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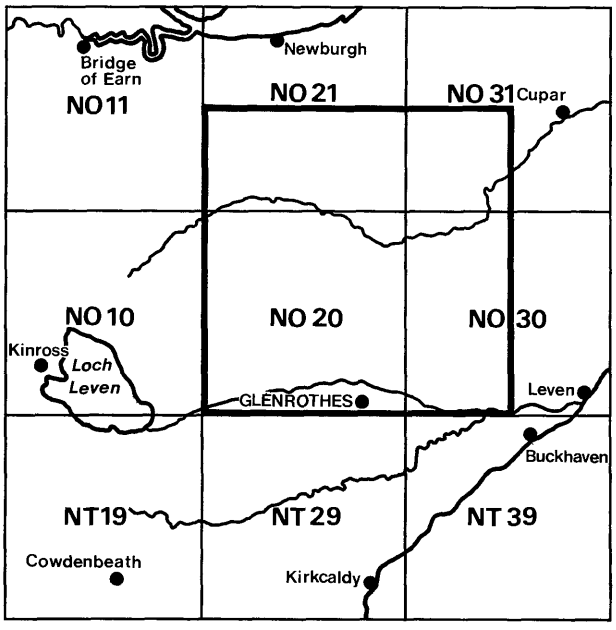

The sand and gravel resources of the country around Glenrothes, Fife Region

Description of 1:25 000 sheet NO 20 and parts of NO 21, 30 and 31

A. M. Aitken and D. L. Ross

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

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

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The asterisk on the cover indicates that parts of sheets adjacent to the ones cited are described in this report.

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, 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 225 km^2 of country around Glenrothes, Fife Region, shown on the accompanying resource map. The survey was conducted by A. M. Aitken and D. L. Ross, and the work was controlled from the sub-unit in Edinburgh (E. F. P. Nickless, Officer-in-Charge). The work is based on Sheets 40 and 48 of the one-inch Geological Map of Scotland first published in 1867 and 1883 respectively with the former last republished in a revised edition in 1973. The geological lines, now presented at the 1:25 000 scale, include a reappraisal of the drift geology by A. M. Aitken based on field surveys in 1979 under the supervision of M. A. E. Browne. The section of this report on the geology of the area was prepared by A. M. Aitken and M. A. E. Browne. D. L. Ross wrote the section on mechanical and physical properties of the aggregates. Palaeontological examination of the clay samples was undertaken by D. K. Graham.

G. I. Coleman, ARICS and W. N. Pierce, ARICS (Land Agents) have been responsible for negotiating access to land for drilling. The ready cooperation of land owners and tenants, and the assistance of officials of North-east Fife and Kirkcaldy districts and of Glenrothes Development Corporation is gratefully acknowledged.

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SUMMARY

The geological maps of the Institute of Geological Sciences, sixty-three boreholes and thirty shallow pits sunk for the Industrial Minerals Assessment Unit, four boreholes drilled for the Hydrogeology Unit and pre-existing borehole information, together with data from the inspection of five sections form the basis of the assessment of sand and gravel resources in the Glenrothes area, Fife 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 seven resource blocks, six of which are assessed statistically and contain between 7.1 and 12.3 km² of potentially workable sand and gravel. For the seventh resource block inferred assessments are offered for 6.3 km² of mineral. The geology of the deposits is described and the mineral-bearing area, the mean thickness of overburden and mineral and the mean grading are stated. Detailed sample point data are given. The geology, the outlines of the resource blocks and the position of sample points used in the assessment are shown on the accompanying resource map.

Bibliographic reference

AITKEN, A. M. and ROSS, D. L. 1982. The sand and gravel resources of the country around Glenrothes, Fife Region. Description of 1:25 000 sheet NO 20 and parts of NO 21, 30 and 31. *Miner. Asses. Rep. Inst. Geol. Sci.*, No. 101.

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Note

National Grid references are given in square brackets. In this publication all lie within the 100-km square NO.

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, 1981; Harris and others, 1974).

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

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

The following arbitrary physical criteria have been adopted:

a The deposit should average at least 1 m in thickness.
b The ratio of overburden to sand and gravel should be no more than 3:1.
c The proportion of fines (particles passing the No.240 mesh BS sieve, about $\frac{1}{16}$ 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.

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

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

clay and silt fractions) and sand, and between sand and gravel grade material, are placed at $\frac{1}{16}$mm and 4mm respectively (see Appendix C).

The volume and other characteristics are assessed within resource blocks, each of which ideally, contains approximately 10km^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 THE RESOURCE SHEET

GENERAL

The area assessed covers 225 km^2 of country north of Glenrothes, Fife Region (Figure 1). The sand and gravel resources were first described by Anderson (1945) and Haldane (1948). More recently, published and unpublished information for the Fife Region was summarised by Browne (1977). Sand and gravel is currently worked mainly in the Ladybank and Collessie areas.

The Leven valley is traditionally noted for paper milling, whisky distilling and formerly coal mining. Light industry has developed with the growth of the new town of Glenrothes. The Howe of Fife contains rich agricultural land; barley is the principal crop, but root crops, peas and green beans, soft fruit, livestock rearing and forestry are also important. The area is traversed by the main east coast railway line.

The assessment of sand and gravel resources in the Newport-on-Tay area which lie 5 km to the north-east is published in Mineral Assessment Report 89 (Laxton and Ross, 1981).

TOPOGRAPHY

The physiography of the resource sheet area is largely controlled by rock type. The area is bounded on the north by the volcanic rocks of the Ochil Hills which are relatively subdued in Fife, in contrast with Tayside to the west. The central part is dominated by the principally doleritic Lomond Hills, culminating in East Lomond Hill (440 m above Ordnance Datum) which is a volcanic vent. High ground east of the broad saddle at Kirkforthar [287 047] also corresponds largely with outcrops of dolerite.

The Loch Leven basin, a small part of which lies within the resource sheet area west of Auchmuirbridge [218 011], is drained by the easterly-flowing River Leven which occupies a deeply incised valley to the south of the Lomond Hills, from Leslie [250 018] to Windygates [347 005] where it is jointed by the River Ore. The river has created an impressive system of terraces eastwards from Markinch.

