five resource blocks containing between 7.1 and 15.5 km^2 of potentially workable sand and gravel. The geology of the deposits is described and the mineral-bearing area, the mean thickness of overburden and mineral, and the mean grading of the various types of deposit are stated. Detailed borehole and section data are given. The geology and the outlines of the resource blocks, the position of boreholes, shallow pits and sections used in the assessment are shown on the accompanying map.

Bibliographic reference

AITKEN, A.M., MERRITT, J.W., SHAW, A.J. 1979. The sand and gravel resources of the country around Garmouth, Grampian Region: Description of 1:25 000 resource sheet NJ 36. Miner. Assess. Rep. Inst. Geol. Sci., No. 41.

Authors

A.M. AITKEN, BSc, J.W. MERRITT, BSc and A.J. SHAW, BSc.
Institute of Geological Sciences, Murchison House, West Mains Road, Edinburgh, EH9 3LA.

INTRODUCTION

The survey is concerned with the estimation of resources, which include deposits that are not currently exploitable but have a foreseeable use, rather than reserves, which can only be assessed in the light of current, locally prevailing, economic considerations. Clearly, both the economic and the social factors used to decide whether a deposit may be workable in the future cannot be predicted; they are likely to change with time. Deposits not currently economically workable may be exploited as demand increases, as higher grade or alternative materials become scarce, or as improved processing techniques are applied to them. The improved knowledge of the main physical properties of the resource and their variability which this survey seeks to provide will add significantly to the factual background against which planning policies can be decided (Archer, 1969; Thurrell, 1971; Harris and others, 1974).

The survey provides information at the 'indicated' level "for which tonnage and grade are computed partly from specific measurements, samples or production data and partly from projection for a reasonable distance on geological evidence. The sites available for inspection, measurement, and sampling are too widely spaced to permit the mineral bodies to be outlined completely or the grade established throughout" (Bureau of Mines and Geological Sciences, 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 one metre in thickness.
b. The ratio of overburden to sand and gravel should be no more than 3:1.
c. The proportion of fines (particles passing the No. 240 mesh BS sieve, about 1/16 mm) should not exceed 40 per cent.
d. The deposit must lie within 25 m of the surface, this being taken as the likely maximum working depth under most circumstances. It follows from the second criterion that boreholes are drilled no deeper than 18 m if no sand and gravel has been proved.

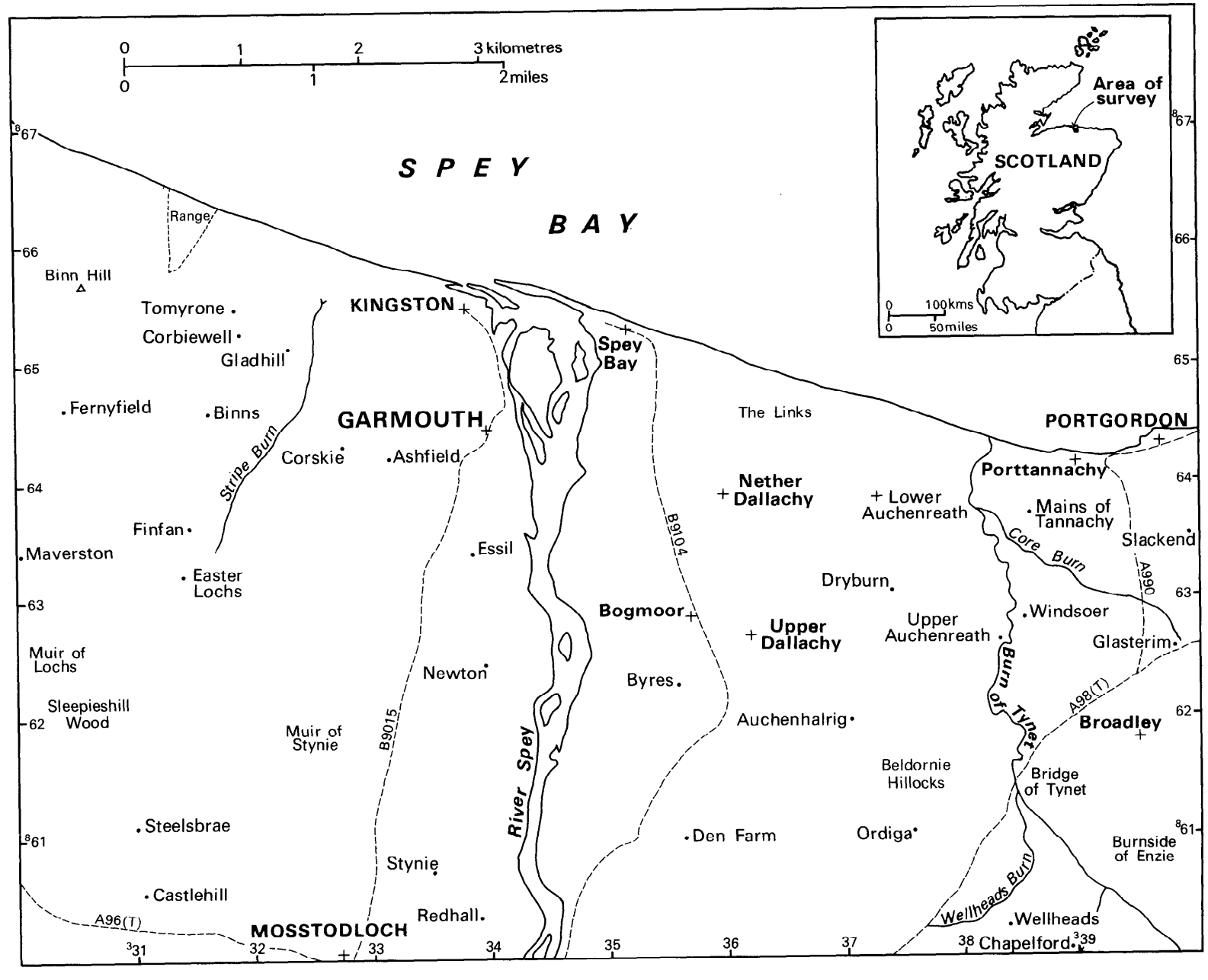


Figure 1 Location sketch map

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.

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

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

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

DESCRIPTION OF RESOURCE SHEET

GENERAL

The area assessed covers 54.4 km^2 (about 21 square miles) of country around Garmouth, Grampian Region, almost all of which is underlain by sand and gravel. By road, Garmouth is situated 260 km north of Edinburgh, 70 km east of Inverness, 12 km east of Elgin and 100 km north-west of Aberdeen (Fig. 1).

The primary aim of this survey is to assess the mineral content of the superficial deposits which comprise till, glacial and fluvioglacial sand and gravel, alluvium, glaciolacustrine, channel-fill, and beach deposits. Statistical assessments are offered for five resource blocks.

In the Garmouth area, much of the till is potentially workable; that is, it meets the arbitrary physical criteria adopted for this survey. However, till and sand and gravel pose different planning problems in terms of methods of extraction, particularly the visual impact of workings and mode of restoration of worked ground. For these reasons till and sand and gravel have been assessed separately in this report and distinguished by different colours on the resource map.

In addition to the gravel-bearing drift deposits, conglomeratic beds within the Old Red Sandstone are locally highly weathered and in this form the bedrock constitutes a potential source of sand and gravel. The weathering is haphazard and it is not possible to predict either its distribution or extent. However, as a generalisation, the decomposition is quite widespread, especially to the south and east of Fochabers [34 58][1] which lies just south of the assessed area. Samples of weathered rock obtained from boreholes suggest that the fines content is generally greater than 20 per cent and may exceed 60 per cent. Specialised processing would be required to work such deposits.

Gravel workings have been concentrated on the shingle banks which back the coastline west of Portgordon [39 64]. A number of small pits, mostly in sand, are found inland. The area is rural, with several large forestry plantations, the remainder being given over to mixed agriculture.

GEOLOGY

The geological classification is summarised in Table 1, where the deposits are in general listed in order of increasing age. A more exhaustive description of the geology of the Garmouth area can be found in 'The Geology of the Elgin District', an explanation of the one-inch Geological Elgin (95) Sheet, by Peacock and others (1968).

Table 1. Geological classification of deposits

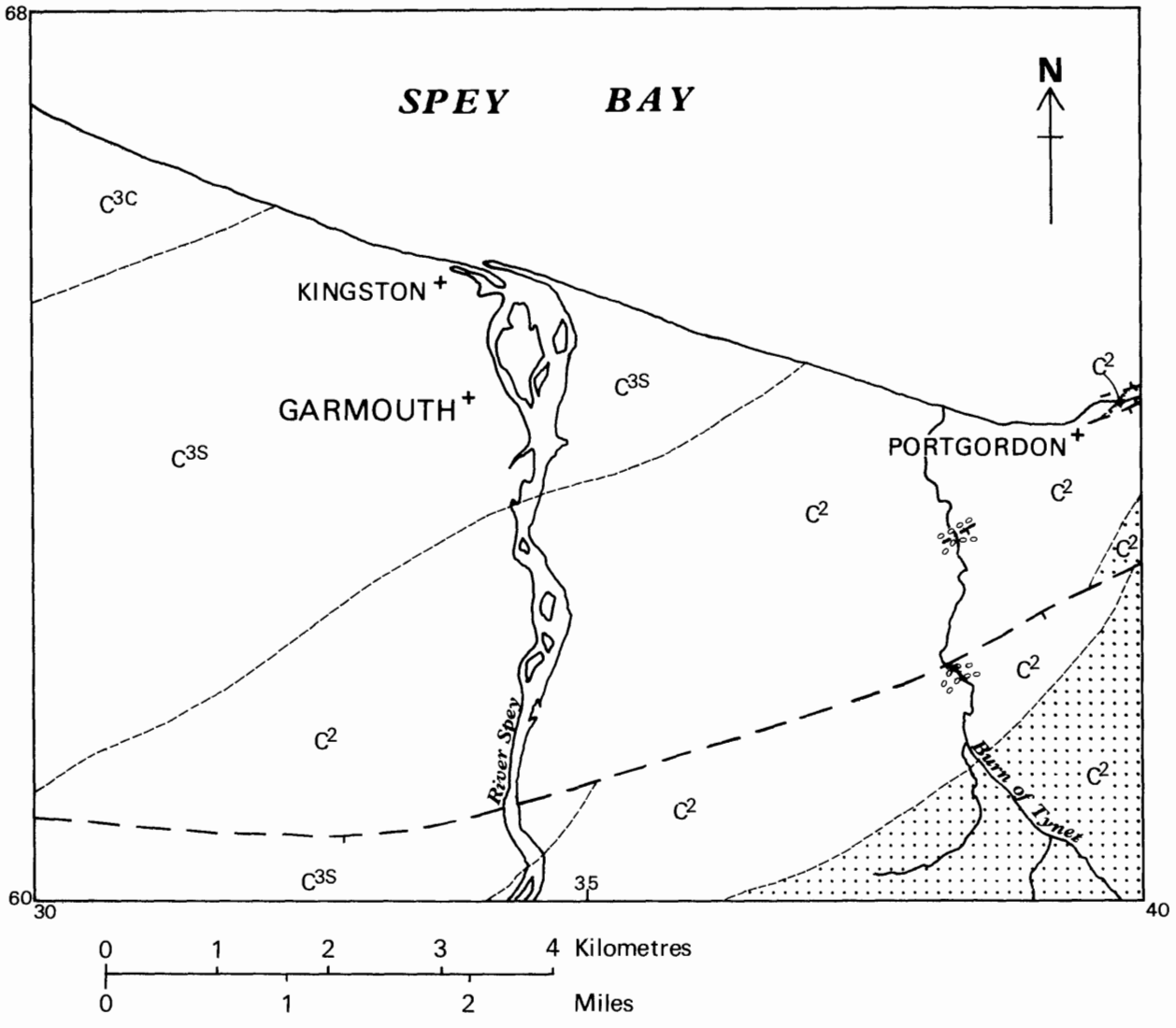
DRIFT	
Recent and Pleistocene	Blown sand
	Peat
	Alluvium (undifferentiated)
	Lake alluvium
	Alluvial cone
	Present day beach deposits
	Storm beach deposits
	Raised beach deposits, post-Glacial
	Raised beach deposits, late-Glacial
	Fluvioglacial sand and gravel (usually flat or terraced at surface)
	Glacial sand and gravel (usually moundy at surface)
	Glaciolacustrine deposits
	Till
	Channel-fill deposits
SOLID	
Devonian	Upper Old Red Sandstone
	Middle Old Red Sandstone

SOLID

Bedrock is undifferentiated on the resource map accompanying this report. The distribution and classification of solid rock are shown in Fig. 2.

Rocks of Moine and Dalradian age are not exposed in the assessment area, but because they

[1] National Grid references are given in square brackets. In this publication all lie within the 100-km square NJ.



Upper Old Red Sandstone

C3C — *Cornstone Beds*

C3S — *Scaat Craig Beds*

Middle Old Red Sandstone

C2 — *Undivided (sandstone and conglomerate)*

Calcareous nodule bed

C2 — *Basal Conglomerate*

Geological boundary

Fault, crossmark on downthrow side

Figure 2 Sketch map showing the solid geology

contribute to much of the Old Red Sandstone, till and sand and gravel, a brief description of the main lithologies is included. Although Moine rocks do not crop out near Garmouth they underlie much of the catchment of the Spey and the river has transported huge quantities of eroded debris into the area. Dalradian rocks crop out to the east of sheet NJ 36 from the coast east of Buckie, south to the Hill of Stonyslacks [434 588]. The succession and lithologies are as follows:

Dalradian	
Cairnfield Actinolitic Flags	Fine-grained, dark, semi-pelitic flags with white calcareous ribs and micaceous partings
Findlater Flags	Fissile, grey, fine-grained, semi-pelitic flags with a thick quartzite band at Hill of Stonyslacks
West Sands Mica-Schist	Garnet-mica-schist with numerous psammitic ribs
Cullen Quartzite	Light-grey, cross-bedded, quartzite with subordinate calcareous, muscovite mica-schist and grit bands
Moine (undifferentiated)	Quartzo-feldspathic granulite, quartzite, pelitic and semi-pelitic schist

Strata of Devonian age (Old Red Sandstone) overlie the Dalradian rocks with great unconformity and the contact crops out just to the east of the area assessed. The lower division of the Old Red Sandstone is not found in the vicinity of the Moray Firth, the basal beds being Middle Old Red Sandstone breccia and conglomerate which are succeeded by a mostly arenaceous sequence, part of which is well exposed in the Burn of Tynet and on the shore at Portgordon. In the Garmouth area the Upper Old Red Sandstone which is distinguished from the middle division on palaeontological grounds, succeeds it without apparent disconformity or lithological change.

The Devonian succession and lithologies are as follows:

Upper Old Red Sandstone	
Cornstone Beds	Sandy limestone and calcareous sandstone
Scaat Craig Beds	Reddish sandstone, siltstone, shale and conglomerate
Middle Old Red Sandstone (Undivided)	Interbedded conglomerate, shale and siltstone, mostly red and commonly calcareous
Basal Conglomerate	Reddish conglomerate and breccia, with pebbles of Cullen Quartzite, feldspathic flags, psammitic granulite and mica schist

Within the assessment area Scaat Craig Beds are exposed only in Redhall Quarry [341 603] which has yielded a fauna assignable to the Upper Old Red Sandstone (Taylor, 1900; Peacock and others, 1968).

Red arenaceous and argillaceous beds were proved in boreholes over a large part of the area, but no differentiation can be made on solely lithological grounds between Middle and Upper Old Red Sandstone.

In the Binn Hill [307 657] area the Scaat Craig Beds are probably overlain by Cornstone Beds which crop out at the Boar's Head Rock [289 679] further to the north-west.

The Old Red Sandstone strata dip generally about ten degrees to the north-west. A fault with a downthrow to the south, exposed in the Burn of Tynet, [3822 6205] crosses the area (Fig. 2), but its sub-drift position is conjectural; the main effect is to repeat the outcrop of part of the Upper Old Red Sandstone in the Redhall district.

DRIFT

Most of the resource area is mantled by drift deposits, which, with the notable exceptions of the coastal belt and the flood plain of the River Spey, are predominantly glacial and fluvioglacial. As many of the assessment boreholes prove bedrock, it has been possible to construct a generalised contour map of the sub-drift surface (Fig. III on resource map). For the greater part, the topography east of the flood plain of the River Spey broadly mirrors the bedrock surface. To the west, between Binn Hill and Steelsbrae [310 611] where the drift is often greater than 25 m in thickness and where bedrock has not been proved in boreholes, the thickness of the glacial deposits indicates that the form of the bedrock surface probably bears little relationship to the present topography. Drilling indicates that there is probably a buried former channel of the River Spey excavated in solid rock. This follows the general course of the present valley, but passes west of the hill on which Redhall [339 603] stands and reaches the position of the present coastline east of Spey Bay [353 649].

Till

Much of the bedrock is draped with a cover of till which can be divided into a lower dark, usually olive-grey till, in some places containing shell fragments, and an upper brown to red, commonly sandy till. In borehole SW 21 however, grey till overlies brown. This sequence of brown till generally overlying grey till was recognised by Peacock and others (1968, pp. 89, 90) during the geological survey of the Elgin area and the authors describe a section of till exposed in the bank of the Stripe Burn [3253 6512].

West of the Spey drilling has proved the lower dark till only locally. It was found most widely in the area around Binn Hill and south towards Muir of Lochs, but has not been proved beneath that hill as the thickness of sand overlying it exceeds 25 m, the maximum depth to which boreholes were sunk during this survey.

Dark coloured till overlies sand and gravel in boreholes NW 4, SW 2, 13, 18 and 25. At the last-mentioned site this sequence rests on sand believed to be a buried channel deposit, suggesting that the ancient river channel may predate the oldest known till in the area.

Elsewhere boreholes SE 21 and 26, near Chapelford [389 600] encountered dark grey, stiff till. It is noteworthy that although each borehole proved strata containing shell fragments, at the latter site deposits also contain fragments of black, carbonaceous shale, presumably derived from the floor of the Moray Firth.

The upper tills are more variable than the dark grey till. The colour tends to brown or reddish brown, but shades of grey, yellow, orange and pink occur widely. In composition they are sandier than the older till, but considerable variation exists from stony clay to sand and gravel. It has been noted (Peacock and others, 1968) that the reddish till becomes stonier to the south-east, probably a reflection of overall change in the underlying Old Red Sandstone lithology. Much of the reddish till satisfies the arbitrary physical criteria adopted for assessment and is considered to be potentially workable, that is, it is classified as mineral.

West of the River Spey till is infrequently exposed, but sizeable exposures occur north west of Garmouth and at Muir of Lochs [30 62]. Thicknesses vary considerably, the greatest total recorded thickness being 13.6 m in borehole SW 4.

Till is often thin or completely absent beneath the flood plain of the River Spey and particularly towards the river mouth. There is almost continuous exposure of till in the ancient river cliff which forms the eastern boundary of the alluvial plain and boreholes indicate that but for a mask of soil and solifluction deposits, till would be exposed in the corresponding cliff-line on the west side of the river.

The most extensive exposures of sandy till in the assessment area are found east of the valley of the River Spey. Drilling indicates that till is present at the surface more widely than is shown on the one-inch Geological Elgin (95) Sheet in the Auchenhalrig [370 619] district. Thicknesses vary considerably, the maximum proved thickness being 16.3 m in boreholes SE 23.

Channel-fill and glaciolacustrine deposits

Channel-fill deposits comprising medium and fine grained, greenish grey sand are found in boreholes SW 17, SW 25 and SE 3. This sand, which is unlike any other found during the survey, occurs in a depression in the bedrock surface, interpreted as an ancient, probably pre-Glacial channel of the River Spey. A similar but siltier deposit proved in borehole SW 15 might be a product of sedimentation near the margin of, or in a backwater to, the channel. The configuration and location of the channel margin agrees with an independent interpretation of bedrock surface contours (Fig. III on resource map). In borehole SW 25 12.5 m of channel-fill deposit was proved but nowhere was the full thickness of the deposit determined.

Glaciolacustrine deposits consisting of sandy silt with subordinate clay seams are present near to the surface in the vicinity of Corskie [328 643] (borehole SW 12) and Wallfield Wood [303 649] (borehole SW 1), concealed beneath a veneer of blown sand. They are also found at no great depth in boreholes SW 2 and 7. Similar deposits occur in the Steelsbrae and Muir of Stynie [327 616] areas (boreholes SW 5, 6 and 15).

Peacock and others (1968, p. 103) refer to patches of lacustrine silt and clay at Wallfield [296 653] and Waterscott [292 652] just west of the assessed area. The new evidence suggests a more extensive development of glacial lakes than was recognised by Peacock and others, as the deposits at Corskie and elsewhere are probably contiguous with those at Wallfield and Waterscott.

East of the River Spey glaciolacustrine deposits have been proved only in borehole SE 26.

Glacial sand and gravel

Glacial sand and gravel, usually moundy at the surface, constitutes the largest composite area of drift outcrop in the Garmouth area. In addition buried glacial sand and gravel deposits are known from boreholes (see Fig. II on resource map).

The surface deposits present a typically undulating, hummocky form over much of the area, most noticeable in the case of Binn Hill where drilling proved that the uppermost 25 m comprise sand, but provided no information about the core of the hill. At Steelsbrae a kame-like plateau rises to over 80 m above Ordnance Datum and borehole SW 5 indicates glaciolacustrine deposits overlain by glacial sand and gravel, which in turn have been eroded into terraces and covered by fluvioglacial sand and gravel.

East of the River Spey the topography of the glacial sand and gravel tends to be more subdued and the deposits thinner than in the west, except to the south of Portgordon. The unevenness of relief also reflects the irregular till and bedrock surface. Near Tulloch Cottage [380 606] and Beldornie Hillocks [37 61] small sandy and pebbly mounds are common.

The composition of the surface glacial sand and gravel deposits forming the large area of outcrop west of the River Spey is variable, but north towards Binn Hill, sand predominates (see Fig. 3). Deposits east of the River Spey are variable in composition but generally become increasingly gravelly with depth. Like the deposits to the west of the river there is a progressive increase in sand content northwards, particularly noticeable in the Portgordon area.

A number of boreholes prove glacial sand and gravel deposits beneath till. In several cases this situation is confined to isolated sites but in two areas buried sand and gravel occurs in several adjacent boreholes (Fig. II). With the exception of borehole NW 4, sand and gravel is not known in boreholes to underlie till north of a line from Maverston Wood [302 644] to Garmouth. Boreholes SW 2, 13 and 18 south of this line all demonstrate dark, olive-grey till on sand and gravel, indicating a relatively older age for these deposits. However in several boreholes further south, the same or similar buried glacial sand and gravel underlie and are also interbedded with reddish sandy till, implying a more complex

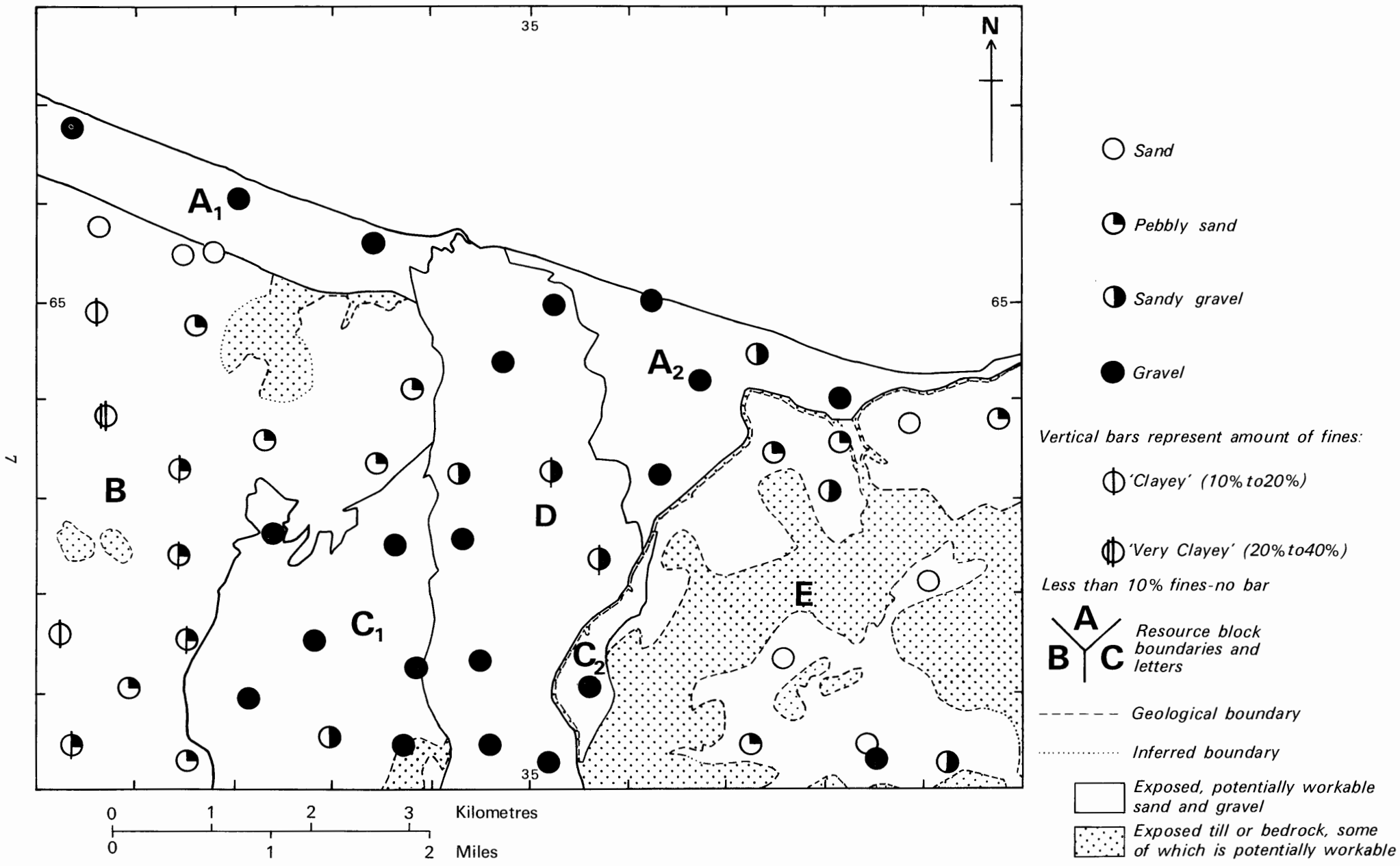


Figure 3 Grading characteristics of the exposed sand and gravel based on the mean grading at 52 sample points

stratigraphical and chronological relationship and indicating that it may be unreasonable to assume the sand and gravel occurs as a single deposit. Such arguments also apply to the buried sand and gravel proved in boreholes SE 9 and 13. In general the buried glacial sand and gravel deposits grade as sandy gravel (see Fig. 8).

Fluvioglacial sand and gravel

Well defined terraces, at heights of 10–20 m above the River Spey, flank the alluvial plain and are cut into glacial sand and gravel. To the west of the river the terraces are extensive but on the east side only comparatively small remnants persist. The highest and presumably oldest terraces are the result of superficial modification of the kame-like plateau on which Steelsbrae stands and the material which underlies them may have been derived from a nearby ice-front or may have been carried from the Blackhills overflow channel (Peacock and others, 1968). An area of moundy sand and gravel separates the plateau from the terraces associated with the Spey, the highest of which, the Mosstodloch Terrace, is the most extensive and, in common with the Lunan Wood and more recent, lower terraces, declines seawards at 3 m per km (Peacock and others, 1968, p. 105). To the east of the river, the terrace remnant which runs from Bellie Hill [355 609] to near Dryburn [374 631] is believed to be equivalent to the Mosstodloch Terrace. Kettle holes within the Mosstodloch Terrace indicate the presence of glacier ice at the time of formation.

The terraced sand and gravel mostly comprises coarse, clean, well rounded gravel with a particle size composition similar to that of the sand and gravel forming the alluvial terraces (see Fig. 4).

Raised and storm beach deposits

A late-Glacial raised beach gives rise to a well marked bench feature which attains a maximum height of 14 m above Ordnance Datum, for example at Lower Auchenreath [372 639] where it is incised into sandy till (Peacock and others, 1968), and is believed to mark sea level when the Lunan Wood Terrace was formed. Dallachy aerodrome [36 63] stands on a well marked raised beach of post-Glacial age.

Up to nine storm beach ridges parallel the coast between Porttannachy [385 642] and Binn Hill and attain a width of over 800 m west of Kingston [338 655]. They terminate inland west of the River Spey, below Binn Hill, against a prominent ancient sea cliff, the base of which stands 8 m above Ordnance Datum.

The ancient and recent beach deposits are composed of shingle comprising well sorted, well rounded, fine to cobble gravel with negligible fines.

Lake alluvium

Post-Glacial lacustrine deposits comprising fine sand, silt and clay, occur in basins and hollows between mounds of glacial sand and gravel. They are found at four localities, Corskie, Burniestripe, Muir of Lochs and Tullochmoss [376 609].

Alluvium (undifferentiated)

Spreads of fluviatile alluvium are restricted to the valleys of the River Spey and Burn of Tynet. The deposits of the River Spey occur as several well defined low lying terraces, some of which are traceable for over 6 km. In composition and grading the alluvium is similar to the fluvio-glacial sand and gravel comprising coarse gravel with numerous cobbles and boulders. Commonly the surfaces of the terraces are draped with a thin, sandy, overbank deposit.

Blown sand

Blown sand is found between storm beach ridges in the north-west of the area. Considerable redistribution of the sandy facies of the glacial sand and gravel deposits has probably occurred as a result of wind action.

Peat

Basin peat is found in a few hollows which are probably the sites of former lakes.

COMPOSITION OF THE MINERAL DEPOSITS

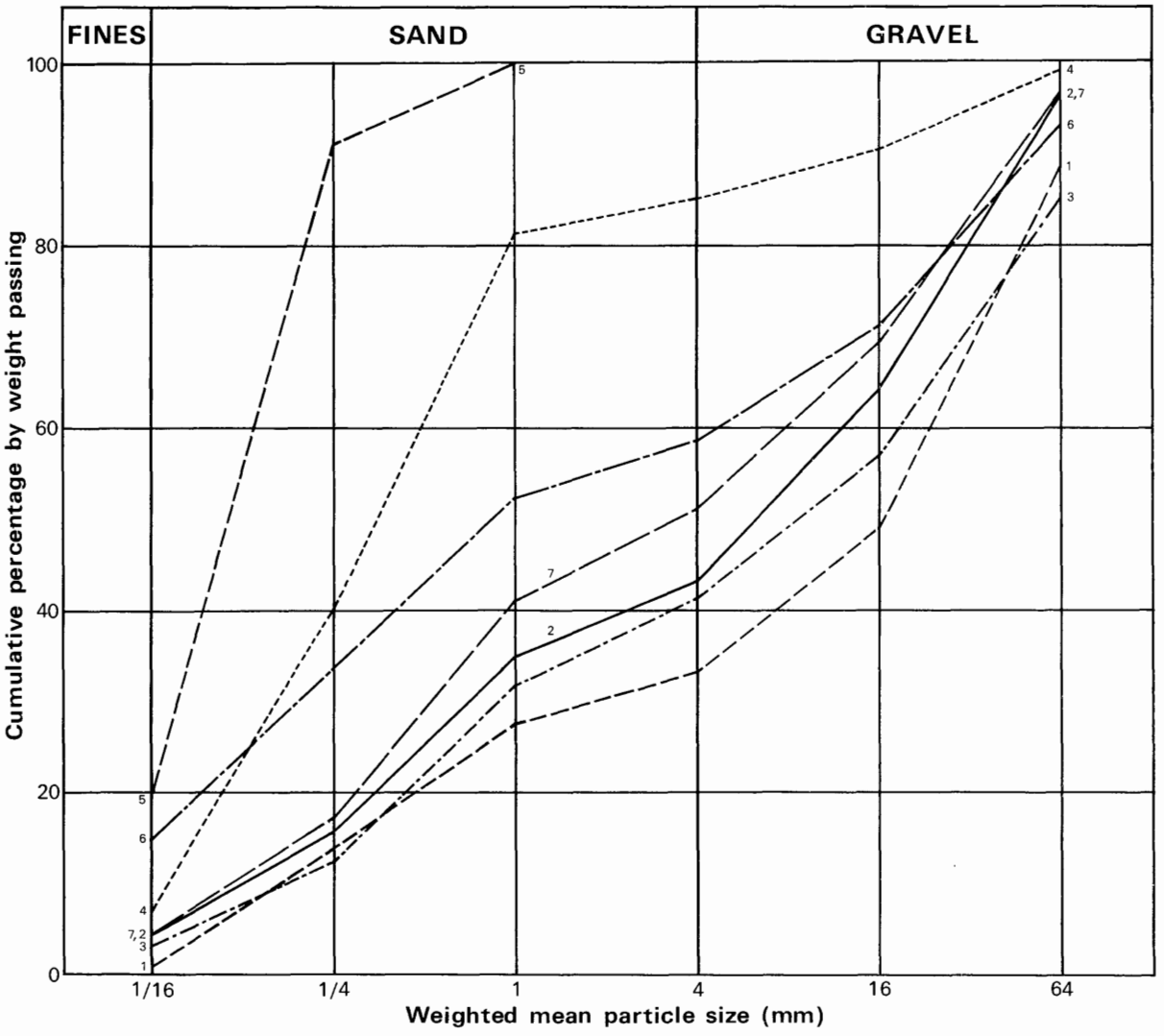
PARTICLE-SIZE DISTRIBUTION

Detailed mean grading data (particle-size distributions) for the mineral deposits within each resource block are presented in Tables 8 to 12. A summary of this data is included in Table 7. Diagrammatic representations of the mean grading data are offered for further guidance: Fig. 3 shows the mean gradings of surface deposits of sand and gravel proved at 52 sample points, and Fig. 4 the comparative overall mean gradings of seven mineral deposits identified over the resource sheet. In addition, for each borehole the mean grading of individual mineral deposits is plotted on triangular diagrams (Fig. 5). Fig. 4 allows comparison between overall mean gradings of the various mineral deposits; Fig. 5 demonstrates the variability in grading of the individual deposits.

Beach deposits

The beach deposits comprise storm beach and raised beach deposits together with some alluvium at the mouth of the Burn of Tynet.

The overall mean grading of the beach deposits is fines 1 per cent, sand 32 per cent and gravel 67 per cent (for definition of terms see Table 13). The shingle ridges of the storm beach comprise well sorted, well rounded, coarse with fine gravel containing very little interstitial sand or fines. Inland, the raised beach deposits commonly contain more sand and fines. Although it is generally spherical, wave action has caused local accumulations of tabular or bladed gravel. Cobbles are abundant accounting for 10 per cent of the deposit, but constituting up to 21 per cent of the material recovered from boreholes SE 9 and SE 11. In general, the percentage of sand increases towards the base of the deposits; fine sand tends to predominate in the storm beach and medium in the raised beach and alluvium.



MINERAL DEPOSIT	RESOURCE BLOCK	Cumulative percentage by weight passing					
		1/16mm	1/4mm	1mm	4mm	16mm	64mm
1 Beach deposits	A	1	14	28	33	49	88
2 Fluvioglacial sand and gravel	C	4	16	35	43	65	97
3 Alluvium (of the Spey)	D	3	13	32	41	57	86
4 (Surface) glacial sand and gravel	B and E	6	40	81	85	91	99
5 Glaciolacustrine deposits	B	19	91	100	100	100	100
6 Potentially workable till	Whole Sheet	14	34	52	58	71	94
7 (Buried) glacial sand and gravel	Whole Sheet	4	17	41	51	69	97

Figure 4 Comparison of the mean particle-size distribution of the potentially workable deposits

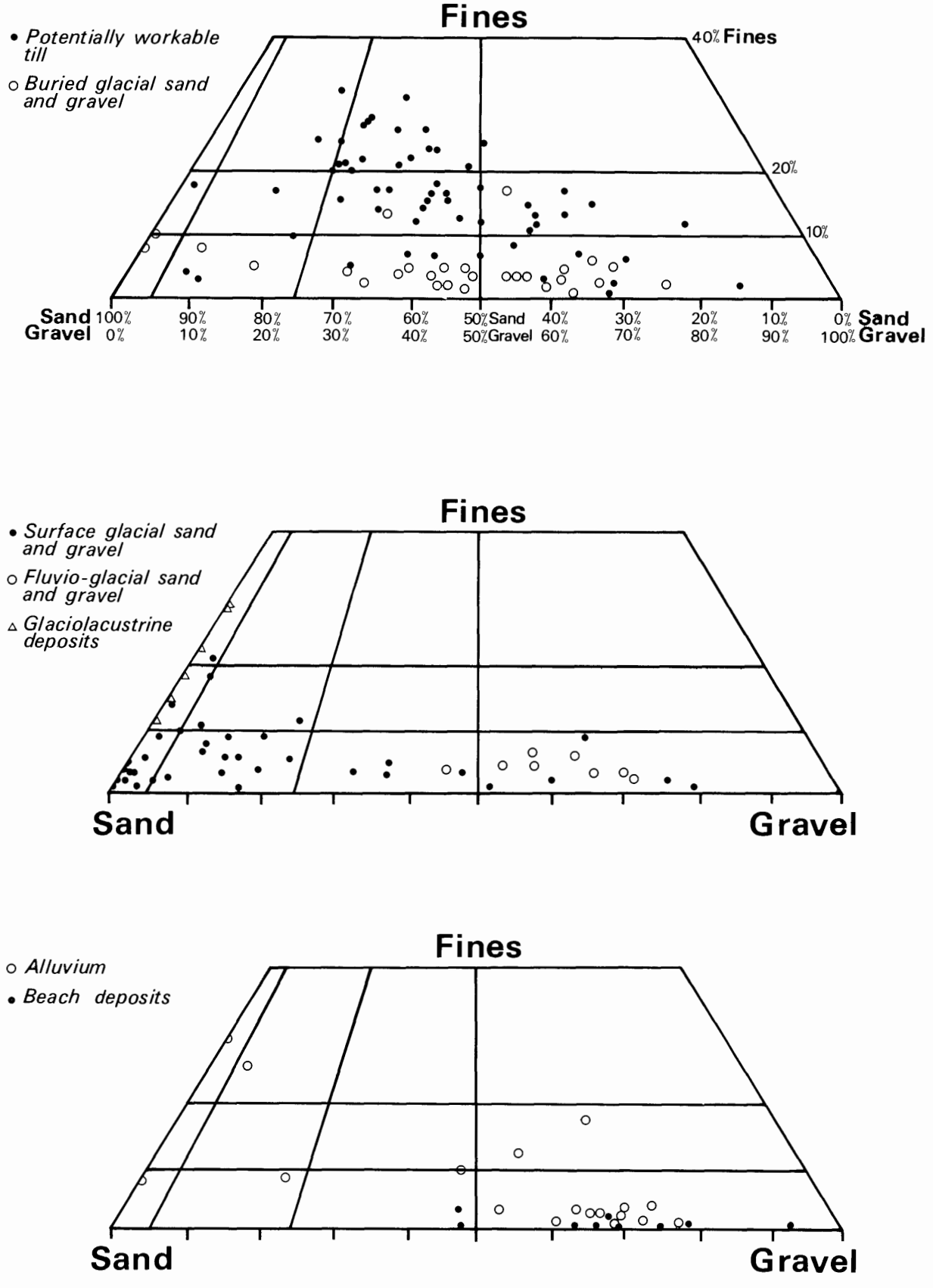


Figure 5 Diagram comparing mean particle-size distributions of mineral deposits proved at 58 sample points

Fluvioglacial sand and gravel

The mean grading of the fluvioglacial sand and gravel is fines 4 per cent, sand 39 per cent and gravel 57 per cent. Coarse gravel exceeds fine, the former tending to be more rounded than the latter. As cobbles and small boulders are found scattered across cultivated ground and are frequently exposed by ploughing in new forestry plantations, the mean grading calculation of 3 per cent exceeding +64 mm is probably an understatement. The gravel is predominantly spherical in shape.