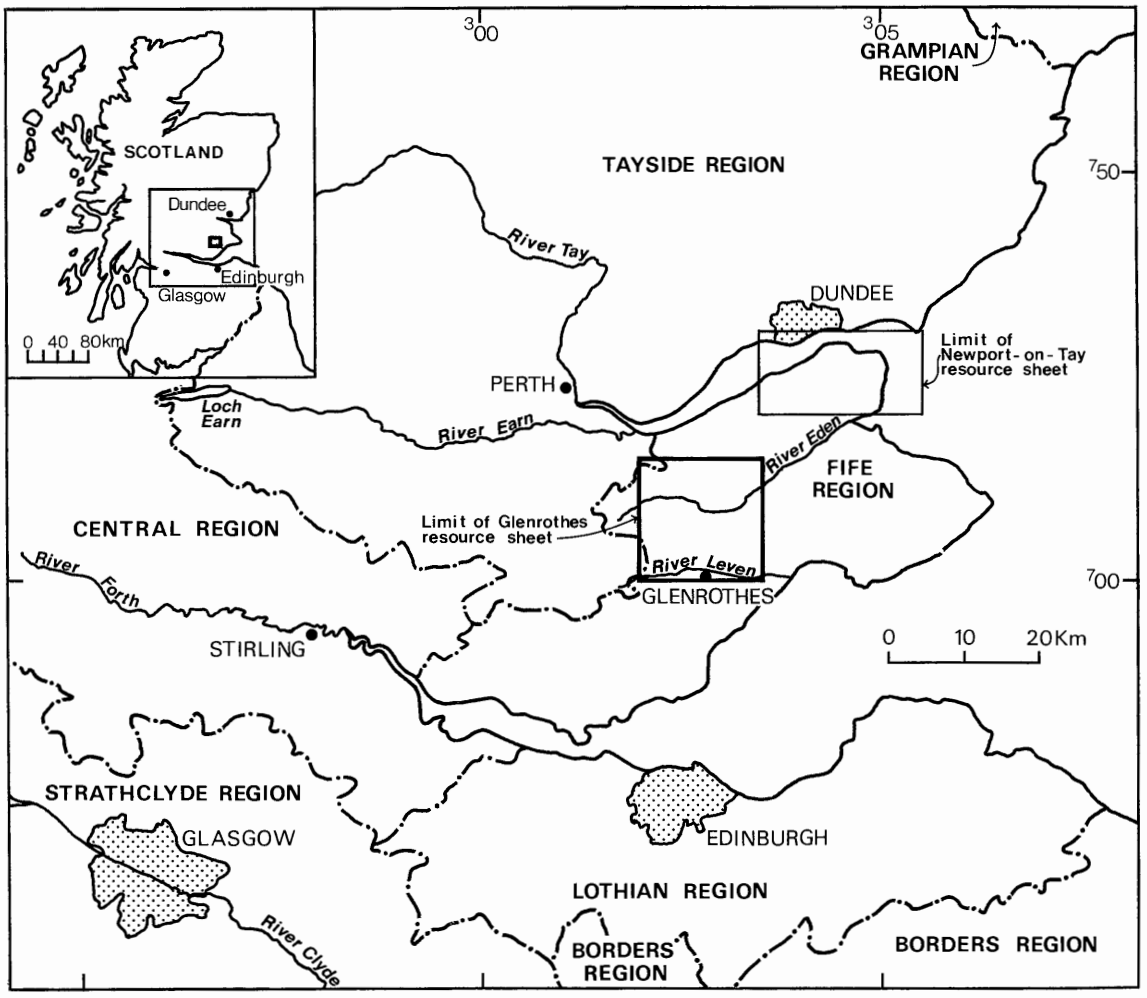

Figure 1 Sketch map showing the location of the Glenrothes area.

Plate 1 The Howe of Fife and the Lomond Hills, looking north-west from near Bowden Hill at [334 081].
The foreground is dominated by a prominent glacial drainage channel which descends north-eastwards for 1.8 km along the flanks of Cults Hill towards Pitlessie. The flattish valley floor of the River Eden occupies the middle ground, bounded on the left by Lomond Hills from which protrude the volcanic vents of East and West Lomond. Beyond Stratheden lie the Ochil Hills through which has been cut the Lindores Gap, visible in line with Burnturk Farm [329 086], and thought to have been the source route of much of the glacial melt waters which deposited extensive spreads of sand and gravel, most thickly developed in the afforested ground north of Ladybank. Ramornie sand pit is visible in the right middle distance. (D3322 and D3323).

The Howe of Fife (Plate 1), lying between the Lomond and Ochil hills, is the name given to the broad, flat-bottomed valley of the River Eden and corresponds closely with the outcrop of unresistant Devonian sandstone which underlies much of it. Downstream from Pitlessie [336 096] the valley of the Eden is incised.

GEOLOGY

The resource sheet area falls mainly within the published one-inch Geological Sheet 40 (Kinross) and partly within the 1:50000 Geological Sheets 48W (Perth) and 48E (Cupar), which are in the press. The area was originally geologically surveyed by H. H. Howell between 1858 and 1867. Sheet 40 was published in 1867 and Sheet 48 in 1883. Partial resurveys were conducted by J. Knox and J. K. Allen between 1926 and 1946, by W. Tulloch and N. Martin in 1946, by J. I. Chisholm in 1966 to 1968 and by M. A. E. Browne in 1968 to 1969. In connection with the present investigation A. M. Aitken revised the drift mapping of much of the area, but not the ground surveyed by Chisholm and Browne.

The geological sequence is shown in Table 1, where the deposits are listed, as far as possible, in order of increasing age. The solid rocks are undifferentiated on the resource map accompanying this report, but their distribution is shown in a sketch map (Figure 2), which is a provisional reinterpretation incorporating recent borehole and temporary section data.

Table 1 Geological classification of deposits

DRIFT	
Recent and Pleistocene	Peat
	Alluvium (undifferentiated)
	Alluvial cone
	Lacustrine alluvium
	Late-Glacial alluvium
	Late-Glacial raised beach and estuarine deposits
	Fluvioglacial sand and gravel
	Glacial sand and gravel
	Glaciolacustrine deposits
	Till
SOLID	
Permo-Carboniferous	Quartz-dolerite intrusions
Carboniferous	Sandstone, mudstone, limestone, coal and igneous intrusions
Devonian	Sandstone, conglomerate, andesitic lava and lava conglomerate

SOLID

The oldest known rocks in the resource sheet area are Lower Devonian lavas and associated lava conglomerates of the Arbuthnott Group. The lavas, which occur in flows about 3 to 20 m thick, are mainly basic andesites. They form the Ochil Hills, part of which lie within the resource sheet area, forming the northern flank of Stratheden. Although the volcanic sequence exceeds 2000 m in thickness, only some 300 m of andesite and some 300 m of conglomerate forming the upper part of the lava sequence are present here. The Lower Devonian rocks were extensively faulted during the Middle Devonian and they form the southern limb of the Ochil Anticline. During this time they were extensively eroded and the oldest Upper Devonian sediments were laid down on an irregular land surface.

Upper Devonian sediments belonging to the Burnside, Glenvale and Knox Pulpit formations unconformably overlie the Lower Devonian (Chisholm and Dean, 1974). Sandstone is the most abundant lithology within the approximately 600-m thick succession. Conglomerates composed of lava and quartz pebbles occur at the base of the sequence in the Burnside Formation, sandstones with mudstone pebbles and silty mudstones are common in the Glenvale Formation, and sandstones constitute the Knox Pulpit Formation which forms an important aquifer in the district (Foster and others, 1976).

The Upper Devonian is generally separated from the Lower Devonian on the north side of the Howe of Fife by the north-easterly-trending Fernie Fault which downthrows to the south, but the basal unconformity is exposed in the Fernie Burn [322 136] near Bow of Fife. The valley of Stratheden corresponds closely with the outcrop of the generally soft and friable Upper Devonian sediments.

On the south side of the valley the Upper Devonian is overlain conformably by the Kinnesswood Formation (40 to 110 m in thickness), which crops out on the northern flanks of the Lomond Hills and their eastward continuation towards Cults Hill, and consists mainly of sandstones with subordinate beds of mudstone and bands of rubbly nodular carbonate (cornstone). The boundary between the Devonian and Carboniferous systems probably occurs within the Kinnesswood Formation which is succeeded by undoubted Lower Carboniferous, comprising the Ballagan Formation (0 to 130 m), the remainder of the Calciferous Sandstone Measures (30 to 300 m) and the Lower Limestone Group (up to 150 m thick). The Ballagan Formation consists mainly of silty mudstone with thin seams of dolomite (cementstone). The rest of the Carboniferous is characterised mainly by sedimentary cycles of, from the base up, calcareous mudstone, limestone, mudstone and siltstone, sandstone, seatrock and coal. In the Calciferous Sandstone Measures sandstone predominates over mudstone; for the Lower Limestone Group the converse is true and in addition this unit contains at least two limestones which were formerly quarried or mined, for example, at Balgeddie [256 028]. The Lower Carboniferous rocks crop out in the southern half of the resource sheet area but the distribution pattern is complicated by igneous intrusions and numerous faults.

The Upper Carboniferous is represented by the Limestone Coal Group (up to 250 m thick), the Upper Limestone Group (up to 320 m), the Passage Group (up to 300 m), the Lower Coal Measures (up to 240 m) and the Middle Coal Measures (up to 200 m thick). In the Limestone Coal Group sandstone predominates over mudstone, and there are several coal seams which have been worked, for example in the Rameldry [325 065] and Cadham [278 021] areas. In the Upper Limestone Group, mudstone is more common than sandstone and thin coals and limestone occur. The Passage Group is characterised by sandstone with thin seams of seatrock and mudstone. The Lower and Middle Coal Measures contain numerous seams of coal, but in the resource sheet area the formation is restricted to ground between Milton of Balgonie and Markinch, within the Thornton–Balgonie syncline.