Sand is medium grade with fine and coarse. The fine and medium sand is chiefly subangular to subrounded; the coarse contains angular, comminuted rock debris.

The fines consist mostly of disseminated silt with rare laminae of clay. The mean content ranges from 2 per cent in borehole SW 15 to 7 per cent in SW 20.

Alluvium (of the Spey)

The overall mean grading of the potentially workable alluvial deposits of the Spey is fines 3 per cent, sand 38 per cent and gravel 59 per cent. Coarse gravel predominates over fine, cobbles are numerous making up 27 per cent of the deposit at borehole SW 23 and giving a mean of 14 per cent. Sand is mainly of medium grade with subordinate coarse and fine. The mean fines content of boreholes proving mineral ranges from a trace at SE 2 to 12 per cent at SE 3 and consists chiefly of disseminated silt. The uppermost parts of the deposit are sometimes clayey and slightly cohesive.

The gravel is predominantly spherical, the coarse being chiefly rounded to well rounded and the fine more angular. The medium and fine sand is chiefly subangular to subrounded, the coarse generally being 'sharp' due to the presence of angular comminuted rock.

In areas that have not been cultivated boulders commonly up to 500 mm in diameter are scattered on the surface, especially within abandoned distributary channels of the River Spey. Shallow pits indicate that the amount of large cobble and boulder material is underestimated in samples obtained from boreholes, due chiefly to comminution caused by the drilling method employed. This disparity is common to all mineral deposits containing coarse material but is particularly applicable to the alluvium of the Spey. However, material smaller than about 120 mm is not unduly affected by the drilling and the grading analyses of sand and gravel obtained from boreholes are more directly comparable with those of similar material obtained from shallow pits.

Glacial sand and gravel

Exposed glacial sand and gravel is widespread over blocks B and E. Similarly classified, yet lithologically distinct sand and gravel occurs at depth over much of the sheet. To distinguish these deposits for purposes of assessment the prefixes 'surface' and 'buried' are used as a qualification.

a) Surface glacial sand and gravel Potentially workable surface glacial sand and gravel in block B has a mean grading of fines 7 per cent, sand 84 per cent and gravel 9 per cent. The deposit is predominantly sandy becoming more gravelly in the south and east of the block (see Fig. 3). The gravel is chiefly between 10 and 30 mm diameter with fine and coarse fractions roughly equal; cobbles are relatively rare. Pebbles are mainly spherical, being chiefly rounded to well rounded in the sandier areas and more angular in the gravelly areas.

The sand is medium to fine grained with very little coarse, is generally well sorted, 'soft' and micaceous. The fines usually consist of disseminated silt, but also occur in seams of silt and laminae of clay, the latter being more common towards the bases of deposits. The mean fines content ranges from 1 per cent at exposure NW 6 to 18 per cent in borehole SW 2.

Over much of the block a fining downwards sequence is observed, as demonstrated by boreholes NW 2, SW 2, SW 5 and SW 6, where the basal parts are classified as glaciolacustrine deposits.

In contrast to block B, the surface glacial sand and gravel of block E is generally more gravelly and the sand less fine grained. The mean grading is fines 4 per cent, sand 68 per cent and gravel 28 per cent. Although the deposit is less silty than in block B, the particle-size distribution of the gravel fraction is similar in both blocks.

A deposit of sand and gravel proved in borehole SE 21 is unusual in that both the sand and gravel fractions are exceptionally angular. Although the origin of this deposit is unclear it is classified as glacial sand and gravel.

The mean grading for the potentially workable surface glacial sand and gravel in both blocks is fines 6 per cent, sand 79 per cent and gravel 15 per cent. The lateral variation of grading is shown diagrammatically in Fig. 3.

Borehole SE 26 sited on alluvium of the Burn of Tynet is included in the assessment of the surface glacial sand and gravel. However, the mineral proved at this site has a minimal influence on the overall grading.

b) Buried glacial sand and gravel It is difficult to generalise about the grading, which is variable. Many of the deposits identified pass vertically into potentially workable till with little change in their grading characteristics. As the deposits are localised and of such variable character details are given where appropriate in the notes on resource blocks.

The buried glacial sand and gravel has been assessed for convenience in two parts, the resource sheet being divided along easting 35. The mean grading for the deposits in the western area is fines 5 per cent, sand 51 per cent and gravel 44 per cent; in the eastern area it is fines 2 per cent, sand 37 per cent and gravel 61 per cent.

Glaciolacustrine deposits

The surface glacial sand and gravel within block B generally becomes increasingly fine grained with depth. Although there is often a gradual transition downwards from silty fine sand through sandy silt to silty clay an attempt is made to identify the more silty parts of the sequence as glaciolacustrine deposits.

When an arbitrary break in a sequence has to be made, for example at borehole SW 6, a figure of 80 per cent combined fine sand and fines is taken as the dividing point between deposits.

The glaciolacustrine deposits are chiefly thinly bedded or laminated, micaceous fine sand with a variable content of silt. Thin seams of tenacious silty clay are common and towards the base may constitute the bulk of the deposit.

A little over half of the deposits drilled contain less than 40 per cent fines and are potentially workable, the mean grading being fines 19 per cent and sand 81 per cent.

Potentially workable till

The deposit is generally poorly sorted and variable in composition; details are included in the descriptions of individual resource blocks. As with buried glacial sand and gravel, potentially workable till occurring over each half of the resource sheet has been assessed separately.

In the western half of the sheet potentially workable till has a mean grading of fines 10 per cent, sand 46 per cent and gravel 44 per cent, cobbles accounting for 6 per cent of the last-named component. Coarse gravel predominates over fine and the sand is fine and medium grained, with some coarse. Both the sand and the gravel tend to be angular.

As the deposit is cohesive, and in places firm or stiff, it is thought that a significant proportion of the fines consists of clay. On the whole the extensive pale yellowish grey to reddish brown coloured till is less clayey than the medium to dark grey type that is sometimes encountered at depth, especially in the north-west of the area.

Potentially workable till in the eastern half of the sheet has a mean grading of fines 17 per cent, sand 43 per cent and gravel 40 per cent. Cobbles make up 6 per cent of the gravel. The mean particle-size distribution is similar in both eastern and western areas excepting for a higher percentage of fines in the east, which ranges up to 28 per cent in borehole SE 16. Much of the difference in fines content between the areas may be due to the drilling technique. Although over 60 per cent of the potentially workable till drilled in the eastern area was sampled with minimal disturbance above the water table, only about 10 per cent was dry-drilled in the western area where most samples were recovered as a slurry with some unavoidable loss of fines and fine sand.

Channel-fill deposits

Relatively thick deposits of greenish pale grey, chiefly medium grained sand are identified in boreholes SW 17, SW 25 and SE 3. As these borehole sites coincide with an inferred elongated depression in the sub-drift surface (Fig. III on the resource map), the sands are identified as possible channel-fill deposits. White, silty, medium to fine grained sand proved in borehole SW 15 is tentatively included with these deposits.

The mean grading is fines 6 per cent, sand 93 per cent and gravel 1 per cent.

PETROGRAPHY, MECHANICAL AND PHYSICAL PROPERTIES OF THE AGGREGATE

Aggregate Impact Value (AIV), Aggregate Crushing Value (ACV), relative density, apparent relative density and water absorption determinations are offered for a selection of composite samples taken from mineral deposits of different origin within the survey area. Composition analyses (pebble-counts) for a more extensive series of samples are also included to enable a comparative study to be made.

Method

To provide data truly representative of aggregate deposits, a programme of pebble-counting and laboratory testing ideally requires examination of numerous randomly selected samples. With limited time available, laboratory examination was restricted to several representative composite samples. Depending on the volume of material available, up to three composite samples were prepared for each deposit. The boreholes and the mineral deposits from which thirteen composite samples were selected are shown in Table 2.

To obtain data that can be used as a basis for comparing properties of aggregate from a number of sources, limited particle-size ranges are examined. As British Standard 812.3: 1975 specifies that mechanical testing is conducted on material passing a 14 mm and retained on a 10 mm test sieve, that size range was also used for all composition analyses. The drawback to such a procedure is that the properties of pebbles in a restricted size range are determined and the results may not be representative of the gravel fraction as a whole.

In practice commercial laboratories responsible for carrying out the sieve-grading of bulk samples were asked to retain all +4 mm material: this fraction was later re-sieved to obtain the test samples. For some sandy deposits insufficient material was available to allow the mechanical properties to be determined although a pebble-count is offered, for example in composite groups H and I. For most mineral deposits test material was obtained by grouping samples from several boreholes, the exceptions being the late-Glacial beach deposits proved in one borehole, and the glacial sand and gravel proved in borehole SE 21, which appears to be unique within the area and warrants separate attention.

Composition analyses

The gravels of the Garmouth area are composed predominantly of Moine and Dalradian metasediments which can be classified in a number of ways depending upon the detail of petrological examination. As the main purpose of composition analysis in this report is to provide a basis for a

Table 2. Location and classification of deposits yielding composite samples representative of potentially workable aggregate

Composite sample	Mineral deposit represented by composite sample	Boreholes, and depths within boreholes from which aggregate was grouped to make composite samples
A	Storm beach deposits and post-Glacial raised beach deposits, west of the River Spey	NW 1 (0.0 to 9.0 m), NW 4 (0.0 to 8.7 m), NW 5 (0.0 to 5.6 m)
B	Storm beach deposits and post-Glacial raised beach deposits, east of the River Spey	SE 9 (0.0 to 7.5 m), SE 10 (0.0 to 11.0 m), SE 13 (0.0 to 5.0 m)
C	Late-Glacial raised beach deposits, east of the River Spey	SE 11 (0.0 to 6.0 m)
D	Fluvioglacial sand and gravel, 'Mosstodloch Terrace', west of the River Spey	SW 14 (0.1 to 5.1 m), SW 15 (0.0 to 9.3 m), SW 16 (0.1 to 3.6 m), SW 22 (0.6 to 4.7 m)
E	Fluvioglacial sand and gravel, 'Lunan Wood Terrace', west of the River Spey	SW 20 (0.5 to 7.2 m), SW 21 (0.0 to 12.3 m)
F	Alluvium (of the Spey), southern half of Spey Valley	SW 25 (0.0 to 4.5 m), SW 27 (0.0 to 12.0 m), SE 7 (0.0 to 7.2 m)
G	Alluvium (of the Spey), northern half of Spey Valley	SW 23 (0.0 to 4.6 m), SW 24 (0.0 to 8.7 m), SE 2 (0.0 to 7.5 m), SE 3 (1.0 to 5.2 m)
H	Surface glacial sand and gravel, west of the River Spey	SW 6 (0.1 to 9.2 m), SW 11 (0.1 to 5.1 m), SW 19 (1.0 to 5.8 m)
I	Surface glacial sand and gravel, east of the River Spey	SE 20 (0.6 to 4.4 m), SE 24 (0.2 to to 5.0 m)
J	Buried glacial sand and gravel	SW 2 (20.0 to 24.4 m), SW 3 (5.4 to 10.0 m), SW 11 (11.8 to 20.8 m), SW 19 (11.5 to 19.0 m), SE 5 (8.0 to 15.0 m)
K	Potentially workable till	SW 3 (1.2 to 5.4 m), SW 11 (6.1 to 11.8 m), SE 3 (5.2 to 10.0 m), SE 5 (5.0 to 8.0 m), SE 8 (0.6 to 13.9 m), SE 13 (7.4 to 12.0 m), SE 23 (0.6 to 11.1 m), SE 25 (0.6 to 8.3 m)
L (two samples)	Glacial sand and gravel at borehole SE 21	a) SE 21 (0.5 to 5.0 m) b) SE 21 (5.0 to 15.1 m)

Table 3. Classification of rock-types* adopted for composition analyses based upon the BS trade group classification scheme (BS 812.1:1975)

(i) Quartzite trade group
- Quartzites
  - quartzitic sandstone (orthoquartzite)
  - recrystallised quartzite (metaquartzite)
- Psammites
  - psammitic granulite (quartz + feldspar (sodic or calcic) with $< \sim$ 20% mafic minerals)

Vein-quartz

(ii) Granite trade group
- granite
- granodiorite
- acid gneiss
- potash feldspar granulite
- pegmatite

(iii) Porphyry trade group
- felsite
- porphyry
- microgranite
- aplite

(iv) Gritstone trade group
- sandstone
- arkose

(v) Schist trade group
- mica schist
- phyllite
- slate
- sheared pelites

(vi) Gabbro trade group
- basic gneiss
- hornblende-rock
- basic diorite
- gabbro

(vii) Limestone trade group
- limestone
- dolomite

(viii) Flint trade group
- chert

* All the rocks listed have been identified in the gravel samples analysed

comparative study of physical and mechanical properties, a simple classification scheme has been adopted, based on the British Standard petrological groups (trade groups) outlined in BS 812.1: 1975.

The trade groups are modified slightly (Table 3) because they do not satisfactorily accommodate metamorphic rocks which are inherently of variable composition and contain hybrid rock types, for example, migmatites and banded granulites. The quartzite trade group is divided into two sub-groups, one containing quartzitic sandstone (orthoquartzite) and recrystallised quartzite (metaquartzite) with up to 10 per cent mafic minerals; the other contains what is commonly termed psammite or psammitic granulite, a predominantly unfoliated quartzo-feldspathic rock containing up to about 20 per cent mafic minerals. Acid gneiss and potash-feldspar granulites are included within the granite trade group as suggested in the British Standard, although some of the latter, if fine grained, are classified as microgranite and therefore contained within the porphyry trade group.

Composition analyses are presented in Tables 4 and 5, the former for comparison including analyses of a selection of samples of 14 to 37.5 mm material. The analyses are expressed in terms of weight per cent rather than by number of clasts. Ideally between 300 and 400 pebbles are included in each analysis.

As the composition of the potentially workable till (proved in eight boreholes) is more variable than the sand and gravel deposits separate analyses are offered (Table 5) and an average is calculated. Material from the same boreholes also forms a composite sample for which mechanical and physical test data are presented in Table 6.

Mechanical and Physical Properties

Where sufficient material was available AIV, ACV, relative density, apparent relative density and water absorption were determined for each of the composite samples according to BS 812: 1975. AIV is a measure of the resistance of an aggregate to sudden shock or impact which in some materials differs from its resistance to a slowly applied compressive load as indicated by the ACV. Relative density (specific gravity) is quoted both on a surface-dry and oven-dry basis. Water absorption is a measure of the water absorbed by an aggregate sample after 24 hours of immersion in distilled water, expressed as a percentage of oven-dry weight. The results are shown in Table 6.

Table 4. Composition analyses (pebble-counts) for 20 composite samples of potentially workable aggregate expressed as weight per cent

Composite sample	Size-range mm	No. of pebbles counted	Quartzite trade group (i)		Vein-quartz	Granite trade group (ii)	Porphyry trade group (iii)	Gritstone trade group (iv)	Schist trade group (v)	Gabbro trade group (vi)	Limestone trade group (vii)	Flint trade group (viii)	Quartzite trade group with vein-quartz	Potentially deleterious rock-types (groups iv, v, vi)	Ratio of quartzite to psammite in group (i)
			Quartzites	Psammite											
A	-37.5 +14.0	249	49.4	26.1	6.1	10.3	4.1	1.3	2.7	0	0	0	81.6	4.0	1.9:1
	-14.0 +10.0	272	42.2	26.9	8.9	11.7	8.2	0	2.1	0	0	0	78.0	2.1	1.6:1
B	-37.5 +14.0	184	35.8	41.4	5.1	8.3	1.5	1.1	6.9	0	0	0	82.3	8.0	1:1.2
	-14.0 +10.0	465	44.6	31.5	7.2	8.9	3.4	0.4	3.7	0	0.2	0	83.3	4.1	1.4:1
C	-14.0 +10.0	412	49.5	30.2	5.8	9.6	3.1	0	0.7	1.2	0	0	85.5	1.9	1.6:1
D	-37.5 +14.0	278	43.4	42.7	3.8	5.5	1.3	0.4	2.7	0	0	0.3	87.9	3.1	1.0:1
	-14.0 +10.0	320	48.6	29.0	6.9	5.7	2.8	0.9	6.0	0	0	0.3	84.5	6.9	1.7:1
E	-37.5 +14.0	280	44.2	40.6	1.5	10.5	1.9	0	0.8	0	0	0.4	86.3	0.8	1.1:1
	-14.0 +10.0	240	40.4	35.0	8.8	10.4	2.2	1.0	2.3	0	0	0.4	84.2	3.3	1.2:1
F	-37.5 +14.0	441	45.6	33.0	4.4	9.6	1.7	0.9	3.9	0.8	0	0	83.0	5.6	1.4:1
	-14.0 +10.0	371	41.9	36.7	6.5	6.9	2.0	2.5	3.5	0	0	0	85.1	6.0	1.1:1
G	-37.5 +14.0	312	39.9	37.9	5.5	10.3	3.2	0.9	2.2	0.2	0	0	83.3	3.3	1.1:1
	-14.0 +10.0	407	46.9	32.4	4.5	8.1	2.8	0.4	4.3	0.6	0	0	83.8	5.3	1.4:1
H	-14.0 +10.0	342	35.1	29.3	8.9	17.7	6.4	1.9	0.7	0	0	0	73.3	2.6	1.2:1
I	-14.0 +10.0	258	63.5	18.6	6.0	6.8	1.8	2.0	1.3	0	0	0	88.1	3.3	3.4:1
J	-37.5 +14.0	348	34.6	39.0	6.0	9.2	8.6	0.6	1.1	0.1	0.7	0	79.6	1.8	1:1.1
	-14.0 +10.0	445	42.2	31.6	6.6	9.5	7.0	0.7	1.7	0	0.2	0.6	80.4	2.4	1.3:1
K	-14.0 +10.0	332	59.8	19.2	5.4	7.9	3.0	2.6	1.3	0.8	0	0	84.4	4.7	3.1:1
L (a)	-14.0 +10.0	361	64.1	16.0	13.9	1.1	0	3.8	1.0	0	0	0	94.0	4.8	4.0:1
L (b)	-14.0 +10.0	387	72.6	8.6	8.7	1.6	0	7.1	1.1	0	0	0.3	89.9	8.2	8.4:1

Table 5. Composition analyses (pebble-counts) for 8 composite samples of potentially workable till expressed as weight per cent

Borehole	Size-range in mm*	No. of pebbles counted	Quartzite trade group (i)		Vein-quartz	Granite trade group (ii)	Porphyry trade group (iii)	Gritstone trade group (iv)	Schist trade group (v)	Gabbro trade group (vi)	Lime-stone trade group (vii)	Flint trade group (viii)	Quartzite trade group with vein-quartz	Potentially deleterious rock-types (groups iv, v, vi)	Ratio of quartzite to psammite in group (i)
			Quart-zites	Psam-mite											
SW 3		319	45.1	27.6	5.4	11.9	3.4	1.5	2.2	2.8	0	0.1	78.1	6.5	1.6:1
SW 11		272	63.8	16.2	3.2	9.1	2.7	2.9	1.7	0.5	0	0	83.2	5.1	3.9:1
SE 3		458	49.0	29.1	4.0	8.5	4.4	1.5	2.4	0.9	0	0.2	82.1	4.8	1.7:1
SE 5		392	54.9	28.1	3.5	7.4	2.9	1.9	0.5	0.8	0	0	86.5	3.2	2.0:1
SE 8		340	71.7	12.9	4.6	7.5	0.7	0.6	1.5	0.6	0	0	89.2	2.7	5.6:1
SE 13		393	57.7	20.9	5.7	6.3	5.1	3.2	0.9	0	0.1	0	84.3	4.1	2.8:1
SE 23		304	62.7	15.7	6.9	7.7	2.9	2.9	0.8	0	0	0.3	85.3	3.7	4.0:1
SE 25		175	73.2	3.2	9.7	4.3	2.1	6.4	0	0.5	0	0	86.1	6.9	22.9:1
Average		332	59.8	19.2	5.4	7.9	3.0	2.6	1.3	0.8	0	0	84.4	4.7	3.1:1

*Material passing a 14 mm and retained upon a 10 mm sieve was used for all tests

Table 6. Results of mechanical and physical tests (BS 812 : 1975) conducted upon 11 composite samples of potentially workable aggregate

Composite sample †	Mineral deposit ≠	A.I.V.	A.C.V.	Relative‡ density (oven-dried basis)	Relative‡ density (surface-dried basis)	Apparent‡ relative density	Water‡ absorption
A	Beach deposits	11	13	2.60	2.62	2.65	0.7%
B	Beach deposits	15	19	2.59	2.61	2.65	1.0%
C	Beach deposits	18	*	*	*	*	*
D	Fluvioglacial sand and gravel	17	19	2.57	2.60	2.65	1.1%
E	Fluvioglacial sand and gravel	17	20	2.58	2.61	2.66	1.2%
F	Alluvium	17	20	2.58	2.61	2.65	1.1%
G	Alluvium	18	19	2.58	2.61	2.66	1.1%
J	Buried glacial sand and gravel	18	19	2.56	2.59	2.64	1.2%
K	Potentially workable till	18	19	2.55	2.58	2.64	1.2%
L (a)	Glacial sand and gravel in borehole SE 21	16	*	*	*	*	*
L (b)	Glacial sand and gravel in borehole SE 21	18	20	2.53	2.57	2.64	1.6%

A.I.V. = Aggregate impact value A.C.V. = Aggregate crushing value

† Material passing a 14 mm and retained upon a 10 mm test sieve was used for all tests

≠ Details given in Table 2

‡ Based on one test per sample

* Insufficient material available for test

Results and observations

Composition analyses

10 mm to 14 mm size range

The gravel examined consists chiefly of rocks belonging to the quartzite trade group (see Table 3), in particular, impure recrystallised quartzite, psammitic granulite and vein-quartz. Material in this trade group, including vein-quartz, constitutes between 73 and 94 per cent of the composite samples analysed (see Table 4). Rocks of the granite trade group are next in abundance and constitute between 1.1 and 17.7 per cent of the material examined; of this group of rocks, grey granite and pink, fine grained granulite are predominant with pink granite and gneiss less common. In the majority of the samples examined other rock types are poorly represented. Rocks of the porphyry trade group, including micro-granite, porphyry and felsite, constitute up to 8.2 per cent of the material examined and are found in all composite samples except those from the glacial sand and gravel in borehole SE 21. The sandstone, schist and gabbro trade groups, which collectively contain most potentially deleterious rock types, comprise between 1.9 and 8.2 per cent of the material examined, chert and limestone are rare, and no rocks belonging to either the basalt or the hornfels trade groups were identified.

The average composition of the 10 mm to 14 mm material examined is 83 per cent quartzite trade group (including vein-quartz), 9 per cent granite trade group, 4 per cent porphyry trade group and 4 per cent sandstone, schist and gabbro trade groups combined. The amount of other rock types identified is negligible.

Although the overall proportion of quartzitic material in all samples is similar, subtle variations are disclosed by considering the ratio of quartzite to psammite (Table 4). For the beach, alluvial and fluvioglacial gravel the ratio of quartzite to psammite ranges between 1.1:1 and 1.7:1. In contrast, the till samples reveal a ratio of up to 23.0:1 at borehole SE 25 and the glacial sand and gravel sampled in borehole SE 21 has a ratio of between 4.0:1 and 8.4:1. From the limited data available it appears that the relative percentage of both quartzite and vein-quartz within potentially workable till and surface glacial sand and gravel increases towards the south-east of the area.

The amount of potentially deleterious rocks in the beach deposits is predictably low, especially in areas well clear of the mouth of the River Spey towards the western margin of the sheet, and is highest in the potentially workable till and glacial sand and gravel proved in borehole SE 21. The percentage of sandstone is negligible in the beach deposits and fluvioglacial sand and gravel, is higher in the alluvial deposits of the Spey and reaches a maximum of 7.1 per cent in the gravel proved in borehole SE 21. Schist, pelite and gabbro are most abundant in the fluvioglacial sand and gravel and alluvial deposits.

14 mm to 37.5 mm size

Pebble-counts on 14 mm to 37.5 mm material from seven composite samples are included in Table 4. The proportion of vein-quartz plus quartzite group material is very similar in those deposits for which two size ranges were examined; 84 per cent for the +14 mm material, 83 per cent for the -14 mm material. It is apparent, however, that psammite is more abundant in the +14 mm gravel: the average ratio of quartzite to psammite is 1.1:1 for the +14 mm size range, and 1.4:1 for the -14 mm size range, although in two of the composite samples psammite is more abundant than quartzite in the coarser material. Vein-quartz is predictably more abundant in the finer gravel, the -14 mm size range containing on average 7.1 per cent compared with an average of 4.6 per cent for the +14 mm size range.

Mechanical and physical properties

Results of the testing programme are given in Table 6. The mechanical tests show that all material examined is of reasonable strength. The AIV results range between 11 and 18, cluster between 17 and 18 and have a mode of 18. The ACV results show a similar trend: the values range between 13 and 20, cluster between 19 and 20 and have a mode of 19. The beach gravel from west of the Spey is especially strong: the material has a high sphericity and contains very few deleterious components such as, for example, friable sandstone.

The average value obtained for water absorption is 1.1 per cent: the results range from 0.7 to 1.6 per cent. The beach gravel west of the Spey yields the lowest value, compatible with the findings mentioned above. The gravel from borehole SE 21 has a relatively high value, probably on account of the high sandstone content of the deposit and the abnormally high degree to which much of the psammite is weathered. In general the water absorption values recorded indicate that potentially workable aggregate in the area is unlikely to be susceptible to significant volume change upon wetting and should therefore produce concretes with low shrinkage properties (Edwards, 1970).

Values of relative density (oven-dried basis) range from 2.53 to 2.60 and have an average of 2.57. The beach gravel west of the Spey gives the highest value: potentially workable till and glacial sand and gravel in borehole SE 21 yield the lowest value. The two last-mentioned have a relatively high proportion of quartzite and sandstone at the expense of psammite and schist.

Apparent relative density values vary between 2.64 and 2.66 and the results obtained mirror the trend indicated by the relative densities.

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 Second Series in grey, on which topography is

shown by contours in blue, the geological lines and symbols in black, potentially workable sand and gravel, notes and block boundaries in red, potentially workable till in purple, areas of bedrock or barren ground in white and assessment borehole data in madder rose.

Geological data

The geological boundary lines, symbols etc. shown are taken from the geological map of this area which was last surveyed at a scale of 1:10 560 between 1961 and 1963. This information was obtained by detailed application of field mapping techniques, by the staff in the Institute's Highlands and Islands Unit. Borehole data, which include the stratigraphic relations and mean particle-size distribution of aggregate samples collected during the assessment survey, are also shown.

The geological boundaries show the best available interpretation of the information to hand at the time of survey. However, it is inevitable, particularly with glacial deposits (such as those included in the area of sheet NJ 36) which change rapidly vertically and laterally, that local irregularities or discrepancies will be revealed by some data points (for example, at pit SE P10). These are taken into account in the assessment of resources (see below and Appendix B).

Mineral resource information

The resource map is in part a profile map, that is, it attempts to show the disposition and extent of the two potentially workable aggregates recognised in the area. A distinctive colour is used to identify each resource and a convention, which may be thought of as a trench or slot, is used where one potentially workable material, say sand and gravel overlies another, say till. Because these two materials pose different problems in terms of resource planning and exploitation they have been assessed separately.

A continuous colour other than white identifies a particular resource and indicates that overburden, if any, averages less than 1 m in thickness. For example, continuous red distinguishes areas of exposed potentially workable sand and gravel; continuous purple, exposed potentially workable till.

Areas where bedrock crops out, where boreholes indicate the absence of a resource and where material is interpreted as not potentially workable, are uncoloured on the map; where appropriate the relevant criterion is noted on the explanatory small scale maps (Figs I and II) accompanying the resource map. In such barren areas it has been assumed that mineral is absent except in infrequent and relatively minor patches which can neither be outlined nor assessed quantitatively in the context of this survey.

In areas where two resources are superimposed the broad colour band denotes the upper, the narrow band the buried material. For example, narrow purple bands through an area coloured predominantly red denote exposed potentially workable sand and gravel (red) overlying continuous or almost continuous spreads of potentially workable till (purple). In the Garmouth area borehole evidence suggests that any waste partings separating these two resources are discontinuous: only in one borehole (SE 14) does the waste parting exceed 1 m in thickness. A narrow purple band through white indicates continuous or almost continuous spreads of potentially workable till beneath overburden.

The recognition of the continuity of a resource beneath overburden is dependent upon the importance attached to the proportion of boreholes which prove potentially workable material and the distribution of barren boreholes within a block. The resource is described as 'almost continuous' if it is present in 75 per cent or more of the boreholes in a resource block. It follows that in some areas, though not on sheet NJ 36, a 'discontinuous' category might be recognised. This category would be portrayed by the slot or trench convention, with the narrow band showing white with the appropriate diagnostic colour of the buried, discontinuous resource.

The area of exposed potentially workable material is measured from the mapped geological boundary lines. The whole of this area is considered as mineral, although it may include small undefined areas where the resource is not present or not potentially workable. Inferred boundaries have either been used to delineate areas where potentially workable material is thought to be absent or to locate transitions between categories. Such boundaries (for which a distinctive symbol is used) are drawn primarily for the purpose of volume estimation. The symbol is intended to convey an approximate location within a likely zone of occurrence rather than to represent the breadth of the zone, its size being limited only by cartographic considerations. For the purpose of measuring areas the centre-line of the symbol is used.

RESULTS

Results are summarised in Table 7; further particulars are given in Tables 8 to 12.

For each block a statistical assessment of all the potentially workable drift deposits is offered together with a separate statistical assessment of the exposed sand and gravel (see Table 7a). As the resource block boundaries reflect the areal distribution of different mineral-bearing drift deposits, for example, beach deposits and fluvioglacial sand and gravel, an independent assessment is offered in effect for each of the major deposits developed at the surface. Although there are insufficient thickness and grading data to enable separate statistical assessments to be offered, block by block, for the buried mineral deposits (till, buried glacial sand and gravel and channel-fill deposits), by subtraction a rough estimate can be made of the volume of this material present in each block.

For additional information statistical assessments are offered for the buried mineral deposits in areas spanning several resource blocks. As potentially workable till is not laterally persistent beneath the valley of the River Spey (see Figs I and II on the resource map), it is

Table 7. The sand and gravel resources of sheet NJ 36

a Summary of statistical assessments

RESOURCE BLOCK	Mineral Deposit Assessed	Sample points	Area		Mean Thickness				Volume		Limits at 95% probability level		Mean Grading Percentage		
			Block	Mineral	Overburden		Mineral		Million	Million			Fines	Sand	Gravel
			km^2	km^2	m	ft	m	ft	m^3	yd^3	±x%	±x million m^3	-1/16 mm	-4+1/16 mm	+4 mm
A	Beach deposits	8	7.3	7.1	0.1	0.5	8.4	27.5	60	78	19	11	1	32	67
	All potentially workable material*	8	7.3	7.1	0.1	0.5	9.7	32	69	90	18	12	- †	-	-
B	Glacial sand and gravel and glaciolacustrine deposits	16	15.6	15.0	0.4	1.5	10.8	35.5	162	212	36	58	10	83	7
	All potentially workable material*	17	15.6	15.5	1.4	4.5	16.5	54	256	335	19	49	- †	-	-
C	Fluvioglacial sand and gravel	8	7.3	7.0	0.4	1.5	7.1	23.5	50	65	44	22	4	39	57
	All potentially workable material*	8	7.3	7.1	0.4	1.5	14.5	47.5	103	134	31	32	- †	-	-
D	Alluvium (of the Spey)	9	8.9	8.9	0.4	1.5	6.1	20	54	71	41	22	3	38	59
	All potentially workable material*	9	8.9	8.9	0.4	1.5	10.1	33	90	117	50	45	- †	-	-
E	Surface sand and gravel deposits, chiefly glacial sand and gravel and alluvium	10	15.3	8.1	0.5	1.5	6.1	20	49	65	46	23	4	68	28
	All potentially workable material*	16	15.3	15.0	0.5	1.5	10.6	35	159	209	21	33	- †	-	-
A to E	Surface sand and gravel deposits only	51	54.4	46.1	0.4	1.5	8.1	26.5	373	488	18	67	6	60	34
	All potentially workable material*	58	54.4	53.6	0.5	1.5	12.7	41.5	680	891	12	82	- †	-	-

*Excluding bedrock

†Overall mean grading is not given because of the great variety of material. Details of the mean grading for parts of the resource are given in Tables 8 to 12.

Table 7. (continued)

b Summary of additional assessments ≠

Area Assessed	Mineral Deposits	Sample points	Area		Mean Thickness				Volume		Limits at 95% probability level		Mean Grading Percentage		
			Overall	Mineral	Overburden		Mineral		Million	Million			Fines	Sand	Gravel
			km^2	km^2	m	ft	m	ft	m^3	yd^3	±x%	±x million m^3	-1/16 mm	-4+1/16 mm	+4 mm
Area to the west of Easting 335	Potentially workable till	16	30.9	15.0	-	-	5.7	18.5	86	112	32	27	10	46	44
	Buried glacial sand and gravel	13	30.9	10	-	-	4.8	15.5	48	63	37	18	5	51	44
Area to the east of Easting 335	Potentially workable till	17	23.5	16.3	-	-	6.6	21.5	108	141	28	30	17	43	40
	Buried glacial sand and gravel [inferred assessment]	7	23.5	2.5	-	-	3.3	11	8	11	-	-	2	37	61
Whole sheet	Potentially workable till	33	54.4	31.3	-	-	6.2	20.5	194	254	19	37	14	44	42
Whole sheet	Buried glacial sand and gravel	20	54.4	12.5	-	-	4.3	14	54	70	29	16	4	47	49

≠ All assessments are statistical unless otherwise stated.

convenient to divide the sheet into two halves along easting 35. A statistical assessment is offered for the potentially workable till and for the buried glacial sand and gravel in the western area. For the eastern area a statistical assessment is offered for the potentially workable till and an inferred assessment is presented for the buried glacial sand and gravel. Results of these additional assessments are given in Table 7b.

Accuracy of results

For the resource blocks assessed statistically the accuracy of the results at the symmetrical 95 per cent probability level ranges from 18 to 58 per cent. However, the true values are more likely to be nearer the figure estimated than the limits. Moreover it is probable that in each block roughly the same percentage limits would apply for the estimate of volume of a very much smaller parcel of ground (say 100 ha) containing similar sand and gravel deposits if results from the same number of sample points (as provided by, say ten boreholes) were used in the calculation. Thus, if closer limits are needed for the quotation of reserves of part of a block it can be expected that data from more than ten sample points will be required, even if the area is quite small.

However, it must be emphasised that the quoted volume of sand and gravel 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 land for mineral working.

NOTES ON THE RESOURCE BLOCKS

The majority of the resource comprises beach deposits, river alluvium, fluvioglacial sand and gravel and glacial sand and gravel. By comparison minor amounts of potentially workable sand and gravel occur within glaciolacustrine deposits and channel-fill deposits. Although not sand and gravel in the everyday sense, a little over half of the till drilled is also potentially workable judged in terms of the arbitrary criteria adopted for this survey.

The resource block boundaries have been drawn to reflect the surface distribution of the mineral-bearing deposits within the area. Thus beach deposits are restricted to block A, the fluvioglacial sand and gravel is contained within block C, the alluvium of the Spey within block D and the exposed glacial sand and gravel within blocks B and E, respectively west and east of the River Spey.

Block A

The block includes storm beach and raised beach deposits together with a spread of alluvium at the mouth of the Burn of Tynet and small patches of alluvium in the vicinity of Kingston [338 655]. All potentially workable material in the block other than bedrock, including till and glacial sand and gravel underlying the beach material has been assessed. An independent assessment of the beach deposits is also offered.

To the west of the River Spey storm beach-ridges form a belt approximately 850 m wide fringing a well defined ancient cliff-line that extends along the face of Binn Hill [306 658] as far as Winnyhaugh [336 651]. Apart from a low-lying, marshy alluvial flat to the south-west of Kingston the surface deposits are predominantly gravelly and covered by little if any soil. Boreholes NW 1, NW 4 and NW 5 sited on the storm beach deposits respectively prove 8.9 m, 8.7 m and 7.6 m of mineral.

For a distance of over 2 km to the west of Kingston the beach shingle has been extensively dug for aggregate. However, due to the limitations imposed by the relatively high water table only the storm beach-ridges have been removed and the resource may therefore be regarded as being only partially exploited.

East of the River Spey the belt of storm beach-ridges narrows to about 650 m. Between Spey Bay and Lower Auchenreath [372 639] the deposits are backed by a low feature and eastwards, between Lower Auchenreath and Portgordon, by a prominent ancient cliff-line. Boreholes SE 9, SE 13 and SE 18 respectively prove 7.5 m, 7.4 m and 6.0 m of mineral. The deposits are predominantly gravelly and soil, if present, is very thin.

Immediately west of Porttannachy [385 642] the beach has been modified by the Burn of Tynet and an area of alluvium is shown on the map. As borehole SE 18 shows the mean grading of the alluvium to be broadly similar to the beach material proved elsewhere (excepting that the former contains relatively more fines in the form of red silt introduced by the Burn of Tynet), the deposits have been considered together in the assessment.

To the east of the Burn of Tynet the storm beach abutts a low raised beach backed by a well marked ancient cliff-line behind the village of Porttannachy. Geological mapping suggests that this part of the beach is underlain by rock at no great depth. The veneer of gravel, largely built over, is excluded from the assessment and represents the only barren area within the block.

Raised beach deposits are identified to the south of the feature backing the storm beach deposits to the east of the Spey. They form a triangular shaped shingle platform lying between Spey Bay to the west, Lower Auchenreath to the east and Upper Dallachy [363 626] to the south. To the south-east the deposits are backed by a prominent ancient cliff-line, largely cut into till; to the west they form a low terrace bordering alluvium.

Raised beach deposits are proved in boreholes SE 10 and SE 11 which respectively reveal 12.0 m and 9.0 m of mineral covered by thin soil. There are old, shallow gravel workings [362 643] north-east of Nether Dallachy and [364 642] north of the Moor of Dallachy. At [366 642] gravel was being worked above the water table in 1977.

Except in borehole SE 10 where beach deposits rest directly on Old Red Sandstone, boreholes indicate that the beach deposits rest on a bench cut in till generally lying at 2.0 m to 3.5 m below Ordnance Datum along the coast. Inland the platform rises and in borehole SE 11 stands at

3.4 m above Ordnance Datum.

The mean thicknesses of potentially workable storm beach and raised beach deposits for the block as a whole are respectively 7.7 m and 10.5 m. Additional data are shown in Table 8.

The mean thickness for the storm beach and raised beach deposits combined is 8.4 m. They cover an area of 7.1 km^2. Based upon eight Industrial Minerals Assessment Unit boreholes and one pit section (SE 27), the volume of mineral is estimated at 60 million m^3 (78 million yd^3) $\pm$ 19 per cent. The mean grading of the mineral is 1 per cent fines, 32 per cent sand and 67 per cent gravel and the mean thickness of overburden is 0.1 m.

Only minor amounts of potentially workable material underlie the beach deposits. West of the River Spey all boreholes proved till beneath beach deposits but only in borehole NW 5 is the material judged to be potentially workable. Boreholes NW 1 and NW 4 which were terminated short of 25 m (the maximum depth to which boreholes were sunk during this survey) proved stiff, medium grey, very clayey till judged not potentially workable. Although locally the till may be potentially workable it is thought unlikely to be so in the vicinity of boreholes NW 1 and NW 4.