Sills of quartz-dolerite and olivine-dolerite have been intruded into the Carboniferous sediments and now crop out over a significant proportion of the resource

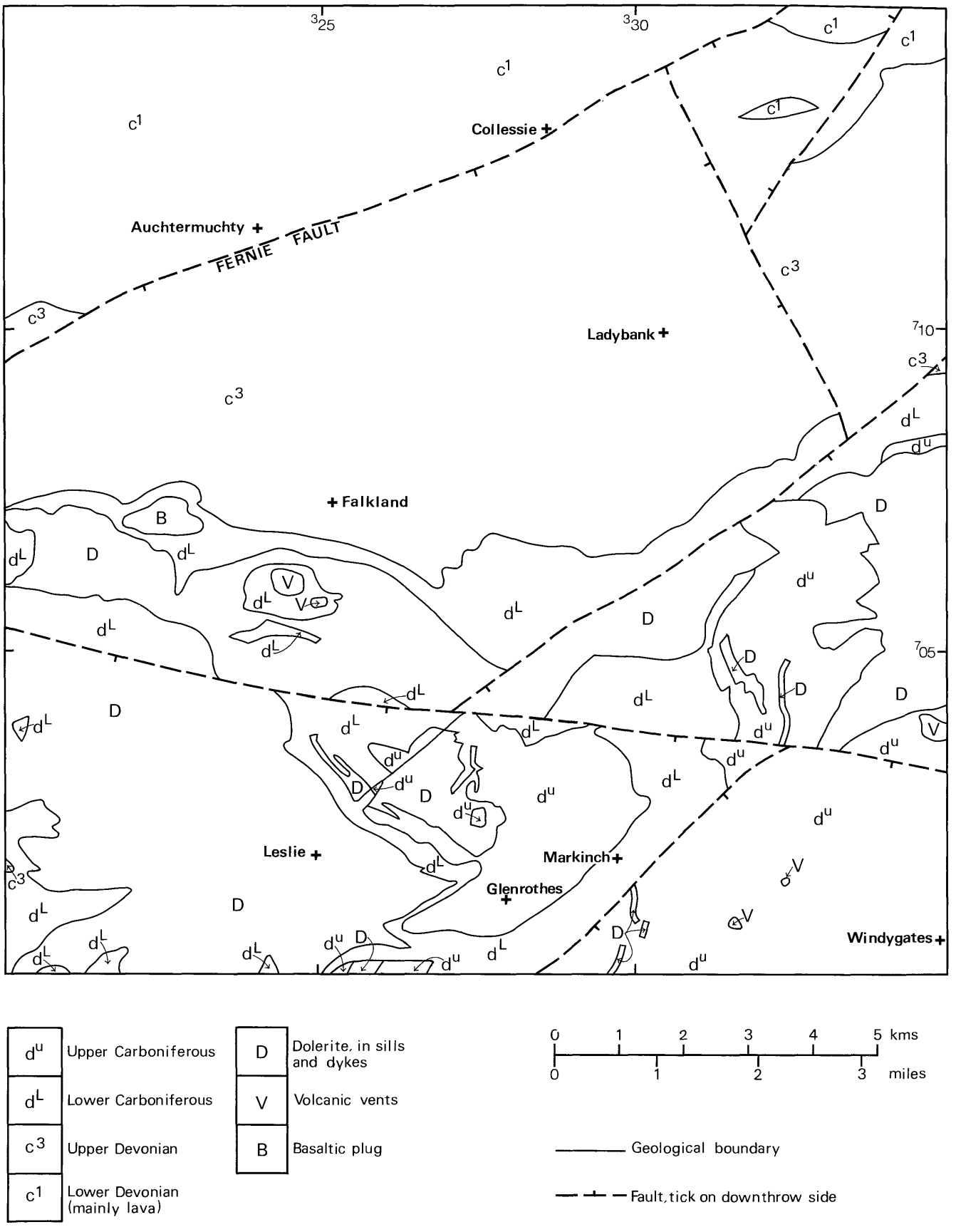

Figure 2 Sketch map showing the solid geology of the Glenrothes area (simplified).

sheet area, notably in the Lomond Hills and west of Glenrothes. Volcanic vents filled with dolerite, basalt or agglomerate occur at several localities, for example Green Hill [225 073], East Lomond [244 062] and Langside Hill [346 038].

DRIFT

At the acme of the late-Devensian glaciation about 18 000 years ago (Penny and others, 1969) the whole area was covered by a thick ice sheet. East Lomond, the highest hill within the resource sheet area, is a crag and tail and glacial striae have been recorded at levels above 330 m above Ordnance Datum. From the evidence of glacial striae in various places on the Lomond and Ochil hills and at Devon Common [337 051] the general trend of ice movement is inferred to have been to the south-east, or east-south-east.

The ice sheet deposited extensive spreads of till which conceal much of the bedrock. In general the till is thinner on the 'exposed' north-western flanks of the hills but is thicker and present at much higher elevations on the leeward, south-eastern sides (Geikie, 1900). Over the low ground between Glenrothes [270 010] and Milton of Balgonie [320 006], borehole and mining evidence show that thick deposits (up to 50 m) mainly of till have filled a supposed pre-glacial valley of the River Leven (Allan and Knox, 1934; Knox, 1954). It is as likely that this elongate bedrock depression owes its origin to erosion at the base of the ice sheet and is a glacially over-deepened hollow. The depth to which the hollow is cut is at least 20 m below Ordnance Datum north-west of Milton of Balgonie where drift deposits were met in underground workings of the Dysart Main Coal.

The oldest fluvioglacial deposits associated with the decay of the ice sheet probably formed over 15 000 years ago and consist of eskers and mounds of sand and gravel found at elevations of up to approximately 220 m above Ordnance Datum between Purin [269 061] and Bandon [277 041] on the flanks of East Lomond Hill. Borehole 20 NE 26 at Purin showed 12.3 m of pebbly sand (resting on till) thought to have been deposited by meltwater streams flowing in englacial tunnels. There are four easterly-trending esker-like linear deposits near here, the orientation of which might correspond with a crevasse system resulting from the ice sheet crossing the saddle at Kirkforthar [287 047] between the Lomond Hills and Hilton of Forthar [305 055].

These eskers, on the basis of their elevation, are considered to be the oldest fluvioglacial sediments. At lower levels it is difficult to correlate geographically separated deposits chronologically. On the north side of the valley of the Leven, extensive spreads of moundy sand and gravel were laid down within an area which extends from Leslie [250 018] through Markinch [295 016]. Dead-ice hollows (kettles) are common. By contrast, on the south side of the Leven between Auchmuirbridge [218 011] and Markinch, sand and gravel is absent at the surface except very close to the river. Examples of eskers also occur, for example near Leslie at [242 019], at Whinnyhill Plantation [262 022] and in Drummy Wood [322 053].

Evidence of the direction of subglacial meltwater flow in the vicinity of Glenrothes is provided by the numerous glacial drainage channels eroded in the hill slopes between Auchmuirbridge [218 011] and Holl Reservoir [226 036]. The channels at lower levels indicate the progressive melt-down of the ice sheet. In Drummy Wood glacial drainage channels indicate southerly meltwater flow but here eskers also occur. Deposits at Carriston [323 041] and Pyeston [315 044] are interpreted to be pro-glacial.

Lake deposits were also formed, for example south of Rameldry [325 065] where there are deposits of fine sand, silt and clay with many coal fragments. The maximum surface elevation of these sediments is above 150 m above Ordnance Datum. Other glaciolacustrine deposits were proved at Lochmuir Wood [296 039] by boreholes 20 SE 365 and 366.