To the east of the River Spey two boreholes prove buried mineral deposits. At SE 9, 0.5 m of stiff, yellowish brown non-mineral till underlying the beach deposits passes down into 3.0 m of mineral classified as glacial sand and gravel. In borehole SE 13, 2.0 m of stiff, grey till underlying the beach deposits is potentially workable and in turn passes down into 2.6 m of glacial sand and gravel with seams of mottled, greenish grey till. In borehole SE 18 alluvial gravel rests upon 8.6 m of firm, greyish brown, faintly laminated silty pebbly clay which becomes sandy and gravelly below 15.1 m. However, due to an obstruction, the borehole was terminated at 17.0 m without proving the full thickness, and therefore the lower deposit is judged not potentially workable because of the thickness of overburden.

To the west of Kingston, borehole NW 5 proved from 10.6 m to 17.8 m, maroon coloured, chiefly medium grained, micaceous sand probably representative of deeply weathered sandstone bedrock. The deposit is not included in the assessment.

Based on two IMAU boreholes, potentially workable till has a mean thickness of 2.5 m; the mean grading is fines 5 per cent, sand 44 per cent and gravel 51 per cent. The mean thickness of the buried glacial sand and gravel, also based on two boreholes is 2.8 m and the mean grading is fines 2 per cent, sand 36 per cent and gravel 62 per cent.

The mean thickness of all potentially workable material within the block is 9.7 m and the volume is estimated at 69 million m^3 (90 million yd^3) $\pm$ 18 per cent.

Block B

The block, which is mapped principally as glacial sand and gravel, is bordered to the north by a prominent ancient cliff-line backing the beach deposits, and to the east and south-east by the back-features of terraces of the River Spey. The soil is generally sandy and well drained; the hills are largely afforested and the lower lying areas provide good agricultural land.

Much of the block is gently undulating country and is drained by the Stripe Burn which reaches the coast near Gladhill [323 652]. The burn follows an elongate, flat bottomed, relatively poorly drained depression partially underlain by alluvium of a former lake. Similar depressions occur to the south-south-west of Corbiewell [318 653] and to the east of Burniestripe [3166 6301], the latter also being associated with lake alluvium. The north of the block is dominated by Binn Hill, which is a little over 85 m (280 ft) above Ordnance Datum in height; in the south remnants of a kame-like plateau attain a height of 77.1 m (257 ft) above Ordnance Datum [3044 6084]. The eastern part of the block between Binn Hill and Loch Crofts [304 624] displays kettle and mound terrain more characteristic of country lying to the west of the resource sheet.

The glacial sand and gravel exposed over much of the block is underlain by a thick spread of till that crops out locally as isolated inliers, for example, at Muir of Lochs [304 625] and to the south-east of Gladhill. In the central part of the block in particular, beds of sand and gravel classified as glacial sand and gravel occur within the till, and between till and bedrock. To distinguish these deposits for purposes of assessment from the similarly classified, yet lithologically distinct sand and gravel occurring at the surface the glacial sand and gravel is qualified by the prefixes 'surface' and 'buried'.

Two assessments are offered. One considers the surface glacial sand and gravel and associated glaciolacustrine deposits; the other all potentially workable sand and gravel other than bedrock but including till.

Of the 16 boreholes sunk to investigate the surface glacial sand and gravel the majority show material to become increasingly fine grained with depth and at some localities to grade down into silt and clay. If a substantial part of the sequence proved at a borehole site grades at more than 80 per cent fines plus fine sand, the fine grained part is classified as glaciolacustrine deposits. Grading data for both the potentially workable surface glacial sand and gravel and glaciolacustrine deposits are presented in Table 9. Insufficient data are available to estimate separately the volumes of the deposits.

The mean grading of potentially workable surface glacial sand and gravel is fines 7 per cent, sand 84 per cent and gravel 9 per cent. The deposits are almost entirely of sand grade in the north-west of the block, particularly beneath Binn Hill, but become more gravelly to the south and east, the maximum proved gravel content (24 per cent) occurring in borehole SW 6. The proportion of silt generally increases with depth,

Table 8. Block A: data from assessment boreholes and exposures

Borehole	Recorded thickness (m)		Mean grading percentage						
	Over-burden	Mineral	Fines	Fine sand	Medium sand	Coarse sand	Fine gravel	Coarse gravel	Cobble gravel
			-1/16 mm	+1/16-¼ mm	+¼-1 mm	+1-4 mm	+4-16 mm	+16-64 mm	+64 mm
BEACH DEPOSITS									
(a) Storm beach deposits (including alluvium at SE 18)									
NW 1	0.1	8.9	1	15	8	8	22	42	4
NW 4	0	8.7	1	20	13	4	12	45	5
NW 5	0	7.6	1	8	9	5	22	44	11
SE 9	0	7.5	1	22	10	2	12	32	21
SE 13	0	7.4	1	32	17	3	10	31	6
SE 18	0.5	6.0	3	8	13	8	17	48	3
mean	0.1	7.7	1	18	12	5	16	40	8
(b) Raised beach deposits (Late-Glacial and post-Glacial)									
SE 10	0	12.0	2	5	22	5	18	37	11
SE 11	0	9.0	1	5	16	5	13	39	21
SE 27	0	4.7	2	4	12	4	14	36	28
mean	0	10.5	2	5	18	5	15	37	18
Overall mean	0.1	8.4	1	13	14	5	16	39	12
POTENTIALLY WORKABLE TILL									
NW 5	-	3.0	6	26	31	7	8	19	3
SE 13	-	2.0	2	5	6	3	8	17	59
mean	-	2.5	5	18	21	5	8	18	25
BURIED GLACIAL SAND AND GRAVEL									
SE 9	-	3.0	2	6	20	14	19	37	2
SE 13	-	2.6	1	9	14	9	24	39	4
mean	-	2.8	2	7	17	12	21	38	3

and consequently, boreholes sited on low lying ground tend to prove the more silty part of the sequence, as for example, boreholes SW 2, SW 8 and SW 9 where respectively 18, 11 and 12 per cent mean fines content are recorded. The mean fines content also appears to fall towards the east of the block where boreholes SW 18 and SW 19 respectively prove 2 and 5 per cent.

At borehole SW 5, near Steelsbrae [310 611], 2.0 m of orange brown sandy gravel overlies 9.2 m of pinkish pale brown pebbly sand. The upper material is classified as fluvioglacial sand and gravel because it probably relates genetically to the terrace feature upon which the borehole is sited. However, the two deposits are taken as one for the purpose of assessment.

Glaciolacustrine deposits identified at eight borehole sites within the block prove to be potentially workable in boreholes NW 3, SW 1, SW 2, SW 5 and SW 6. In boreholes SW 7, SW 12 and SW 13 no part of the sequence is regarded as potentially workable. The mineral thickness, which ranges from 10.9 m in borehole NW 3 to 5.2 m in SW 6 has a mean value of 8.0 m. Thickness and grading data are presented in Table 9.

Near Corskie [3276 6432], neither pit SW P6 nor borehole SW 12 proves potentially workable material within the lake deposits. (At the borehole site glaciolacustrine deposits lie just beneath the surface, concealed only by blown sand). Consequently an area of barren ground which may be more or less extensive is indicated on the resource map. However, not only is the surface deposit in this region judged not potentially workable, but so also is the till upon which it rests, and consequently a second, lower barren area is shown on the map. Although generally the upper barren area is superimposed on the lower, locally the areas are not coincident and consequently on the resource map the zig-zag lines delineating the barren ground appear to cross.

The potentially workable surface glacial sand and gravel and glaciolacustrine deposits, cover an area of 15.0 km^2. The thickness of overburden ranges up to 1.8 m in borehole SW 9 and has a mean of 0.4 m. The mineral, mean thickness 10.8 m, has an estimated volume of 162 million m^3 (212 million yd^3) $\pm$ 36 per cent. The mean grading of the mineral is fines 10 per cent, sand 83 per cent and gravel 7 per cent.

There are minor buried resources of potentially workable material comprising till and buried glacial sand and gravel. The area beneath which till is considered to be mineral is appropriately coloured on the resource map and delineated using zig-zag, inferred boundary lines. Explanatory notes are given on Fig. I accompanying the resource map. Whilst it is generally not possible to identify on the resource map areas in which potentially workable sand and gravel underlies till, an attempt is made on Fig. II to outline the major occurrence of this buried deposit.

Thickness and grading data from the 11 boreholes proving potentially workable till are listed in Table 9. Thickness ranges from 1.4 m in borehole SW 2 to 10.6 m in SW 4: the mean is 5.4 m. The mean grading is fines 10 per cent, sand 45 per cent and gravel 45 per cent.

In the north of the block till is generally clayey, and as indicated by boreholes SW 1 and SW 12, and boreholes NW 1 and NW 4 in block A, is not potentially workable. Pits SW P5, SW P6 and SW P7 in the vicinity of Corskie also proved till not to be potentially workable. Beneath much of Binn Hill the glacial sand and gravel and glaciolacustrine deposits thicken, locally exceeding 25 m, and consequently any underlying till has not been assessed. Similarly in the vicinity of Steelsbrae the surface mineral deposits thicken to over 25 m and consequently an area where the underlying till is not potentially workable is delineated on the resource map.

Of the exposed till, only the deposits at Muir of Lochs have been sampled. Borehole SW 3 and pits SW P2, SW P3 and SW P4 all proved potentially workable material.

Deposits of buried glacial sand and gravel have been identified beneath till at nine borehole sites. Thickness and grading data are listed in Table 9.

On Fig. II an area is outlined containing buried sand and gravel. The map should be interpreted cautiously, because it does not necessarily indicate the presence of a laterally continuous deposit as any correlation between borehole sites is speculative. For example, the buried sand and gravel identified in boreholes SW 18 and SW 19 lies between till and bedrock whereas in boreholes SW 3, SW 4, SW 8 and SW 9 it is both overlain and underlain by till. Correlation is also made difficult because 10 boreholes were abandoned short of 25 m; boreholes SW 2, SW 8, SW 11 and SW 13 terminated in sand and gravel, boreholes SW 1, SW 3, SW 9, SW 10 and SW 12 in not potentially workable till, and borehole SW 7 within glaciolacustrine deposits. Nevertheless this sketch map is considered to indicate very generally the extent of buried sand and gravel.

All the buried glacial sand and gravel sampled in boreholes proved to be potentially workable. The thickness, mean 5.3 m, ranges from 2.3 m in SW 18 to 10.0 m in borehole SW 11. The mean grading is fines 5 per cent, sand 51 per cent and gravel 44 per cent. Because of the paucity of sample points in the block, buried glacial sand and gravel has been considered in a statistical assessment, given later, which includes all such deposits and potentially workable till identified within the western half of the resource sheet.

The mean thickness of all potentially workable material (excluding bedrock) within the block is 16.5 m. The volume is estimated at 256 million m^3 (335 million yd^3) $\pm$ 19 per cent.

Block C

Apart from a small outcrop of bedrock at Redhall [3388 6030] and a patch of till nearby, potentially workable sand and gravel covers the whole block. In addition, over much of the block potentially workable till occurs at depth and the appropriate ornament is used on the resource map to portray the extent of this resource. Notes of explanation are given on a sketch map (Fig. I) accompanying the resource map. Buried sand and gravel deposits, restricted in extent, form a third

Table 9. Block B: data from assessment boreholes and exposures

Borehole	Recorded thickness (m)		Mean grading percentage						
	Over-burden	Mineral	Fines	Fine sand	Medium sand	Coarse sand	Fine gravel	Coarse gravel	Cobble gravel
			-1/16 mm	+1/16-¼ mm	+¼-1 mm	+1-4 mm	+4-16 mm	+16-64 mm	+64 mm
SURFACE GLACIAL SAND AND GRAVEL									
NW 2	0.1	24.9	9	48	40	1	1	1	0
NW 3	0.1	14.0	4	21	74	1	0	0	0
NW 6*	0.8	11.6	1	65	34	0	0	0	0
SW 2	0.2	2.0	18	50	27	1	3	1	0
SW 4	0.1	8.4	10	46	39	1	2	2	0
SW 5 †	0.5	11.2	6	24	46	4	7	10	3
SW 6	0.1	13.1	9	35	28	4	9	15	0
SW 7	0.6	4.0	8	46	35	2	4	3	2
SW 8	0.5	5.0	11	33	45	2	4	5	0
SW 9	1.8	3.0	12	30	32	6	9	11	0
SW 10	0	11.0	11	50	30	2	2	4	1
SW 11	0.1	6.0	6	21	43	9	8	12	1
SW 13	0.3	8.5	7	30	51	3	4	4	1
SW 18	0.1	7.0	2	23	69	1	2	2	0
SW 19	1.0	4.8	5	20	55	3	6	11	0
mean	0.4	8.9	7	38	44	2	3	5	1
GLACIOLACUSTRINE DEPOSITS									
NW 3	-	10.9	15	73	12	0	0	0	0
SW 1	-	8.0	12	86	2	0	0	0	0
SW 2	-	8.4≠	30	53	17	0	0	0	0
SW 5	-	7.3	23	74	3	0	0	0	0
SW 6	-	5.2	15	72	13	0	0	0	0
mean	-	8.0	19	72	9	0	0	0	0
Overall mean	0.4	10.8	10	45	36	2	3	4	0

* Natural section

† Including 2.0 m fluvioglacial sand and gravel

≠ Not including 5.4 m waste

Table 9. Block B: data from assessment boreholes and exposures (continued)

Borehole	Recorded thickness		Mean grading percentage						
	Over-burden	Mineral	Fines -1/16 mm	Fine sand +1/16-¼ mm	Medium sand +¼-1 mm	Coarse sand +1-4 mm	Fine gravel +4-16 mm	Coarse gravel +16-64 mm	Cobble gravel +64 mm
POTENTIALLY WORKABLE TILL									
SW 2	-	1.4	12	18	11	7	12	40	0
SW 3	1.2	4.2	15	21	19	7	14	24	0
SW 4	-	10.6	No grading information available						
SW 6	-	4.0	14	23	11	6	10	33	3
SW 8	-	2.0	15	20	25	5	8	17	10
SW 9	-	8.0	3	12	19	9	13	32	12
SW 10	-	7.0	9	20	13	8	11	31	8
SW 11	-	5.7	7	19	23	10	14	15	12
SW 13	-	4.5	16	23	17	9	10	25	0
SW 18	-	6.4	12	22	20	6	11	23	6
SW 19	-	5.7	13	25	18	3	21	20	0
mean	-	5.4	10	20	18	7	13	26	6
BURIED GLACIAL SAND AND GRAVEL									
SW 2	-	4.4	5	22	29	7	8	25	4
SW 3	-	5.1	5	10	25	14	20	25	1
SW 4	-	2.9	4	9	14	15	20	29	9
SW 8	-	9.5‡	5	20	27	11	11	22	4
SW 9	-	3.0	13	13	33	11	12	15	3
SW 11	-	10.0	4	13	24	7	14	36	2
SW 13	-	2.9	4	11	21	11	19	28	6
SW 18	-	2.3	3	19	35	10	13	20	0
SW 19	-	7.5	2	10	32	9	18	26	3
mean	-	5.3	5	14	27	10	15	26	3

‡ Not including 2.0 m waste

resource.

Sand and gravel is largely confined to the terraced, fluvioglacial sand and gravel for which an assessment is offered. In addition, a statement of resources embracing all potentially workable material, including fluvioglacial sand and gravel, till and buried glacial sand and gravel but excluding bedrock is presented.

The fluvioglacial sand and gravel is most extensive to the west of the River Spey where the deposit underlies two prominent terraces. The larger of the two, the Mosstodloch Terrace (Peacock and others, 1968), extends from Orton, 6 km south of the resource sheet, through Mosstodloch [330 600] and northwards across the Muir of Stynie towards Spey Farm [331 626]. Along its western margin the terrace truncates a plateau underlain by glacial sand and gravel. In the north, between [3200 6234] near Maggierag and [3326 6271] near Drum Wood it merges into glacial sand and gravel and a back-feature is often difficult to trace. East of Muir of Stynie the Mosstodloch Terrace is cut by the lower, Lunan Wood Terrace. The latter borders the alluvium of the River Spey along a pronounced back-feature that extends from the southern margin of the sheet, northwards as far as [3400 6345], near Essil. In the vicinity of Redhall the terraces flank a low hill formed principally of Old Red Sandstone capped by patches of till and glacial sand and gravel. Bedrock is mapped at Redhall and is exposed nearby in an old quarry [341 603]. East of the hill, borehole SW 22 is sited upon a small, rather indefinite feature that is probably related to the Mosstodloch Terrace.

A detached portion of the block to the east of the River Spey includes a small area of terrace in the vicinity of Den Farm [3566 6099]. Probably equivalent to the Mosstodloch Terrace, the feature extends from [3554 6028] near Quarry Garden, northwards until it merges with glacial sand and gravel north-east of Upper Dallachy. The prominent back-feature to the alluvium of the River Spey truncates the terrace to expose both till and bedrock. In the north, this back-feature merges with an ancient cliff-line backing raised beach deposits.

West of the River Spey, boreholes SW 14, SW 15, SW 16 and SW 17 sited on the Mosstodloch Terrace respectively proved 5.0 m, 9.0 m, 3.5 m and 12.0 m of potentially workable fluvioglacial sand and gravel. Sited on the higher, indefinite terrace abutting the hill at Redhall, borehole SW 22 proved 4.1 m of potentially workable material. Boreholes SW 20 and SW 21 on the Lunan Wood Terrace respectively proved 6.7 m and 12.2 m of fluvioglacial sand and gravel. East of the Spey borehole SE 5 proved 4.3 m of potentially workable fluvioglacial sand and gravel underlying the terrace in the vicinity of Den Farm. Overburden which is generally thin ranges up to 1.6 m in borehole SW 17 (sited on made-ground) and has a mean thickness of 0.4 m.

The potentially workable fluvioglacial sand and gravel grades as gravel (see Appendix C) at all sites within the block except at SW 17, where it is sandy gravel. The mean grading is fines 4 per cent, sand 39 per cent and gravel 57 per cent; details are presented in Table 10.

Fluvioglacial sand and gravel covers an area of 7.0 km^2 of which 6.4 km^2 lies to the west of the River Spey and 0.6 km^2 to the east. The mean thickness of the potentially workable material is 7.1 m and the volume is estimated at 50 million m^3 (65 million yd^3) $\pm$ 22 per cent.

Although the borehole evidence indicates that the fluvioglacial sand and gravel generally rests upon till, at borehole SW 17 it overlies channel-fill deposits and at borehole SW 22 rests directly on bedrock. Buried glacial sand and gravel, chiefly gravel, occurs beneath till in the north of the block, and much of the latter is also potentially workable. These buried deposits constitute a minor resource of potentially workable material.

Boreholes SW 14, SW 16, SW 20 and SE 5 respectively proved 13.3 m, 7.4 m, 1.3 m and 3.0 m of potentially workable till at depth. The mean thickness of this mineral is 6.3 m and the mean grading is fines 9 per cent, sand 52 per cent and gravel 39 per cent; details are given in Table 10. At boreholes SW 15 and SW 21 the till penetrated was considered not to be potentially workable.

Potentially workable buried glacial sand and gravel was identified at boreholes SW 14, SW 20, SW 21 and SE 5. Boreholes SW 14 and SW 20, respectively proved 2.6 m and 7.2 m of the material (SW 20 was abandoned in glacial sand and gravel at a depth of 15.7 m). At both these sites the glacial sand and gravel and the underlying potentially workable till into which they pass are alike in composition, grading and colour, but the till generally is more cohesive and compact. A similar situation exists at borehole SE 5 where 3.0 m of potentially workable till passes down into 7.1 m of sand and gravel overlying bedrock. Two beds of glacial sand and gravel were proved in borehole SW 21; an upper bed, 1.4 m thick underlies 2.0 m of not potentially workable till and is separated by a further 4.4 m of the till from a lower bed, 2.4 m thick which rests upon bedrock.

The mean thickness of the potentially workable buried glacial sand and gravel, based on four boreholes, is 5.2 m and the mean grading is fines 4 per cent, sand 45 per cent and gravel 51 per cent; details are given in Table 10.

In borehole SW 15 the fluvioglacial sand and gravel overlies 4.2 m of medium grey, faintly laminated clayey silt probably interbedded with a stiff, clayey till. This non-mineral sequence passes downwards into poorly consolidated, pale grey to white, silty sand containing seams of clay. However the borehole was abandoned for technical reasons at a depth of 19.5 m, having proved 6.0 m of the material. In borehole SW 17, 7.4 m of greenish pale grey, chiefly medium grained sand directly underlies fluvioglacial material (the hole was abandoned at 21.0 m). Although the basal sand deposit in borehole SW 15 has not been found elsewhere, material similar to the basal sand at SW 17 is identified beneath till in boreholes SW 25 and SE 3 outwith the block. As these four boreholes lie within an inferred elongate depression in the buried bedrock surface (Fig. III) possibly a channel, the sands are classified as 'channel-fill

Table 10. Block C: data from assessment boreholes

Borehole	Recorded thickness (m)		Mean grading percentage						
	Over-burden	Mineral	Fines -1/16 mm	Fine sand +1/16-¼ mm	Medium sand +¼-1 mm	Coarse sand +1-4 mm	Fine gravel +4-16 mm	Coarse gravel -16-64 mm	Cobble gravel +64 mm
FLUVIOGLACIAL SAND AND GRAVEL									
SW 14	0.1	5.0	5	17	23	4	17	32	2
SW 15	0.3	9.0	2	7	11	10	27	39	4
SW 16	0.1	3.5	3	9	17	7	22	29	13
SW 17	1.6	12.0	4	19	24	7	17	28	1
SW 20	0.5	6.7	7	10	20	9	25	28	1
SW 21	0.1	12.2	5	14	19	7	21	31	3
SW 22	0.6	4.1	6	9	15	10	27	32	1
SE 5	0.2	4.3	3	7	15	6	21	43	5
mean	0.4	7.1	4	12	19	8	22	32	3
POTENTIALLY WORKABLE TILL									
SW 14	-	13.3	11	27	22	8	8	17	7
SW 16	-	7.4	7	18	18	10	11	29	7
SW 20	-	1.3	10	45	23	3	7	12	0
SE 5	-	3.0	7	14	14	6	23	36	0
mean	-	6.3	9	24	20	8	11	22	6
BURIED GLACIAL SAND AND GRAVEL (not including channel-fill deposits)									
SW 14	-	2.6	6	17	12	4	19	26	16
SW 20	-	7.2	4	16	27	6	18	28	1
SW 21	-	3.8*	6	23	41	9	6	15	0
SE 5	-	7.1	2	5	17	11	29	32	4
mean	-	5.2	4	13	24	8	20	27	4
CHANNEL-FILL DEPOSITS									
SW 15	-	6.0	10	39	49	2	0	0	0
SW 17	-	7.4	4	35	61	0	0	0	0

*Not including 4.4 m waste

deposits'.

Grading data for the channel-fill deposits are presented in Table 10.

Based upon eight Industrial Minerals Assessment Unit boreholes, the mean thickness of all potentially workable material (excluding bedrock) within the block is 14.5 m and the volume is estimated at 103 million m^3 (134 million yd^3) ± 31 per cent.

Block D

The block has been drawn to include the floodplain and alluvial terraces of the River Spey which together represent a continuous spread of exposed potentially workable sand and gravel. Concealed, discontinuous spreads of potentially workable till, glacial sand and gravel and channel-fill deposits constitute an additional, minor resource. Two assessments are offered. One considers the alluvium only; the other all potentially workable aggregate including alluvium, till, glacial sand and gravel and channel-fill deposits but excluding bedrock.

The river deposits form a tract up to 2 km wide which is deeply incised into the fluvioglacial deposits and backed by prominent, steep cliff-features commonly 8 m to 10 m high. To the west of the River Spey the tract is generally cut into sand and gravel deposits but to the east the sand and gravel has been eroded to reveal both till and bedrock between Upper Dallachy and the southern margin of the resource sheet. At Upper Dallachy the prominent back-feature to the alluvium merges north-eastwards with a former cliff-line backing the raised beach deposits; between Upper Dallachy and the coast, alluvium abutts against beach deposits along a low, and sometimes indefinite back-feature.

Soil is generally very stony as the alluvium contains much coarse gravel and large parts of the block are afforested or abandoned as rough scrubland. Cultivation generally occurs in areas where sand and gravel is covered by silty over-bank deposits, for example, in the vicinity of Byres [3562 6234].

The assessment of the alluvium is based upon nine boreholes. Overburden is generally thin, ranges up to 1.8 m at borehole SE 4 and has a mean thickness of 0.4 m. The mineral, mean thickness 6.1 m, ranges from 1.2 m in borehole SE 4 to 12.0 m in borehole SW 27. Taking the area of mineral-bearing ground as 8.9 km^2 (the area of the whole block, including the River Spey), the volume of potentially workable alluvium is estimated as 54 million m^3 (71 million yd^3) ± 41 per cent. The mean grading of the mineral is fines 3 per cent, sand 38 per cent and gravel 59 per cent; details are given in Table 11.

A surface deposit of micaceous, silty sand containing sporadic pebbles overlies gravel in boreholes SW 24, SE 3 and SE 7 which respectively proved 1.0 m, 1.9 m and 1.0 m of the material. However, the other six boreholes within the block show little vertical variation in grading except for a slight decrease in gravel content towards the base of the deposit.

As few boreholes are sited toward the margins of the block, it is not possible to determine whether there is much thinning of the alluvial deposits in these areas. However, they do thin towards the back-feature to the alluvium south of Upper Dallachy where borehole SE 4 revealed only 2.3 m of alluvium, the upper 1.8 m of which consisted of stiff, sandy clay, and at [3504 6098] to the west of Bellie Hill bedrock is close to the surface.

Boreholes SW 23, SW 24, SW 27, SE 2 and SE 7 prove alluvium resting directly on bedrock; boreholes SW 26, SE 3 and SE 4 reveal alluvium overlying potentially workable till and borehole SW 25 shows it to overlie till that is not potentially workable. An area which may be more or less extensive than is shown, beneath which alluvium is considered to rest upon significant thicknesses of potentially workable till, is appropriately coloured and delineated on the resource map. Additional notes are given on a sketch map (Fig. I) adjacent to the resource map.

The mean thickness of the potentially workable till, based upon two boreholes, is 5.9 m and the mean grading fines 10 per cent, sand 29 per cent and gravel 61 per cent. At borehole SW 26, 7.4 m of this material separates alluvium from bedrock whereas in borehole SE 3, 4.4 m of till separates alluvium from buried glacial sand and gravel. At borehole SE 4 alluvium rests upon 3.0 m of bright red till, the upper 0.7 m of which is judged potentially workable. However, as only the basal 0.5 m of the alluvium is potentially workable at this site the two deposits are grouped together, both being considered as 'alluvium' for the purposes of assessment.

Boreholes SW 25 and SE 3 both proved extraordinary thicknesses of sand and gravel. At each site the downward succession is alluvium on till on brown glacial sand and gravel which in turn rests on pale greenish grey, chiefly medium grained sand containing little gravel. The basal sands, classified as 'channel-fill deposits', are tentatively correlated with similar deposits proved in boreholes SW 15 and SW 17 in block C. It is thought that the four boreholes are sited above a local, elongate depression in the bedrock surface (see Fig. III), possibly a buried channel. In borehole SW 25, 1.5 m of buried glacial sand and gravel rests upon 12.5 m of channel-fill deposit, and in borehole SE 3, 3.2 m of the glacial material rests upon 7.3 m of channel-fill deposit. At both sites drilling had to be terminated before reaching 25 m, the maximum depth to which boreholes were sunk during the survey.

Based upon two boreholes, the buried glacial sand and gravel, mean thickness 2.4 m, has a mean grading of fines 4 per cent, sand 54 per cent and gravel 42 per cent. The mean thickness of the channel-fill deposits is 9.9 m, the mean grading, fines 5 per cent, sand 93 per cent and gravel 2 per cent.

The mean thickness of potentially workable material (excluding bedrock) within the block is 10.1 m and the volume is estimated as 90 million m^3 (117 million yd^3) ± 50 per cent.

Block E

The block is formed largely of gently undulating ground, rising in the south towards the rounded

Table 11. Block D: data from assessment boreholes

Borehole	Recorded thickness (m)		Mean grading percentage						
	Over-burden	Mineral	Fines -1/16 mm	Fine sand +1/16-¼ mm	Medium sand +¼-1 mm	Coarse sand +1-4 mm	Fine gravel +4-16 mm	Coarse gravel +16-64 mm	Cobble gravel +64 mm
ALLUVIUM (OF THE SPEY)									
SW 23	0.6	4.0	2	5	18	10	13	25	27
SW 24	0.1	8.6	6	17	24	7	12	23	11
SW 25	0	4.5	2	3	17	10	20	39	9
SW 26	0.1	5.0	3	8	15	12	18	29	15
SW 27	0	12.0	1	6	24	9	17	29	14
SE 2	0.5	7.0	0	3	17	11	23	41	5
SE 3	0.1	5.1	12	27	16	6	10	24	5
SE 4	1.8	1.2	10	25	18	4	2	15	26
SE 7	0	7.2	3	7	15	7	15	29	24
mean	0.4	6.1	3	10	19	9	16	29	14
POTENTIALLY WORKABLE TILL									
SW 26	-	7.4	6	13	8	7	17	40	9
SE 3	-	4.4	17	15	13	3	14	35	3
mean	-	5.9	10	14	10	5	16	38	7
BURIED GLACIAL SAND AND GRAVEL (not including channel-fill deposits)									
SE 3	-	3.2	4	11	27	16	16	26	0
SW 25	-	1.5	3	10	32	12	14	29	0
mean	-	2.4	4	11	28	15	15	27	0
CHANNEL-FILL DEPOSITS									
SW 25	-	12.5	5	18	70	4	1	2	0
SE 3	-	7.3	5	15	75	5	0	0	0

hill south of Ordiga [3718 6043], 87.9 m (293 ft) above Ordnance Datum. The Burn of Tynet drains much of the area, flowing northwards from a relatively flat region in the south-east of the block, through a 2 km-long winding gorge incised into Old Red Sandstone bedrock, to reach the sea a little to the west of Porttannachy. The Wellheads Burn and Core Burn, the two most prominent tributaries of the Burn of Tynet, join the dominant stream respectively at [3845 6137] near the Bridge of Tynet, and [3817 6373], near Mill House. In the north, the resource block boundary generally follows the foot of an ancient cliff-line backing the beach deposits; south of Upper Dallachy it follows the bases of back-features to terraces of the Spey.

Till crops out over about 45 per cent of the resource block and is relatively close to the surface elsewhere. It gives rise to a characteristically irregular and hummocky surface and is exposed over an arcuate belt of country that extends from the south-west corner of the block, north-eastwards to Auchenhalrig [3700 6194], then eastwards towards Glasterim [3983 6256]. This tract underlain by till divides the block into three parts, an area of sand and gravel to the north and north-west, a central area of till, and a southern area of sand and gravel.

In the north of the block till is obscured by a relatively thin cover of glacial sand and gravel, chiefly fine to medium-grained sand. Within this area till forms isolated inliers at [3700 6255], south-west of Cowiemuir Wood. In contrast, glacial sand and gravel forms isolated mounds on till, for example [3756 6182] and [3735 6212], to the west of Auchenhalrig. Glacial sand and gravel also crops out in the south-east of the block principally to the west of the Burn of Tynet where it underlies hummocky, sandy ground in the vicinity of Ordiga and forms a gently sloping, dissected outwash plain between Tulloch [3820 6092] and Wellheads [3842 6022]. From the Bridge of Tynet [3843 6144], as far as Howcore [3909 6222] to the north-east, glacial sand and gravel occupies a shallow depression in the surface of the underlying till.

South of the Bridge of Tynet the Burn of Tynet is confined to a relatively narrow flood plain within a wide alluvial tract, possibly the site of a former lake.

The surface deposits of sand and gravel, chiefly comprising glacial sand and gravel and alluvium have been assessed as an entity. A second assessment is offered for all potentially workable material, including till but excluding bedrock. Apart from within the gorge of the Burn of Tynet and small outcrops of bedrock at Quarry Wood [3560 6016], potentially workable material is present over the whole block, largely at the surface. Grading data is presented in Table 12.

Surface glacial sand and gravel in the north of the block varies considerably in thickness, due mainly to the irregular form of the buried till. Borehole and mapping evidence both indicate that the deposits generally thicken eastwards; from west to east, boreholes SE 14 and SE 20, section SE 28, boreholes SE 19 and SE 22 respectively prove 4.1 m, 3.8 m, 5.2 m, 5.0 m and 8.0 m of mineral, predominantly orange-brown, 'soft', pebbly sand. North-west of the Mains of Tannachy [3856 6374], glacial sand and gravel underlies a prominent hill which attains 37.8 m (126 ft) above Ordnance Datum; in this vicinity a former working [3837 6382] revealed at least 7.5 m of white sand. The irregular thickness of the surface glacial sand and gravel is demonstrated at pit SE P6 [3741 6399] which proved a veneer of sand 0.6 m thick overlying till. Additional pits did not determine the whole thickness of the surface material, pit SE P4 [3613 6177] and SE P5 [3949 6339] both proving 1.6 m of sand beneath 0.5 m soil.

A bench feature cut into glacial sand and gravel, possibly an ancient raised beach, is identified in the vicinity of Cowiemuir [3668 6299]. Although gravel has been observed locally, the feature, mapped as fluvioglacial sand and gravel, is not thought to be associated with any significant thickness of material.

The distribution and composition of the surface glacial sand and gravel is more variable south of the till tract than to the north. Beneath the extensive conifer plantations covering the hill of Ordiga and the Beldornie Hillocks [37 61], sand and gravel occupies hollows in, and forms ridges on the underlying spread of till. Boreholes SE 16 and SE 17 respectively proved 1.5 m and 4.3 m of mineral overlying potentially workable till and pit SE P9 [3719 6093] revealed 1.1 m of mineral at the surface. Although till probably underlies most of the surface glacial sand and gravel in the vicinity, at pit SE P10 [3766 6065] 0.6 m of silty sand rests directly upon Old Red Sandstone conglomerate.

To the south of Tulloch glacial sand and gravel forms a gently inclined outwash spread, truncated to the east by the Burn of Tynet and deeply dissected by the Wellheads Burn. Mapping indicates that the spread is composed predominantly of sand. Pale yellow, 'soft', fine to medium grained sand is revealed by rabbit burrows along the sides of the valley of the Wellheads Burn and similar material has been worked nearby at a small pit [3845 6043] which shows a minimum thickness of 4.3 m of mineral (section SE 29). Despite there being no obvious surface features to indicate a change in geology between the pit and borehole SE 21, some 150 m to the south-east, the sand and gravel proved at both sites is significantly different, both in grading and composition. The borehole revealed 4.5 m orange-brown, poorly sorted, 'clayey' sandy gravel overlying 10.1 m maroon coloured gravel with a remarkably high proportion of angular quartzite in the coarse sand and gravel fractions (see results of composition and mechanical analyses and Tables 4 & 6). The deposit is not thought to be laterally extensive and possibly has a linear form extending south or south-westwards towards high ground underlain by quartzite-rich Old Red Sandstone conglomerate. Pit SE P14 [3879 6004], to the west of Chapelford, revealed interbedded reddish brown sand and pale grey silt probably derived locally from exposed till to the south-west, but possibly related to the material proved in borehole SE 21.

The outwash spread described above adjoins an area of flat ground to the south of Tullochmoss [3808 6086] marking the site of a former lake. The lake alluvium is probably thin, consisting of silt, peat and clay overlying sand. To the west of the hill south of Ordiga a similar area [367 601] is underlain by a thin spread of lake alluvium on white (leached) till. Close to the southern margin of the resource sheet [377 601] the outwash plain adjoins an alluvial cone, the greater part of which lies to the south where it is underlain by red sand and gravel rich in quartzite.

Glacial sand and gravel, predominantly sandy, crops out between the Bridge of Tynet and Howcore. The only borehole sited on this deposit, SE 24, revealed 4.8 m yellowish brown pebbly sand overlying red till. Sites of former sand workings exist to the south of the trunk-road, between Hole [388 619] and Howcore.

Apart from the stretch within the gorge between [3836 6330] and [3838 6194], which is not assessed, the floodplain of the Burn of Tynet is predominantly gravelly and is included for assessment with the glacial sand and gravel. Although there is a gravel bed to the Burn of Tynet and a scrape [3824 6213] revealed 1.2 m of sand and gravel underlying a terrace, there is insufficient thickness or grading information available for an assessment to be offered for the alluvium within the gorge.

To the south of the Bridge of Tynet the floodplain is flanked by alluvial terraces which are chiefly underlain by sand and gravel. Borehole SE 26, near Chapelford Bridge, proved 9.2 m of sand and gravel, the uppermost 3.2 m being classified as alluvium, the remainder as glacial sand and gravel. At this site the sand and gravel is separated from underlying till by 1.8 m of interlaminated silt and fine sand (glaciolacustrine deposits), the mineral deposits being taken as one in the statistical assessment.

East of Burnside of Enzie [3932 6062] the alluvial terrace of the Burn of Tynet merges into a rather flat, poorly drained area mapped as glacial sand and gravel. Two pits, SE P16 [3993 6144], and SE P19 [3986 6063] respectively revealed 1.9 m and 2.1 m of interbedded silt, fine sand and peat judged not to be potentially workable. On the basis of this evidence, and from hand-augering, the surface glacial sand and gravel is considered to be non-mineral in this vicinity and as potentially workable till probably underlies the area the resource map is appropriately ornamented to show mineral till beneath overburden.

The assessment of the surface sand and gravel deposits is based upon nine IMAU boreholes, one natural section (SE 28) and one pit section (SE 29). The mineral thickness ranges from 1.5 m in borehole SE 16 to 14.6 m in borehole SE 21: the mean thickness is 6.1 m. The overburden thickness ranges up to 0.9 m at borehole SE 26 and has a mean of 0.5 m. The mean grading of the mineral is fines 4 per cent, sand 68 per cent and gravel 28 per cent; details are given in Table 12.

Taking the total area of the surface sand and gravel deposits as 8.1 km^2, the estimated volume of this mineral resource is 49 million m^3 (65 million yd^3) $\pm$ 46 per cent.

The assessment of the till is based upon boreholes SE 6, SE 8, SE 12, SE 15, SE 23 and SE 25 sited on the exposed deposit, and boreholes SE 14, SE 16, SE 17, SE 19, SE 20, SE 21, SE 22, SE 24 and SE 26 proving the deposit beneath surface sand and gravel. The natural section, SE 28, provides an additional sample point. The till, chiefly red in colour, is judged to contain potentially workable material at all the sites with the exception of boreholes SE 21 and SE 26. Of the 101 m of till drilled, 56 m are judged to be potentially workable, a relatively higher proportion than observed in other resource blocks.

Exceptionally, the whole thickness of till drilled in a borehole is potentially workable, as for example, in boreholes SE 6, SE 19, SE 22 and SE 25. Although there is no simple correlation between the borehole sites, in general till is judged potentially workable at the surface, but becomes too clayey with depth to be regarded as mineral, as for example, in boreholes SE 8, SE 12, SE 16, SE 17, SE 20 and SE 23. However, in boreholes SE 8, SE 12 and SE 17 there are two deposits of potentially workable till separated by waste and in borehole SE 14, till that is not potentially workable overlies mineral till.

The potentially workable till forms a continuous or almost continuous spread. It is absent from within the gorge of the Burn of Tynet and from an area [390 603] too small to be delineated on the resource map where sand and gravel rests directly on bedrock. Boreholes SE 21 and SE 26 prove sand and gravel on tough, dark grey till. The latter is considered not to be potentially workable and an area, which may be more or less extensive than indicated where till is considered barren, is shown on the resource map.

The potentially workable till ranges in thickness from 1.0 m in borehole SE 16 to 11.5 m in borehole SE 14 and has a mean thickness of 7.2 m. The mean grading of the mineral is 18 per cent fines, 44 per cent sand and 38 per cent gravel; grading details are presented in Table 12.

Potentially workable buried glacial sand and gravel occurs in boreholes SE 16, SE 22 and SE 25 which respectively proved 2.0 m, 2.5 m and 2.8 m of the material. At each of the sites potentially workable till passes down into similarly coloured sand and gravel overlying bedrock. The mean grading of the material is fines 2 per cent, sand 36 per cent and gravel 62 per cent; details are given in Table 12.

Boreholes demonstrate the resource of buried sand and gravel to be discontinuous. At this level of survey there is insufficient thickness and grading data on which to base a statistical assessment. However, an inferred assessment of the buried glacial sand and gravel occurring over the eastern half of the resource sheet is offered in the additional notes at the end of this section.

The mean thickness of all potentially workable material (excluding bedrock) within the block is 10.6 m. The estimated volume is 159 million m^3 (209 million yd^3) $\pm$ 21 per cent.

Table 12. Block E: data from assessment boreholes and exposures

Borehole	Recorded thickness (m)		Mean grading percentage						
	Over-burden	Mineral	Fines -1/16 mm	Fine sand +1/16-¼ mm	Medium sand +¼-1 mm	Coarse sand +1-4 mm	Fine gravel +4-16 mm	Coarse gravel +16-64 mm	Cobble gravel +64 mm
SURFACE GLACIAL SAND AND GRAVEL									
SE 14	0.5	4.1	1	21	59	3	6	10	0
SE 16	0.1	1.5	4	31	64	1	0	0	0
SE 17	0.2	4.3	6	37	43	3	5	6	0
SE 19	1.0	5.0	5	31	58	2	2	2	0
SE 20	0.6	3.8	4	21	34	6	10	25	0
SE 21	0.5	14.6	3	3	5	17	34	37	1
SE 22	0.6	8.0	2	53	39	1	1	3	1
SE 24	0.2	4.8	3	40	54	1	2	0	0
SE 26	0.9	9.2	8	14	22	14	22	18	2
SE 28*	0.5	5.2	3	14	72	5	3	3	0
SE 29†	0.1	4.3	4	86	10	0	0	0	0
mean	0.5	6.1	4	27	34	7	13	14	1
POTENTIALLY WORKABLE TILL									
SE 6	0.2	7.3 ≠	16	22	12	3	6	18	23
SE 8	0.6	11.3	27	22	16	5	10	18	2
SE 12	0.6	5.0	19	32	19	5	7	13	5
SE 14	-	11.5	6	10	14	11	22	29	8
SE 15	0.3	8.3 ‡	27	27	17	4	11	14	0
SE 16	-	1.0	28	28	18	6	12	8	0
SE 17	-	3.7	12	33	40	3	6	6	0
SE 19	-	5.8	22	24	18	6	13	17	0
SE 20	-	5.6	13	13	14	9	18	33	0
SE 22	-	7.4	15	16	14	6	14	20	15
SE 23	0.6	9.5	18	24	17	5	11	17	8
SE 24	0.2	11.2	No grading information available						
SE 25	0.6	4.9	14	20	22	9	14	21	0
SE 28	-	8.9	23	25	16	4	10	18	4
mean	-	7.2	18	21	17	6	13	20	5

Table 12. Block E: data from assessment boreholes and exposures (continued)

Borehole	Recorded thickness (m)		Mean grading percentage						
	Over-burden	Mineral	Fines -1/16 mm	Fine sand +1/16-¼ mm	Medium sand +¼-1 mm	Coarse sand +1-4 mm	Fine gravel +4-16 mm	Coarse gravel +16-64 mm	Cobble gravel +64 mm
BURIED GLACIAL SAND AND GRAVEL									
SE 16	-	2.0	2	2	3	19	31	32	11
SE 22	-	2.5	1	2	17	19	27	34	0
SE 25	-	2.8	4	6	17	19	22	25	7
mean	-	2.4	2	4	13	19	26	30	6

*Natural section
†Pit section
≠Includes 5.5 m for which no grading data is available
‡Includes 6.3 m for which no grading data is available, not including 1.4 m waste

Additional notes and summary

Potentially workable sand and gravel is exposed over 85 per cent (46 km^2) of the resource sheet and is present in each of the five resource blocks. Potentially workable till is exposed over 14 per cent (7.3 km^2) of the sheet and occurs concealed by sand and gravel beneath roughly a further 45 per cent. Buried deposits of sand and gravel generally underlying till, form a third resource extending over approximately 23 per cent of the sheet. Although an appropriate ornament is used to indicate the probable extent of the buried potentially workable till, it is not possible to delineate deposits of buried sand and gravel in a similar fashion on the resource map, and a sketch is offered (Fig. II) showing the major areas over which the third resource occurs.

For additional guidance, the buried mineral deposits occurring over each 'half' of the resource sheet have been assessed statistically (see Table 7b), the sheet being divided along easting 35.

Over the western half of the resource sheet, potentially workable till covers an estimated 15.0 km^2. The thickness of the deposit ranges from 1.3 m in borehole SW 20 to 13.3 m in borehole SW 14. Based upon 16 boreholes the mean thickness is 5.7 m and the volume is estimated at 86 million m^3 (112 million yd^3) ± 32 per cent. Buried glacial sand and gravel covers approximately 10 km^2 and ranges in thickness from 1.5 m in borehole SW 25 to 10.0 m in borehole SW 11. Based upon 13 boreholes the mean thickness of this mineral deposit is 4.8 m and the estimated volume is 48 million m^3 (63 million yd^3) ± 37 per cent.

Over the eastern half of the sheet potentially workable till, usually concealed by other material, occupies an area estimated at 16.3 km^2. The area of exposed mineral till is 6.8 km^2. The thickness, mean 6.6 m, ranges from 1.0 m in borehole SE 16 to 11.5 m in borehole SE 14. Based upon 15 sample points the estimated volume is 108 million m^3 (141 million yd^3) ± 28 per cent.

Although seven boreholes proved buried glacial sand and gravel, over the eastern half of the resource sheet there is insufficient evidence to define with reasonable accuracy the extent of the resource and consequently no statistical assessment is offered. However, evidence to hand indicates the buried glacial sand and gravel to be discontinuous and to cover an area of approximately 2.5 km^2. The thickness ranges from 2.0 m in borehole SE 16 to 7.1 m in borehole SE 5. The mean thickness is estimated to be 3.3 m and a volume of 8 million m^3 (11 million yd^3) is inferred.

Channel-fill deposits are included in the assessments of total resources (excluding bedrock) offered for blocks C and D. As insufficient borehole data are available a separate statistical assessment cannot be offered for these deposits. However, an attempt is made to delineate a possible area of occurrence in Figs. II and III where the deposits are shown to cover approximately 6.4 km^2. Based upon four boreholes (SW 15, SW 17, SW 25 and SE 3), all of which were abandoned short of the maximum depth for technical reasons, the mean thickness is 8.3 m and the volume is estimated very roughly as 53 million m^3 (70 million yd^3). The mean grading of the material is fines 6 per cent, sand 93 per cent and gravel 1 per cent, the sand being chiefly medium grained with some fine and a trace of coarse. Although not formally identified as such, the basal deposit of glacial sand and gravel at borehole SW 21 may form part of the channel-fill deposits.

Immediately to the south of the resource sheet

in the valley of the Fochabers Burn [365 570], Old Red Sandstone conglomerate and breccia crop out and are visibly weathered to a depth of several metres. In this condition the formation is a potential source of aggregate, being rather similar in composition to much of the potentially workable till of block E. Within the assessment area conglomerate is mainly found in the basal Middle Old Red Sandstone which crops out in the south-eastern corner of the resource sheet (see Fig. 2). The formation is generally concealed by drift deposits but in the vicinity of Ordiga, pit SE P10 revealed weathered conglomerate within 0.8 m of the surface. Although an assessment of bedrock is not offered, at this locality the conglomerate and breccia of the Old Red Sandstone are considered to be potentially workable.

It is thought that the conglomerate and breccia are generally clayey, having a fines content greater than 20 per cent and locally in excess of 60 per cent. The coarse sand and the gravel is largely composed of material derived from local Dalradian rocks and is predominantly of quartzite. Schist, micaceous flagstone and acidic porphyry, often deeply weathered, are relatively more abundant than in the tills of rather similar appearance, that commonly overlie the formation. The sand in particular is stained reddish brown by oxides of iron. Mica is abundant and the fines consist chiefly of clay.

APPENDIX A: FIELD AND LABORATORY PROCEDURES

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

The mineral shown on each 1:25 000 sheet is divided into resource blocks. The arbitrary size selected, 10 km², is a compromise to meet the aims of the survey by providing sufficient sample points in each block. As far as possible the block boundaries are determined by geological boundaries so that, for example, glacial and river terrace gravels are separated. Otherwise division is by arbitrary lines, which may bear no relationship to the geology. 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 250 mm (10 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 deposit or, ideally, at every 1 m (3.3 ft) depth. The samples, each weighing between 25 and 45 kg (55 and 100 lb), are despatched in heavy duty polythene bags to a laboratory for grading. The grading procedure is based on British Standard 1377 (1975). Random checks on the accuracy of the grading are made in the IMAU soils laboratory.

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

Detailed records may be consulted at the Institute's Edinburgh Office, upon application to the Officer-in-Charge, Industrial Minerals Assessment Unit.

APPENDIX B: STATISTICAL PROCEDURE

Statistical Assessment

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

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

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

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

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

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

$$\frac{\sum (l_{m_1} + l_{m_2} \ldots l_{m_n})}{n}$$

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, $S_{\bar{l}}$, expressed as a proportion of the mean thickness is given by

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

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

6. The sampled area in each resource block is coloured pink on the map. Wherever possible, calculations relate to the mineral within mapped geological boundaries (which may not necessarily correspond to the limits of deposit). Where the area is not defined by a mapped boundary, that is, where the boundary is inferred, a distinctive symbol is used. Experience suggests that the errors in determining area are small relative to those in thickness. The relationship $S_A/S_{\bar{l}_m} \leqslant 1/3$ is assumed in all cases. It follows from equation [2] that

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

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

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

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

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

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

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

per cent.

11. The application of this procedure to a fictitious area is illustrated in Figures 6 to 8

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

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

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

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

APPENDIX C: CLASSIFICATION AND DESCRIPTION OF SAND AND GRAVEL

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

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

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

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

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

Thus it is possible to classify the mineral into one of twelve descriptive categories (see Figure 8). The procedure is as follows:

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

For example, a deposit grading 11 per cent gravel, 70 per cent sand and 19 per cent fines is classified as 'clayey' pebbly sand. This short description is included in the borehole log (see Note 11, p. 44).

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

The fairly wide intervals in the scale are consistent with the general level of accuracy of the qualitative assessments of the resource blocks. Three sizes of sand are recognised, fine (−¼ +1/16 mm), medium (−1 +¼ mm) and coarse (−4 +1 mm). The boundary at 16 mm distinguishes a range of finer gravel (−16 +4 mm), often characterised by abundance of worn tough pebbles of vein quartz, from larger pebbles often of notably different materials. The boundary at 64 mm distinguishes pebbles from cobbles. The term 'gravel' is used loosely to denote both pebble-sized and cobble-sized material.

The size distribution of borehole samples is determined by sieve analysis, which is presented by the laboratory as logarithmic cumulative curves (see, for example, British Standard 1377:1975). In this report the grading is tabulated on the borehole record sheets (Appendix F), the intercepts corresponding with the simple geometric scale 1/16 mm, ¼ 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 very approximate equal proportions with neither constituent accounting for less than about 25 per cent of the whole; 'flint with quartz' indicates that flint is dominant and quartz, the principal accessory rock types, comprises 5 to 25 per cent of the whole. Where the accessory material accounts for less than 5 per cent of the whole, but is still readily apparent, the phrase 'with some' has been used. Rare constituents are referred to as 'trace'.

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

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

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

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

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

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

Table 13 Classification of gravel, sand and fines

Size limits	Grain size description	Qualification	Primary classification
64 mm	Cobble		Gravel
16 mm	Pebble	Coarse	
		Fine	
4 mm	Sand	Coarse	Sand
1 mm		Medium	
¼ mm		Fine	
1/16 mm	Fines (silt and clay)		Fines

Block Calculation — 1:25 000 Block — Fictitious

Area
- Block: 11.08 km^2
- Mineral: 8.32 km^2

Volume
- Overburden: 21 million m^3
- Mineral: 54 million m^3

Mean Thickness
- Overburden: 2.5 m
- Mineral: 6.5 m

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 m^3

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	Hydrogeological Dept 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	Σw = 8	Σwl_o = 20.2		Σwl_m = 52.0		
Means		$\bar{l}_o$ = 2.5		$\bar{l}_m$ = 6.5		

Calculation of confidence limits

l_m	$(l_m - \bar{l}_m)$	$(l_m - \bar{l}_m)^2$
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

$\Sigma(l_m - \bar{l}_m)^2 = 15.82$

$n = 8$

$t = 2.365$

L_V is calculated as

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

$$= 1.05 \times \frac{2.365}{6.5} \sqrt{\frac{15.82}{8 \times 7}} \times 100$$

$$= 20.3$$

$\simeq$ 20 per cent

Figure 6 Example of resource block assessment: calculation and results

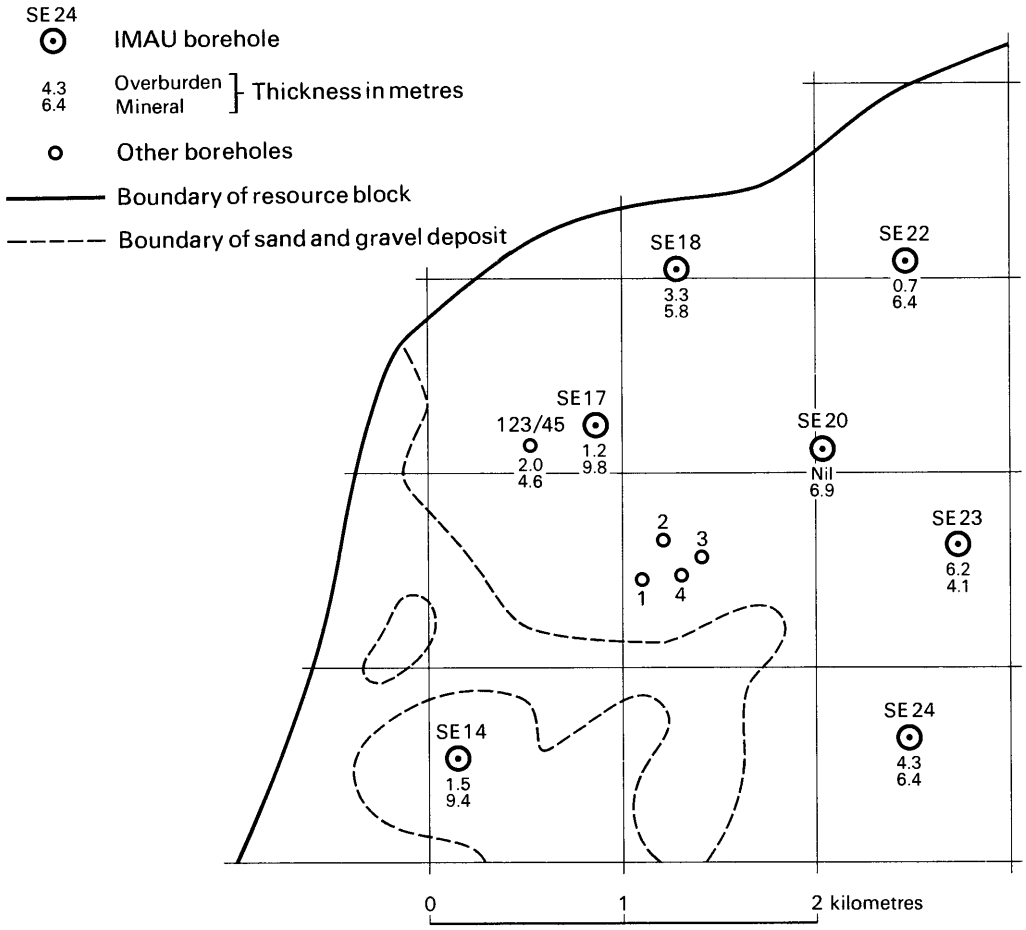


Figure 7 Example of resource block assessment: map of fictitious block

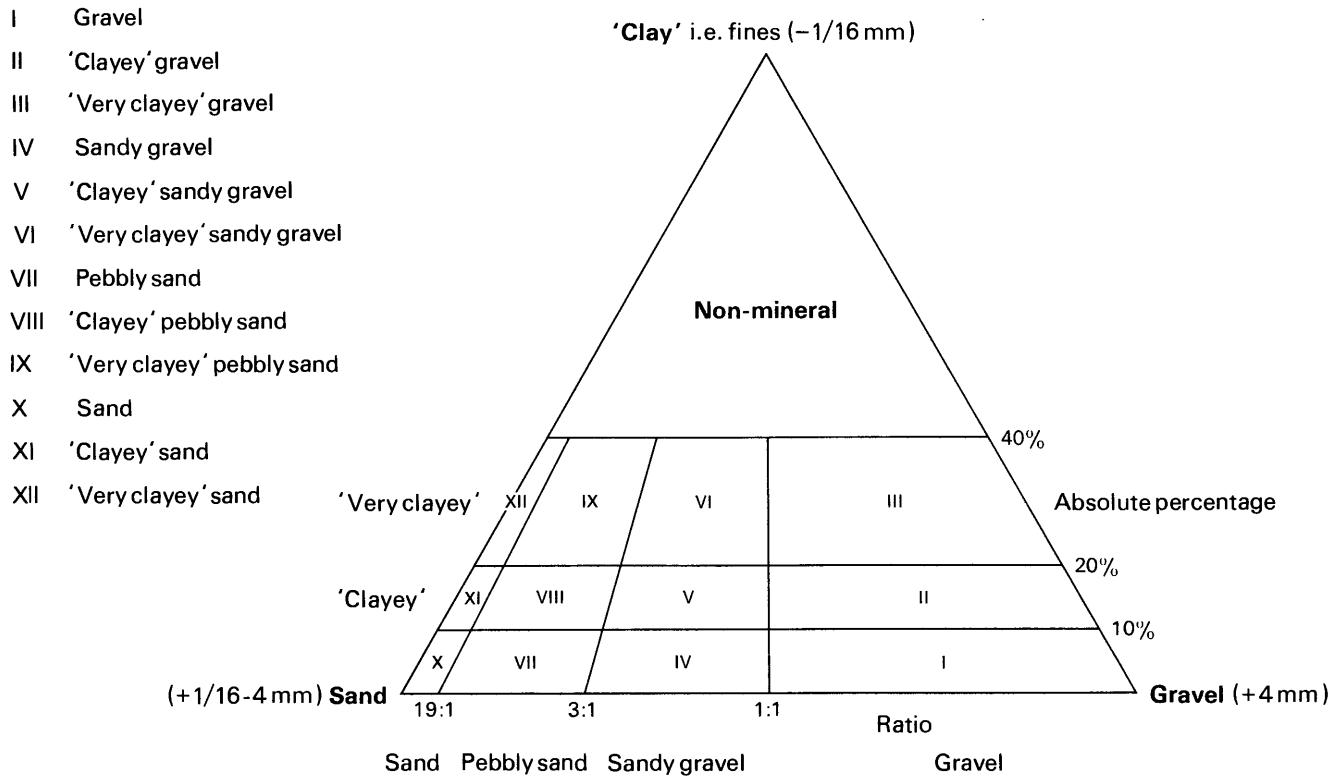


Figure 8 Diagram to show the descriptive categories used in the classification of sand and gravel

APPENDIX D: EXPLANATION OF THE BOREHOLE RECORDS

Annotated Example

NJ 36 SE 5[1] 3564 6105[2] Den Farm, Upper Dallachy[3] Block C

Surface level +27.4 m (+90 ft)[4]
Groundwater level +22.4 m[5]
250 mm and 200 mm percussion[6]
January 1977

Overburden 0.2 m[7]
Mineral I 4.3 m
Waste 0.5 m
Mineral II 3.0 m
Mineral I 7.1 m
Bedrock 0.5 m+

LOG

Geological Classification[10]	Lithology[11]	Thickness m	Depth[8] m
	Soil	0.2	0.2
Fluvioglacial sand and gravel	(a) Gravel Gravel: chiefly coarse, with fine. Frequent cobbles. Boulders (up to 300 mm) towards base, subangular to rounded quartzites, granulites and granite Sand: medium, with fine and coarse, medium to dark brown, becoming greyish brown by 2.0 m Fines: some disseminated silt	4.3	4.5
Till	Pebbly clay: stiff, red and slightly silty	0.5	5.0
	(b) 'Clayey' gravel Gravel: coarse and fine, scattered cobbles, quartzites, granulites and rare granodiorite Sand: fine, with medium and some coarse, reddish brown, becoming greyish brown Fines: much disseminated silt and clay	3.0	8.0
Glacial sand and gravel	(c) Gravel Gravel: coarse and fine, scattered cobbles and a few boulders (up to 300 mm), chiefly granulites and quartzites Sand: medium, with coarse and fine, fining upwards, greyish brown, becoming pinkish medium grey by 13 m Fines: disseminated silt and clay decreasing with depth	7.1	15.1
Old Red Sandstone	Red sandstone containing pebbles, friable becoming hard	0.5+[9]	15.6

GRADING

Mean for Deposit[15] Percentages			Depth below surface (m)[12]		Bulk Samples Percentages[13]						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
3	28	69	0.2	1.0	6	10	13	7	16	48	0
			[14]*1.0	2.0	4	8	11	6	17	32	22
			*2.0	3.0	1	3	6	4	25	61	0
			*3.0	4.5	1	7	23	9	24	36	0
			Mean		3	7	15	6	21	43	5
(b)											
15	39	46	*5.0	6.0	19	22	15	6	15	23	0
			*6.0	7.0	20	22	14	5	13	18	8
			*7.0	8.0	7	14	14	6	23	36	0
			Mean		15	19	14	6	17	26	3
(c)											
2	33	65	*8.0	9.0	5	10	11	6	21	42	5
			*9.0	10.0	3	9	14	9	21	24	20
			*10.0	11.0	1	1	6	13	46	33	0
			*11.0	12.0	1	2	11	9	43	31	3
			*12.0	13.0	0	2	9	10	27	52	0
			*13.0	14.0	1	4	22	19	29	25	0
			*14.0	15.1	2	8	41	14	16	19	0
			Mean		2	5	17	11	29	32	4
(b+c)											
6	35	59	Mean		6	9	16	10	25	30	4
(a to c)											
5	33	62	Mean		5	9	15	9	24	34	4

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

1. Borehole Registration Number
Each Industrial Minerals Assessment Unit (IMAU) borehole is identified by a Registration Number. This consists of two statements.
1) The number of the 1:25 000 sheet on which the borehole lies, for example NJ 36.
2) The quarter of the 1:25 000 sheet on which the borehole lies and its number in a series for that quarter, for example SE 5.

Thus the full Registration Number is NJ 36 SE 5. Usually this is abbreviated to SE 5 in the text.

Natural sections used in the assessment have been registered under the same series.

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

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

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

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

6. Type of Drill and Date of Drilling
Shell and auger rigs both conventional and modified were used in this survey. The drilling method, the external diameter of the casing used, and the month and year of completion of the borehole are stated.

7. Overburden, Mineral, Waste and Bedrock
Mineral is aggregate which falls within the arbitrary definition of potentially workable material (see Introduction). Mineral I is potentially workable sand and gravel; Mineral II is potentially workable till. In the Garmouth area, bedrock is Old Red Sandstone. Locally this formation, which comprises sandstones and conglomerates, is deeply weathered and in this state may be potentially workable aggregate. However, no assessment is offered. Waste is any material other than bedrock or mineral. Where waste occurs between the surface and mineral it is classified as overburden.

8. Thickness and Depth
All measurements were made in metres. Imperial conversions appear in brackets. Imperial conversions of measurements of the thicknesses of beds and the depth from the surface of their bases have been rounded off to the nearest 0.5 ft because a more detailed quotation would imply a higher order of accuracy than could be justified by the original figures. Where figures have been rounded in this way there may be a discrepancy between the sum of the thicknesses and the recorded depths.

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

10. Geological Classification
The geological classification is given whenever possible.

11. Lithological Description
When potentially workable material is recorded a general description based on the mean grading characteristics (for details see Appendix C) is followed by more detailed particulars. The description of other rocks is based on visual examination in the field.

12. Sampling
A continuous series of bulk samples is taken through the thickness of potentially workable aggregate. A new sample is commenced whenever there is an appreciable lithological change within the deposit or ideally at every 1 m of depth.

13. Grading Results
The results are expressed as per cent by weight retained on British Standard sieves whose aperture sizes are given in millimetres or fractions thereof. If, exceptionally, grading results are not available, an attempt may be made to estimate the descriptive category of the mineral by comparing the grading and field descriptions of similar material with the samples in question.

14. Bailed Samples
Fully representative sampling of natural aggregate is difficult to achieve, particularly where groundwater levels are high. Comparison between boreholes and adjacent exposures suggests that in borehole samples the proportion of sand may be higher and the proportions of fines and coarse gravel (+16 mm) may be lower. Samples obtained by the bailing technique (that is, from deposits below the water table) are indicated by an asterisk.

15. Mean Grading
The grading of the full thickness of mineral identified in the log is the mean of the individual sample gradings weighted by the thicknesses represented. The classification used is shown in Table 13. Where two or more distinct mineral deposits form continuous sequences, the mean grading of each is also given. Where two or more mineral deposits form a continuous sequence separated from another sequence by waste, combined mean gradings are given in addition to the mean grading for the full thickness of mineral identified.

APPENDIX E: LIST OF BOREHOLES, SECTIONS AND SHALLOW PITS USED IN THE ASSESSMENT OF RESOURCES

Industrial Minerals Assessment Unit Boreholes

Industrial Minerals Assessment Unit Sections

Section by sheet quadrant	Grid reference	Type of section	Locality	Page
NJ 36 NW				
6	3189 6549	pit	Tomyrone, near Kingston	55
NJ 36 SE				
27	3690 6422	pit	Nether Dallachy	142
28	3818 6354	river-cliff	Burn of Tynet	143
29	3845 6043	pit	Wellheads	144

Industrial Minerals Assessment Unit Pits (shallow pits dug by excavator)

Pit by sheet quadrant	Grid reference	Page	Pit by sheet quadrant	Grid reference	Page
NJ 36 SW			NJ 36 SE		
P 1	3016 6344	145	P 4	3613 6177	158
P 2	3041 6239	146	P 5	3616 6117	159
P 3	3081 6248	147	P 6	3741 6399	160
P 4	3019 6226	148	P 7	3701 6350	161
P 5	3285 6470	149	P 8	3753 6288	162
P 6	3218 6402	150	P 9	3719 6093	163
P 7	3334 6478	151	P10	3767 6065	164
P 8	3353 6457	151	P11	3881 6289	164
P 9	3314 6379	152	P12	3870 6153	165
P10	3483 6393	153	P13	3871 6085	166
P11	3493 6214	154	P14	3879 6004	167
			P15	3949 6339	168
NJ 36 SE			P16	3993 6144	169
P 1	3533 6232	155	P17	3934 6142	169
P 2	3652 6249	156	P18	3937 6130	170
P 3	3666 6191	157	P19	3986 6063	170

APPENDIX F: INDUSTRIAL MINERALS ASSESSMENT UNIT BOREHOLE, SECTION AND SHALLOW PIT RECORDS

NJ 36 NW 1 | 3039 6674 | North of Binn Hill | Block A

Surface level +5.9 m (+19 ft)
Groundwater level +3.3 m
250 and 200 mm percussion
December 1976

Overburden 0.1 m
Mineral I 8.9 m
Waste 3.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Storm beach deposits	Gravel Gravel: coarse with fine, cobbles common; coarse rounded to well rounded, fine angular to well rounded, chiefly quartzites and granulites with vein-quartz and granite, and some Old Red Sandstone conglomerate. Chiefly spherical, with platy or elongate pebbles common in upper few metres Sand: fine to coarse, fine predominating towards base, coarse grains are 'sharp', orange, becoming buff coloured Fines: some disseminated silt especially in upper 2 m	8.9	9.0
Till	Gravelly sandy clay: stiff, olive-grey, material up to boulder size	3.5+	12.5

Borehole abandoned owing to rock obstruction

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
1	31	68	0.1	1.1	5	8	6	6	15	55	5
			1.1	2.1	4	7	4	6	22	57	0
			*2.1	3.1	1	7	5	8	28	51	0
			*3.1	4.1	0	5	5	9	24	51	6
			*4.1	5.1	0	7	9	9	26	49	0
			*5.1	6.1	0	10	12	7	25	46	0
			*6.1	7.1	0	19	15	7	20	26	13
			*7.1	8.1	0	26	11	7	18	29	9
			*8.1	9.0	1	46	8	8	18	13	6
			Mean		1	15	8	8	22	42	4

NJ 36 NW 2 | 3065 6574 | Binn Hill | Block B

Surface level +84.6 m (+278 ft)
Water not struck
250 and 200 mm percussion
March 1977

Overburden 0.1 m
Mineral I 24.9 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Glacial sand and gravel	Sand Gravel: chiefly between 7.8 m and 12.1 m, fine and coarse, largely 10 to 40 mm, subrounded to well rounded granulites and quartzites with granite, vein-quartz, mica schist and sandstone Sand: fine with medium and rare coarse, predominantly medium between 11.1 m and 13.1 m and between 15.1 m and 22.5 m, well sorted, 'soft', micaceous, pale brownish grey to buff Fines: silt, disseminated and rarely as discrete seams. Fines content increases slightly below 7.8 m and again below 21.1 m as seams of silt appear, between 10 and 30 mm thick	24.9+	25.0

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
9	89	2	0.1	1.1	7	57	36	0	0	0	0
			1.1	2.1	3	49	47	1	0	0	0
			2.1	3.1	4	51	44	1	0	0	0
			3.1	4.1	3	67	30	0	0	0	0
			4.1	5.1	4	71	25	0	0	0	0
			5.1	6.1	4	49	47	0	0	0	0
			6.1	7.1	5	46	48	1	0	0	0
			7.1	8.1	11	55	30	4	0	0	0
			8.1	9.1	12	50	34	1	2	0	0
			9.1	10.1	10	48	33	1	3	5	0
			10.1	11.1	9	46	37	1	3	4	0
			11.1	12.1	8	32	57	2	0	1	0
			12.1	13.1	9	43	46	2	0	0	0
			13.1	14.1	12	57	28	1	1	1	0
			14.1	15.1	13	71	16	0	0	0	0
			15.1	16.1	8	46	46	0	0	0	0
			16.1	17.1	8	42	50	0	0	0	0
			17.1	18.1	10	51	39	0	0	0	0
			18.1	19.1	4	18	71	3	3	1	0
			19.1	20.1	11	24	61	2	1	1	0
			20.1	21.1	3	26	70	1	0	0	0
			21.1	22.1	9	26	59	1	1	4	0
			22.1	23.1	25	29	43	1	2	0	0
			23.1	24.1	18	60	21	1	0	0	0
			24.1	25.0	20	72	8	0	0	0	0
			Mean		9	48	40	1	1	1	0

NJ 36 NW 3 | 3151 6545 | Tomyrone, near Garmouth | Block B

Surface level +42.6 m (+140 ft)
Water not struck
250 and 200 mm percussion
March 1977

Overburden 0.1 m
Mineral I 24.9 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Glacial sand and gravel	(a) Sand Sand: medium with fine and traces of coarse, much mica, 'soft', pale yellowish brown Fines: some disseminated silt, increasing with depth	14.0	14.1
Glaciolacustrine deposits	(b) 'Clayey' sand Sand: fine with medium, micaceous, 'soft', pale yellowish brown to pale grey-brown Fines: disseminated silt with infrequent laminae of brown silt. Seam of laminated, micaceous silt between 22.5 m and 22.8 m	10.9+	25.0

NJ 36 NW 3 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
4	96	0	0.1	1.1	1	26	73	0	0	0	0
			1.1	2.1	2	24	72	1	1	0	0
			2.1	3.1	1	15	83	1	0	0	0
			3.1	4.1	3	19	77	1	0	0	0
			4.1	5.1	2	23	75	0	0	0	0
			5.1	6.1	4	24	72	0	0	0	0
			6.1	7.1	4	20	75	1	0	0	0
			7.1	8.1	5	15	78	2	0	0	0
			8.1	9.1	5	20	74	1	0	0	0
			9.1	10.1	5	19	75	1	0	0	0
			10.1	11.1	5	19	75	1	0	0	0
			11.1	12.1	5	18	76	1	0	0	0
			12.1	13.1	5	17	76	2	0	0	0
			13.1	14.1	13	27	58	2	0	0	0
			Mean		4	21	74	1	0	0	0
(b)											
15	85	0	14.1	15.1	4	80	16	0	0	0	0
			15.1	16.1	26	66	8	0	0	0	0
			16.1	17.1	37	62	1	0	0	0	0
			17.1	18.1	37	62	1	0	0	0	0
			18.1	19.1	6	84	10	0	0	0	0
			19.1	20.5	1	59	40	0	0	0	0
			20.5	21.5	4	80	16	0	0	0	0
			21.5	22.5	13	76	11	0	0	0	0
			22.5	23.5	19	79	2	0	0	0	0
			23.5	25.0	11	84	5	0	0	0	0
			Mean		15	73	12	0	0	0	0
(a + b)											
9	91	0	Mean		9	43	47	1	0	0	0

NJ 36 NW 4 | 3203 6601 | North of Tomyrone, near Kingston | Block A

Surface level +5.9 m (+19 ft)[≠]
Groundwater level +2.8 m
250 and 200 mm percussion
November 1976

Mineral I 8.7 m
Waste 11.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
Storm beach deposits	(a) Gravel (upper 2.0 m sampled by hand) Gravel: coarse with some fine, numerous cobbles and a few small boulders, rounded to well rounded, quartzites, granulites and vein-quartz with some granite, conglomerate and various durable metamorphic and igneous rocks, some platy pebbles towards top, otherwise spherical Sand: fine, with medium and some coarse, fine sand increasing downwards, buff coloured, 'soft', trace of shell debris Fines: very little	8.7	8.7
Till	Sandy pebbly clay: firm, brownish grey	2.0	10.7
	Interbedded fine sandy silt and sandy pebbly clay, dark grey streaked with medium grey, soft to firm	2.3	13.0
	(b) Clayey sand Gravel: fine and coarse, subangular to well rounded, granulites and quartzites Sand: fine, with some medium, and trace of coarse, dark grey Fines: much silt	1.1	14.1
	Sandy pebbly clay, firm becoming stiff, reddish brown becoming dark grey	0.9	15.0
	Silty clay, stiff, olive-grey, massive, some mica, breaks with hackly fracture	4.2	19.2
Glacial sand and gravel	(c) Gravel Gravel: coarse with some fine, scattered cobbles, chiefly subangular to well rounded, quartzites and granulites Sand: fine and medium with some coarse, dark grey Fines: much disseminated silt	0.5+	19.7
	Borehole terminated for technical reasons		

[≠] Borehole sited in partially worked ground; uppermost 2 m sampled by hand from adjacent pit face. Level of top of deposit taken.

NJ 36 NW 4 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
1	37	62	0.0	2.0	0	0	0	0	1	99	0
			*2.0	3.0	1	14	10	4	16	55	0
			*3.0	4.0	1	15	19	11	26	28	0
			*4.0	5.0	0	21	24	3	14	32	6
			*5.0	6.0	0	32	13	2	12	26	15
			*6.0	7.0	1	28	14	5	14	27	11
			*7.0	8.0	1	39	23	5	11	21	0
			*8.0	8.7	2	29	17	11	14	10	17
			Mean		1	20	13	4	12	45	5
(b)											
18	80	2	*13.0	14.1	18	63	14	3	1	1	0
(c)											
6	33	61	*19.2	19.7	6	16	13	4	11	33	17

(b) and (c) Non-mineral owing to excessive overburden

NJ 36 NW 5 | 3341 6558 | Lein, Kingston | Block A

Surface level +5.6 m[≠] (+18 ft)
Water struck at +1.6 m
250 and 200 mm percussion
February 1977

Mineral I 7.6 m
Mineral II 3.0 m
Bedrock 7.2 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
Storm beach deposits	(a) Gravel (upper 2 m sampled by hand) Gravel: coarse with fine, numerous cobbles, coarse well rounded, fine subangular to rounded, granulites, metaquartzites, vein-quartz and granite Sand: medium and fine with coarse, subrounded to rounded, medium brown Fines: traces of silt	7.6	7.6
Till	(b) Sandy gravel Gravel: coarse with fine, with cobbles (up to 110 mm diameter), coarse rounded to well-rounded, fine angular to rounded, granulites, vein-quartz, quartzites and granite Sand: medium, with fine and some coarse, subangular to subrounded, reddish brown Fines: some disseminated silt, with small lumps of stiff clay	3.0	10.6
Old Red Sandstone	Sandstone with bands of silty clay and rare well rounded pebbles, micaceous, maroon to red, unconsolidated, becoming hard by 17.8 m. Sand is medium with fine, subrounded to rounded	7.2+	17.8

[≠] Borehole sited in partially worked ground; uppermost 2 m sampled by hand from adjacent pit face. Level of top of deposit taken.