At Windygates, in the south-eastern part of the resource sheet area, there are two prominent, sub-parallel eskers. They are aligned north–south, similar to the Drummy Wood eskers. The western ridge extends southwards from the southern lip of a prominent glacial meltwater channel as far as Cameron Bridge [347 001]. Duniface Hill [349 013], the eastern esker, is markedly asymmetrical, but this may be due to subsequent fluvial erosion by the Kennoway Burn.

In Stratheden the earliest fluvioglacial deposits are probably the remnant terraces near Nether Drums [276 060] at an elevation of about 100 m above Ordnance Datum. The deposits coarsen upwards from a basal silt to gravel but consist mainly of sand. Borehole 20 NE 29 proved 15.8 m of till from the surface. The base of the deposit at 84 m above Ordnance Datum is well below the surface height of the adjacent terrace; consequently it is concluded that the Nether Drums sand and gravel was laid down as a kame delta in water ponded between the ice sheet and the till-covered hillslope. In the same neighbourhood glacial drainage channels occur at elevations up to 140 m above Ordnance Datum, all with an easterly gradient. In common with others at Falkland [254 075], Newton of Falkland [268 071] and north of Bowden Hill [333 077], those at lower levels relate to progressive down-wasting of the local ice.

Later, eskers and moundy deposits accumulated in association with dead-ice on the floor of the valley of the River Eden, principally near Collessie [286 132], but also at Kirkton of Cults [347 098], around Falklandwood [249 087] and south of Easter Cash [233 094]. Ice also occupied the prominent gap at Lindores, but water flowed englacially, depositing an esker east of Lindores Loch [267 164] (Browne, 1977), with a probable continuation extending south from Cornhill [280 132], then eastwards. South of Collessie an extensive fan-shaped accumulation of gravel, often with an irregular, kettled surface, was laid down by meltwaters diverted southwards from the valley of the Tay through the Lindores gap, by an active glacier blocking the Tay estuary east of Newburgh (Browne and others, 1981). Both the gravel content of the fan and deposit thickness diminish away from its apex, which together with current bedding directions noted by Knox (1962) are indicative of a northerly origin. The southern part of the fan, between Giffordtown [290 111] and Pitlair [319 121] is quite planar, as no dead-ice appears to have been incorporated into these sediments, unlike those in the Collessie area.

Reddish brown silty clay up to 9.5 m thick, similar to the marine arctic Errol Beds of the Tay (Paterson and others, 1981), is present extensively beneath alluvium, late-Glacial alluvium and fluvioglacial sand and gravel in the central part of Stratheden, broadly between Dunshelt [249 104] and Pitlessie [336 096]. Samples from boreholes 20 NE 34 and 30 NW 51 near Ladybank contain marine microfossils which prove that the late-Glacial sea had access to the Howe of Fife following deglaciation but while the land was still isostatically depressed (Knox,

1962; Browne and others, 1981). The clay, mapped as late-Glacial raised estuarine deposits, is exposed in the banks of the Eden [281086 to 298086], and near Kingskettle [309083]. Red clay has not been found beneath the pro-glacial deposits of the Ladybank–Collessie area. It is therefore possible that these deposits were laid down in an estuarine delta penecontemporaneously with the red clay to the south.

The highest levels of clay with a marine fauna are approximately 33 m above Ordnance Datum in borehole 20NE34 and 29.4 m above Ordnance Datum in borehole 30NW51. The mean level of the upper surface of red clay from eleven boreholes is 35 m above Ordnance Datum, but reddish brown clayey silt was proved 45 m above Ordnance Datum in pit 21SW4 near Cash Mill [242103], the westernmost locality for such deposits in the Howe of Fife, and at 42 m above Ordnance Datum in a temporary section at Rossie Braes [25611165]. Isobases inferred for the Main Perth Shoreline by Smith, Sissons and Cullingford (1969) suggest that this feature, which formed about 13500 to 13000 years ago (Paterson, 1974), would be at a height of about 20 m above Ordnance Datum in the Howe of Fife. The height of the shoreline is much lower than the recorded marine clay levels, which can be tentatively correlated with the levels of the East Fife Shorelines of Cullingford and Smith (1966). If the Cash Mill deposit is marine, the level would correlate with shoreline EF-4. Otherwise the levels of the confirmed marine clay are equivalent to shoreline EF-5 (Browne and others, 1981).

Probable marine clay at approximately 39 m above Ordnance Datum in temporary section 21SE16 near Easter Kilwhiss [279107] is overlain by silty clay containing macroscopic plants. These remains gave a radiocarbon date of 13636 ± 130 years BP (Harkness and Wilson, 1979), by which time the area was essentially ice-free. It is perhaps not coincidental that the plant remains date from about the time of the Main Perth Shoreline, for this feature may have formed during a period of climatic amelioration (Paterson, 1974). Local masses of buried dead-ice, the largest of which probably occupied the site of Rossie Loch [265111], probably persisted for a considerable time while fluvioglacial sand and gravel was deposited extensively in Stratheden between Strathmiglo [215102] and Springfield [342119] in an estuarine or deltaic environment. The period of deposition of fluvioglacial sand and gravel in the Howe probably occupied a considerable time; the oldest material, described above and found in the neighbourhood of Collessie north of Ladybank, almost certainly predates the marine clay, which was not recorded there, whereas in central Stratheden fluvioglacial sand and gravel overlay late-Glacial estuarine clay in boreholes 20NE27, 20NE33, 20NE34, 30NW51, 30NW59, 31SW14 and 31SW16. The younger, deltaic or estuarine deposits, which are widespread in the central and southern part of the valley, are predominantly sandy, indicating a more distant source.

A further lowering of relative sea level resulted in the formation of a lower late-Glacial alluvial terrace with a back feature which is prominent in the Dunshelt area but becomes more subdued and disappears gradually eastwards. The deposits comprise mainly sand with peat locally, indicative of the warmer conditions which may have prevailed at that time. A sample of peat, observed to underlie sand and overlie till in a temporary section near Darnoe [25960920], gave a radio carbon date of 11862 ± 85 years BP (Harkness and Wilson, 1979). It is likely that a lake had formed by this time on and around the site of Rossie Loch.

According to Cullingford and Smith (1966), the fluvioglacial terraces of the Leven, in contrast to the fine-grained estuarine deposits of the Eden, are alluvial fan gravel deposits, the several distinct surfaces of which correspond to successive changes in relative sea level. The gravel deposits are thought to be younger than Cullingford and Smith's shoreline EF-6. Dead-ice features are absent in the Leven valley area, east of Markinch.

A small portion of the Loch Leven basin lies within the resource sheet area, west of Auchmuirbridge. Sand deposits on the north and south sides of the valley rising to 175 m above Ordnance Datum at East Bowhouse [205012] approximately 67 m above the alluvial plain, indicate a much higher, possibly englacial water-table sometime during the late-Glacial period, as first noted by Geikie (1900). He also observed flat terraces at least 18 m above the present loch surface. Subsequent to the final decay of the ice sheet, thick deposits of silt and clay have accumulated in the loch. The age of the succession of silts and clays, 16.7 m of which were proved in borehole 20SW16, is uncertain; the basal part is late-Glacial and of glaciolacustrine origin, but some of the deposits are probably post-Glacial in age. A bed of peat within late-Glacial sands, 1 m below the base of the post-Glacial deposits, 5 km west of the area, near East Brackley Farm [NT 145 987], gave a radiocarbon date of 11104 ± 155 years BP (Harkness and Wilson, 1979).

Mass movement by solifluction occurred probably as a result of periglacial conditions. Borehole 20SE367 at Newton of Markinch, section 20SE368 at Balbirnie Mains, and pit 30NW65 at Rameldry all proved head (similar in composition to till) overlying glacial sand and gravel. An extensive landslip on the north flank of East Lomond Hill, above House of Falkland [242074], may also be due to periglacial activity. An ice-wedge cast indicative of permafrost conditions was recorded by McManus (1966) in shale in Upper Cults Quarry [338083]. There is no evidence for the age of the periglacial features: they could have formed shortly after the area was deglaciated, but it is suggested that they were formed during the short, very cold period of the Loch Lomond Stade between 11000 and 10000 years ago.

The youngest sedimentary deposits are fluvial and lacustrine alluvium. The former is extensive in the valleys of the Leven and Eden, and borders many of the lesser streams. It is usually 1 to 2 m thick and often silty in composition. Lacustrine silt and fine sand cover the sites of the once much more extensive Loch Leven and the former Rossie Loch, which was shown to be over 2.6 km² in area on Pont's map of Fife, published 1662, but originally exceeded 8 km² (Geikie, 1900). The alluvium of Loch Leven is partly diatomaceous (Duncan, 1920) and gives the soil a creamy colour locally.

During the Flandrian period, peat accumulated widely. Over 2.7 m of basin peat is present under the site of Rossie Loch, 2 m at Lochmuir Wood [296039] and at Star Moss [306042] where it was formerly extensively worked. Small deposits are found at the surface and also buried under the present alluvial plain of Loch Leven and in Stratheden where a peat about 1 m below ground level, from a temporary section at Plains [2527 1093], gave a radiocarbon date of 4040 ± 45 years BP (Harkness and Wilson, 1979). This peat bed, at an

adjacent temporary section [2537 1063], contained logs of oak with axe marks. The deposit therefore appears to date from the time when the area was deforested for agricultural settlement.

COMPOSITION OF THE MINERAL DEPOSITS

Particle-size distribution and petrography

Potentially workable sand and gravel is found in the alluvium, lacustrine alluvium, late-Glacial alluvium, fluvioglacial sand and gravel, glacial sand and gravel and till, but the bulk of the resource was deposited by glacial meltwaters and occurs as fluvioglacial and glacial sand and gravel. The principal grading and compositional characteristics together with the regional variations of each deposit are described. When appropriate, that is where variations are not excessive, mean gradings of deposits are stated.

Composition analyses (pebble counts) were conducted on seven samples of 10 to 14 mm and of 14 to 32 mm material derived by combining samples from eighteen boreholes as listed in Table 2; their approximate locations are shown in Figure 3. The samples correspond to those used in the mechanical and physical testing, described below; grouping of material was necessary to obtain a sufficient quantity of the 10 to 14 mm fraction for a full range of tests. Sample I incorporated material from six boreholes drilled in glacial sand and gravel to the north of Ladybank [305 100]. Sample II comprised material from three boreholes drilled within terraced fluvioglacial deposits to the north-west of Ladybank. Sample III was composed of material from a single borehole (20 NE 26) within a glacial sand and gravel deposit at Purin [269 061] on the eastern flank of East Lomond Hill. Sample IV contained material from borehole 20 SE 4 sited on a glacial sand and gravel mound at Newton [296 028]. Sample V consisted of material from three boreholes drilled within terraced deposits of fluvioglacial sand and gravel of the River Leven around Milton of Balgonie [320 006]. Sample VI consisted of material from a single borehole (30 SW 159) drilled on an esker ridge at Windygates [347 005]. Sample VII amalgamated material from three boreholes drilled in moundy glacial sand and gravel to the north-west and west of Leslie [250 018].

The results of the analysis are presented in Table 3 and Figure 3. The lithological classification used is based on the British Standard petrological groups (trade groups) given in BS 812.1 (1975). This standard classifies the rock types according to their petrological characteristics, but being based primarily on sources of crushed rock aggregate is deficient in terms of friable constituents often found in natural aggregate. The trade group classifications have been slightly modified, therefore, and siltstone is included in the gritstone group, whereas mudstone is tabulated under 'others'.

Approximately 300 pebbles were included in each count. Both the 10 to 14 mm and the 14 to 32 mm fractions were examined but there is no appreciable change in composition with change in size of clast; accordingly only the results of the counts on the smaller fraction are presented in Table 3.

Table 2 Source and classification of composite samples

Composite sample	Geological classification	Source of samples	Depth range (m)	No. of samples*
I	Glacial sand and gravel	21 SE 8	0.3–3.7	3
		21 SE 10	1.2–7.2	6
		21 SE 11	0.2–5.2	5
		21 SE 12	0.2–8.1	8
		31 SW 10	0.2–9.1	9
		31 SW 12	1.1–4.2	3
				(34)
II	Fluvioglacial sand and gravel	21 SE 9	2.2–5.3	3
		21 SE 13	0.4–6.0	6
		31 SW 11	0.4–3.3	3
				(12)
III	Glacial sand and gravel	20 NE 26	0.4–12.7	12
				(12)
IV	Glacial sand and gravel	20 SE 367	3.0–25.0	21
				(21)
V	Fluvioglacial sand and gravel	30 SW 149	0.3–2.6	2
		30 SW 154	0.2–3.5	3
		30 SW 157	0.4–3.8	3
				(8)
VI	Glacial sand and gravel	30 SW 159	0.2–13.1	12
				(12)
VII	Glacial sand and gravel	20 SW 17	0.5–2.0	2
		20 SW 18	0.4–10.0	10
		20 SE 361	0.7–7.6	7
				(19)

*Totals in parenthesis

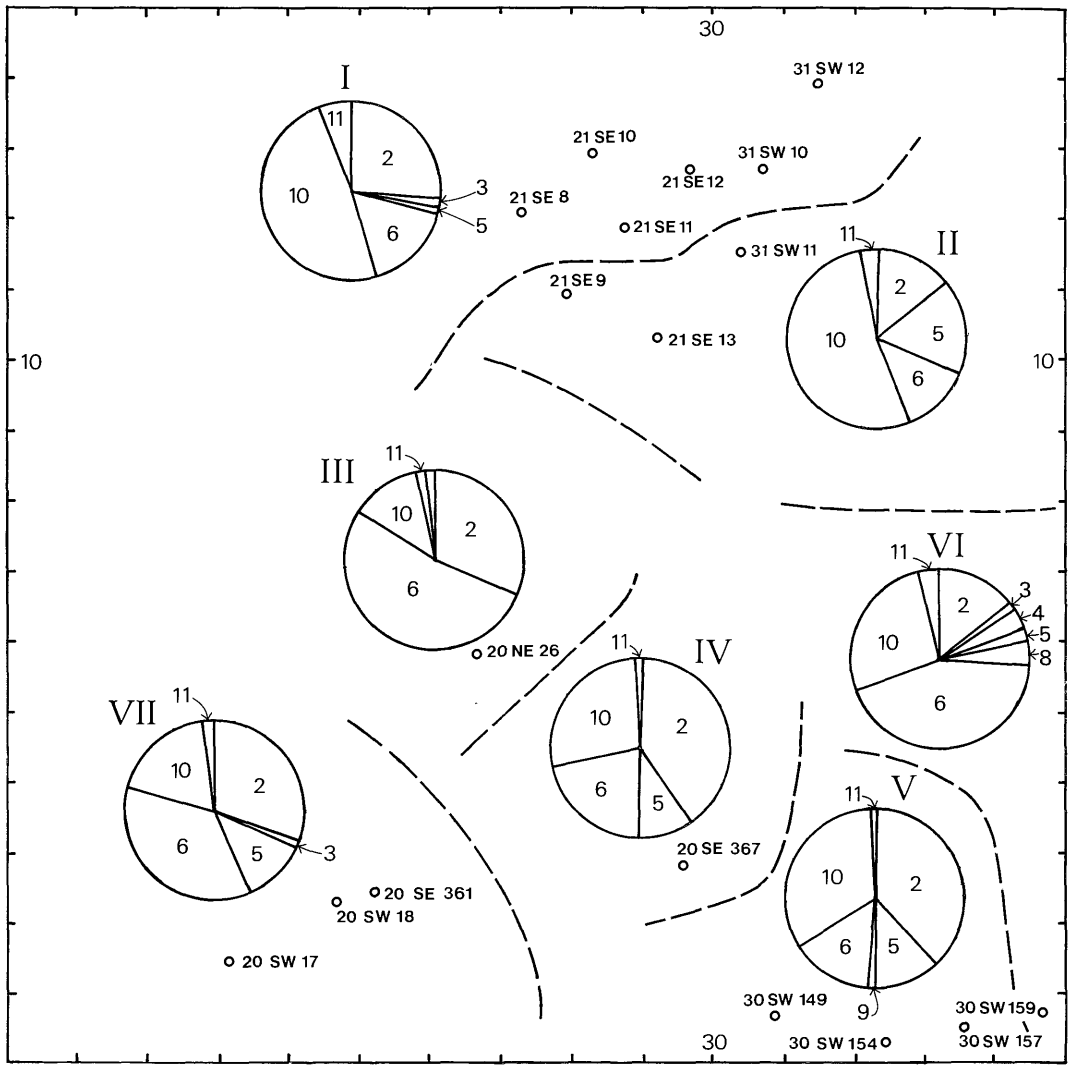

Figure 3 Sketch diagram showing the location of boreholes from which composite samples I to VII were obtained for mechanical and physical tests.