GRADING

Mean for Deposit Percentages				Depth below surface (m)		Bulk Samples Percentages						
						Fines	Sand			Gravel		
Fines	Sand	Gravel		From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)												
1	22	77		0.0	2.0	0	0	0	0	2	74	24
				*2.0	3.0	0	3	3	4	35	45	10
				*3.0	4.0	0	6	6	7	38	36	7
				*4.0	5.0	0	20	13	5	33	29	0
				*5.0	6.0	0	10	10	5	26	49	0
				*6.0	7.0	0	10	21	9	19	17	24
				*7.0	7.6	5	13	27	9	18	28	0
				Mean		1	8	9	5	22	44	11
(b)												
6	64	30		*7.6	8.6	2	24	24	8	14	20	8
				*8.6	9.6	9	29	34	8	5	15	0
				*9.6	10.6	5	25	34	6	6	22	0
				Mean		6	26	31	7	8	19	3
(c)												
6	94	0	†	*10.6	11.6	8	32	59	1	0	0	0
				*11.6	13.6	6	34	59	1	0	0	0
				*13.6	15.6	6	36	58	0	0	0	0
				*15.6	17.8	6	35	58	1	0	0	0
(a+b)												
2	34	64		Mean		2	13	15	6	18	37	9

† Bedrock, data not used in calculation

NJ 36 NW 6 3189 6549 Tomyrone Pit Section, near Kingston Block B

Surface level c +21 m (c+69 ft)
Section dry
Sampling by hand
August 1977

Overburden 0.8 m
Mineral I 11.6 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Blown sand	Sand: medium, yellowish brown	0.5	0.6
Peat	Peat	0.2	0.8
Glacial sand and gravel	Sand Gravel: fine with coarse, well rounded, granite and metasediments, chiefly in a stringer at 1.4 m Sand: fine with medium and rare coarse to 2.4 m, 'soft', yellow-brown to 1.4 m becoming yellowish pale grey Fines: a little disseminated silt	11.6+	12.4

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
1	99	0	0.8	1.4	2	28	66	2	1	1	0
			1.4	2.4	1	68	30	1	0	0	0
			2.4	3.4	1	81	18	0	0	0	0
			3.4	4.4	1	64	35	0	0	0	0
			4.4	5.4	1	79	20	0	0	0	0
			5.4	6.4	trace	83	17	0	0	0	0
			6.4	7.4	1	66	33	0	0	0	0
			7.4	8.4	1	57	42	0	0	0	0
			8.4	9.4	1	64	35	0	0	0	0
			9.4	10.4	1	52	47	0	0	0	0
			10.4	11.4	2	51	47	0	0	0	0
			11.4	12.4	1	75	24	0	0	0	0
			Mean		1	65	34	0	0	0	0

NJ 36 SW 1 | 3062 6487 | Fernyfield | Block B

Surface level +34.0 m (+112 ft)
Water not struck
250 and 200 mm percussion
February 1977

Overburden 0.1 m
Mineral I 8.0 m
Waste 13.9 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Glaciolacustrine deposits	'Clayey' sand Sand: predominantly fine with a trace of medium, very 'soft', slightly micaceous. Fawn to pale brownish grey Fines: disseminated silt. Thin seams of silt appear below 7.1 m where deposit grades into sandy silt	8.0	8.1
	Silt: thin seams of silty fine sand and laminae of tenacious silty clay. Slightly micaceous, chiefly pale yellowish brown	3.4	11.5
Till	Pebbly sandy clay: stiff, olive-grey with rounded to well rounded pebbles of quartzites	0.2	11.7
	Silty clay with subordinate fine sandy silt, firm becoming stiff, rare rounded to well rounded pebbles of quartzites, olive-grey	10.3+	22.0

Borehole terminated owing to excessive overburden

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
12	88	0	0.1	2.1	16	82	2	0	0	0	0
			2.1	4.1	6	92	2	0	0	0	0
			4.1	6.1	3	93	4	0	0	0	0
			6.1	7.1	8	89	3	0	0	0	0
			7.1	8.1	40	59	1	0	0	0	0
			Mean		12	86	2	0	0	0	0

NJ 36 SW 2 | 3071 6380 | Near Finfan Wood | Block B

Surface level +34.4 m (+113 ft)
Groundwater level +21.4 m
250 and 200 mm percussion
December 1976

Overburden 0.2 m
Mineral I 8.0 m
Waste 5.4 m
Mineral I 2.4 m
Mineral II 1.4 m
Waste 2.6 m
Mineral I 4.4 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial sand and gravel	(a) 'Clayey' sand Gravel: rare fine with coarse, well rounded, black-stained, of quartzites and granulites Sand: fine with medium and traces of coarse, 'soft', pale yellowish brown, slightly micaceous Fines: much disseminated silt and frequent laminae of silty clay	2.0	2.2
Glaciolacustrine deposits	(b) 'Very clayey' sand Sand: fine with some medium, 'soft', yellowish brown to brownish pale grey, slightly micaceous Fines: much disseminated silt with seams of yellowish brown silt, especially between 3.4 m and 4.4 m and infrequent laminae of reddish brown tenacious clay	6.0	8.2
	Sandy silt: chiefly pale brownish grey, 'soft' and slightly micaceous	5.4	13.6
	(c) 'Very clayey' sand Sand: fine with some medium, as above Fines: interbedded silt, clayey silt and silty clay	2.4	16.0
Till	(d) 'Clayey' gravel Gravel: coarse with fine, chiefly of quartzites and granulites Sand: fine with medium and coarse, orange-brown Fines: deposit clay-bound	1.4	17.4
	Sandy gravelly clay: stiff, olive-grey	2.6	20.0
Glacial sand and gravel	(e) Sandy gravel Gravel: coarse with fine, frequent cobbles up to 250 mm, coarse subangular to well rounded, fine angular to well rounded becoming more rounded with depth. Quartzites and granulites with some vein-quartz and granite Sand: medium and fine with some coarse, 'sharp' coarse grains especially above 22.0 m, grey becoming brownish grey Fines: disseminated silt	4.4+	24.4
	Borehole terminated for technical reasons		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
18	78	4	0.2	1.2	19	49	23	2	4	3	0
			1.2	2.2	17	51	30	1	1	0	0
			Mean		18	50	27	1	3	1	0
(b)											
30	70	0	2.2	3.4	25	56	18	0	1	0	0
			3.4	4.4			non-mineral				
			4.4	5.7	36	53	11	0	0	0	0
			5.7	7.2	35	53	12	0	0	0	0
			7.2	8.2	21	54	24	1	0	0	0
			Mean		30	54	16	0	0	0	0
(c)											
30	70	0	13.6	14.6	37	51	12	0	0	0	0
			14.6	16.0	25	49	26	0	0	0	0
			Mean		30	50	20	0	0	0	0
(d)											
12	36	52	*16.0	17.4	12	18	11	7	12	40	0
(e)											
5	58	37	*20.0	21.0	4	12	12	10	16	36	10
			*21.0	22.0	5	12	18	13	12	34	6
			*22.0	22.9	9	34	48	6	1	2	0
			*22.9	23.9	3	23	32	3	5	34	0
			*23.9	24.4	6	33	41	4	3	13	0
			Mean		5	22	29	7	8	25	4
(b + c)											
30	70	0	Mean		30	53	17	0	0	0	0
(a + b + c)											
27	72	1	Mean		27	52	19	1	1	0	0
(d + e)											
7	53	40	Mean		7	21	25	7	9	28	3
(a to e)											
19	64	17	Mean		19	40	21	3	4	12	1

NJ 36 SW 3 | 3064 6230 | Muir of Lochs | Block B

Surface level +29.2 m (+96 ft)
Water struck at +24.8 m
250 and 200 mm percussion
November 1976

Overburden 1.2 m
Mineral II 4.2 m
Mineral I 5.1 m
Waste 12.1 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Till	Gravelly sandy clay: firm and cohesive, dark brown	0.7	1.2
	(a) 'Clayey' sandy gravel Gravel: coarse with fine, some cobbles; subangular to well rounded, granulite and quartzites with vein-quartz, granite, red sandstone and cornstone Sand: fine and medium with coarse, pale brown to 2.2 m, then orange-brown Fines: clay and silt. Deposit is cohesive	4.2	5.4
Glacial sand and gravel	Sandy gravel Gravel: coarse and fine, numerous cobbles, subangular to well rounded, granulites and quartzites with vein-quartz, granite and others Sand: medium with coarse and fine, becoming finer downwards, pale brown by 10.0 m Fines: chiefly disseminated silt, clay present below 10.0 m	5.1	10.5
Till	Gravelly sandy clay, stiff becoming firm, dark grey	10.8	21.3
	Gravelly sandy clay, firm, dark reddish brown	1.3+	22.6
	Borehole terminated owing to excessive overburden		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
15	47	38	1.2	2.2	17	12	14	11	24	22	0
			2.2	3.4	12	21	20	7	10	30	0
			3.4	4.4	14	26	21	7	11	21	0
			*4.4	5.4	16	23	20	6	12	23	0
			Mean		15	21	19	7	14	24	0
(b)											
5	49	46	*5.4	6.4	2	6	18	12	20	35	7
			*6.4	7.4	3	3	18	19	23	34	0
			*7.4	8.4	7	9	32	13	14	25	0
			*8.4	9.4	3	7	21	19	28	22	0
			*9.4	10.0	2	25	27	8	22	16	0
			*10.0	10.5	16	22	40	5	7	10	0
			Mean		5	10	25	14	20	25	1
(a + b)											
9	48	43	Mean		9	15	22	11	17	25	1

NJ 36 SW 4 | 3024 6160 | Sleepieshill Wood | Block B

Surface level +37.1 m (+122 ft)
Groundwater level +26.1 m
250 and 200 mm percussion
March 1977

Overburden 0.1 m
Mineral I 8.4 m
Mineral II 3.5 m
Mineral I 1.9 m
Mineral II 7.1 m
Mineral I 1.0 m
Waste 3.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Glacial sand and gravel	(a) 'Clayey' sand Gravel: chiefly fine, becoming coarse with fine below 7.1 m, subrounded to well rounded, quartzites and granulites Sand: fine and medium with traces of coarse, 'soft', yellowish brown becoming pale greyish orange by 2.1 m, rare flakes of mica Fines: much disseminated silt, with thin seams (10 mm thick) of sandy silt especially between 2.1 m and 4.1 m	8.4	8.5
Till	(b) 'Very clayey' sandy gravel, gradational contact with underlying deposit Gravel: fine with coarse, chiefly subangular to rounded, quartzites, vein-quartz, granulites with rotten granite and mica schist Sand: fine to medium, with some angular coarse, reddish brown, becoming sandier with depth Fines: clay, firm to stiff	3.5	12.0
Glacial sand and gravel	(c) Gravel Gravel: coarse with fine, rare cobbles, coarse subangular to well rounded, fine angular to subrounded, chiefly quartzites and granulites with vein-quartz Sand: coarse, medium and fine, coarse grains particularly 'sharp', yellowish brown Fines: disseminated silt	1.9	13.9
Till	(d) 'Very clayey' sandy gravel Gravel: fine with coarse, with rare cobbles, chiefly subangular to rounded, quartzites, vein-quartz, granulites, granite and mica schist Sand: fine to medium with some coarse, angular, becoming sandier between 16.0 m and 18.0 m, pale yellowish brown becoming pale reddish brown Fines: clay, generally stiff	7.1	21.0

NJ 36 SW 4 continued

Geological Classification	Lithology	Thickness m	Depth m
Glacial sand and gravel	(e) Gravel Gravel: coarse with fine, rare cobbles, angular to well rounded, quartzites and granulites with vein-quartz and some granite Sand: coarse and medium with fine, coarse sand particularly 'sharp', pale yellowish brown Fines: chiefly clay, binding deposit	1.0	22.0
Till	Gravelly sandy clay, stiff, pale reddish brown becoming medium grey by 24.0 m	3.0+	25.0

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
10	86	4	0.1	1.1	7	32	55	2	3	1	0
			1.1	2.1	8	39	52	1	0	0	0
			2.1	3.1	20	54	26	0	0	0	0
			3.1	4.1	10	49	40	1	0	0	0
			4.1	5.1	9	53	38	0	0	0	0
			5.1	6.1	9	57	29	2	3	0	0
			*6.1	7.1	8	43	46	1	2	0	0
			*7.1	8.5	10	42	28	3	7	10	0
			Mean		10	46	39	1	2	2	0
(b)											
-	-	-	8.5	12.0	No data available, mineral category estimated						
(c)											
3	38	59	*12.0	13.0	3	8	13	18	28	30	0
			*13.0	13.9	3	12	15	10	15	33	12
			Mean		3	10	14	14	22	31	6
(d)											
-	-	-	13.9	21.0	No data available, mineral category estimated						
(e)											
4	37	59	21.0	22.0	4	7	15	15	17	26	16
(a + c)											
9	77	14	Mean		9	39	34	4	6	7	1
(b + c)											
4	38	58	Mean		4	9	14	15	20	29	9
(a + c + e)											
8	74	18	Mean		8	37	32	5	7	9	2

NJ 36 SW 5 | 3095 6105 | Steelsbrae | Block B

Surface level c +69 m (c +225 ft)
Water not struck
250 and 200 mm percussion
November 1976

Overburden 0.5 m
Mineral I 18.5 m
Waste 6.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Fluvioglacial sand and gravel	(a) Sandy gravel Gravel: coarse with fine, cobbles up to 220 mm, subangular to well rounded, granulites, quartzites and granite with vein-quartz and red sandstone Sand: medium with fine and some coarse, rusty brown Fines: disseminated silt. Thin seams of green clay at 1.0 m. Seam (50 mm) of pink, laminated silt and fine sand at 2.2 m	2.0	2.5
Glacial sand and gravel	(b) Pebbly sand Gravel: coarse and fine, rare cobbles above 3.9 m becoming finer downwards, subrounded to well rounded, granulites, quartzites and granite with vein-quartz, sandstone and cornstone Sand: medium with fine and some coarse, 'soft', pinkish brown, becoming yellowish brown by 9.7 m Fines: disseminated silt	9.2	11.7
Glaciolacustrine deposits	(c) 'Very clayey' sand Sand: fine with rare medium, 'soft', micaceous, pale yellowish brown Fines: much silt, disseminated and as laminae. Laminated silt and fine sand between 17.8 m and 18.0 m	7.3	19.0
	Fine sand and silt (more than 40% fines), laminated in parts, pale yellowish brown	6.0+	25.0

NJ 36 SW 5 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
4	52	44	0.5	1.5	3	18	27	5	11	12	24
			1.5	2.5	5	18	28	8	13	28	0
			Mean		4	18	28	6	12	20	12
(b)											
6	80	14	2.5	3.9	4	21	47	5	7	8	8
			3.9	5.2	4	16	56	6	7	11	0
			5.2	6.2	9	18	48	7	11	7	0
			6.2	7.2	5	21	59	5	7	3	0
			7.2	8.4	5	39	43	2	3	8	0
			8.4	9.7	3	39	50	1	1	6	0
			9.7	10.7	3	22	74	1	0	0	0
			10.7	11.7	17	26	25	7	10	15	0
			Mean		6	26	50	4	6	7	1
(c)											
23	77	0	11.7	12.7	35	61	5	0	0	0	0
			12.7	13.7	24	72	4	0	0	0	0
			13.7	14.7	16	79	5	0	0	0	0
			14.7	15.7	16	79	4	1	0	0	0
			15.7	16.7	16	81	3	0	0	0	0
			16.7	17.8	37	62	1	0	0	0	0
			17.8	18.0			seam of silt				
			18.0	19.0	16	83	1	0	0	0	0
			Mean		23	74	3	0	0	0	0
(a + b)											
6	74	20	Mean		6	24	46	4	7	10	3
(a to c)											
12	76	12	Mean		12	43	30	3	4	6	2

NJ 36 SW 6 | 3037 6041 | Kennieshillock | Block B

Surface +54.9 m (+180 ft)
Groundwater level +37.4 m
250 and 200 mm percussion
February 1977

Overburden 0.1 m
Mineral I 17.9 m
Mineral II 3.0 m
Waste 1.5 m
Mineral II 1.0 m
Waste 1.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Glacial sand and gravel	(a) Sandy gravel Gravel: coarse and fine with some cobbles towards top, chiefly rounded to well rounded, fine gravel subangular to subrounded above 5.1 m, quartzites and granulites with some granite, vein-quartz, gneiss and mica schist Sand: medium with fine and some coarse, 'soft', pale orange-grey Fines: disseminated silt	9.1	9.2
	(b) 'Clayey' sand Gravel: very rare coarse and fine, well rounded Sand: fine with medium, very 'soft', pale yellow Fines: much disseminated silt	3.6	12.8
Glaciolacustrine deposits	(c) 'Clayey' sand Sand: fine with some medium, very 'soft', pale yellow-brown, slightly micaceous Fines: much silt, disseminated and as thin seams. Discrete seam of laminated silt between 12.8 m and 13.0 m	5.2	18.0
Till	(d) 'Clayey' gravel Gravel: coarse with some fine, sporadic cobbles, angular to well rounded, fine gravel particularly angular, quartzites and granulites with some granite and vein-quartz Sand: fine with medium and coarse, coarse very angular making sand 'sharp', pale orange-grey Fines: chiefly clay	3.0	21.0
	Gravelly clay: stiff, reddish pale brown	1.5	22.5
	(e) 'Very clayey' sandy gravel (similar to mineral horizon (d) above)	1.0	23.5
	Gravelly clay: stiff, reddish pale brown	1.5+	25.0

NJ 36 SW 6 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
6	60	34	0.1	1.1	10	16	21	6	14	33	0
			1.1	2.1	6	19	27	5	16	27	0
			2.1	3.6	6	15	26	10	20	23	0
			3.6	5.1	9	40	10	0	15	26	0
			5.1	6.2	5	20	52	7	8	8	0
			6.2	7.2	5	17	43	8	11	16	0
			7.2	8.2	3	19	37	5	9	27	0
			8.2	9.2	5	36	37	5	8	9	0
			Mean		6	23	31	6	13	21	0
(b)											
14	85	1	9.2	10.2	12	60	26	1	0	1	0
			10.2	11.2	14	60	25	1	0	0	0
			11.2	12.2	10	69	20	1	0	0	0
			12.2	12.8	20	53	23	1	1	1	0
			Mean		14	60	24	1	0	1	0
(c)											
15	85	0	12.8	14.2	11	74	15	0	0	0	0
			*14.2	15.2	15	70	15	0	0	0	0
			*15.2	16.2	13	70	17	0	0	0	0
			*16.2	17.2	18	73	9	0	0	0	0
			*17.2	18.0	18	74	8	0	0	0	0
			Mean		15	72	13	0	0	0	0
(d)											
11	38	51	*18.0	19.5	16	32	9	5	8	30	0
			*19.5	21.0	5	13	10	8	14	42	8
			Mean		11	22	9	7	11	36	4
(e)											
23	44	33	*22.5	23.5	23	24	15	5	9	24	0
(a + b)											
10	72	18	Mean		10	45	24	3	7	11	0
(b + c)											
15	85	0	Mean		15	67	18	0	0	0	0
(d + e)											
14	40	46	Mean		14	23	11	6	10	33	3
(a to e)											
11	66	23	Mean		11	41	22	3	8	15	0

NJ 36 SW 7 | 3166 6472 | Bruach | Block B

Surface level +30.1 m (+99 ft)
Water not struck
250 and 200 m percussion
December 1976

Overburden 0.6 m
Mineral I 4.0 m
Waste 12.9 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Glacial sand and gravel	Pebbly sand (grading to sandy silt) Gravel: fine and coarse with rare cobbles, coarse rounded to well rounded, fine angular to well rounded, quartzites and granulites with some vein-quartz and granite Sand: medium and fine, becoming fine with medium, 'soft', dark orange-brown becoming pale yellowish brown, slightly micaceous Fines: disseminated silt increasing towards base. Seams of silt below 3.6 m	4.0	4.6
Glaciolacustrine deposits	Silt and fine sand. Silt either disseminated or as discrete seams. Yellowish brown and slightly micaceous	5.9	10.5
	Silt, with frequent thin seams of soft, pale bluish grey, tenacious, silty clay	1.5	12.0
	Silt with some fine sand interbedded with very silty clay, chiefly brownish dark grey, soft to firm	5.5+	17.5
	Borehole terminated for technical reasons		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
8	83	9	0.6	1.6	3	32	34	4	9	9	9
			1.6	2.6	2	42	50	1	2	3	0
			2.6	3.6	4	53	43	0	0	0	0
			3.6	4.6	23	57	12	2	4	2	0
			Mean		8	46	35	2	4	3	2

NJ 36 SW 8 | 3148 6325 | Easter Lochs | Block B

Surface level +19.9 m (+65 ft)
Groundwater level +18 m
250 and 200 mm percussion
March 1977

Overburden 0.5 m
Mineral I 5.0 m
Mineral II 2.0 m
Mineral I 7.0 m
Waste 2.0 m
Mineral I 2.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil, peaty	0.5	0.5
Glacial sand and gravel	(a) 'Very clayey' sand Gravel: fine with coarse, well rounded, granulites, vein-quartz, pink granite and quartzites Sand: fine and medium with rare coarse, 'soft', yellow-brown, with flecks of white mica Fines: disseminated silt. Tenacious greenish grey silty clay at 2.4 m	2.0	2.5
	(b) Pebbly sand Gravel: coarse with fine, with very rare cobbles (up to 90 mm) below 3.5 m, coarse gravel well rounded, fine gravel subangular to subrounded, granulites, vein-quartz, pink granite and quartzites Sand: medium with fine and rare coarse, rounded, yellow-brown, with flecks of white mica Fines: Some disseminated silt	3.0	5.5
Till	(c) 'Clayey' sandy gravel Gravel: coarse with fine, numerous cobbles (up to 110 mm), chiefly subrounded to well rounded with rare angular, granite, granulites, vein-quartz, quartzites and breccia Sand: medium with fine and some coarse, subrounded, medium grey-brown Fines: partially claybound, some disseminated silt	2.0	7.5
Glacial sand and gravel	(d) Sandy gravel Gravel: coarse with fine, numerous cobbles (up to 120 mm), angular to well rounded, granite, granulites, vein-quartz and quartzites Sand: medium with fine and some coarse, subrounded to rounded, medium grey-brown Fines: some disseminated silt	7.0	14.5
Till	Sandy gravelly clay: stiff, with small pebbles, grey-brown	2.0	16.5
Glacial sand and gravel	(e) Sandy gravel Gravel: coarse with fine and cobbles (up to 90 mm), subangular to well rounded, fine gravel more angular than coarse, granulites, vein-quartz, quartzite, granite and breccia	2.5+	19.0

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Sand: coarse with fine and medium, subrounded, yellow-brown Fines: some disseminated silt		
	Borehole abandoned owing to rock obstruction		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-4	+64
(a)											
21	76	3	*0.5	1.5	8	64	20	1	4	3	0
			*1.5	2.5	34	14	51	1	0	0	0
			Mean		21	39	36	1	2	1	0
(b)											
4	83	13	*2.5	3.5	4	32	55	1	1	7	0
			*3.5	4.5	3	26	53	3	9	6	0
			*4.5	5.5	5	30	47	5	4	9	0
			Mean		4	20	50	3	5	8	0
(c)											
15	50	35	*5.5	6.5	16	25	18	4	9	27	0
			*6.5	7.5	14	14	33	6	6	7	20
			Mean		15	20	25	5	8	17	10
(d)											
4	60	36	*7.5	8.5	4	22	36	12	9	17	0
			*8.5	9.5	2	15	23	7	6	26	21
			*9.5	10.5	4	22	29	11	7	27	0
			*10.5	11.5	3	23	30	11	20	13	0
			*11.5	12.5	5	23	37	7	8	20	0
			*12.5	13.5	7	25	28	14	8	18	0
			*13.5	14.5	7	17	19	9	9	18	21
			Mean		4	21	29	10	10	20	6
(e)											
5	52	43	*16.5	17.5	3	14	23	14	13	33	0
			*17.5	19.0	6	17	23	14	14	26	0
			Mean		5	15	23	14	14	29	0
(a + b)											
11	80	9	Mean		11	33	45	2	4	5	0
(c + d + e)											
7	57	36	Mean		7	20	27	10	10	21	5
(d + e)											
5	58	37	Mean		5	20	27	11	11	22	4
(a to e)											
8	64	28			8	24	32	8	8	16	4

NJ 36 SW 9 | 3146 6238 | Lochs | Block B

Surface level +30.1 m (+99 ft)
Groundwater level +26.3 m
250 and 200 mm percussion
March 1977

Overburden 1.8 m
Mineral I 3.0 m
Mineral II 8.0 m
Mineral I 3.0 m
Waste 5.2 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil, dark and peaty	0.6	0.6
Alluvium	Sand and gravel: medium-grained, brown sand with well rounded, chiefly coarse gravel	0.3	0.9
	Gravelly sandy clay, stiff, green and brown, mottled	0.9	1.8
Glacial sand and gravel	(a) 'Clayey' pebbly sand Gravel: coarse and fine, some cobbles toward base, subangular to well rounded, fine gravel generally more angular than coarse, granulites, quartzites and vein-quartz with some white granite Sand: medium and fine with some coarse, 'soft', orange-brown Fines: disseminated silt	3.0	4.8
Till	(b) Gravel Gravel: coarse with fine, many cobbles; angular to well rounded granulites and quartzites with vein-quartz and granite Sand: medium with fine and coarse, generally 'soft', reddish brown Fines: clay and disseminated silt. Deposit is 'clay-bound', firm to stiff between 4.8 m and 5.8 m and between 7.8 m and 8.8 m	8.0	12.8
Glacial sand and gravel	(c) 'Clayey' sandy gravel Gravel: coarse and fine with rare cobbles, very compact, subangular to well rounded, fine gravel more angular than coarse, granulites and quartzites with some vein-quartz and granite Sand: medium with fine and coarse, 'soft', orange-brown Fines: disseminated silt	3.0	15.8
Till	No representative samples recovered owing to rock obstruction (granulite). Deposit probably a pale yellowish grey to white sandy till	5.2+	21.0

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
12	68	20	1.8	2.3	14	33	34	6	7	6	0
			2.3	4.8	9	28	30	7	11	15	0
			Mean		12	30	32	6	9	11	0
(b)											
3	40	57	*4.8	5.8	2	9	13	10	21	33	12
			*5.8	6.8	3	13	19	12	13	22	18
			*6.8	7.8	2	11	22	4	7	15	39
			*7.8	8.8	5	14	19	10	11	41	0
			*8.8	9.8	4	14	22	11	13	28	8
			*9.8	10.8	3	9	22	9	13	37	7
			*10.8	11.8	6	13	20	12	7	33	9
			*11.8	12.8	3	9	17	6	15	50	0
			Mean		3	12	19	9	13	32	12
(c)											
13	57	30	*12.8	13.8	21	21	27	10	3	8	10
			*13.8	14.8	7	7	40	8	17	21	0
			*14.8	15.8	11	10	31	14	18	16	0
			Mean		13	13	33	11	12	15	3
(b + c)											
6	45	49	Mean		6	12	23	10	13	27	9
(a to c)											
7	48	45	Mean		7	15	24	9	12	25	8

NJ 36 SW 10 | 3156 6151 | Castlehill Wood | Block B

Surface level +43.3 m (+142 ft)
Groundwater level +27.8 m
250 and 200 mm percussion
February 1977

Mineral I 11.0 m
Mineral II 7.0 m
Waste 2.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
Glacial sand and gravel	(a) 'Clayey' pebbly sand Gravel: chiefly fine but coarse at surface and below 9.6 m, subrounded to well rounded quartzites and granulites with some granite, vein-quartz, sandstone, cherty rock and Old Red Sandstone conglomerate Sand: fine with medium and a trace of coarse (chiefly medium between 3.5 m and 5.6 m), very 'soft', pale brownish grey to pinkish pale brown Fines: variable. Much disseminated silt in uppermost 2.0 m and below 9.6 m. Thin seams (10-30 mm thick) of silt and clayey silt with laminae of tenacious clay common between 4.5 m and 7.6 m	11.0	11.0
Till	(b) Gravel Gravel: coarse with fine, cobbles frequently encountered; coarse gravel, subrounded to well rounded, fine gravel angular to well rounded, quartzites and granulites with some granite, vein-quartz and mica schist Sand: fine, with medium and some coarse, coarse grains particularly 'sharp', pale yellowish brown Fines: deposit generally clay-bound and cohesive, less consolidated between 15.0 m and 17.0 m	7.0	18.0
	Gravelly sandy clay, very tough with frequent cobbles, yellowish reddish brown	2.5+	20.5
	Borehole abandoned owing to rock obstruction		

NJ 36 SW 10 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
11	82	7	0.0	1.0	10	32	23	3	8	24	0
			1.0	2.0	6	54	37	1	1	1	0
			2.0	3.5	5	45	45	1	2	2	0
			3.5	4.5	4	31	62	3	0	0	0
			4.5	5.6	13	30	53	2	1	1	0
			5.6	6.6	15	39	41	3	2	0	0
			6.6	7.6	23	64	12	0	0	1	0
			7.6	8.6	4	75	21	0	0	0	0
			8.6	9.6	16	80	4	0	0	0	0
			*9.6	11.0	17	51	6	2	5	13	16
			Mean		11	50	30	2	2	4	1
(b)											
9	41	50	*11.0	13.0	7	36	8	6	10	21	12
			*13.0	15.0	9	21	12	8	7	27	16
			*15.0	16.0	9	25	13	9	12	32	0
			*16.0	17.0	3	15	17	12	17	23	13
			*17.0	18.0	8	15	11	8	22	36	0
			Mean		9	20	13	8	11	31	8
(a + b)											
10	65	25	Mean		10	38	23	4	6	15	4

NJ 36 SW 11 | 3158 6030 | Castle Hill | Block B

Surface level +41.5 m (+136 ft)
Groundwater level +35.5 m
250 and 200 mm percussion
February 1977

Overburden 0.1 m
Mineral I 6.0 m
Mineral II 5.7 m
Mineral I 10.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Glacial sand and gravel	(a) Pebbly sand Gravel: coarse with fine, rare cobbles below 3.1 m, chiefly subrounded to well rounded, fine gravel more angular with depth, quartzites and granulites Sand: medium with fine and some coarse, chiefly fine sand above 2.1 m, 'soft', slightly micaceous and pale greenish grey. Becoming 'sharp' and medium grey below 2.1 m Fines: disseminated silt with rare thin seams of silt, especially below 5.1 m	6.0	6.1
Till	(b) Sandy gravel Gravel: coarse with fine, numerous cobbles, subangular to well rounded quartzites and granulites with some granite Sand: medium and fine with some coarse, very pale grey becoming bluish medium grey by 11.5 m Fines: deposit slightly 'clay-bound' and cohesive	5.7	11.8
Glacial sand and gravel	(c) Gravel (with seams of till) Gravel: coarse with fine, numerous cobbles, angular to well rounded quartzites and granulites with some vein-quartz and granite. Less angular with depth Sand: medium with fine and coarse, coarse grains particularly 'sharp', chiefly medium grey Fines: much silt, micaceous	10.0+	21.8

Borehole terminated owing to rock obstruction

NJ 36 SW 11 continued

Mean for Deposit Percentages			Depth below surface (m)		GRADING Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-$\frac{1}{4}$	+$\frac{1}{4}$-1	+1-4	+4-16	+16-64	+64
(a)											
6	73	21	0.1	1.1	10	57	13	5	8	7	0
			1.1	2.1	8	23	32	11	11	15	0
			*2.1	3.1	1	10	63	10	5	11	0
			*3.1	4.1	1	11	64	10	5	9	0
			*4.1	5.1	1	4	56	13	11	8	7
			*5.1	6.1	14	22	29	7	9	19	0
			Mean		6	21	43	9	8	12	1
(b)											
7	52	41	*6.1	7.1	8	21	31	11	14	15	0
			*7.1	8.1	8	24	36	10	7	15	0
			*8.1	9.1	6	21	24	6	6	6	31
			*9.1	10.1	7	11	9	4	18	26	25
			*10.1	11.1	8	20	22	21	24	5	0
			*11.1	11.8	11	16	11	8	14	25	15
			Mean		7	19	23	10	14	15	12
(c)											
4	44	52	*11.8	12.8	6	11	15	11	11	41	5
			*12.8	13.8	11	15	19	11	20	24	0
			*13.8	14.8	5	15	14	5	18	43	0
			*14.8	15.8	3	17	27	3	7	43	0
			*15.8	16.8	1	9	27	6	24	27	6
			*16.8	17.8	2	11	21	4	11	51	0
			*17.8	18.8	2	10	34	8	12	25	9
			*18.8	19.8	2	10	18	11	15	44	0
			*19.8	20.8	1	15	40	9	10	25	0
			*20.8	21.8		rock obstruction, no sample					
			Mean		4	13	24	7	14	36	2
(b + c)											
5	47	48	Mean		5	15	23	9	14	28	6
(a to c)											
5	55	40	Mean		5	17	29	9	12	23	5

NJ 36 SW 12 | 3277 6441 | Corskie | Block B

Surface level +25.6 m (+84 ft)
Groundwater level +13.1 m
250 and 200 mm percussion
December 1976

Waste 17.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil: sandy loam	0.8	0.8
Glaciolacustrine	Sandy silt with frequent thin seams of tenacious silty clay above 7.0 m, deposits pale yellowish brown, faintly laminated between 1.8 m and 5.0 m	9.7	10.5
Till	(a) 'Very clayey' sandy gravel Gravel: coarse with fine, chiefly subrounded to well rounded, quartzites and granulites with some granite, vein-quartz and pegmatite Sand: fine, with some medium and trace of coarse, orange-brown Fines: deposit is clay-bound and very cohesive	1.0	11.5
	Gravelly sandy clay: stiff, with frequent cobbles; orange-brown becoming reddish orange-brown, and more sandy at 12.8 m	2.4	13.9
	(b) Gravel Gravel: coarse with fine, frequent cobbles, angular to well rounded with fine gravel particularly angular, chiefly quartzites and granulites Sand: coarse to fine, poorly sorted and very 'sharp', reddish orange-brown Fines: much disseminated silt. Deposit particularly clay-bound and cohesive	1.1	15.0
	Sandy gravelly clay: firm to stiff with frequent cobbles, reddish orange-brown	2.5+	17.5
	Borehole abandoned owing to rock obstruction		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
21	59	20	*10.5	11.5	21	43	13	3	7	13	0
(b)											
4	30	66	*13.9	15.0	4	10	7	13	16	40	10

NJ 36 SW 13 | 3233 6355 | Upper Ashfield | Block B

Surface level +31.2 m (+102 ft)
Groundwater level +19.2 m
250 and 200 mm percussion
November 1976

Overburden 0.3 m
Mineral I 8.5 m
Waste 0.7 m
Mineral II 4.5 m
Waste 2.2 m
Mineral I 2.9 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	(a) Pebbly sand (seam of laminated sand, silt and clay between 3.8 m and 4.6 m) Gravel: fine and coarse, chiefly subrounded to well rounded, quartzites, granulites and vein-quartz Sand: medium, with fine and some coarse, 'soft', pale orange-brown and grey Fines: disseminated silty material. Thin seams of micaceous silt and clay, especially between 4.6 m and 5.6 m	8.5	8.8
Till	Pebbly sandy clay, firm, pale yellowish brown	0.7	9.5
	(b) 'Clayey' sandy gravel Gravel: coarse with fine, sporadic cobbles, chiefly subangular to well rounded, quartzites, granulites and flags Sand: fine, with medium and coarse, poorly sorted, pale yellowish brown Fines: deposit is clay-bound and cohesive	4.5	14.0
	Gravelly sandy clay: firm to stiff, pale yellowish brown becoming olive-grey between 15.0 m and 15.8 m	2.2	16.2
Glacial sand and gravel	(c) Gravel Gravel: coarse with fine, frequent cobbles, coarse chiefly subrounded to well rounded, fine angular to well rounded, quartzites and granulites with vein-quartz, garnet schist, red and grey granite and red conglomerate Sand: medium, with fine and coarse, 'sharp', yellowish brown Fines: disseminated silt and seams of silty clay	2.9+	19.1
	Borehole abandoned owing to rock obstruction		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
7	84	9	0.3	1.3	1	16	72	5	4	2	0
			1.3	2.3	4	19	69	2	2	4	0
			2.3	3.8	12	32	54	1	1	0	0
			3.8	4.6	non - mineral						
			4.6	5.6	16	62	22	0	0	0	0
			5.6	6.9	5	35	49	1	2	8	0
			6.9	7.9	4	27	46	5	8	10	0
			7.9	8.8	5	15	45	7	14	8	6
			Mean		7	30	51	3	4	4	1
(b)											
16	49	35	9.5	10.5	20	21	16	9	15	19	0
			*10.5	12.5	15	21	16	8	11	29	0
			*12.5	14.0	14	25	19	11	6	25	0
			Mean		16	23	17	9	10	25	0
(c)											
4	43	53	*16.2	17.0	5	8	13	8	17	40	9
			*17.0	19.1	4	13	24	12	19	23	5
			Mean		4	11	21	11	19	28	6
(a + b)											
10	71	19	Mean		10	27	39	5	6	12	1
(b + c)											
11	47	42	Mean		11	18	19	10	14	26	2
(a to c)											
9	65	26	Mean		9	24	35	6	9	15	2

NJ 36 SW 14 | 3241 6260 | Poundler's Wood | Block C

Surface level +28.2 m (+93 ft)
Groundwater level +23.2 m
250 and 200 mm percussion
February 1977

Overburden 0.1 m
Mineral I 5.0 m
Mineral II 3.0 m
Mineral I 2.6 m
Mineral II 10.3 m
Bedrock 0.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Fluvioglacial sand and gravel	(a) Gravel Gravel: coarse with fine, sporadic cobbles; chiefly subrounded to well rounded, fine gravel more angular, quartzites and granulites with granite and some vein-quartz and augen-gneiss Sand: medium with fine and some coarse, 'soft', becoming 'sharp' by 1.5 m, pale yellowish brown becoming medium grey by 3.1 m Fines: disseminated silt. Rare thin seams of silt	5.0	5.1
Till	(b) 'Very clayey' sandy gravel Gravel: coarse with fine, numerous cobbles, chiefly angular to subrounded, quartzites and granulites. Rare fragments of white cornstone (? ORS) Sand: fine, with medium and some coarse, coarse 'sharp', medium grey Fines: deposit bound by clay and therefore firm and cohesive. Thin seams of white silt	3.0	8.1
Glacial sand and gravel	(c) Gravel Gravel: coarse with fine, rare cobbles, subangular to well rounded, quartzites and granulites with granite and some vein-quartz Sand: fine with medium and some coarse, coarse sand and fine gravel 'sharp', brownish medium grey Fines: silt, disseminated and as thin seams	2.6	10.7
Till	(d) Sandy gravel Gravel: coarse with fine, numerous cobbles, angular to subrounded, quartzites and granulites Sand: fine and medium, some coarse, coarse sand and fine gravel 'sharp', medium grey Fines: much disseminated silt. Parts of deposit clay-bound and very compact	10.3	21.0
Old Red Sandstone	Reddish brown, fissile clay and calcareous sandstone	0.5+	21.5

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
5	44	51	0.1	1.1	7	30	20	3	15	25	0
			1.1	2.1	3	11	23	5	21	37	0
			2.1	3.1	3	7	10	4	16	50	10
			3.1	4.1	6	13	21	7	24	29	0
			4.1	5.1	5	22	42	3	11	17	0
			Mean		5	17	23	4	17	32	2
(b)											
25	56	19	*5.1	6.1	23	34	24	4	9	6	0
			*6.1	7.1	36	40	18	4	2	0	0
			*7.1	8.1	15	24	13	6	14	28	0
			Mean		25	32	19	5	8	11	0
(c)											
6	33	61	*8.1	9.1	8	26	17	6	20	23	0
			*9.1	10.1	5	12	8	3	19	28	25
			*10.1	10.7	unrepresentative sample						
			Mean		6	17	12	4	19	26	16
(d)											
7	57	36	*10.7	11.1	10	31	28	8	9	14	0
			*11.1	12.1	8	33	24	6	6	12	11
			*12.1	13.1	7	28	23	10	11	15	6
			*13.1	15.1	10	35	30	9	11	5	0
			*15.1	17.1	4	17	17	5	9	16	32
			*17.1	19.1	4	16	17	14	5	44	0
			*19.1	21.0	8	25	24	14	5	16	8
			Mean		7	25	22	10	8	19	9
(b + d)											
11	57	32	Mean		11	27	22	8	8	17	7
(b + c + d)											
10	53	37	Mean		10	25	20	8	10	19	8
(a to d)											
9	50	41	Mean		9	23	21	7	11	22	7

NJ 36 SW 15 | 3284 6152 | Muir of Stynie | Block C

Surface level +30.9 m (+101 ft)
Groundwater level +26.9 m
250 and 200 mm percussion
February 1977

Made ground 0.3 m
Mineral I 9.0 m
Waste 4.2 m
Mineral I 6.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Made ground	0.3	0.3
Fluvioglacial sand and gravel	(a) Gravel (sandy gravel to 1.3 m) Gravel: coarse and fine, cobbles and small boulders below 2.3 m, coarse rounded to well rounded, fine angular to subrounded, chiefly quartzites and granulites with granite and rare diorite, ?rhyolite, vein-quartz and Old Red Sandstone conglomerate Sand: fine to coarse, 'soft' above 2.3 m, becoming 'sharp', yellowish brown to buff Fines: disseminated silt	9.0	9.3
Glaciolacustrine deposits	Clayey silt with thin seams of clay, faintly laminated, slightly micaceous. Medium grey to chocolate-brown	1.1	10.4
Till	Gravelly sandy clay, firm to stiff, medium grey	0.9	11.3
Glaciolacustrine deposits	Clayey silt, as between 9.3 m and 10.4 m	2.2	13.5
Channel-fill deposits	(b) 'Clayey' sand Sand: medium and fine with trace of coarse (some fine sand lost) unconsolidated deposit, chiefly quartz with white feldspar and vein-quartz Fines: pale grey to white silt. Infrequent seams (10 to 20 mm thick) of pale greenish grey, sandy silty clay.† Fines lost in drilling	6.0+	19.5
	Borehole abandoned for technical reasons		

† Illite with kaolinite (R.I. Lawson pers. comm.)