In the area under consideration pebbles falling in the granite, quartzite and schist groups are probably of Highland origin.

In the samples tested the quartzite trade group is the largest, with the weight percentage of the analysed fraction ranging from 13 to 54 per cent. It is composed of psammite/granulite, recrystallised quarztite and vein-quartz.

The gritstone trade group comprises 12 to 49 per cent of the samples and is composed of sandstones, tuffs and grits, chiefly of Devonian age, but also contains a high proportion (22 per cent by weight) of siltstone of probable Carboniferous age in composite sample III.

The basalt group comprises 14 to 40 per cent by weight of the samples examined and is composed of quartz-dolerite and olivine-dolerite of Permo-Carboniferous age, andesite (frequently porphyritic) and basalt of Lower Devonian age. These rock types are thought to be of local origin.

Other trade groups represented in smaller proportions are shown in Table 3 and Figure 3.

The distribution, grading characteristics and lithology of the sand and gravel-bearing deposits are discussed in the succeeding section, in which the categories are described in order of increasing age, as set out in Table 4.

Table 3 Pebble counts of composite samples I to VII (10 to 14mm size fraction)

Composite sample number		I	II	III	IV	V	VI	VII
Resource block		A	A, B	E	E	F	F	G_1
British Standard Trade Group	Rock Type							
BASALT (2)*	Dolerite	–	–	11	–	14	–	–
	Andesite	20	12	9	20	18	3	15
	Basalt	6	2	11	20	6	11	15
	Total, undivided	**26**	**14**	**31**	**40**	**38**	**14**	**30**
FLINT (3)	Chert	**1**	–	–	**0.3**	–	**1**	**1**
GABBRO (4)	Diorite	–	–	–	–	–	**4**	–
GRANITE (5)	Granodiorite	1	13	–	10	12	2	12
	Granite	–	4	–	–	–	–	–
	Total, undivided	**1**	**17**	–	**10**	**12**	**2**	**12**
GRITSTONE (6)	Siltstone	–	–	22	–	–	–	–
	Grit (schistose)	10	–	–	0.3	–	–	0.3
	Grit (sedimentary)	–	2	7	4	6	4	4
	Welded tuff	2	1	–	2	1	1	2
	Sandstone	5	10	24	16	8	39	30
	Total, undivided	**17**	**13**	**53**	**22**	**15**	**44**	**36**
LIMESTONE (8)	Undivided	–	–	**0.4**	–	–	**4**	–
PORPHYRY (9)	Undivided	–	–	–	–	**1**	–	–
QUARTZITE (10)	Psammite	–	6	5	3	4	2	–
	Vein quartz	6	6	1	8	4	2	5
	Quartzite	43	41	7	16	25	23	14
	Total, undivided	**49**	**53**	**13**	**27**	**33**	**27**	**19**
SCHIST (11)	Pelite and semipelite	**5**	**2**	**2**	**1**	**1**	**4**	**2**
OTHERS	Mudstone	–	–	1	–	–	1	–
	Vein calcite	–	–	0.6	–	–	–	–
	Ironstone	–	–	–	–	–	3	–
	Total	–	–	**1.6**	–	–	**4**	–
Number of pebbles counted		307	276	282	310	295	321	377

Results are given in frequency per cent. Calculations of weight per cent showed a close correlation. For origin of samples see Table 2.

*The numbers in parenthesis correspond with those used in BS 812.1:1975. Petrological groups 1 and 7 are not represented here.

Table 4 Mean grading of deposits

Deposit	Mean grading percentages						
	Fines $-\frac{1}{16}$mm	Fine sand $+\frac{1}{16}-\frac{1}{4}$mm	Medium sand $+\frac{1}{4}-1$mm	Coarse sand $+1-4$mm	Fine gravel $+4-16$mm	Coarse gravel $+16-64$mm	Cobbles and boulders $+64$mm
Alluvium	11	46	26	6	6	5	–
Lacustrine alluvium	10	50	33	6	1	–	–
Late-Glacial alluvium	16	45	26	6	5	2	–
Fluvioglacial sand and gravel	8	38	31	7	8	7	1
Glacial sand and gravel	6	28	23	11	12	15	5
Till	17	36	16	7	8	9	7

Alluvium Although most of the valleys of the rivers and burns contain deposits of alluvium, much of it is either too thin or too 'clayey' to be judged mineral. No assessment boreholes were sunk in the alluvial terraces of the river Leven. However, it is reasonable to conclude from field survey that the deposits are comparable in grade and composition with the fluvioglacial sand and gravel of the higher terraces.

In the valley of the River Eden, the mean grading of alluvium, based on three assessment boreholes, is fines 11 per cent, sand 87 per cent and gravel 2 per cent, but the composition varies between boreholes from pebbly sand to 'very clayey' sand (for definition of descriptive categories, see diagram in Appendix C).

Shallow pit 30 SW 174 proved 1.2 m of gravel on sand in the alluvium of the Kennoway Burn, but this is believed to be untypical of the deposit as a whole. The sand and gravel deposit grades as fines 1 per cent, sand 47 per cent and gravel 52 per cent, the last-mentioned component comprising sandstone, dolerite, andesite and quartz. Shallow pit 20 NW 4 in the valley of the Arraty Burn proved sand and 'clayey' sandy gravel interbedded with silt. The deposit is largely derived from the sandstone crags bounding the valley to the south.

Lacustrine alluvium Lacustrine alluvium is restricted to the one-time sites of Loch Leven and the Rossie Loch. At the former, borehole 20 SW 16 proved 1.8 m of mainly fine and medium sand on a thick sequence of silt and clay. In the case of the Rossie Loch, where the geology is varied, borehole 21 SE 5 proved 2.3 m of 'clayey' sand, 60 per cent of which was fine sand, borehole 21 SW 2 proved silt, borehole 21 SE 7 proved peat and silt and temporary section 21 SE 16 exposed 1.2 m of sand.

Late-Glacial alluvium Late-Glacial alluvium is confined to the Howe of Fife where it occurs as a terrace deposit altitudinally between fluvioglacial sand and gravel and alluvium of the River Eden. The mean grading is fines 16 per cent, sand 77 per cent and gravel 7 per cent (Table 4), which is broadly similar to, but more 'clayey' than, the fluvioglacial sand and gravel in the vicinity.

The gravel fraction is largely composed of durable lithologies such as quartzite, vein-quartz, andesite, felsite, basalt and dolerite with subsidiary sandstone. The gravel is mainly fine and cobbles are extremely rare. The sand is principally fine and medium with some coarse. Beds of peat have been recorded within the deposits.

Fluvioglacial sand and gravel Fluvioglacial sand and gravel is widespread in the valley of the Eden, is found between Kirkforthar [287 047] and Star [311 033], and occurs in the valleys of the Leven and Back Burn east of Markinch [295 016]. In the Howe of Fife the size frequency distribution of the deposit is variable but overall it grades as pebbly sand, with the gravel component comprising less than 10 per cent on average. The major exception to this is an area north of Ladybank where the deposit may comprise reworked glacial sand and gravel or may be closer to the source of supply. Here the mean grading from IMAU boreholes is fines 3 per cent, sand 51 per cent and gravel 46 per cent. Overall the gravel content generally decreases southwards towards Freuchie and Falkland. Small patches of sand and gravel forming remnants of fluvioglacial terraces high up on the valley side south of Freuchie, are mainly sandy with silt at depth.

In the valley of the Leven between Markinch and Windygates, coarse gravelly deposits of fluvioglacial sand and gravel occur in a series of well-developed terraces. The mean grading of the deposits, from three IMAU boreholes, is fines 11 per cent, sand 38 per cent and gravel 51 per cent, that is 'clayey' gravel. Fluvioglacial sand and gravel in the valley of the Back Burn, on the basis of one IMAU borehole grades as sandy gravel.

Between Kirkforthar and Star, fluvioglacial sand and gravel grades as sand, 56 per cent by weight falling in the fine sand fraction.

Two samples of fluvioglacial sand and gravel, from the valley of the Leven and from north of Ladybank were examined petrographically. In the former, the basalt and quartzite trade groups accounted for 38 and 33 per cent respectively of the 10 to 14 mm gravel fraction (Table 3). In the latter sample, obtained from boreholes 21 SE 9, 21 SE 13 and 31 SW 11, the quartzite and granite trade groups comprised 53 and 17 per cent respectively. In the pebble counts on fluvioglacial sand and gravel, the gritstone group constitutes a lower percentage than in any of the five samples from the glacial sand and gravel.

The sand is fine and medium, and, in common with the glacial sand and gravel, is largely free of coal fragments only in the Howe of Fife.

Glacial sand and gravel Most of the glacial sand and gravel is found around Collessie, between Markinch and Kennoway, at Leslie and around Kirkforthar, but small moundy deposits are quite common elsewhere; they are described in the notes on the resource blocks.

The mean grading of glacial sand and gravel is fines 6 per cent, sand 62 per cent and gravel 32 per cent (Table 4). The most widespread occurrence of gravelly material occurs south of Collessie, where the deposits grade as gravel.

It should be noted that the drilling technique employed in this survey has a slightly deleterious effect on the representativeness of gravelly samples in that the coarser fraction, especially cobbles and boulders, suffers comminution or may be forced aside by the drilling tool. Therefore the gradings of pit face samples, for example from 21 SE 14 and 21 SE 15, may give a truer picture of the size frequency distribution within the gravel fraction and the ratio of sand to gravel than do samples from adjacent boreholes, for example 21 SE 12 and 31SW 10. Outwith the Collessie area, the glacial sand and gravel commonly grades as sandy gravel or pebbly sand, but it must be emphasised that the deposits are intrinsically heterogeneous. For example glacial sand and gravel at Rameldry (borehole 30 NW 55) grades as 'very clayey' sand, at Cuinin Hill (borehole 30 SW 147) grades as sand of which 68 per cent was fine sand and at Pittillock (borehole 20 SE 362) grades as sand. The sand is fine and medium with coarse; only in the Howe of Fife is it free of coal fragments.

Five of seven pebble counts (see Table 3) are for glacial sand and gravel. Regional variations in gravel composition are considerable and it is therefore impossible to generalise. However, the salient points are that sandstone is abundant, and that the lithologies present, whether from Devonian or Carboniferous strata, are

largely dependent on the location of the deposits in relation to the rock source. Andesite, basalt and dolerite are also common, especially around Markinch; dolerite is less frequent within the 10 to 14 mm size range on which the count was made than its spatial occurrence would imply, but is abundant in the coarse and cobble gravel size ranges. Quartz and quartzite are ubiquitous, but most frequent in the Collessie area where the composite sample contained 49 per cent of these rock types. Flaky pebbles of siltstone were unusually common in borehole 20 NE 26 which contained 53 per cent of the gritstone group, much of it probably locally derived from bedrock forming the flanks of the Lomond Hills.

Till Till is present at surface or beneath younger deposits over a large part of the resource sheet area. In some boreholes a proportion of the deposit proved to be potentially workable, particularly where the local bedrock, from which much of the till is derived, is arenaceous and poorly indurated, as for example along the southern margin of the Howe of Fife in boreholes 20 NE 25, 30, 30 NW 54 and 31 SW 18 (Table 11). However, these samples were obtained from below the water table, where washing action during drilling tends to reduce seriously the amount of fines (material less than $\frac{1}{16}$ mm) recovered in samples. This assertion is reinforced by the results of grading of till samples from boreholes 30 SW 147, 148, 155, 157 and 158 which, although not in the Howe of Fife, were obtained from above the permanent water table and show much higher fines contents (mean value 21 per cent).

Examination of the borehole logs show that the composition of the till is extremely variable. This aspect, together with the conclusion that most of the till sampled in this survey is non-mineral, has determined that, with the exception of an area between Markinch and Kennoway, which is shown as discontinuous mineral exposed or beneath overburden on the resource map, potentially workable till has been excluded from the assessment of resources.

The till is generally a sandy, silty, stony clay the degree of consolidation of which depends largely on the clay to sand ratio. Clast shape ranges from angular to well rounded and clast composition generally reflects the local bedrock lithology. Sandstone, dolerite and andesite account for the bulk of the clasts, but the range of constituent rock types is extremely varied and includes siltstone, shale, coal, granite, felsite, quartz, quartzite, schist and schistose grit.

MECHANICAL AND PHYSICAL PROPERTIES OF THE AGGREGATE

Mechanical and physical tests were carried out on material from the seven composite samples listed in Table 4. Aggregate impact value (AIV), aggregate crushing value (ACV), ten per cent fines value, relative density (oven dried and surface dried), apparent relative density and water absorption were conducted in accordance with BS 812.2 and BS 812.3 (1975). Tests for aggregate impact value residue (AIVR) and aggregate crushing value residue (ACVR) were also performed to the procedure set out by Dhir, Ramsay and Balfour (1971).

AIV, AIVR, ACV, ACVR and 10 per cent fines are tests of the strength of an aggregate. AIV is a relative measure of the resistance of an aggregate to sudden shock or impact. AIVR is a measure of the proportion of original-sized material remaining after impact and is thought to be a sensitive reflector of the influence of shape (Ramsay, Dhir and Spence, 1974), whereas AIV is more dependent on petrography. ACV is a measure of the resistance of an aggregate to a slowly applied compressive load, whereas ACVR is a measure of the proportion of original-sized material remaining after compression. The 10 per cent fines value, like ACV is an indication of an aggregate's resistance to compression but the former is thought to be a more accurate indicator for weaker aggregates (Cox, 1973). Both these measurements vary chiefly as a function of the petrology of the gravel, but also of clast size, surface texture, flakiness, elongation and degree of weathering. The behaviour of crushed rock aggregates in response to mechanical testing has been studied exhaustively, for example Ramsay (1965), Dhir and others (1971), Ramsay and others (1973, 1974), allowing predictions about mechanical properties to be made which with caution may be extended to natural aggregates.

The results of the mechanical and physical tests are shown in Table 5. The values for the AIV are all higher than 19, the figure given by Edwards (1970) as the average for worked gravels in Scotland. Sample I, with an AIV of 20, is closest to the figure, possibly reflecting a high proportion of quartzite group material in this sample. The aggregate forming the composite samples taken from the south of the area tends to be weaker than that from the north, possibly due to higher proportions of friable sandstone and weak porphyritic lava. The results of the other mechanical tests show a similar pattern to those for AIV suggesting that the samples have a comparable resistance to impact and compression. The values of ACV range from 15 to 25 and cluster around the figure of 17, the average result quoted by Edwards (1970) for 'all worked Scottish gravel'. Measurements for ACV and 10 per cent fines correlate closely.