NJ 36 SW 15 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
2	28	70	0.3	1.3	9	20	22	5	15	28	0
			1.3	2.3	5	11	19	9	25	31	0
			*2.3	3.3	1	5	12	9	28	40	5
			*3.3	4.3	2	5	14	16	30	21	12
			*4.3	5.3	1	2	6	9	22	60	0
			*5.3	6.3	1	4	11	10	24	50	0
			*6.3	7.3	trace	3	5	18	39	35	0
			*7.3	8.3	1	2	5	12	42	38	0
			*8.3	9.3	1	7	7	3	16	44	22
			Mean		2	7	11	10	27	39	4
(b)											
10	90	0	*13.5	16.5	11	39	48	2	0	0	0
			*16.5	19.5	9	39	50	2	0	0	0
			Mean		10	39	49	2	0	0	0
(a + b)											
4	39	57	Mean		4	12	18	9	22	32	3

NJ 36 SW 16 | 3217 6093 | Wood of Stynie | Block C

Surface level +32.5 m (+107 ft)
Groundwater level +29.0 m
250 and 200 mm percussion
March 1977

Overburden 0.1 m
Mineral I 3.5 m
Mineral II 7.4 m
Waste 3.1 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Fluvioglacial sand and gravel	(a) Gravel Gravel: coarse with fine, sporadic cobbles. Boulders up to 500 mm below 2.1 m, chiefly subangular to subrounded with fine gravel more angular, quartzites and granulites with vein-quartz, granite and some mica schist and conglomerate Sand: medium with fine and coarse, coarse sand 'sharp', rusty yellowish brown to buff Fines: disseminated silt. Clay between 1.1 m and 2.1 m	3.5	3.6
Till	(b) Gravel Gravel: coarse with fine, cobbles common, coarse more angular than fine between 3.6 m and 4.6 m, fine gravel becoming more angular with depth, granulites and quartzites with vein-quartz and granite Sand: fine and medium with coarse, 'soft' becoming 'sharp' below 4.6 m, medium grey Fines: much disseminated silt and some clay forming matrix. Stiff seams (10 to 30 mm thick) of silty clay below 5.6 m	7.4	11.0
	No representative sample recovered between 11.0 m and 14.1 m owing to rock obstruction. Deposit penetrated is probably medium grey clayey till	3.1+	14.1
	Borehole abandoned at 14.1 m		

NJ 36 SW 16 continued

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
3	33	64	0.1	1.1	4	11	19	6	19	32	9
			1.1	2.1	5	13	19	6	17	25	15
			*2.1	3.1	1	4	13	6	26	28	22
			*3.1	3.6	1	6	21	13	25	34	0
			Mean		3	9	17	7	22	29	13
(b)											
7	46	47	*3.6	4.6	6	15	12	2	9	44	12
			*4.6	5.6	8	16	19	11	12	14	20
			*5.6	6.6	11	27	24	7	7	24	0
			*6.6	7.6	6	17	22	12	10	26	7
			*7.6	8.6	5	15	20	15	16	29	0
			*8.6	9.6	10	23	20	12	14	21	0
			*9.6	11.0	4	11	12	9	13	42	9
			Mean		7	18	18	10	11	29	7
(a + b)											
6	41	53	Mean		6	14	18	9	15	29	9

NJ 36 SW 17 | 3299 6052 | Stynie | Block C

Surface level +30.3 m (+99 ft)
Groundwater level +27.4 m
250 and 200 mm percussion
October 1976

Overburden 1.6 m
Mineral I 19.4 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Made ground	1.6	1.6
Fluvioglacial sand and gravel	(a) Sandy gravel Gravel: coarse and fine, rare cobbles, coarse chiefly subrounded to well rounded, fine subangular to well rounded, quartzites and granulites with some basic metamorphic rocks, granite and felsite Sand: medium with fine and some coarse, coarse particularly angular, dark grey, becoming pale grey by 3.7 m Fines: disseminated silt. Deposit is clay-bound and cohesive in upper 2.0 m	12.0	13.6
Channel-fill deposits	(b) Sand Gravel: trace of fine, subangular to subrounded, milky quartz Sand: medium with fine, less fine towards base, chiefly quartz, subangular to subrounded with rare mica, greenish pale grey, becoming brownish pale grey below 18.0 m Fines: a little disseminated silt	7.4+	21.0
	Borehole abandoned for technical reasons		

NJ 36 SW 17 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
4	50	46	1.6	2.6	6	17	19	5	19	34	0
			2.6	3.7	5	17	12	5	19	34	8
			*3.7	4.7	4	30	21	9	16	20	0
			*4.7	5.6	1	20	22	6	13	30	8
			*5.6	6.6	2	22	35	6	16	19	0
			*6.6	7.6	5	32	31	8	13	11	0
			*7.6	8.6	1	8	16	7	18	50	0
			*8.6	9.6	3	18	25	9	18	27	0
			*9.6	10.6	11	18	28	9	12	22	0
			*10.6	11.6	3	13	21	7	16	40	0
			*11.6	12.6	2	9	16	8	30	35	0
			*12.6	13.6	3	19	46	3	13	16	0
			Mean		4	19	24	7	17	28	1
(b)											
4	96	0	*13.6	14.6	3	30	66	1	0	0	0
			*14.6	15.6	7	69	24	0	0	0	0
			*15.6	16.6	4	50	46	0	0	0	0
			*16.6	17.6	4	39	57	0	0	0	0
			*17.6	18.6	4	29	66	1	0	0	0
			*18.6	19.6	2	16	82	0	0	0	0
			*19.6	21.0	2	18	80	0	0	0	0
			Mean		4	35	61	0	0	0	0
(a + b)											
4	67	29	Mean		4	25	38	4	10	18	1

NJ 36 SW 18 | 3381 6409 | Connagedale, Garmouth | Block B

Surface level +19.9 m (+65 ft)
Groundwater level +12.9 m
250 and 200 mm percussion
December 1976

Overburden 0.1 m
Mineral I 7.0 m
Mineral II 6.4 m
Waste 3.2 m
Mineral I 2.3 m
Bedrock 0.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Glacial sand and gravel	(a) Pebbly sand Gravel: fine and coarse, chiefly well rounded, quartzite Sand: medium with fine and trace of coarse, 'soft', orange-brown to fawn Fines: some disseminated silt	7.0	7.1
Till	(b) 'Clayey' gravel Gravel: coarse with fine, rare cobbles, chiefly quartzites and granulites with some vein-quartz Sand: fine and medium with some coarse, olive-grey to reddish grey Fines: much of deposit bound by clay into a firm to stiff till	3.4	10.5
	(c) 'Clayey' sandy gravel Gravel: coarse with fine, numerous cobbles, chiefly subangular to well rounded, quartzites and granulites Sand: fine and medium, with some coarse, 'sharp', orange-brown becoming medium grey Fines: disseminated silt. Deposit becomes bound by clay and very cohesive by 11.5 m	3.0	13.5
	Gravelly sandy clay: stiff, olive-grey to dark grey, composition similar to above	3.2	16.7
Glacial sand and gravel	(d) Sandy gravel Gravel: coarse and fine, rare cobbles, coarse gravel chiefly well rounded, fine gravel subangular to well rounded, blackened pebbles of quartzite and granulite with granite and vein-quartz Sand: medium with fine and some coarse, coarse 'sharp', medium grey becoming salmon pink by 18.0 m Fines: some disseminated silt	2.3	19.0
Old Red Sandstone	Clay: firm to stiff, fissile, deep brick-red	0.5+	19.5

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
2	93	5	0.1	1.1	trace	11	82	1	3	3	0
			1.1	2.1	1	11	81	2	3	2	0
			2.1	3.1	2	21	69	1	3	4	0
			3.1	5.1	4	31	61	1	1	2	0
			*5.1	6.1	2	31	66	0	1	0	0
			*6.1	7.1	3	27	61	2	3	4	0
			Mean		2	23	69	1	2	2	0
(b)											
12	44	44	*7.1	10.5	12	19	19	6	11	26	7
(c)											
12	53	35	*10.5	11.5	6	24	29	5	13	15	8
			*11.5	12.5	21	27	15	3	7	22	5
			*12.5	13.5	9	26	21	8	11	20	5
			Mean		12	26	22	5	10	19	6
(d)											
3	64	33	*16.7	18.0	2	11	25	10	19	33	0
			*18.0	19.0	4	29	48	10	5	4	0
			Mean		3	19	35	10	13	20	0
(a + b + c)											
7	72	21	Mean		7	23	46	3	6	12	3
(b + c)											
13	46	41	Mean		13	25	18	3	21	20	0
(b + c + d)											
10	52	38	Mean		10	21	24	7	11	22	5
(a to d)											
6	71	23	Mean		6	22	44	5	7	13	3

NJ 36 SW 19 3347 6331 Essil Block B

Surface level +24.4 m (+80 ft)
Water struck at +13.0 m
250 and 200 mm percussion
November 1976

Overburden 1.0 m
Mineral I 4.8 m
Mineral II 5.7 m
Mineral I 7.5 m
Bedrock 0.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	1.0	1.0
Glacial sand and gravel	(a) Pebbly sand Gravel: coarse with fine, rare cobbles, subrounded to well rounded, granulites, vein-quartz, quartzites and granite Sand: medium with fine and rare coarse, subangular, quartzose, orange-brown Fines: some disseminated silt	4.8	5.8
Till	(b) 'Clayey' sandy gravel Gravel: coarse and fine, rare cobbles (up to 150 mm), chiefly well rounded, granulites, vein-quartz, quartzites and decomposed red sandstone Sand: fine with medium and rare coarse, greenish grey becoming reddish brown below 9.5 m Fines: much disseminated silt and thin seams of greenish grey silty clay to 9.5 m	5.7	11.5
Glacial sand and gravel	(c) Sandy gravel Gravel: coarse with fine, rare cobbles, chiefly well rounded, granulites, vein-quartz, granite, quartzite, red sandstone Sand: medium with fine and coarse, subrounded, chiefly quartz and feldspar, reddish brown Fines: some disseminated silt	7.5	19.0
Old Red Sandstone	Sandstone and marl: red, micaceous, weathered	0.5+	19.5

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
5	78	17	1.0	2.0	4	17	28	4	14	33	0
			2.0	3.0	2	16	63	5	6	8	0
			3.0	4.0	2	13	67	5	6	7	0
			4.0	5.0	3	26	65	2	2	2	0
			5.0	5.8	17	28	51	1	1	2	0
			Mean		5	20	55	3	6	11	0
(b)											
13	46	41	5.8	7.0	11	32	34	3	7	13	0
			7.0	8.0	17	23	10	4	18	28	0
			8.0	9.5	14	24	15	3	24	20	0
			9.5	10.5	13	24	14	3	27	19	0
			10.5	11.5	12	21	13	3	28	23	0
			Mean		13	25	18	3	21	20	0
(c)											
2	51	47	*11.5	12.5	4	14	24	13	18	27	0
			*12.5	13.5	2	12	39	10	14	23	0
			*13.5	14.5	2	13	42	11	18	14	0
			*14.5	15.5	2	9	28	10	18	17	16
			*15.5	17.0	1	11	29	11	19	29	0
			*17.0	18.0	1	8	27	3	21	32	8
			*18.0	19.0	3	6	35	7	15	34	0
			Mean		2	10	32	9	18	26	3
(b + c)											
7	49	44	Mean		7	16	26	7	19	23	2
(a to c)											
7	56	37	Mean		7	17	33	6	16	20	1

NJ 36 SW 20 | 3367 6249 | Lunan Wood | Block C

Surface level +22.4 m (+74 ft)
Water struck at +17.9 m
250 and 200 mm percussion
December 1976

Overburden 0.5 m
Mineral I 6.7 m
Mineral II 1.3 m
Mineral I 7.2 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Fluvioglacial sand and gravel	(a) Gravel Gravel: coarse and fine, with cobbles (up to 150 mm), chiefly well rounded, granulites, vein-quartz, granite and quartzites Sand: medium, with fine and coarse, rounded, dark brown to 1.5 m becoming light brown Fines: some silt, disseminated	6.7	7.2
Till	(b) 'Clayey' pebbly sand Gravel: coarse with fine, with cobbles (up to 200 mm), chiefly well rounded, granulites, vein-quartz, quartzites and granite Sand: fine, with medium and rare coarse, reddish brown Fines: some clayey material, deposit slightly cohesive	1.3	8.5
Glacial sand and gravel	(c) Sandy gravel Gravel: coarse with fine, frequent cobbles, chiefly well rounded, granulites, vein-quartz, quartzites and granite Sand: medium with fine and some coarse, reddish brown Fines: some disseminated silt	7.2+	15.7
	Borehole terminated owing to rock obstruction		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
7	39	54	0.5	1.5	6	13	19	7	24	31	0
			1.5	2.5	7	12	20	10	21	30	0
			2.5	3.5	11	9	21	8	23	28	0
			3.5	4.5	7	13	21	8	25	26	0
			*4.5	5.5	2	5	19	11	36	27	0
			*5.5	6.5	4	7	21	10	30	28	0
			*6.5	7.2	9	15	18	5	12	29	12
			Mean		7	10	20	9	25	28	1
(b)											
10	71	19	*7.2	8.5	10	45	23	3	7	12	0
(c)											
4	49	47	*8.5	9.5	5	21	14	5	17	33	5
			*9.5	10.5	5	19	16	9	23	28	0
			*10.5	11.5	3	12	36	5	17	27	0
			*11.5	12.5	7	15	28	8	16	26	0
			*12.5	13.5	1	7	24	8	24	36	0
			*13.5	14.5	1	8	25	6	22	38	0
			*14.5	15.7	3	29	44	5	6	13	0
			Mean		4	16	27	6	18	28	1
(b + c)											
4	52	44	Mean		4	20	26	6	17	26	1
(a to c)											
6	45	49	Mean		6	15	23	7	21	27	1

NJ 36 SW 21 | 3389 6124 | Manse, Stynie | Block C

Surface level +24.2 m (+79 ft)
Groundwater level +14.2 m
250 and 200 mm percussion
November 1976

Overburden 0.1 m
Mineral I 12.2 m
Waste 2.0 m
Mineral I 1.4 m
Waste 4.4 m
Mineral I 2.4 m
Bedrock 1.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Fluvioglacial sand and gravel	(a) Gravel Gravel: coarse and fine, frequent cobbles, chiefly subrounded to well rounded, becoming more angular by 10.1 m, quartzites and granulites with some basic metamorphic rocks, granite and felsite. 'Rotten' sandstone at top Sand: medium, with fine and some coarse, coarse sand 'sharp' by 10.1 m, yellowish orange, becoming fawn by 4.0 m Fines: chiefly disseminated silt. Rare seams of micaceous, sandy silt	12.2	12.3
Till	Sandy pebbly clay, stiff, olive-greyish brown	2.0	14.3
Glacial sand and gravel	(b) Sandy gravel Gravel: coarse with fine, chiefly subangular to well rounded, quartzites and granulites Sand: medium, with fine and some coarse, 'sharp', orange-brown Fines: disseminated silt	1.4	15.7
Till	Gravelly sandy clay: stiff, dark reddish brown	4.4	20.1
Glacial sand and gravel	(c) Pebbly sand Gravel: coarse with fine, chiefly subangular to well rounded, quartzites Sand: chiefly medium, with fine and some coarse, subangular to well rounded, conspicuous vein-quartz and mafic minerals, pale grey, reddening with depth Fines: silt, disseminated and as seams	2.4	22.5
Old Red Sandstone	Sandy clay, clayey sand and mudstone, bright red to reddish brown with streaks of pale grey	1.0+	23.5

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
5	40	55	0.1	1.1	5	11	10	10	25	36	3
			1.1	2.1	5	16	15	8	21	30	5
			2.1	3.1	5	19	22	3	25	26	0
			3.1	4.1	5	27	54	2	4	8	0
			4.1	5.2	5	13	18	7	18	39	0
			5.2	6.7	7	13	13	10	24	33	0
			6.7	7.7	8	18	12	6	16	28	12
			7.7	9.0	5	10	13	7	18	40	7
			9.0	10.1	6	11	17	7	21	38	0
			*10.1	11.4	2	5	15	7	29	38	4
			*11.4	12.3	6	14	24	10	23	23	0
			Mean		5	14	19	7	21	31	3
(b)											
3	53	44	*14.3	15.7	3	17	27	9	14	30	0
(c)											
8	84	8	*20.1	22.5	8	27	49	8	2	6	0
(b + c)											
6	73	21	Mean		6	23	41	9	6	15	0
(a to c)											
6	48	46	Mean		6	16	24	8	17	27	2

NJ 36 SW 22 | 3374 6043 | Redhall | Block C

Surface level +32.4 m (+106 ft)
Water not struck
250 mm percussion
November 1976

Overburden 0.6 m
Mineral I 4.1 m
Bedrock 0.3 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Fluvioglacial sand and gravel	Gravel Gravel: coarse and fine, rare cobbles, coarse subrounded to well rounded, fine subangular, chiefly quartzites and granulites Sand: medium, with coarse and fine, 'sharp', coarse towards top, orange-brown to pinkish pale grey. Dark grey above 2.4 m Fines: deposit is clay-bound above 2.4 m. Disseminated silt	4.1	4.7
Old Red Sandstone	Medium-grained sand, bright salmon pink and slightly clayey (poor recovery)	0.3+	5.0

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
6	34	60	0.6	1.6	6	11	17	8	25	33	0
			1.6	2.7	7	10	15	10	28	27	3
			2.7	3.8	5	7	14	9	28	37	0
			3.8	4.7	7	9	15	11	27	31	0
			Mean		6	9	15	10	27	32	1

NJ 36 SW 23 | 3476 6438 | Spey Viaduct, Garmouth | Block D

Surface level +4.9 m (+16 ft)
Groundwater level +1.9 m
250 mm percussion
January 1977

Overburden 0.6 m
Mineral I 4.0 m
Bedrock 0.2 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Alluvium	Gravel Gravel: coarse with fine, abundant cobbles, rounded to well rounded, quartzites and granulites with sandstone, vein-quartz and granite Sand: medium with coarse and some fine Fines: some disseminated silt	4.0	4.6
Old Red Sandstone	Sandstone: soft, red and laminated	0.2+	4.8

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
2	33	65	0.6	1.6	2	10	14	10	20	40	4
			1.6	2.6	2	3	11	6	6	19	53
			2.6	3.6	2	4	26	13	11	26	18
			3.6	4.6	1	3	19	12	14	18	33
			Mean		2	5	18	10	13	25	27

NJ 36 SW 24 | 3431 6321 | Bow Bridge, Essil | Block D

Surface level +7.9 m (+26 ft)
Groundwater level +6.4 m
250 and 200 mm percussion
November 1976

Overburden 0.1 m
Mineral I 8.6 m
Bedrock 1.3 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Alluvium	(a) 'Very clayey' sand Sand: chiefly fine, with some medium, mottled brownish orange-grey, slightly micaceous Fines: abundant disseminated silt	1.0	1.1
	(b) Gravel Gravel: coarse with fine, cobbles and rare boulders up to 300 mm, coarse rounded to well rounded, fine angular to well rounded, chiefly quartzites, granulites and granite with some vein-quartz, red conglomerate and others Sand: medium with fine and coarse, 'sharp', orange-brown to 4.5 m then brownish grey to grey with conspicuous grains of pink feldspar and black mafic minerals Fines: deposit is clay-bound and cohesive in upper 2 m. Disseminated silt present below 2 m	7.6	8.7
Old Red Sandstone	Sandy clay and fine-grained sandstone; firm becoming hard, brick-red and yellow, slightly micaceous	1.3+	10.0

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
30	70	0	0.1	1.1	30	61	9	0	0	0	0
(b)											
3	45	52	1.1	2.1	9	15	9	5	10	18	34
			*2.1	3.1	1	4	13	9	21	37	15
			*3.1	4.1	2	8	23	8	18	33	8
			*4.1	5.1	3	15	40	8	8	12	14
			*5.1	6.1	2	13	32	6	11	23	13
			*6.1	7.1	2	11	27	7	12	33	8
			*7.1	7.9	1	11	30	8	15	29	6
			*7.9	8.7	2	9	37	15	13	24	0
			Mean		3	11	26	8	13	26	13
(a + b)											
6	48	46	Mean		6	17	24	7	12	23	11

NJ 36 SW 25 | 3434 6255 | Newton | Block D

Surface level +9.4 m (+31 ft)
Water struck at +8.5 m
250 and 200 mm percussion
November 1976

Mineral I 4.5 m
Waste 4.0 m
Mineral I 14. 0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
Alluvium	(a) Gravel Gravel: coarse with fine, frequent cobbles, chiefly well rounded, granulites, quartzites, vein-quartz, granite, quartz porphyry, red sandstone and cornstone Sand: medium, with coarse and some fine, 'sharp', medium brown Fines: a little disseminated silt	4.5	4.5
Till	Gravelly clay: dark grey, stiff, much gravel with cobbles, little sand	4.0	8.5
Glacial sand and gravel	(b) Sandy gravel Gravel: coarse with fine, rare cobbles (up to 120 mm), chiefly well rounded, granite, granulites, vein-quartz, quartzite, quartz porphyry and red sandstone Sand: medium with coarse and fine, 'sharp', quartz, feldspar, reddish brown Fines: a little disseminated silt	1.5	10.0
Channel-fill deposits	(c) Sand Gravel: rare coarse and fine, chiefly well rounded, granulites, vein-quartz, quartzites and granite. Band of cobble gravel at 18.0 m. Sand: medium, with fine and some coarse, subrounded, micaceous, greenish grey Fines: a little disseminated silt	12.5+	22.5

Borehole terminated owing to rock obstruction

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
2	30	68	0.1	1.0	3	4	11	11	24	35	12
			*1.0	2.5	1	3	17	10	18	43	8
			*2.5	3.5	2	3	19	10	19	47	0
			*3.5	4.5	2	3	20	7	20	30	18
			Mean		2	3	17	10	20	39	9
(b)											
3	54	43	*8.5	9.5	3	9	26	14	15	33	0
			*9.5	10.5	4	12	43	7	14	20	0
			Mean		3	10	32	12	14	29	0
(c)											
5	92	3	*10.0	11.5	11	16	69	2	1	1	0
			*11.5	12.5	2	17	73	4	3	1	0
			*12.5	14.5	2	19	76	2	1	0	0
			*14.5	16.5	4	22	70	3	1	0	0
			*16.5	18.5	4	20	66	3	1	6	0
			*18.5	20.5	4	20	72	3	0	1	0
			*20.5	22.5	3	14	62	10	3	8	0
			Mean		5	18	70	4	1	2	0
(b + c)											
4	89	7	Mean		4	18	66	5	2	5	0
(a to c)											
4	74	22	Mean		4	14	54	6	7	13	2

Surface level +13.8 m (+45 ft)
Groundwater level +11.8 m
250 and 200 mm percussion
February 1977

Overburden 0.1 m
Mineral I 5.0 m
Mineral II 7.4 m
Bedrock 0.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Alluvium	(a) Gravel Gravel: coarse with fine, numerous cobbles and rare boulders, coarse chiefly well rounded, fine angular to well rounded, quartzites and granulites with granite and vein-quartz Sand: medium, coarse and fine, 'sharp', quartz with quartzite, buff Fines: disseminated silt below 3.1 m	5.0	5.1
Till	(b) Gravel Gravel: coarse with fine, numerous cobbles and rare small boulders, subangular to well rounded, fine gravel tending to be more angular, quartzites and granulites Sand: fine with medium and coarse, reddish brown becoming more red below 8.8 m Fines: much silt and clay. Fines lost during drilling. Soft, tenacious, red clay recovered below 8.8 m	7.4	12.5
Old Red Sandstone	Sandstone, medium to coarse grained, red and micaceous, weathered	0.5+	13.0

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
3	35	62	*0.1	1.1	trace	trace	6	19	27	24	24
			*1.1	2.1	1	1	10	11	20	34	23
			*2.1	3.1	trace	1	6	8	16	51	18
			*3.1	4.1	3	11	30	14	17	25	0
			*4.1	5.1	13	26	22	9	10	8	9
			Mean		3	8	15	12	18	29	15
(b)											
6	28	66	*5.1	6.1	11	12	6	4	16	48	3
			*6.1	7.1	4	8	5	4	7	45	27
			*7.1	9.1	3	7	5	5	20	44	16
			*9.1	11.1	5	11	7	9	23	42	3
			*11.1	12.5	9	28	17	11	14	21	0
			Mean		6	13	8	7	17	40	9
(a + b)											
5	31	64	Mean		5	11	11	9	18	35	11

NJ 36 SW 27 | 3463 6045 | Warren Wood | Block D

Surface level +18.0 m (+59 ft)
Groundwater level +16.1 m
250 mm percussion
February 1977

Mineral I 12.0 m
Bedrock 1.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
Alluvium	Gravel Gravel: coarse with fine, frequent cobbles, subrounded to well rounded, granulites, quartzites, vein-quartz, amphibolite, granite and sandstone Sand: medium with coarse and some fine, quartzose, light orange-brown Fines: a little disseminated silt	12.0	12.0
Old Red Sandstone	Sandstone: red, medium grained	1.0+	13.0

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
1	39	60	0.0	1.0	2	2	14	14	32	36	0
			*1.0	2.0	1	2	19	14	27	21	16
			*2.0	3.0	0	1	6	13	23	51	6
			*3.0	4.0	1	1	16	18	24	40	0
			*4.0	5.0	0	1	11	7	17	20	44
			*5.0	6.0	3	4	23	4	12	33	21
			*6.0	7.0	0	4	26	2	9	35	24
			*7.0	8.0	2	11	34	10	11	12	20
			*8.0	9.0	1	9	33	8	14	26	9
			*9.0	10.0	1	9	31	7	10	18	24
			*10.0	11.0	2	10	48	9	11	20	0
			*11.0	12.0	2	12	31	4	11	40	0
			Mean		1	6	24	9	17	29	14

NJ 36 SE 2 | 3529 6495 | Spey Bay | Block D

Surface level +3.0 m (+10 ft)
Groundwater level +2.0 m
250 mm percussion
February 1977

Overburden 0.5 m
Mineral I 7.0 m
Bedrock 0.8 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Alluvium	Gravel Gravel: coarse with fine, rare cobbles, coarse chiefly rounded to well rounded, fine angular to subrounded, granulites, quartzites, red and grey granites, sandstones, vein-quartz, basic igneous rocks Sand: coarse and medium, with some fine, 'sharp' coarse grains, chiefly of quartz, medium brown to 6.8 m and yellow to 7.5 m Fines: trace; thin seams of yellow silty clay below 6.8 m	7.0	7.5
Old Red Sandstone	Sandstone: medium grained, yellow with streaks of red, firm becoming hard	0.8+	8.3

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
0	31	69	*0.5	1.5	trace	1	7	8	19	53	12
			*1.5	2.5	trace	2	8	11	24	42	13
			*2.5	3.5	trace	2	15	8	18	48	9
			*3.5	4.5	trace	3	21	10	21	45	0
			*4.5	5.5	trace	2	9	11	34	44	0
			*5.5	6.8	1	2	18	14	27	38	0
			*6.8	7.5	1	14	54	11	7	10	3
			Mean		trace	3	17	11	23	41	5

NJ 36 SE 3 | 3523 6323 | Near Chicken Hatchery, Bogmoor | Block D

Surface level +8.3 m (+27 ft)
Groundwater level +7.6 m
250 and 200 mm percussion
December 1976

Overburden 0.1 m
Mineral I 5.1 m
Mineral II 4.4 m
Mineral I 10.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Alluvium	(a) 'Very clayey' pebbly sand Gravel: coarse, rounded, quartzites Sand: fine with medium, micaceous, dark brown Fines: much disseminated silt	1.9	2.0
	(b) Gravel Gravel: coarse with fine, rare cobbles, coarse chiefly well rounded, fine subangular, granulites, quartzites, granite, vein-quartz and quartz porphyry Sand: medium with coarse and fine, sub-angular, orange-brown Fines: a little disseminated silt	3.2	5.2
Till	(c) 'Clayey' gravel (bound and cohesive) Gravel: coarse with fine, rare cobbles, chiefly granulites, quartzites, granite, vein-quartz and amphibolite schist Sand: medium and fine, with some coarse, medium grey Fines: clay	4.4	9.6
Glacial sand and gravel	(d) Sandy gravel Gravel: coarse with fine, with rare cobbles, coarse chiefly well rounded, fine subangular, granulites, quartzites, vein-quartz, and granite Sand: medium with coarse and fine, 'sharp', mid-brown Fines: disseminated silt	3.2	12.8
Channel-fill deposits	(e) Sand Gravel: rare fine, rounded, vein-quartz, granulites, quartzites, present down to 15.0 m Sand: medium with fine and some coarse, 'sharp', micaceous, greenish grey Fines: disseminated silt, with thin seams of reddish brown silt between 18.9 m and 19.2 m	7.3+	20.1

Borehole abandoned owing to rising sand

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
26	69	5	0.1	1.0	27	54	15	2	0	2	0
			1.0	2.0	24	54	13	1	0	8	0
			Mean		26	54	14	1	0	5	0
(b)											
2	34	64	*2.0	3.0	4	8	19	15	17	37	0
			*3.0	4.0	1	3	11	6	14	37	28
			*4.0	5.2	2	15	18	8	16	41	0
			Mean		2	9	16	9	16	39	9
(c)											
17	31	52	*5.2	6.0	22	10	7	3	11	47	0
			*6.0	7.0	18	19	12	3	16	32	0
			*7.0	8.0	12	22	11	2	11	42	0
			*8.0	9.0	16	12	24	3	13	20	12
			*9.0	9.6	22	6	7	7	19	39	0
			Mean		17	15	13	3	14	35	3
(d)											
4	54	42	*9.6	11.0	6	14	23	18	17	22	0
			*11.0	12.0	3	9	29	20	14	25	0
			*12.0	12.8	1	9	31	7	16	36	0
			Mean		4	11	27	16	16	26	0
(e)											
5	95	0	*12.8	14.0	2	15	81	1	1	0	0
			*14.0	15.0	2	16	79	2	1	0	0
			*15.0	17.0	2	15	77	6	0	0	0
			*17.0	18.0	2	14	75	9	0	0	0
			*18.0	19.0	18	16	58	8	0	0	0
			*19.0	20.1	7	11	79	3	0	0	0
			Mean		5	15	75	5	0	0	0
(a + b)											
12	49	39	Mean		12	27	16	6	10	24	5
(d + c)											
5	82	13	Mean		5	14	60	8	5	8	0
(a to e)											
9	63	28	Mean		9	17	39	7	8	18	2

NJ 36 SE 4 | 3572 6234 | Byres, Upper Dallachy | Block D

Surface level +11.9 m (+39 ft)
Groundwater level +11.2 m
250 mm percussion
December 1976

Overburden 1.8 m
Mineral I 1.2 m
Waste 2.3 m
Bedrock 2.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Alluvium	Sandy clay: stiff, orange-brown	1.3	1.8
	'Clayey' sandy gravel Gravel: coarse with fine, with cobbles, coarse chiefly well rounded, fine subangular to rounded, quartzites, granulites and granite Sand: fine and medium with some coarse, orange-brown Fines: much disseminated silt, deposit slightly cohesive	1.2	3.0
Till	Gravelly clay: hard, red. Gravel chiefly coarse, rounded granulites, quartzites, granite and decomposed red sandstone	2.3	5.3
Old Red Sandstone	Sandstone: medium grained, micaceous, red, soft and weathered	2.0+	7.3

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
10	47	43	*1.8	3.0	10	25	18	4	2	15	26

NJ 36 SE 5 | 3564 6105 | Den Farm, Upper Dallachy | Block C

Surface level +27.4 m (+90 ft)
Groundwater level +22.4 m
250 and 200 mm percussion
January 1977

Overburden 0.2 m
Mineral I 4.3 m
Waste 0.5 m
Mineral II 3.0 m
Mineral I 7.1 m
Bedrock 0.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Fluvioglacial sand and gravel	(a) Gravel Gravel: chiefly coarse, with fine. Frequent cobbles. Boulders (up to 300 mm) towards base, subangular to rounded quartzites, granulites and granite Sand: medium with fine and coarse, medium to dark brown, becoming greyish brown by 2.0 m Fines: some disseminated silt	4.3	4.5
Till	Pebbly clay: stiff, red and slightly silty	0.5	5.0
	(b) 'Clayey' gravel Gravel: coarse and fine, scattered cobbles, quartzites, granulites and rare granodiorite Sand: fine, with medium and some coarse, reddish brown, becoming greyish brown Fines: much disseminated silt and clay	3.0	8.0
Glacial sand and gravel	(c) Gravel Gravel: coarse and fine, scattered cobbles and a few boulders (up to 300 mm), chiefly granulites and quartzites Sand: medium, with coarse and fine, fining upwards, greyish brown, becoming pinkish medium grey by 13 m Fines: disseminated silt and clay decreasing with depth	7.1	15.1
Old Red Sandstone	Red sandstone containing pebbles, friable becoming hard	0.5+	15.6

NJ 36 SE 5 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
3	28	69	0.2	1.0	6	10	13	7	16	48	0
			*1.0	2.0	4	8	11	6	17	32	22
			*2.0	3.0	1	3	6	4	25	61	0
			*3.0	4.5	1	7	23	9	24	36	0
			Mean		3	7	15	6	21	43	5
(b)											
15	39	46	*5.0	6.0	19	22	15	6	15	23	0
			*6.0	7.0	20	22	14	5	13	18	8
			*7.0	8.0	7	14	14	6	23	36	0
			Mean		15	19	14	6	17	26	3
(c)											
2	33	65	*8.0	9.0	5	10	11	6	21	42	5
			*9.0	10.0	3	9	14	9	21	24	20
			*10.0	11.0	1	1	6	13	46	33	0
			*11.0	12.0	1	2	11	9	43	31	3
			*12.0	13.0	0	2	9	10	27	52	0
			*13.0	14.0	1	4	22	19	29	25	0
			*14.0	15.1	2	8	41	14	16	19	0
			Mean		2	5	17	11	29	32	4
(b + c)											
6	35	59	Mean		6	9	16	10	25	30	4
(a to c)											
5	33	62	Mean		5	9	15	9	24	34	4

NJ 36 SE 6 3600 6109 Near Den Farm, Upper Dallachy Block E

Surface level +35.4 m (+116 ft)
Groundwater level +29.4 m
250 and 200 mm percussion
January 1977

Overburden 0.2 m
Mineral II 7.3 m
Waste 5.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	(a) 'Clayey' gravel Gravel: coarse with fine, rare cobbles, rounded to well rounded, coarse-grained igneous and metamorphic rocks Sand: fine with medium and some coarse, medium brown Fines: much disseminated silt. Increasing clay content below 1.5 m	1.8	2.0
	(b) 'Very clayey' gravel Gravel: fine to coarse with some cobbles, metamorphic, fine and coarse-grained igneous rocks, sandstones Sand: mainly medium, mid-brown Fines: disseminated silt and clay	5.5	7.5
	Silty gravelly clay: stiff, medium brown, boulders up to 300 mm	5.0+	12.5

Borehole abandoned owing to rock obstruction

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
16	37	47	0.2	1.0	18	24	13	3	7	21	14
			1.0	2.0	15	19	10	3	6	15	32
			Mean		16	22	12	3	6	18	23

(b)

Mineral category estimated

NJ 36 SE 7 | 3521 6027 | Near Quarry Garden, Fochabers | Block D

Surface level +26.8 m (+88 ft)
Groundwater level +23.8 m
250 and 200 mm percussion
January 1977

Mineral I 7.2 m
Bedrock 0.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
Alluvium	(a) 'Clayey' gravel Gravel: coarse with fine, rare cobbles, chiefly quartzites and sandstone Sand: fine with medium and some coarse Fines: some clay, disseminated or as lumps, containing carbonaceous material	1.0	1.0
	(b) Gravel Gravel: coarse with some fine, scattered cobbles, chiefly quartz, quartzite, granulite, sandstone and schist Sand: medium with coarse and fine Fines: some disseminated silt	6.2	7.2
Old Red Sandstone	Sandstone, red, soft becoming hard	0.5+	7.7

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
13	37	50	0.0	1.0	13	19	13	5	8	8	34
(b)											
1	28	71	*1.0	2.0	2	4	12	9	24	25	24
			*2.0	3.0	1	4	7	4	24	39	21
			*3.0	4.0	2	3	13	10	5	31	36
			*4.0	5.0	2	6	15	7	24	35	11
			*5.0	6.0	1	3	10	3	8	48	27
			*6.0	7.2	1	11	33	9	11	21	14
			Mean		1	5	16	7	16	33	22
(a + b)											
3	29	68	Mean		3	7	15	7	15	29	24

NJ 36 SE 8 | 3599 6015 | Near Quarry Garden, Fochabers | Block E

Surface level +75.1 m (+246 ft)
Groundwater level +65.1 m
250 and 200 mm percussion
February 1977

Overburden 0.6 m
Mineral II 2.0 m
Waste 2.0 m
Mineral II 9.3 m
Waste 1.6 m
Bedrock 1.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Till	(a) 'Very clayey' gravel (clay-bound) Gravel: coarse with fine, chiefly subangular to well rounded, quartzites and granulites Sand: fine, with medium and some coarse, 'soft', yellowish pale brown Fines: silt and clay	2.0	2.6
	Gravelly sandy clay, firm to stiff, colour and composition as above	2.0	4.6
	(b) 'Very clayey' sandy gravel (clay-bound) Gravel: coarse and fine, rare cobbles, chiefly subangular to well rounded, quartzites and granulites Sand: fine with medium and some coarse, 'soft', yellowish pale brown, becoming reddish pale brown by 6.0 m Fines: silt and clay. Discrete seam (200 mm thick) of medium grey silty clay at 10.4 m	9.3	13.9
	Gravelly sand clay: firm to stiff, pale yellowish brown. Composition as above	1.6	15.5
Old Red Sandstone	Sandstone, fine grained, with seams of medium-grained sandstone and fissile clay, deep brick-red with yellowish streaks	1.0+	16.5

NJ 36 SE 8 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
25	37	38	0.6	2.6	25	21	13	3	11	27	0
(b)											
27	44	29	4.6	6.0	20	19	11	5	10	35	0
			6.0	8.0	28	24	20	7	11	10	0
			8.0	10.0	30	25	9	4	11	21	0
			*10.0	11.9	29	22	22	5	10	12	0
			*11.9	13.9	26	20	18	8	11	7	10
			Mean		27	22	16	6	11	16	2
(a + b)											
27	43	30	Mean		27	22	16	5	10	18	2

Surface level +3.9 m (+13 ft)
Groundwater level +1.9 m (tidal)
250 and 200 mm percussion
January 1977

Mineral I 7.5 m
Waste 0.5 m
Mineral I 3.0 m
Waste 1.4 m
Bedrock 1.6 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
Storm beach deposits	(a) Gravel Gravel: coarse with fine and cobbles, discoidal pebbles common between 4.0 and 5.0 m otherwise spherical, chiefly rounded to well rounded, quartzites, granulites, vein-quartz, sandstone and others Sand: fine with medium and some coarse, chiefly quartz, medium brown Fines: a little clay making deposit slightly cohesive above 4.0 m, otherwise disseminated silt	7.5	7.5
Till	Pebbly clay: stiff, yellowish brown, composition as above	0.5	8.0
Glacial sand and gravel	(b) Gravel Gravel: coarse and fine, rare cobbles, chiefly rounded to well rounded, quartzites, granulites, vein-quartz and sandstone Sand: medium and coarse with fine, 'sharp', chiefly quartz, medium brown Fines: some clay, binding deposit towards top	3.0	11.0
Till	No representative sample recovered owing to rock obstruction. The deposit penetrated is probably clayey till	1.4	12.4
Old Red Sandstone	Sandstone, medium grained, white, becoming medium to coarse grained, bright red by 14.0 m, scattered pebbles of vein-quartz and granulites	1.6+	14.0

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
1	34	65	*0.0	1.0	trace	19	14	2	13	52	0
			*1.0	2.0	trace	42	11	0	6	24	17
			*2.0	3.0	3	37	9	0	7	37	7
			*3.0	4.0	trace	23	9	2	17	37	12
			*4.0	5.0	trace	15	5	2	16	32	30
			*5.0	6.0	1	11	12	4	17	45	10
			*6.0	7.0	2	14	13	5	7	7	52
			*7.0	7.5	1	8	8	3	6	12	62
			Mean		1	22	10	2	12	32	21
(b)											
2	40	58	*8.0	9.0	1	5	18	17	25	34	0
			*9.0	10.0	1	5	18	12	20	38	6
			*10.0	11.0	2	8	26	11	13	40	0
			Mean		2	6	20	14	19	37	2
(a + b)											
1	36	63	Mean		1	17	13	6	14	33	16

NJ 36 SE 10 | 3675 6419 | Moor of Dallachy | Block A

Surface level +8.5 m≠(+28 ft)
Groundwater level +4.5 m
250 and 200 mm percussion
January 1977

Mineral I 12.0 m
Bedrock 1.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
Raised beach deposits	Gravel Gravel: coarse with fine, and cobbles (up to 150 mm), subrounded to rounded, schist, gneiss, granite, gabbro, vein-quartz and sandstone Sand: medium with coarse and fine, subangular to subrounded, quartzose, light to medium brown, black between 5.0 and 6.0 m Fines: a little silt	12.0	12.0
Old Red Sandstone	Sandstone: soft and pink becoming harder and red with depth	1.5+	13.5+

≠ Borehole sited in partially worked ground; roughly 2 m of gravel has been removed at the surface

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
2	32	66	*0.0	1.0	1	2	4	5	14	30	44
			*1.0	2.0	2	2	14	7	21	34	20
			*2.0	3.0	2	2	16	8	19	46	7
			*3.0	4.0	1	1	6	3	13	65	11
			*4.0	5.0	2	2	16	7	20	48	5
			*5.0	6.0	1	2	11	4	17	44	21
			*6.0	7.0	1	1	7	5	27	43	16
			*7.0	8.0	2	2	20	5	26	45	0
			*8.0	9.0	3	9	35	5	20	28	0
			*9.0	10.0	3	12	41	5	10	20	9
			*10.0	11.0	5	10	47	4	14	20	0
			*11.0	12.0	no representative sample						
			Mean		2	5	22	5	18	37	11

NJ 36 SE 11 | 3633 6320 | Disused airfield, Dallachy | Block A

Surface level +12.4 m (+41 ft)
Groundwater level +11.4 m
250 and 200 mm percussion
January 1977

Mineral I 9.0 m
Waste 0.2 m
Bedrock 0.8 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
Raised beach deposits	Gravel	9.0	9.0
	Gravel: coarse with fine, many cobbles, coarse chiefly rounded, fine angular to rounded, granulites, granite and some white, medium-grained sandstone		
	Sand: medium with coarse and fine, quartz with some feldspar, dull yellowish brown		
	Fines: a little disseminated silt, clay appearing below 6.0 m		
Till	Sandy pebbly clay: stiff, red, slightly laminated	0.2	9.2
Old Red Sandstone	Clayey pebbly sand: medium grained, red-brown to pink, becoming hard and deep-red	0.8+	10.0

GRADING

Fines	Sand	Gravel	Depth below surface (m) From	To	Percentages Fines -1/16	Sand +1/16-¼	+¼-1	+1-4	Gravel +4-16	+16-64	+64
1	26	73	*0.0	1.0	2	4	10	6	15	58	5
			*1.0	2.0	0	5	19	3	7	60	6
			*2.0	3.0	1	2	12	3	11	52	19
			*3.0	4.0	2	1	13	7	19	39	19
			*4.0	5.0	1	3	12	5	15	39	25
			*5.0	6.0	1	4	26	5	18	31	15
			*6.0	7.0	1	3	14	2	5	26	49
			*7.0	8.0	1	7	16	3	8	26	39
			*8.0	9.0	2	12	22	7	15	26	16
			Mean		1	5	16	5	13	39	21

Surface level +34.1 m (+112 ft)
Water struck at +26.1 m
250 mm percussion
January 1977

Overburden 0.6 m
Mineral II 3.0 m
Waste 1.4 m
Mineral II 2.0 m
Waste 1.0 m
Bedrock 0.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Till	(a) 'Very clayey' pebbly sand Gravel: coarse and fine, scattered cobbles, subrounded to rounded, quartzites, granulites and igneous rock types Sand: fine with medium and some coarse, orange-brown Fines: much disseminated silt. Deposit becomes increasingly clay-bound and consolidated	3.0	3.6
	Pebbly sandy clay: stiff, orange-brown	1.4	5.0
	(b) 'Clayey' sandy gravel Gravel: coarse with fine, scattered cobbles, subrounded to rounded, quartzites, granulites and igneous rock types Sand: fine and medium with some coarse, reddish brown Fines: much disseminated silt. Deposit slightly cohesive and clay-bound	2.0	7.0
	Pebbly sandy clay: stiff, reddish brown with yellowish brown patches	1.0	8.0
Old Red Sandstone	Clayey, red sandstone and marl	0.5+	8.5

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
20	60	20	0.6	1.6	22	48	21	3	3	3	0
			1.6	2.6	20	38	21	3	5	6	7
			2.6	3.6	19	28	14	3	8	17	11
			Mean		20	38	19	3	5	9	6
(b)											
18	47	35	5.0	6.0	19	27	19	5	10	20	0
			6.0	7.0	17	17	18	9	12	20	7
			Mean		18	22	18	7	11	20	4
(a + b)											
19	56	25	Mean		19	32	19	5	7	13	5

Surface level +4.3 m (+14 ft)
Groundwater level +3.2 m
250 and 200 mm percussion
January 1977

Mineral I 7.4 m
Mineral II 2.0 m
Mineral I 2.6 m
Bedrock 0.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
Storm beach deposits	(a) Sandy gravel, predominantly blown sand to 2.0 m Gravel: coarse with fine, with cobbles below 2.1 m (up to 150 mm), well rounded to 5.0 m, coarse becoming rounded to well rounded and fine subrounded to rounded, granulites, quartzites, vein-quartz, red and yellow sandstones, blackened to 5.0 m Sand: fine with medium, rare coarse, rounded to 5.0 m, becoming sub-rounded, yellow-brown to 2.1 m, dark grey to 5.0 m becoming medium grey-brown Fines: trace of silt	7.4	7.4
Till	(b) Gravel Gravel: coarse with fine, numerous cobbles (up to 250 mm), rounded quartzites, coarse and fine-grained igneous rocks Sand: medium and fine with coarse, greenish grey Fines: deposit clay-bound and quite stiff in places	2.0	9.4
Glacial sand and gravel	(c) Gravel Gravel: coarse with fine, rare cobbles, granulites, igneous rock, red sand-stone Sand: medium with coarse and fine Fines: some clay in lumps, mottled grey-green	2.6	12.0
Old Red Sandstone	Sandy clay, slightly laminated, red, probably weathered	0.5+	12.5

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages							
						Sand			Gravel			
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)												
1	52	47	*0.0	1.0	trace	71	23	0	0	6	0
			*1.0	2.0	trace	65	29	0	0	6	0
			*2.0	3.0	0	6	5	1	15	67	6
			*3.0	4.0	trace	13	11	2	9	44	21
			*4.0	5.0	1	31	14	5	17	32	0
			*5.0	6.0	3	20	13	4	9	37	14
			*6.0	7.4	3	22	20	6	15	29	5
			Mean		1	32	17	3	10	31	6
(b)												
2	14	84	*7.4	8.4	2	6	7	3	10	14	58
			*8.4	9.4	1	4	5	2	7	21	60
			Mean		2	5	6	3	8	17	59
(c)												
1	32	67	*9.4	10.4	1	10	14	9	26	40	0
			*10.4	12.4	1	8	15	9	23	38	6
			Mean		1	9	14	9	24	39	4
(b + c)												
1	24	75	Mean		1	7	11	6	17	30	28
(a to c)												
1	40	59	Mean		1	22	14	4	13	31	15

NJ 36 SE 14 | 3749 6342 | Lower Auchenreath | Block E

Surface level +22.5 m (+74 ft)
Water struck at +18.0 m, +12.3 m and +8.0 m
250 and 200 mm percussion
January 1977

Overburden 0.5 m
Mineral I 4.1 m
Waste 3.4 m
Mineral II 11.5 m
Bedrock 0.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial sand and gravel	(a) Pebbly sand (coarsening downwards) Gravel: coarse with fine, rare cobbles below 3.5 m, coarse chiefly rounded to well rounded, fine subangular to rounded, granulites, quartzites and granite Sand: medium with fine and some coarse, 'soft' down to 3.5 m becoming 'sharp', orange-brown Fines: a little disseminated silt	4.1	4.6
Till	Sandy gravelly clay: stiff to hard, light to dark brown, subangular to rounded, coarse and fine gravel and cobbles, medium sand	3.4	8.0
	(b) 'Very clayey' sandy gravel Gravel: coarse and fine, subrounded to well rounded, granulites, quartzites and granite Sand: fine and medium with coarse, subrounded, yellow-brown becoming reddish brown Fines: clay	2.0	10.0
	(c) Gravel Gravel: coarse with fine, with some cobbles (up to 180 mm), subangular to well rounded, granulites, granite, cornstone and red sandstone towards base Sand: medium and coarse with fine, reddish brown Fines: a little disseminated silt, concentrated from 13.3 to 14.0 m and 18.0 to 19.5 m	9.5	19.5
Old Red Sandstone	Sandstone: bright red	0.5+	20.0

NJ 36 SE 14 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
1	83	16	0.5	1.5	trace	23	76	0	1	0	0
			1.5	2.5	2	13	78	3	3	1	0
			2.5	3.5	1	34	55	1	2	7	0
			*3.5	4.6	2	13	27	7	20	31	0
			Mean		1	21	59	3	6	10	0
(b)											
21	50	29	8.0	9.0	20	26	22	6	14	12	0
			9.0	10.0	21	23	18	6	13	19	0
			Mean		21	24	20	6	14	15	0
(c)											
3	31	66	*10.0	11.0	4	7	12	9	27	41	0
			11.0	12.0	2	6	12	11	28	41	0
			12.0	13.0	3	6	13	27	26	25	0
			13.0	14.0	7	9	13	12	26	24	9
			*14.0	15.0	4	7	14	10	24	41	0
			*15.0	16.0	3	4	13	9	25	36	10
			*16.0	17.0	1	1	3	8	34	46	7
			*17.0	18.0	2	5	10	7	21	28	27
			*18.0	19.0	3	11	19	9	22	19	17
			*19.0	19.5	5	12	21	11	17	20	14
			Mean		3	6	13	12	25	33	8
(b + c)											
6	35	59	Mean		6	10	14	11	22	29	8
(a to c)											
5	47	48	Mean		5	12	26	9	18	24	6

NJ 36 SE 15 | 3798 6215 | Wood of Auchenhalrig | Block E

Surface level +51.3 m (+168 ft)
Water struck at +48.3 m
250 mm percussion
January 1977

Overburden 0.3 m
Mineral II 3.8 m
Waste 1.4 m
Mineral II 4.5 m
Bedrock 1.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	(a) 'Very clayey' sandy gravel Gravel: coarse and fine with rare cobbles, subangular to well rounded, granulite, vein-quartz, red granite and weathered red sandstone Sand: fine with medium and some coarse, reddish brown Fines: deposit clay-bound and cohesive, fines increase with depth	3.8	4.1
	Pebbly sandy clay: stiff, pale green	1.4	5.5
	(b) 'Very clayey' sandy gravel Gravel: coarse and fine with rare cobbles, subangular to well rounded, granulite, vein-quartz, granite and red sandstone Sand: fine with medium and some coarse, reddish maroon Fines: deposit clay-bound and cohesive, fines increase with depth	4.5	10.0
Old Red Sandstone	Sandstone and marl, weathered, red	1.0+	11.0

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
27	48	25	0.3	2.3	27	27	17	4	11	14	0
			2.3	4.1	No grading data available						

(b)

Mineral category estimated

Surface level +61.3 m (+201 ft)
Groundwater level 57.3 m
250 mm diameter percussion
January 1977

Overburden 0.1 m
Mineral I 1.5 m
Mineral II 1.0 m
Waste 3.9 m
Mineral I 2.0 m
Bedrock 1.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Glacial sand and gravel	(a) Sand Sand: medium with fine and trace of coarse, subrounded, dark brown becoming lighter with depth Fines: some disseminated silt	1.5	1.6
Till	(b) 'Very clayey' sandy gravel Gravel: fine with coarse, rare cobbles, subrounded to well rounded, chiefly granulite with vein-quartz and granite Sand: fine with medium and some coarse, reddish brown Fines: deposit clay-bound, cohesive, fines increasing with depth	1.0	2.6
	Sandy clay: reddish brown with pebbles, cohesive	3.9	6.5
Glacial sand and gravel	(c) Gravel Gravel: coarse and fine with cobbles and rare boulders (up to 260 mm), subrounded to rounded, quartzite, granulites and vein-quartz Sand: coarse with medium and fine, subangular Fines: a little disseminated silt	2.0	8.5
Old Red Sandstone	Conglomerate: reddish maroon, weathered, mudstone, sandstone, andesite and schist pebbles set in a medium-grained micaceous sand	1.0+	9.5

NJ 36 SE 16 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-$\frac{1}{4}$	+$\frac{1}{4}$-1	+1-4	+4-16	+16-64	+64
(a)											
4	96	0	*0.1	1.6	4	31	64	1	0	0	0
(b)											
28	52	20	*1.6	2.6	28	28	18	6	12	8	0
(c)											
2	24	74	*6.5	7.5	1	1	3	16	34	33	12
			*7.5	8.5	2	2	4	22	28	32	10
			Mean		2	2	3	19	31	32	11
(a to c)											
8	54	38	Mean		8	17	27	10	17	16	5

NJ 36 SE 17 | 3727 6044 | Bracken Hillock | Block E

Surface level +89.2 m (+293 ft)
Groundwater level +79.2 m
250 and 200 mm percussion
February 1977

Overburden 0.2 m
Mineral I 4.3 m
Mineral II 1.0 m
Waste 1.8 m
Mineral II 2.7 m
Waste 9.5 m
Bedrock 0.8 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial sand and gravel	(a) Pebbly sand Gravel: coarse and fine, chiefly subrounded to well rounded with fine gravel more angular, granulites and quartzites with vein-quartz and granite Sand: medium and fine with rare coarse, 'sharp', orange-brown to 1.5 m, becoming yellowish brown Fines: disseminated silt	4.3	4.5
Till	(b) 'Clayey' pebbly sand Gravel: coarse with fine, rare cobbles, angular to rounded, granulites and quartzites with vein-quartz Sand: fine with some medium and rare coarse, brown Fines: deposit bound by clay, crumbly	1.0	5.5
	Pebbly sandy clay, stiff, red becoming yellowish brown	1.8	7.3
	(c) Pebbly sand Gravel: fine and coarse, angular to rounded, granulites, quartzites and vein-quartz with granite and sandstone Sand: medium with fine and rare coarse, fining upwards, yellowish brown Fines: deposit bound by clay above 8.4 m, firm. Disseminated silt below 8.4 m	2.7	10.0
	Gravelly sandy clay, stiff, reddish brown	9.5	19.5
Old Red Sandstone	Conglomerate, red, weathered becoming fresh by 20.3 m. Fine to coarse gravel of quartzites, vein-quartz, mica schist, acid igneous rocks, red sandstone and red shale. Sand, chiefly medium and micaceous	0.8+	20.3

NJ 36 SE 17 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
6	83	11	0.2	1.2	5	16	44	7	13	15	0
			1.2	2.2	4	66	27	1	1	1	0
			2.2	3.2	6	42	39	2	5	6	0
			3.2	4.5	7	27	58	1	3	4	0
			Mean		6	37	43	3	5	6	0
(b)											
29	51	20	4.5	5.5	29	38	10	3	7	13	0
(c)											
5	87	8	7.3	8.4	9	45	44	1	1	0	0
			8.4	10.0	3	22	57	5	8	5	0
			Mean		5	32	52	3	5	3	0
(b+c)											
12	76	12	Mean		12	33	40	3	6	6	0
(a to c)											
8	81	11	Mean		8	36	42	3	5	6	0

NJ 36 SE 18 | 3817 6400 | Porttannachy | Block A

Surface level +7.8 m (+26 ft)
Groundwater level +6.6 m
250 and 200 mm percussion
December 1976

Overburden 0.5 m
Mineral I 6.0 m
Waste 10.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Alluvium	(a) Gravel Gravel: coarse with fine and rare cobbles, coarse chiefly well rounded, fine angular, granulite, quartzite, vein-quartz and granite Sand: medium with coarse and fine, 'soft' down to 1.5 m becoming 'sharp', reddish brown becoming dark grey-brown below 5.5 m Fines: some disseminated silt with rare dark grey clayey 'nodules' below 3.5 m	6.0	6.5
	Silty clay: stiff to hard, rare pebbles, dark grey-brown, with thin red silty seams	8.6	15.1
Till	(b) Clayey gravel Gravel: coarse with fine, numerous cobbles, subrounded, granulite, quartzite, vein-quartz and granite Sand: fine with medium and some coarse, 'sharp' reddish grey Fines: deposit is clay-bound	1.9+	17.0
	Borehole abandoned owing to rock obstruction		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
3	29	68	0.5	1.5	11	33	33	4	7	12	0
			*1.5	2.5	trace	1	4	8	21	50	16
			*2.5	3.5	1	3	9	10	20	57	0
			*3.5	4.5	1	3	5	7	19	65	0
			*4.5	6.0	trace	1	10	8	19	62	0
			*6.0	6.5	17	10	23	14	14	22	0
			Mean		3	8	13	8	17	48	3
(b)†											
12	16	72	*15.1	17.0	12	8	5	3	11	25	36

† Non-mineral due to excessive overburden

NJ 36 SE 19 3888 6373 Mains of Tannachy, Portgordon Block E

Surface level +31.6 m (+104 ft)
Groundwater level +24.6 m
250 and 200 mm percussion
December 1976

Overburden 1.0 m
Mineral I 5.0 m
Mineral II 5.8 m
Bedrock 0.2 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil, sandy, dark brown	1.0	1.0
Glacial sand and gravel	(a) Sand Sand: medium with fine, 'soft', orange-brown to 2.0 m, becoming yellow-brown Fines: disseminated silt	3.0	4.0
	(b) Pebbly sand Gravel: coarse and fine with rare cobbles, chiefly well rounded granulites, quartzites and granite Sand: medium with fine and rare coarse, 'sharp', yellow-brown to 5.0 m, becoming orange-brown Fines: disseminated silt, increasing with depth	2.0	6.0
Till	'Very clayey' sandy gravel (non-mineral between 7.0 m and 7.9 m) Gravel: coarse and fine, chiefly well rounded granulites and quartzites with some decomposed red sandstone Sand: fine with medium and some coarse, generally 'sharp', reddish brown to 7.0 m, bright red to 11.0 m and brownish red to 11.8 m Fines: deposit is bound by clay. Very clayey and stiff between 7.0 m and 7.9 m	5.8	11.8
Old Red Sandstone	Sandstone, medium grained, red and micaceous	0.2+	12.0

NJ 36 SE 19 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
2	98	0	1.0	2.0	trace	27	73	0	0	0	0
			2.0	3.0	2	39	59	0	0	0	0
			3.0	4.0	3	27	70	0	0	0	0
			Mean		2	31	67	0	0	0	0
(b)											
9	80	11	4.0	5.0	6	33	52	3	3	3	0
			5.0	6.0	13	27	38	6	7	9	0
			Mean		9	30	45	5	5	6	0
(c)											
22	48	30	6.0	7.0	24	27	17	4	11	17	0
			*7.0	7.9	non-mineral						
			*7.9	11.0	24	24	19	6	12	15	0
			*11.0	11.8	15	18	18	7	18	24	0
			Mean		22	24	18	6	13	17	0
(a+b)											
5	91	4	Mean		5	31	58	2	2	2	0
(a to c)											
13	70	17	Mean		13	27	39	4	7	10	0

NJ 36 SE 20 3806 6304 Court Hillock, Upper Auchenreath Block E

Surface level +32.2 m (+106 ft)
Water struck at +24.2 m
250 and 200 percussion
February 1977

Overburden 0.6 m
Mineral I 3.8 m
Mineral II 5.6 m
Waste 2.0 m
Bedrock 0.3 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil: pebbly loam	0.6	0.6
Glacial sand and gravel	(a) Sandy gravel Gravel: coarse with fine, scattered cobbles below 1.5 m, subangular to well rounded, quartzites and granulites with some vein-quartz in fine gravel Sand: medium with fine and some coarse, 'soft', pale yellowish orange Fines: a little disseminated silt	3.8	4.4
Till	'Clayey' gravel Gravel: coarse with fine, frequent cobbles, chiefly subangular to well rounded, quartzites and granulites with vein-quartz. Pebbles of Old Red Sandstone towards base Sand: fine, medium and coarse, pale yellowish orange, becoming pinkish pale brown by 5.4 m and vivid reddish brown by 8.4 m Fines: deposit is clay-bound, crumbly to cohesive, becoming more compact below 5.4 m	5.6	10.0
	Gravelly sandy clay: stiff; vivid reddish brown, composition as deposit above	2.0	12.0
Old Red Sandstone	Fine to medium-grained, 'rotten' sandstone and siltstone, reddish brown	0.3+	12.3

NJ 36 SE 20 continued

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-$\frac{1}{4}$	+$\frac{1}{4}$-1	+1-4	+4-16	+16-64	+64
(a)											
4	61	35	0.6	1.6	1	9	47	5	8	30	0
			1.6	2.6	5	15	35	9	15	21	0
			2.6	3.6	4	40	28	5	8	15	0
			3.6	4.4	4	21	25	7	10	33	0
			Mean		4	21	34	6	10	25	0
(b)											
13	36	51	4.4	5.4	16	12	17	5	13	38	0
			5.4	6.4	1	3	5	12	33	46	0
			6.4	7.4	14	14	17	9	15	31	0
			7.4	8.4	13	14	14	11	16	32	0
			8.4	10.0	18	18	16	9	14	25	0
			Mean		13	13	14	9	18	33	0
(a+b)											
9	46	45	Mean		9	16	22	8	15	30	0

Surface level +64.7 m (+212 ft)
Groundwater level +56.7 m
250 and 200 mm percussion
January 1977

Overburden 0.5 m
Mineral I 14.6 m
Waste 2.9 m

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil, dark brown and stony	0.5	0.5
Glacial sand and gravel	(a) Gravel Gravel: fine and coarse, sporadic cobbles, angular to well rounded, chiefly quartzites, granulites and vein-quartz Sand: coarse with medium and fine, 'sharp' coarse grains, orange-brown Fines: much disseminated silt, deposit slightly cohesive. Thin seams (up to 50 mm) of grey silty sandy clay	4.5	5.0
	(b) Gravel Gravel: coarse and fine rare cobbles, chiefly angular to subrounded, red quartzites Sand: mainly coarse, with some medium and fine; very 'sharp' and chiefly 'chips' of red quartzite, scattered flakes of mica Fines: very little, some disseminated silt towards base	10.1	15.1
Till	Sandy gravelly clay: stiff to hard, reddish brown. Gravel mainly coarse with cobbles, of subangular to rounded vein-quartz, granulite and quartzite.	2.5	17.6
	Sand chiefly fine to medium, becoming dark grey to black, extremely tough and containing shell fragments	0.4+	18.0
	Borehole abandoned owing to rock obstruction		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
9	32	59	0.5	1.9	10	7	12	18	29	24	0
			1.9	2.9	10	9	11	14	32	24	0
			2.9	3.9	8	6	8	13	31	30	4
			3.9	5.0	9	5	8	15	33	30	0
			Mean		9	7	10	15	31	27	1
(b)											
1	21	78	*5.0	6.0	1	1	4	19	50	25	0
			*6.0	7.0	2	2	5	20	47	24	0
			*7.0	8.0	1	1	5	15	32	46	0
			*8.0	9.0	0	1	2	21	40	36	0
			*9.0	10.0	1	0	1	24	48	26	0
			*10.0	11.0	0	0	0	14	30	56	0
			*11.0	12.0	0	0	1	7	22	64	6
			*12.0	13.0	1	1	1	7	29	61	0
			*13.0	14.0	0	0	1	19	29	46	5
			*14.0	15.1	1	6	10	23	32	28	0
			Mean		1	1	3	17	36	41	1
(a+b)											
3	25	72	Mean		3	3	5	17	34	37	1

NJ 36 SE 22 3978 6379 Slackend, Portgordon Block E

Surface level +32.6 m (+107 ft)
Groundwater level +24.6 m
250 and 200 mm percussion
December 1976

Overburden 0.6 m
Mineral I 8.0 m
Mineral II 7.4 m
Mineral I 2.5 m
Bedrock 0.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Glacial sand and gravel	(a) Pebbly sand Gravel: present from 0.6 to 0.8 m, and 8.0 to 8.6 m. Coarse with fine, coarse gravel chiefly well rounded, fine gravel subrounded, granulites, quartzites, vein-quartz and granite Sand: fine with medium, subrounded to rounded, yellow-brown Fines: a little disseminated silt	8.0	8.6
Till	(b) 'Clayey' gravel Gravel: coarse with fine, frequent cobbles (up to 100 mm), well rounded, granulites, quartzites, vein-quartz and granite Sand: fine and medium, with coarse, subangular, red Fines: deposit clay-bound and cohesive	7.4	16.0
Glacial sand and gravel	(c) Gravel Gravel: coarse with fine, rare cobbles (up to 80 mm), coarse chiefly rounded, fine angular to subangular, granulites, vein-quartz and granite Sand: coarse and medium, with some fine, 'sharp', quartzose, red	2.5	18.5
Old Red Sandstone	Sandstone: medium grained, micaceous, red, with rare mudstone	0.5+	19.0

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
2	93	5	0.6	1.6	5	42	42	1	3	7	0
			1.6	2.6	1	73	26	0	0	0	0
			2.6	3.6	6	65	29	0	0	0	0
			3.6	4.6	2	68	28	0	0	2	0
			4.6	5.6	2	71	27	0	0	0	0
			5.6	6.6	2	51	47	0	0	0	0
			6.6	7.6	1	40	59	0	0	0	0
			*7.6	8.6	1	13	53	2	5	18	8
			Mean		2	53	39	1	1	3	1
(b)											
15	36	49	*8.6	10.6	19	22	17	5	9	8	20
			*10.6	13.6	11	12	10	5	11	26	25
			*13.6	16.0	18	16	15	9	19	23	0
			Mean		15	16	14	6	14	20	15
(c)											
1	38	61	*16.0	17.0	0	1	10	18	28	43	0
			*17.0	18.0	1	3	22	19	27	28	0
			Mean		1	2	17	19	27	34	0
(a to c)											
7	61	32	Mean		7	31	25	5	10	15	7

NJ 36 SE 23 | 3980 6256 | Glasterim, Broadley | Block E

Surface level +51.1 m (+168 ft)
Groundwater level +39.1 m
250 and 200 mm percussion
February 1977

Overburden 0.6 m
Mineral II 5.3 m
Waste 1.0 m
Mineral II 4.2 m
Waste 5.8 m
Bedrock 1.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Till	(a) 'Clayey' sandy gravel Gravel: coarse with fine, rare cobbles (up to 90 mm), sub-rounded to well rounded, fine tending to be more angular than the coarse, chiefly granulites, vein-quartz and quartzites Sand: fine with medium and some coarse, subrounded, brown becoming reddish brown below 3.9 m Fines: deposit clay-bound, slightly cohesive	5.3	5.9
	Sandy gravelly clay: reddish brown, slightly cohesive	1.0	6.9
	(b) 'Very clayey' sandy gravel Gravel: coarse with fine, rare cobbles (up to 120 mm), angular to well rounded, granulites, vein-quartz, quartzites and granite Sand: fine with medium and some coarse, subrounded, reddish brown Fines: deposit clay-bound, slightly cohesive	4.2	11.1
	Sandy gravelly clay: red, fines content increasing with depth, firm becoming stiff	5.8	16.9
Old Red Sandstone	Breccio-conglomerate: soft, decomposed, pebbles of red sandstone, cornstone, pelite, schist and andesite set in red sand matrix	1.0+	17.9

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
16	47	37	0.6	1.6	18	33	22	7	12	8	0
			1.6	2.6	12	26	16	5	9	8	24
			2.6	3.9	17	25	20	5	14	19	0
			3.9	4.9	11	13	16	8	17	35	0
			4.9	5.9	21	21	13	5	7	11	22
			Mean		16	24	17	6	12	16	9
(b)											
21	46	33	6.9	7.9	17	27	19	6	11	14	6
			7.9	8.9	28	25	14	4	9	20	0
			8.9	9.9	22	20	13	4	7	14	20
			9.9	11.1	17	24	20	7	14	18	0
			Mean		21	24	17	5	10	17	6
(a+b)											
18	46	36	Mean		18	24	17	5	11	17	8

NJ 36 SE 24 | 3903 6211 | Broadley Wood | Block E

Surface level +46.9 m (+154 ft)
Groundwater level +44.9 m
250 and 200 mm percussion
January 1977

Overburden 0.2 m
Mineral I 4.8 m
Mineral II 11.2 m
Bedrock 1.8 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial sand and gravel	(a) Sand Gravel: fine with coarse, coarse rounded to well rounded, fine subrounded to rounded, granulite, quartzite, vein-quartz and red granite Sand: medium with fine and a little coarse, subrounded to rounded, quartzose with some white mica, buff Fines: disseminated silt	4.8	5.0
Till	(b) 'Very clayey' pebbly sand Gravel: coarse and fine with cobbles, angular to rounded, granulite, quartzite, vein-quartz and granite Sand: fine with medium and some coarse, reddish with grey mottling Fines: clay, deposit stiff	11.2	16.2
Old Red Sandstone	Breccio-conglomerate: subangular to subrounded quartzite, decomposed schist, andesite and red sandstone clasts set in red, micaceous, medium-grained sand matrix	1.8+	18.0

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
3	95	2	0.2	1.2	6	45	44	2	2	1	0
			1.2	2.2	3	44	49	1	2	1	0
			*2.2	3.2	2	41	55	1	1	0	0
			*3.2	4.2	1	46	51	1	1	0	0
			*4.2	5.0	3	21	71	2	2	1	0
			Mean		3	40	54	1	2	trace	0
(b)											
33	53	14	*5.0	7.5	33	27	19	7	10	4	0
(a+b)											
24	65	11	Mean		24	31	29	5	8	3	0

NJ 36 SE 25 | 3933 6130 | Mains of Cuffurach, Broadley | Block E

Surface level +77.6 m (+255 ft)
Groundwater level +71.0 m
250 and 200 mm percussion
January 1977

Overburden 0.6 m
Mineral II 4.9 m
Mineral I 2.8 m
Bedrock 0.7 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Till	(a) 'Clayey' sandy gravel Gravel: coarse with fine, rare cobbles (up to 100 mm), coarse chiefly rounded to well rounded, fine subangular to rounded, granulites, vein-quartz, quartzites, pink granite, decomposed red sandstone and amphibolite schist Sand: medium and fine with coarse, rounded, orange-brown Fines: much disseminated silt	4.9	5.5
Glacial sand and gravel	Gravel Gravel: coarse and fine, rare cobbles (up to 120 mm), coarse chiefly rounded to well rounded, fine angular to subrounded, quartzites, granulites, vein-quartz, pink granite and yellow sandstone, cobbles up to 170 mm at 8.2 m Sand: coarse with medium and some fine, coarse angular, fine, 'soft', some mica, orange-brown Fines: some disseminated silt	2.8	8.3
Old Red Sandstone	Breccio-conglomerate: subrounded to angular pebbles of andesite, cornstone(?), red sandstone and metasediments in a medium-grained, micaceous, red sand matrix	0.7+	9.0

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
14	51	35	0.6	1.6	9	16	18	10	16	31	0
			1.6	2.6	10	16	18	7	14	35	0
			2.6	3.5	15	21	19	9	18	18	0
			3.5	4.5	21	23	24	9	11	12	0
			4.5	5.5	15	27	30	9	10	9	0
			Mean		14	20	22	9	14	21	0
(b)											
4	42	54	*5.5	6.5	2	6	24	15	26	27	0
			*6.5	7.5	3	4	11	25	23	34	0
			*7.5	8.3	7	8	17	17	16	12	23
			Mean		4	6	17	19	22	25	7
(a+b)											
10	48	42	Mean		10	15	20	13	17	22	3

Surface level +66.7 m (+219 ft)
Groundwater level +62.7 m
250 and 200 mm percussion
January 1977

Overburden 0.9 m
Mineral I 9.2 m
Waste 6.3 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.9	0.9
Alluvium	(a) Pebbly sand Gravel: fine with coarse, rare cobbles (up to 80 mm), coarse chiefly rounded to well rounded, fine subrounded to rounded, granulites, vein-quartz and quartzites Sand: medium, with coarse and fine, subangular, reddish brown Fines: clay	2.3	3.2
Glacial sand and gravel	(b) 'Clayey' gravel Gravel: coarse with fine, rare cobbles (up to 90 mm), subrounded to well rounded, granulites and vein-quartz Sand: medium and fine with coarse, subrounded, medium grey Fines: disseminated silt	2.0	5.2
	(c) Gravel Gravel: coarse and fine, rare cobbles, coarse chiefly well rounded, fine subangular to subrounded, granulites, vein-quartz, quartzites and pink granite Sand: coarse with medium and fine, coarse subangular, medium subrounded, greenish medium grey and micaceous to 6.6 m, becoming reddish brown Fines: some disseminated silt	3.1	8.3
	(d) Sandy gravel Gravel: fine with coarse (up to 40 mm), subrounded to well rounded, granite, granulites and vein-quartz Sand: medium and fine with coarse, subrounded, red, some mica Fines: disseminated silt, thin red silt band at 8.9 m	1.8	10.1
	Silt: laminated, red and yellow to 10.3 m, red and black below, laminae 1 to 15 mm thick, some fine sand	1.8	11.9
Till	Pebbly clay: very hard, dark grey with clasts of metasediments, red sandstone, cornstone, black shale and shell fragments	4.5+	16.4
	Borehole abandoned owing to rock obstruction		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
9	71	20	0.9	1.9	9	10	38	16	16	11	0
			1.9	3.2	8	12	47	18	12	3	0
			Mean		9	11	43	17	14	6	0
(b)											
17	38	45	3.2	4.2	18	14	15	11	19	23	0
			4.2	5.2	16	14	12	9	18	31	0
			Mean		17	14	14	10	18	27	0
(c)											
5	30	65	*5.2	6.2	4	6	10	15	23	30	12
			*6.2	7.2	7	11	9	13	28	24	8
			*7.2	8.3	5	7	6	13	35	34	0
			Mean		5	8	8	14	29	29	7
(d)											
5	65	30	*8.3	9.3	4	24	27	13	26	6	0
			*9.3	10.1	5	25	27	15	22	6	0
			Mean		5	24	27	14	24	6	0
(a to d)											
8	50	42	Mean		8	14	22	14	22	18	2

NJ 36 SE 27 3690 6422 Nether Dallachy Pit Section Block A

Surface level c +10 m (c +33 ft) Mineral I 4.7 m+
Section dry
Sampled by hand
August 1977

LOG

Geological Classification	Lithology	Thickness m	Depth m
Raised beach deposits	(a) Gravel (displaying imbrication) Gravel: coarse and cobbles, well rounded Sand: fine with medium Fines: a little disseminated silt, some peat	0.9	0.9
	(b) Gravel Gravel: coarse with fine, numerous cobbles, chiefly well rounded Sand: medium with coarse and fine, subrounded, orange-brown Fines: some disseminated silt	3.8+	4.7
	Base of section		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
1	8	91	0.0	9.0	1	5	3	trace		51	40
(b)											
2	24	74	0.9	1.9	6	5	11	3	13	42	20
			1.9	2.9	2	4	18	3	16	53	4
			2.9	4.7	1	3	14	8	20	14	40
			Mean		2	4	14	6	17	32	25
(a + b)											
2	20	78	Mean		2	4	12	4	14	36	28

NJ 36 SE 28 | 3818 6354 | Burn of Tynet Section | Block E

Surface level c +26 m (c +86 ft)
Section dry
Sampled by hand
August 1977

Overburden 0.5 m
Mineral I 5.2 m
Mineral II 8.9 m

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial sand and gravel	(a) Pebbly sand (exhibiting cross bedding between 4.5 m and 5.7 m) Gravel: fine and coarse, chiefly sub-rounded to well rounded, becoming rarer with depth, mainly as stringers Sand: medium with fine and some coarse, rounded, mid-brown-grey to 1.1 m becoming orange-brown with some reddish brown colour banding Fines: some disseminated silt	5.2	5.7
Till	'Very clayey' sandy gravel Gravel: coarse with fine, with some cobbles, subrounded to well rounded Sand: fine with medium and some coarse, reddish brown Fines: clay, increasing with depth	8.9+	14.6
	Base of section		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
3	91	6	0.5	1.5	3	23	61	3	5	5	0
			1.5	2.5	2	6	68	10	8	6	0
			2.5	3.5	1	6	84	7	2	0	0
			3.5	4.5	11	19	65	3	1	1	0
			4.5	5.7	1	15	82	1	1	0	0
			Mean		3	14	72	5	3	3	0
(b)											
23	45	32	5.7	6.7	17	22	14	3	8	22	14
			6.7	7.7	16	23	11	4	10	16	20
			7.7	9.2	19	29	17	5	13	17	0
			9.2	10.7	24	26	17	4	9	20	0
			10.7	12.5	28	27	16	4	9	16	0
			12.5	14.6	25	23	18	5	11	18	0
			Mean		23	25	16	4	10	18	4
(a + b)											
15	63	22	Mean		15	21	37	5	8	12	2

Surface level c +64 m (c +210 ft)
Section dry
Sampled by hand
August 1977

Overburden 0.1 m
Mineral I 4.3 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Glacial sand and gravel	Sand (cross bedding below 3.1 m) Gravel: to 0.5 m, rare, fine Sand: fine with medium and trace of coarse, 'soft', micaceous, orange-brown to light yellow-grey Fines: some disseminated silt, thin silt seams at 0.5 and 0.7 m	4.3+	4.4
	Base of section		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
4	96	0	0.1	1.1	10	72	17	1	trace	0	0
			1.1	2.1	1	90	9	trace	0	0	0
			2.1	3.1	2	91	7	trace	0	0	0
			3.1	4.4	3	91	6	0	0	0	0
			Mean		4	86	10	0	0	0	0

Industrial Minerals Assessment Unit Shallow Pit Records

NJ 36 SW P1 | 3016 6344 | Maverston | Block B

Surface level +29.5 m (+97 ft)
Water not struck
Pit
August 1977

Overburden 0.3 m
Mineral I 2.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	(a) Sand Gravel: in a stringer at 0.8 m, rare coarse and fine, well rounded Sand: fine with medium, 'soft', orange-brown Fines: some disseminated silt	0.5	0.8
	(b) 'Clayey' sand Gravel: traces of fine Sand: fine with some medium, 'soft', beige with orange banding Fines: disseminated silt and thin silty seams	1.5+	2.3
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand				Gravel	
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
5	93	2	0.3	0.8	5	63	30	trace	1	1	0
(b)											
16	84	0	0.8	2.3	16	75	9	trace	trace	0	0
(a + b)											
13	87	0	Mean		13	72	15	trace	trace	trace	0

NJ 36 SW P2 | 3041 6239 | Muir of Lochs | Block B

Surface level +26.6 m (+87 ft)
Water not struck
Pit
August 1977

Overburden 0.4 m
Mineral I/II 1.5 m
Waste 0.2 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	The pit cuts across a vertical contact between sandy till and sand and gravel		
	Soil	0.4	0.4
Till	'Very clayey' sandy gravel Gravel: till; coarse and fine, subangular to well rounded granulites, schist and sandstone, weathered. Sand and gravel; rare coarse, well rounded Sand: fine with medium and some coarse, till mottled reddish orange-brown becoming grey below 0.7 m; sand and gravel yellow-brown Fines: till; clay. Sand and gravel, a little disseminated silt	1.5	1.9
	Pebbly clay: medium grey, sticky clay with scattered pebbles	0.2+	2.1
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand				Gravel	
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
20	58	22	0.4	1.9	20	33	21	4	11	11	0

NJ 36 SW P3 | 3081 6248 | Wester Lochs | Block B

Surface level c +26 m (c 85 ft)
Water not struck
Pit
August 1977

Overburden 0.3 m
Mineral II 1.7 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	'Clayey' sandy gravel Gravel: coarse with fine with rare cobbles (up to 90 mm), subrounded to well rounded Sand: fine with medium and some coarse, orange-brown to 0.6 m, becoming medium brown-grey and mottled to 1.0 m and pale grey-brown below Fines: deposit clay-bound, quite hard	1.7+	2.0
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
17	56	27	0.3	2.0	17	31	20	5	12	15	0

NJ 36 SW P4 3019 6226 Muir of Lochs Block B

Surface level +27.3 m (+89 ft)
Water not struck
Pit
August 1977

Overburden 0.1 m
Mineral I 0.2 m
Mineral II 1.2 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.1	0.1
Blown sand	Sand: fine to medium, pale grey, containing roots	0.2	0.3
Till	'Very clayey' pebbly sand Gravel: coarse with fine with rare cobbles, subrounded to well rounded Sand: fine with medium and rare coarse, orange-brown to grey, mottled Fines: clay, deposit hard, weathered to 0.5 m	1.2+	1.5
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand				Gravel	
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
25	60	15	0.3	1.5	25	32	23	5	5	10	0

NJ 36 SW P5 | 3285 6470 | Corskie | Block B

Surface level +15.8 m (+52 ft)
Water not struck
Pit
August 1977

Overburden 0.5 m
Mineral I 1.6 m
Waste 0.3 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial sand and gravel	Sand (iron-pan between 0.5 m and 0.8 m) Gravel: very rare, coarse, well rounded Sand: fine with some medium, 'soft', orange-brown, becoming yellow-brown Fines: a little disseminated silt	1.6	2.1
Till	Sandy gravelly clay: cohesive, with subangular to well rounded coarse and fine gravel, with some cobbles and chiefly fine sand	0.3+	2.4
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
3	96	1	0.5	1.5	3	92	3	0	trace	2	0
			1.5	2.1	2	71	27	0	0	0	0
			Mean		3	84	12	0	0	1	0

NJ 36 SW P6 | 3218 6402 | Corskie | Block B

Surface level +15.3 m (+50 ft)
Water not struck
Pit
August 1977

Overburden 0.4 m
Mineral I 0.8 m
Waste 1.2 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Lake alluvium	Pebbly sand Gravel: fine with coarse (up to 30 mm), well rounded Sand: medium and fine with trace of coarse, rounded, yellow-brown to 0.8 m, becoming dark brown and containing humus and roots Fines: a little disseminated silt	0.8	1.2
Till	Pebbly sandy clay: soft, very cohesive, blue-grey clay with some coarse and fine gravel, rare cobbles and fine sand	1.2+	2.4
	Base of pit		

GRADING

Mean for Deposit			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
2	93	5	0.4	1.2	2	43	49	1	3	2	0

NJ 36 SW P7 3334 6478 Smithfield Block B

Surface level +12.3 m (+40 ft)
Water not struck
Pit
August 1977

Waste 1.9 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.9	0.9
Glacial sand and gravel	Sand: fine with medium with rare fine gravel, cemented into an iron-pan	0.4	1.3
Till	Pebbly sandy clay: soft, tenacious, pale grey clay with subrounded to well rounded, coarse and fine gravel, fine sand, and containing roots	0.6+	1.9
	Base of pit		

NJ 36 SW P8 3353 6457 Smithfield Block B

Surface level +15.0 m (+49 ft)
Water struck at +13.3 m
Pit
August 1977

Overburden 0.3 m
Mineral I 1.4 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	Sand (iron-pan between 0.3 and 0.6 m) Gravel: fine with rare coarse, sub-angular to well rounded Sand: medium with some fine and coarse, subrounded to rounded, quartzose, orange-brown Fines: a little disseminated silt	1.4+	1.7
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
1	96	3	0.3	1.7	1	12	78	6	3	0	0

NJ 36 SW P9 | 3314 6379 | Upper Ashfield | Block B

Surface level +21.3 m (+70 ft)
Water not struck
Pit
August 1977

Overburden 0.4 m
Mineral I 0.8 m
Mineral II 0.7 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial sand and gravel	(a) Pebbly sand Gravel: mainly towards base of deposit, coarse and fine with rare cobbles, rounded to well rounded Sand: medium and fine with rare coarse, subangular to rounded, quartzose, beige Fines: disseminated silt	0.8	1.2
Till	(b) 'Very clayey' pebbly sand Gravel: coarse and fine with some cobbles, subangular to well rounded Sand: fine with medium and rare coarse, mottled, pinkish medium grey-brown Fines: clay, making deposit cohesive	0.7+	1.9
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand				Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
9	75	16	0.4	1.2	9	33	38	4	7	9	0
(b)											
25	62	13	1.2	1.9	25	38	19	5	6	7	0
(a + b)											
17	69	14	Mean		17	35	29	5	6	8	0

NJ 36 SW P10 3483 6393 Spey Viaduct Block D

Surface level +5.7 m (+19 ft)
Water struck at +4.8 m
Pit
August 1977

Mineral I 1.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
Alluvium	Gravel Gravel: coarse and fine with numerous cobbles (up to 120 mm), chiefly well rounded Sand: medium and coarse with some fine, 'sharp', medium brown Fines: a little disseminated silt	1.0+	1.0
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-$\frac{1}{4}$	+$\frac{1}{4}$-1	+1-4	+4-16	+16-64	+64
1	31	68	0	1.0	1	2	16	13	28	33	7

NJ 36 SW P11 3493 6214 By River Spey, west of Byres Block D

Surface level +11.7 m (+38 ft)
Water struck at +9.9 m
Pit
August 1977

Overburden 0.2 m
Mineral I 1.9 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Alluvium	(a) 'Clayey' gravel Gravel: coarse with fine with numerous cobbles, rounded to well rounded Sand: fine with medium and some coarse, 'soft', medium brown Fines: much disseminated silt, with humus	0.4	0.6
	(b) Gravel Gravel: coarse with fine with numerous cobbles and boulders (up to 260 mm) subrounded to well rounded, fine gravel tending to be more angular than coarse Sand: medium with coarse and some fine, subangular to subrounded, medium brown, black staining between 1.0 and 1.2 m Fines: a little disseminated silt, decreasing with depth	1.5+	2.1
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand				Gravel	
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
19	26	55	0.2	0.6	19	16	7	3	8	14	33
(b)											
3	26	71	0.6	1.6	4	6	13	10	16	37	14
			1.6	2.1	1	2	12	9	24	41	11
			Mean		3	5	12	9	19	39	13
(a + b)											
7	26	27	Mean		7	7	11	8	16	34	17

NJ 36 SE P1 3533 6232 Byres Block D

Surface level +10.7 m(+35 ft)
Water struck at +9.0 m
Pit
August 1977

Overburden 0.5 m
Mineral I 1.5 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Alluvium	(a) Sand Sand: medium and fine with traces of coarse, subrounded to rounded, yellow-brown Fines: disseminated silt, common above 0.9 m	0.7	1.2
	(b) Gravel Gravel: coarse with fine and numerous cobbles and boulders (up to 330 mm), chiefly rounded to well rounded Sand: medium with coarse and fine, subrounded, medium brown Fines: a little disseminated silt	0.8+	2.0
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
8	92	0	0.5	1.2	8	44	47	1	0	0	0
(b)											
1	23	76	1.2	2.0	1	4	13	6	13	32	31
(a + b)											
4	54	42	Mean		4	22	29	3	7	17	18

NJ 36 SE P2 3652 6249 Reservoir, Upper Dallachy Block E

Surface level +32.6 m(+107 ft)
Water not struck
Pit
August 1977

Overburden 0.3 m
Mineral II 0.8 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	'Clayey' gravel (iron-pan between 0.3 m and 0.6 m) Gravel: coarse with fine with numerous cobbles, chiefly rounded to well rounded Sand: fine with medium and some coarse, yellow-orange-brown Fines: clay, deposit hard and compact	0.8+	1.1
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-$\frac{1}{4}$	+$\frac{1}{4}$-1	+1-4	+4-16	+16-64	+64
13	32	54	0.3	1.1	13	17	11	4	10	27	18

NJ 36 SE P3 3666 6191 Auchenhalrig Block E

Surface level +45.6 m (+150 ft)
Water not struck
Pit
August 1977

Overburden 0.4 m
Mineral II 1.1 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Till	'Clayey' sandy gravel Gravel: coarse with fine, with cobbles, subrounded to well rounded Sand: fine with medium and some coarse, subangular to subrounded, orange-brown to 0.7 m, reddening with depth Fines: clay, deposit slightly cohesive and weathered to 0.7 m, becoming hard	1.1+	1.5
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
18	41	41	0.4	1.5	18	20	16	5	11	24	6

NJ 36 SE P4 3613 6177 Romancamp Gate Block E

Surface level +28.2 m (+92 ft)
Water struck at +26.3 m
Pit
August 1977

Overburden 0.5 m
Mineral I 1.6+ m

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial sand and gravel	(a) Sand Gravel: rare fine, chiefly well rounded Sand: medium and fine, 'soft', with some mica, orange-brown becoming yellow with depth Fines: a little disseminated silt	1.0	1.5
	(b) Gravel Gravel: coarse with fine, with cobbles, chiefly well rounded Sand: medium with fine and coarse, subrounded, medium to dark brown Fines: a little disseminated silt	0.6+	2.1
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand				Gravel	
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
(a)											
2	97	1	0.5	1.5	2	45	52	0	1	0	0
(b)											
1	48	51	1.5	2.1	1	10	31	7	15	36	0
(a + b)											
2	79	19	Mean		2	32	44	3	6	13	0

NJ 36 SE P5 | 3616 6117 | North-east of Den Farm | Block E

Surface level +36.0 m (+118 ft)
Water not struck
Pit
August 1977

Overburden 0.6 m
Mineral II 1.0 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Till	'Clayey' sandy gravel Gravel: coarse with fine, with some cobbles, chiefly rounded to well rounded Sand: fine with medium and some coarse, mottled reddish orange-brown to grey, and grey-brown between 1.0 and 1.1 m Fines: clay, making deposit cohesive from 0.6 to 1.0 m and 1.1 to 1.6 m. Deposit is well sorted between 1.0 m and 1.1 m, with a little disseminated silt	1.0+	1.6
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
17	54	29	0.6	1.6	17	31	18	5	11	18	0

NJ 36 SE P6 | 3741 6399 | Lower Auchenreath | Block E

Surface level +20.4 m (+67 ft)
Water not struck
Pit
August 1977

Overburden 0.3 m
Mineral I 0.6 m
Waste 0.9 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	Sandy gravel Gravel: coarse with fine with rare cobbles, chiefly well rounded Sand: medium with fine and some coarse, 'soft', mid-brown Fines: some disseminated silt	0.6	0.9
Till	Sandy, gravelly clay: hard, mottled grey-green to reddish orange-brown, coarse and fine gravel with cobbles and boulders, fine with medium and coarse sand	0.9+	1.8
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand				Gravel	
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
4	65	31	0.3	0.9	4	20	40	5	9	16	6

NJ 36 SE P7 3701 6350 Airfield, Nether Dallachy Block A_2

Surface level +10.6 m (+35 ft)
Water not struck
Pit
August 1977

Overburden 0.2 m
Mineral I 2.2 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Raised beach deposits	Sandy gravel Gravel: rare below 1.6 m, coarse with fine with some cobbles, chiefly rounded to well rounded Sand: medium with fine and some coarse, 'soft', orange-brown to 0.6 m, dark grey to 0.7 m, dark brown to 1.3 m, becoming beige Fines: some disseminated silt, especially between 0.6 and 0.7 m, thin silty seams below 1.2 m	2.2+	2.4
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
3	51	46	0.2	1.2	4	11	15	6	15	41	8
			1.2	2.4	3	29	33	5	15	15	0
			Mean		3	21	25	5	15	27	4

NJ 36 SE P8 3753 6288 Wood of Auchenreath Block E

Surface level +29.3 m (+96 ft)
Water not struck
Pit
August 1977

Overburden 0.4 m
Mineral II 1.1 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Made ground	0.4	0.4
Till	'Very clayey' sandy gravel Gravel: coarse with fine with cobbles, chiefly subrounded to well rounded Sand: fine with medium and some coarse, subrounded, mottled, pinkish to yellow-grey Fines: clay, making deposit cohesive and hard	1.1+	1.5
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
21	41	38	0.4	1.5	21	22	14	5	16	22	0

NJ 36 SE P9 3719 6093 Ordiga Block E

Surface level +63.0 m (+207 ft)
Water struck at +61.4 m
Pit
August 1977

Overburden 0.5 m
Mineral I 1.1 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial sand and gravel	Gravel (iron-pan between 0.7 m and 0.8 m) Gravel: coarse with fine with cobbles, chiefly rounded to well rounded Sand: medium and fine with coarse, orange-brown to 0.7 m, dark brown to 0.8 m, becoming medium brown, with some mica Fines: a little disseminated silt	1.1+	1.6
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand				Gravel	
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
2	39	59	0.5	1.6	2	16	16	7	18	32	9

NJ 36 SE P10 3767 6065 Tulloch Cottage Block E

Surface level +66.3 m (+218 ft)
Water not struck
Pit
August 1977

Waste 0.8 m
Bedrock 1.2 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Glacial sand and gravel	Silty sand: yellow-brown to orange-brown, laminated fine sand and silt, with cobbles at base	0.6	0.8
Middle Old Red Sandstone	Conglomerate, becoming less gravelly with depth Gravel: coarse and fine, some cobbles, quartzites and weathered red sandstone Sand: medium with coarse and fine, reddish maroon, micaceous Fines: some silt and clay	1.2+	2.0
	Base of pit		

NJ 36 SE P11 3881 6289 Windsoer Block E

Surface level c +30 m (c +98 ft)
Water not struck
Pit
August 1977

Overburden 0.5 m
Mineral II 0.7 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Till	'Very clayey' sandy gravel Gravel: fine and coarse with some cobbles, chiefly rounded to well rounded Sand: fine with medium and some coarse, reddish brown to yellow Fines: clay, making deposit hard and cohesive	0.7+	1.2
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
28	52	20	0.5	1.2	28	29	17	6	11	9	0

NJ 36 SE P12 3870 6153 North-west of Cuffurach Block E

Surface level +59.3 m (+195 ft)
Water not struck
Pit
August 1977

Overburden 0.4 m
Mineral I 0.4 m
Mineral II 0.8 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Blown sand	Sand Gravel: rare, coarse and fine, chiefly well rounded Sand: fine and medium, sub-angular to subrounded, medium grey Fines: trace	0.4	0.8
Till	'Very clayey' sandy gravel Gravel: fine and coarse (up to 35 mm), rounded to well rounded Sand: fine with medium and some coarse, mottled, reddish to pale grey Fines: clay, making deposit hard and cohesive	0.8+	1.6
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand				Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
28	52	20	0.8	1.6	28	28	18	6	12	8	0

NJ 36 SE P13 3871 6085 Burnside House Block E

Surface level +52.4 m (+172 ft)
Water struck at +50.2 m
Pit
August 1977

Overburden 1.6 m
Mineral II 0.6 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Alluvium	Silt: reddish yellow-brown, some lamination	1.1	1.5
	Pebbly clay: dark grey, tenacious, with rare pebbles (up to 30 mm) and wood fragments	0.1	1.6
Till	'Clayey' sandy gravel Gravel: coarse and fine with rare cobbles, chiefly subrounded to well rounded Sand: fine with medium and coarse, subrounded orange-brown Fines: disseminated silt and clay	0.6+	2.2
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
12	44	44	1.6	2.2	12	19	15	10	21	23	0

NJ 36 SE P14 | 3879 6004 | Chapelford | Block E

Surface level +70.0 m (+230 ft)
Water not struck
Pit
August 1977

Waste 2.2 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Glacial sand and gravel	Sand Sand: fine with medium and some coarse, 'soft', orange-brown to red Fines: some disseminated silt	0.6	1.0
	Silt: pale grey, micaceous, with small lenses of sand (as above)	0.2	1.2
	Sand Sand: fine with medium and some coarse, 'soft', orange-brown to red Fines: some disseminated silt	0.2	1.4
	Silt: pale grey, micaceous, exhibiting some lamination	0.8+	2.2
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
4	96	0	0.4	1.0	4	63	25	8	0	0	0

NJ 36 SE P15 3949 6339 Parkside Block E

Surface level +31.9 m (+105 ft)
Water not struck
Pit
August 1977

Overburden 0.5 m
Mineral I 1.6 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Glacial sand and gravel	Sand (iron-pan between 0.5 m and 0.8 m) Gravel: rare, fine and coarse (up to 25 mm) well rounded Sand: fine with medium and traces of coarse, rounded, quartzose, orange-brown to 0.8 m becoming yellow-brown Fines: a little disseminated silt	1.6+	2.1
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
						Sand			Gravel		
Fines	Sand	Gravel	From	To	Fines -1/16	+1/16-$\frac{1}{4}$	+$\frac{1}{4}$-1	+1-4	+4-16	+16-64	+64
2	97	1	0.5	1.5	2	64	31	1	1	1	0
			1.5	2.1	3	77	20	0	0	0	0
			Mean		2	69	27	1	1	0	0

NJ 36 SE P16 3993 6144 Kirkland Block E

Surface level +62.0 m (+203 ft)
Water struck at +60.1 m
Pit
August 1977

Waste 1.9 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Alluvium	Silty sand: reddish brown, laminated, fine with some medium sand and disseminated silt	0.3	0.6
	Peat containing fragments of wood	0.1	0.7
	Silty sand: orange-grey to brown, with rare pebbles (up to 20 mm), fine with medium sand and disseminated silt	0.2	0.9
	Silt: tenacious, medium to dark grey, laminated, with thin seams of fine sand. Roots run vertically through deposit	1.0+	1.9
	Base of pit		

NJ 36 SE P17 3934 6142 Mains of Cuffurach Block E

Surface level c +77 m (c +253 ft)
Water not struck
Pit
August 1977

Overburden 0.3 m
Mineral II 0.8 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	'Very clayey' sandy gravel Gravel: coarse with fine, with rare cobbles, rounded to well rounded Sand: fine with medium and some coarse, reddish brown Fines: clay, making deposit cohesive	0.8+	1.1
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-$\frac{1}{4}$	+$\frac{1}{4}$-1	+1-4	+4-16	+16-64	+64
31	45	24	0.3	1.1	31	26	14	5	9	15	0

NJ 36 SE P18 3937 6130 Mains of Cuffurach Block E

Surface level c +77 m (c +253 ft)
Water not struck
Pit
August 1977

Overburden 0.5 m
Mineral II 0.9 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Till	'Clayey' sandy gravel Gravel: coarse and fine, with some cobbles (up to 110 mm), chiefly rounded to well rounded Sand: medium with fine and coarse, rounded, reddish brown Fines: clay, deposit becoming hard with depth	0.9+	1.4
	Base of pit		

GRADING

Mean for Deposit Percentages			Depth below surface (m)		Bulk Samples Percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	From	To	-1/16	+1/16-¼	+¼-1	+1-4	+4-16	+16-64	+64
14	57	29	0.5	1.4	14	19	25	13	11	13	5

NJ 36 SE P19 3986 6063 Burnside of Enzie Block E

Surface level +65.3 m (+214 ft)
Water not struck
Pit
August 1977

Waste 2.1 m+

LOG

Geological Classification	Lithology	Thickness m	Depth m
	Soil	1.0	1.0
Alluvium	Sandy silt: medium brown-grey with fine sand and rare pebbles of vein-quartz	0.4	1.4
	Peat, dark brown	0.3	1.7
	Silty fine sand, cohesive, light to medium grey	0.4+	2.1
	Base of pit		

APPENDIX G: LIST OF WORKINGS

In March 1978 two sand and gravel pits were operational on a small scale; pits at other localities were known to be worked intermittently A list of the active and the more extensive disused workings is given below.

Location	Grid references	Deposit worked
Active		
Nether Dallachy	362 642	Raised beach deposits
Nether Dallachy	3690 6422	Raised beach deposits
Tomyrone, near Kingston	3189 6549	Glacial sand and gravel
Wellheads	3845 6043	Glacial sand and gravel
Disused		
Kingston	326 659	Storm beach deposits
Castle Hill	3153 6027	Glacial sand and gravel
Nether Dallachy	364 641	Raised beach deposits

APPENDIX H: CONVERSION TABLE, METRES TO FEET (TO NEAREST 0.5 FT)

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

REFERENCES

ALLEN, V.T. 1936. Terminology of medium-grained sediments. Rep. Natl Res. Counc. Washington, 1935-1936. App. 1, Rep. Comm. Sedimentation, pp. 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., Vol. 2, Mining and Petroleum Geology. (London: The Institute of Mining and Metallurgy), pp. 495–508.

—— 1970a. Standardisation of the size classification of naturally occurring particles. Géotechnique, Vol. 20, pp. 103–207.

—— 1970b. Making the most of metrication. Quarry Mgr's J., Vol. 54, pp. 223-227.

ATTERBERG, A. 1905. Die Rationelle Klassifikation der Sande und Kiese. Chem. Z., Vol. 29, pp. 195–198.

BRITISH STANDARD. 1975. Methods for sampling and testing of mineral aggregates, sands and fillers. Br. Stand., No. BS 812, 104 pp.

—— 1975. Methods of testing soils for civil engineering purposes. Br. Stand., No. BS 1377, 143 pp.

BUILDING RESEARCH STATION. 1963. Shrinkage of natural aggregates in concrete. Digest 35, 7 pp.

BUREAU OF MINES AND GEOLOGICAL SURVEY. 1948. Mineral Resources of the United States. (Washington, D.C.: Public Affairs Press), pp. 14–17.

EDWARDS, A.G. 1970. Scottish Aggregates: their suitability for concrete with regard to rock constituents. Current paper 28/70, Building Research Station.

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

LANE, E.W. and others. 1947. Report on the sub-committee on sediment terminology. Trans. Am. Geophys. Union, Vol. 23, pp. 936–938.

PEACOCK, J.D., BERRIDGE, N.G., HARRIS, A.L. and MAY, F. 1968. The geology of the Elgin District. Mem. Geol. Surv. G.B. (Edinburgh: Her Majesty's Stationery Office).

PETTIJOHN, F.J. 1957. Sedimentary Rocks (2nd Ed.) (London: Harper and Row).

TAYLOR, W. 1900. New localities for Upper Old Red Sandstone in the Moray Firth area. Trans. Inverness Scient. Soc. Fld. Club, Vol. 6, pp. 46–8.

THURRELL, R.G. 1971. The assessment of mineral resources with particular reference to sand and gravel. Quarry Mgr's J., Vol. 55, pp. 19–25.

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

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

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

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

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

Dd. 595772 K8

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

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 £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 990614 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 sheets 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 sheets 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: Parts of resource sheets 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. Resource sheets 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. Resource sheet SK 89.
J. 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: Resource sheets 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 sheets SU 49, 59 and 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, and parts of SU 84, 94, 95, 96. M. R. Clarke, A. J. Dixon.
ISBN 0 11 8840851 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 £4.75

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

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 of 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 884025 8 £1.20

78/1 Sand and gravel resources 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

41

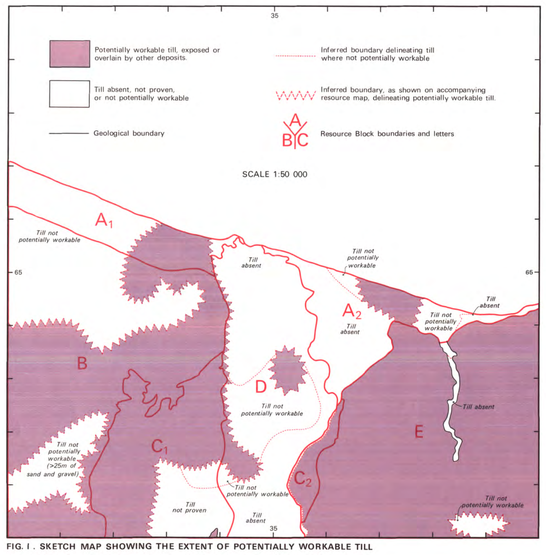


FIG. I . SKETCH MAP SHOWING THE EXTENT OF POTENTIALLY WORKABLE TILL

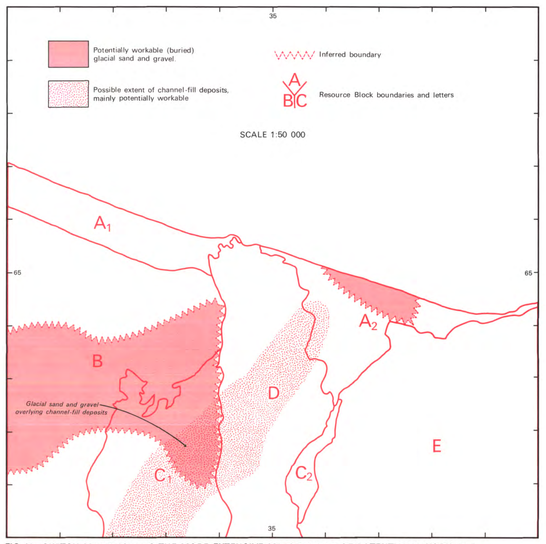


FIG. II . SKETCH MAP SHOWING THE MORE EXTENSIVE MAJOR AREAS OF POTENTIALLY WORKABLE SAND AND GRAVEL LARGELY CONCEALED BY TILL. In addition boreholes SW 11, SE 5, SE 16, SE 22 and SE 25 prove potentially workable sand and gravel beneath till. However, the scatter of information does not permit these areas of buried mineral to be delineated

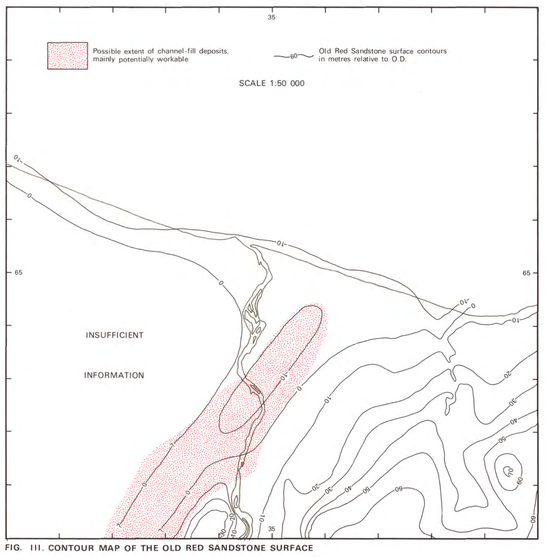


FIG. III. CONTOUR MAP OF THE OLD RED SANDSTONE SURFACE

Geological lines from a Six-Inch survey in 1961-63 by N.G.Berridge, F.May and J.D.Peacock. T.R.M. Lawrie, District Geologist.

Sand and gravel survey by J.W.Merritt, A.J.Shaw and A.M.Hamilton in 1970-72, under the supervision of A.M.Aitken. R.G.Thurrell, Head, Industrial Minerals Assessment Unit.

1:25000 Sand and Gravel Resource Sheet published 1979
Austin W. Woodland, C.B.E., Director, Institute of Geological Sciences incorporating the Geological Survey of Great Britain, the Museum of Practical Geology, and Overseas Geological Surveys

1100/79

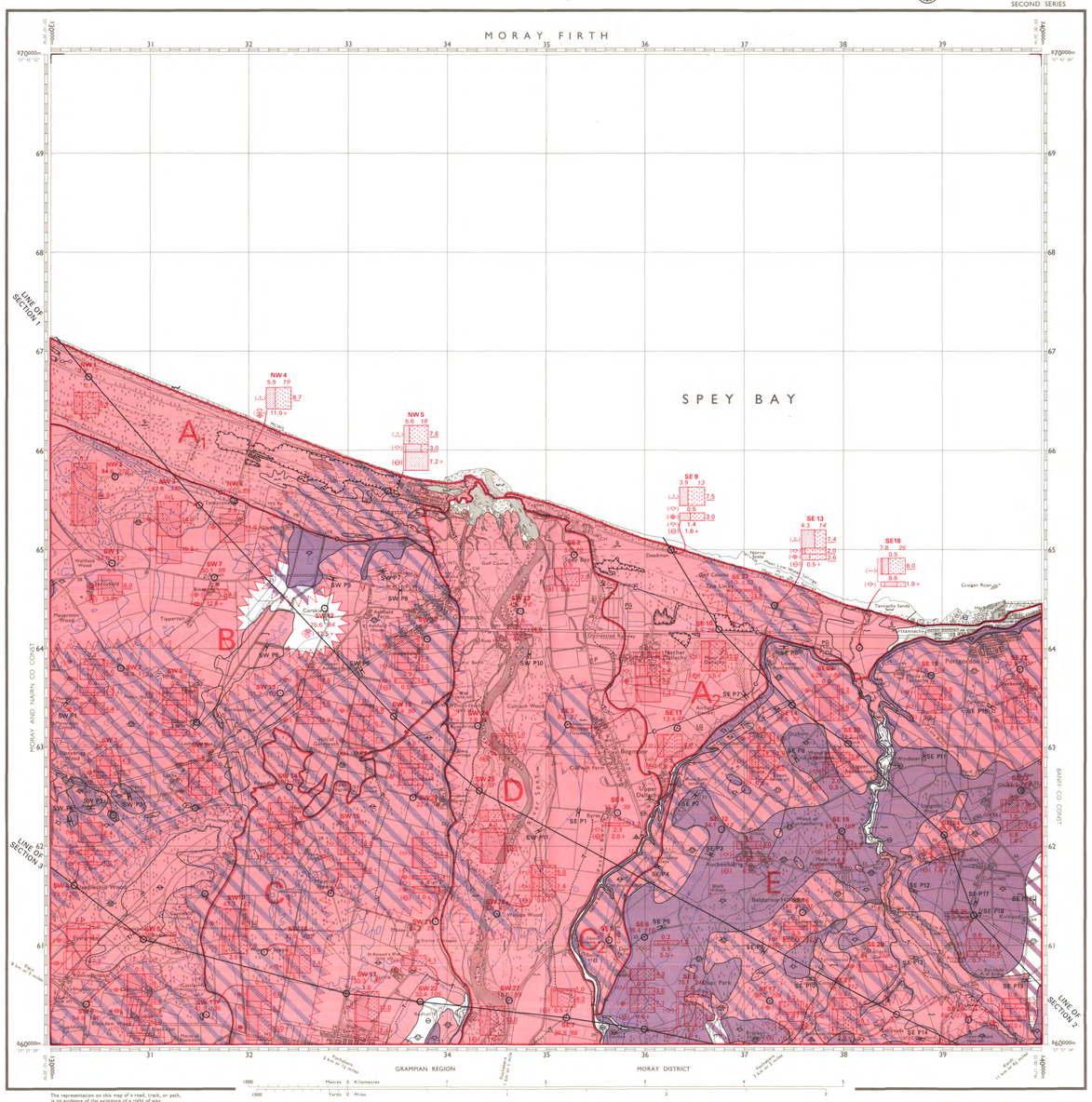
INSTITUTE OF GEOLOGICAL SCIENCES

INDUSTRIAL MINERALS ASSESSMENT UNIT

THE SAND AND GRAVEL RESOURCES OF SHEET NJ 36 (GARMOUTH, GRAMPIAN REGION)

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

ORDNANCE SURVEY
SHEET NJ 36
SECOND SERIES



The representation on this map of a road, track, or path, is no 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 99 629 acres on the ground.

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

Compiled from 1:10 560 or 1:10 000 scale maps surveyed 1964-73. Revised for significant changes 1975.
Major roads revised 1976.
Contours taken from the 1:25 000 Provisional Edition.

Detailed records may be consulted on application to the Officer-in-charge, Industrial Minerals Assessment Unit, Institute of Geological Sciences, Murchison House, West Mains Road, Edinburgh EH9 3LA.

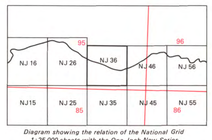
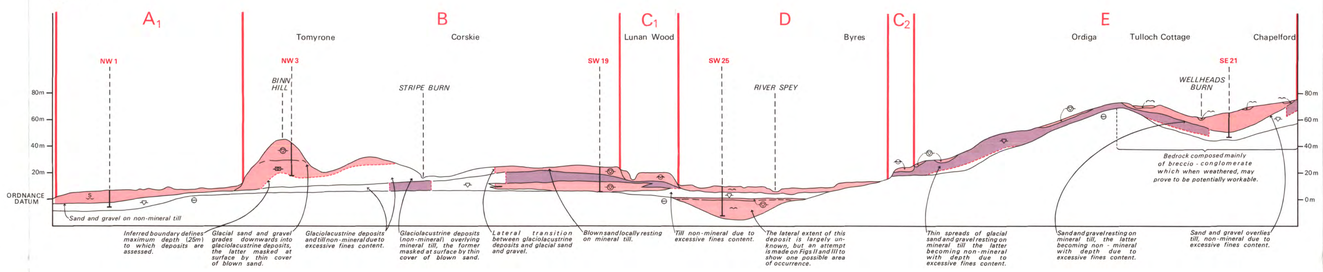


Diagram showing the relation of the National Grid 1:25,000 sheets with the One-Inch New Series Geological Sheets 85, 86, 95, and 96

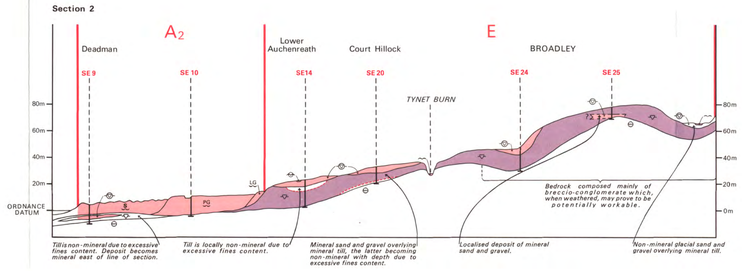
GENERALISED HORIZONTAL SECTIONS SHOWING RELATIONSHIPS OF DRIFT DEPOSITS

HORIZONTAL SCALE 1:25 000 VERTICAL EXAGGERATION 12.5x

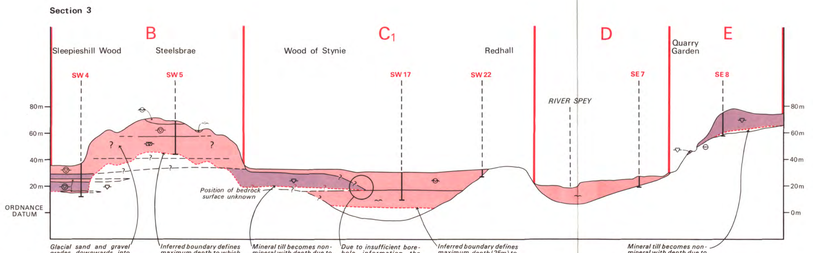
Section 1



Section 2



Section 3



41

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

41

EXPLANATION OF SYMBOLS AND ABBREVIATIONS AS SHOWN ON RESOURCE MAP

DRIFT

RECENT AND PLEISTOCENE

- **Peat** P-1
- **Blown sand** BS-13
- **Alluvium (undifferentiated) including channel-fill deposits** -gravel and sand in present river valleys and fine to medium sand in channel-fill deposits (proved only at depth in boreholes). A-84
- **Alluvial cone** -sand and gravel. AC-6
- **Lake alluvium** -fine sand, silt and clay. LK-3
- **Present day beach deposits** -mainly shingle. PB-6
- **Storm beach deposits**, post-Glacial to present day. ST-5
- **Raised beach deposits**, post-Glacial. RS-14
- **Raised beach deposits**, late-Glacial. RS-15

(Storm beach deposits, Raised beach deposits, Raised beach deposits: gravel with some sand.)

- **Fluvioglacial sand and gravel (usually flat or terraced at surface)** -gravel with sand. FL-36
- **Glacial sand and gravel (usually moundy at surface)** -sand with some gravel. GS-96
- **Glaciolacustrine deposits** -fine sand, silt or clay, often laminated. G-11
- **Till** -firm to stiff, sandy or gravelly clay with clayey sand and gravel. TL-28

SOLID

- **Bedrock** -Old Red Sandstone -red sandstone, siltstone, shale and breccio-conglomerate.
- **Worked ground** (sand and gravel or till) WG-11
  position of pit face at March 1978

Digitise as drift boundary

BOUNDARY LINES

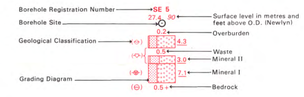
- Geological boundary. – Digitise as Geological boundary, Drift
- Line marking terrace feature. – Do not capture
- Geological boundary following terrace feature. } Digitise as Geological Boundary, Dri
- Geological boundary following former coastline. }
- Inferred boundary between categories of deposit at surface.
- Inferred boundary between categories of deposit at depth. – New boundary line on job control sheet
- Resource Block boundary.

BOREHOLE AND OTHER DATA

SITE LOCATIONS

- Industrial Minerals Assessment Unit (I.M.A.U.) boreholes
- Recorded exposures
- Shallow pits

I.M.A.U. BOREHOLES



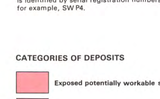
Notes
(i) Figures underlined denote thicknesses used in the assessment of resources.
(ii) The + sign indicates that the base of the deposit was not reached.
(iii) The figures in *italics* are Imperial conversions of measurements recorded in metres.
(iv) Two types of mineral are recognised; mineral I is sand and gravel, mineral II is till.

Borehole Registration Number

Each I.M.A.U. borehole is identified by a Registration Number, e.g.SE5. The letters refer to the relevant standard quarter sheet and the figures to the I.G.S. serial number for that quarter. The unique designation for borehole SE 5 is NJ36SE5.

Grading Diagrams

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



The height of the diagram is proportional to the mineral thickness.

The widths of the divisions show the proportions of **Fines**, **Sand** and **Gravel**

EXPOSURE RECORDS

Information from the inspection of exposures is shown in the same way as for I.M.A.U. boreholes but they are located by an asterisk, thus ✳. The exposures are registered in the same series as the boreholes, for example, SE29

SHALLOW PITS

Where space permits the locations of shallow pits providing ancillary assessment data are shown. The symbol indicates the location of the site and the alignment on which the pit was cut. Each pit is identified by serial registration numbers indexed by the letters of the relevant standard quarter sheet, for example, SW P4.

CATEGORIES OF DEPOSITS

- **Exposed potentially workable sand and gravel.** CAT-E7
- **Exposed potentially workable till.** CAT-E12
- **Exposed potentially workable sand and gravel directly overlying continuous, or almost continuous spreads of potentially workable till, (any intervening waste is discontinuous and rarely greater than 1.0m in thickness).** CAT-E13
- **Exposed potentially workable till directly overlying continuous, or almost continuous spreads of potentially workable sand and gravel.** CAT-E14
- **Continuous, or almost continuous spreads of potentially workable till beneath overburden.** CAT-C5
- **Potentially workable material absent.** CAT-A5

RESOURCE BLOCKS

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

KEY TO SECTIONS

- Potentially workable sand and gravel
- Potentially workable till
- Geological boundary (broken line denotes uncertainty)
- Inferred boundary limiting the extent of potentially workable material

Otherwise symbols and abbreviations as map legend

41

Made and printed for the Institute of Geological Sciences, by the Director General of the Ordnance Survey, Southampton.