The water absorption value of an aggregate is a measure of the absorption after 24 hours of immersion in distilled water, expressed as a percentage of the oven-dried weight. This test is particularly important because there is a broad linear relationship between water absorption and drying shrinkage, both of the aggregate itself and any concrete made with it. 'Moisture movement' which includes drying shrinkage and wetting expansion is a key factor in determining the stress-carrying ability of concrete and its susceptibility to weathering.

The water absorption values given in Table 5, which range from 2.7 to 6.1 per cent (average 4.1 per cent),are very high compared with the range of average values (0.27 to 1.36 per cent) for various groups of crushed rocks listed by Edwards (1966, 1970) and compare little better with the average of 1.48 per cent and the range of 0.09 to 2.77 per cent quoted for natural aggregates (Edwards, 1970). Sample I, which gave the best mechanical test results, just falls within the range quoted by Edwards.

Using the graph drawn by Edwards (1970) linking water absorption with concrete drying shrinkage, all the samples tested have inferred shrinkage values in excess of 0.085 per cent which would limit their use to structures where complete drying-out never occurs. However, it must be emphasised that derived shrinkage values should be interpreted cautiously as accurate results can only be obtained by laboratory testing of concrete blocks made from the various aggregates.

Table 5 Results of mechanical and physical tests BS 812 (1975)

Composite sample	Deposit type	AIV (%)	AIVR (%)	ACV (%)	ACVR (%)	10% fines value (kn)	Relative density (oven-dried basis)	Relative density (surface-dried basis)	Apparent relative density	Water absorption
I	Glacial sand and gravel	20	49	15	43	240	2.51	2.58	2.69	2.7
II	Fluvioglacial sand and gravel	24	38	18	41	210	2.49	2.56	2.69	3.0
III	Glacial sand and gravel	23	*	*	*	*	2.36	2.50	2.76	6.1
IV	Glacial sand and gravel	26	41	21	41	180	2.48	2.56	2.70	3.3
V	Fluvioglacial sand and gravel	23	35	21	34	190	2.44	2.54	2.71	4.1
VI	Glacial sand and gravel	33	30	25	30	100	2.47	2.58	2.79	4.7
VII	Glacial sand and gravel	28	39	25	34	100	2.39	2.50	2.69	4.6

*Insufficient material for test

The relative density is quoted both on an oven-dried and a saturated surface-dry basis. Values of the former range from 2.36 to 2.51, with a mean of 2.44: those of the latter range from 2.50 to 2.58, with a mean of 2.54. Values for apparent relative density vary from 2.69 to 2.76 and in general reflect the results obtained for the relative densities. Samples I and II, from the glacial and fluvioglacial gravels to the north of Ladybank, show the highest resistance to impact and compression, and exhibit a relatively low water absorption.

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 1:25000 Outline Edition which together with the contours is printed in grey: the geological lines and symbols are in black. Mineral resource information, is presented in shades of red.

Geological data The geological boundary lines are taken from geological maps surveyed at the scale of 1:10000 or 1:10560; these offer the best interpretation of the available data but, due to the highly variable nature of the deposits, the accuracy of the map will be improved as new evidence from boreholes and excavations becomes available.

Borehole data, which include the stratigraphical relations and mean particle-size analysis of the sand and gravel samples collected during the assessment, are also shown on the map.

Mineral resource information The map is divided into resource blocks (see Appendix A) within which the extent of mineral-bearing ground is shown in red. The dark shade denotes where mineral is exposed, that is, the overburden averages less than 1.0 m in thickness: a lighter tone is used to identify where it is present in relatively continuous spreads beneath overburden averaging more than 1.0 m in thickness. Within these areas, however, there may be small patches where sand and gravel is absent or not potentially workable, as for example, around borehole 20NE32.

A further category which is shown on the resource map in the lightest tone of red, is recognised where mineral is considered discontinuous. The recognition of categories is subjective, depending on the proportion of boreholes which did not find potentially workable sand and gravel, and the distribution of these barren boreholes within an area. The mineral is described as 'almost continuous' if it is present in 75 per cent or more of the boreholes in a prescribed area and as 'discontinuous' if present in more than 25 per cent but less than 75 per cent of the boreholes in a prescribed area.

Areas where sand and gravel is deemed to be not potentially workable, where superficial deposits do not contain mineral, or where bedrock crops out, are shown uncoloured. Sand and gravel within built-up areas and patches too small to be assessed, but which may nevertheless be potentially workable, are indicated by red stipple.

For the most part the distribution of resource categories is based on mapped geological boundaries. Where transitions between categories cannot be related to the geological map, inferred boundaries have been inserted. Such boundaries, drawn primarily for the purpose of volume estimation, are shown by a distinctive zigzag symbol, which is intended to convey an approximate location within a likely zone of occurrence rather that to represent the breadth of the zone; its width is dictated by cartographic considerations. For the purpose of measuring areas the centre-line of the symbol is used.

RESULTS

The results of the assessment of resources are summarised in Tables 6 and 7. More detailed grading and thickness data by block are given in Tables 8 to 14 and presented graphically in Figures 4 to 12, which show mean grading plotted both cumulatively and as a frequency distribution, with grading envelopes for the former. No statistical assessment is given for block G where the distribution of mineral is limited and uneven.

Accuracy of results: For the six resource blocks assessed statistically, the accuracy of the results at the symmetrical 95 per cent probability level ranges from 20 to 59 per cent (that is, it is probable that nineteen times out of twenty the true yields or volumes present lie within these limits). However, the real values are more likely to be nearer the median than the limits. Moreover, it is probable that roughly the same percentage limits would apply for the estimate of mineral volume within a very much smaller parcel of ground (for example, 100 hectares) containing similar sand and gravel deposits, if the results from the same number of sample points (as provided by, say, ten boreholes) were used in the calculation. Thus, if closer limits are needed for the quotation of reserves, data from more sample points would 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.

Table 6 The sand and gravel resources: summary of statistical assessments

Resource block (deposits)	Area		Mean thickness		Volume of sand and gravel			Yield of sand and gravel	Mean grading percentage		
	Block	Mineral	Overburden	Mineral		Limits at the 95% probability level		m^3 per	Fines	Sand	Gravel
	km^2	km^2	m	m	$m^3 \times 10^6$	±%	$\pm m^3 \times 10^6$	hectare	$-\frac{1}{16}$mm	$+\frac{1}{16}$ -4mm	+4mm
A *Glacial and fluvioglacial sand and gravel*	14.0	12.3	0.4	5.4	67	30	20	54000	4	44	52
B *Fluvioglacial sand and gravel*	9.9	9.9	0.5	4.5	45	20	9	45000	9	82	9
C *Glacial and fluvioglacial sand and gravel and late-Glacial alluvium*	10.0	10.0	1.2	3.1	31	43	13	31000	13	74	13
D* *Glacial and fluvioglacial sand and gravel and late-Glacial alluvium*	12.6	11.6	0.5	2.9	33	39	13	29000	7	84	9
E *Glacial and fluvioglacial sand and gravel*	11.8	7.1	0.6	7.6	54	83	45	76000	7	79	14
F *Till, glacial and fluvioglacial sand and gravel*	13.0	7.6	1.4	4.3	33	59	19	43000	13	40	47
Totals	71.3	58.5			263						

*Excluding potentially workable till

Table 7 The sand and gravel resources: summary of inferred assessments (within block G)

Sub-block	Deposit	Locality	Area (km^2)	Thickness (m)	Inferred volume (million m^3)
G_1	Glacial sand and gravel	Balsillie Laws [248023]	1.28	6.0	7.7
G_1	Lacustrine alluvium	Auchmuirbridge [218011]	1.23	1.8	2.2
G_1	Glacial and fluvioglacial sand and gravel	Ballingall Burn [234088]	0.11	2.2	0.2
G_1	Alluvium	Chancefield [232081]	0.13	1.4	0.2
G_2	Glacial sand and gravel	Rameldry [325065]	1.71	2.2	3.8
G_3	Alluvium	River Eden [290085]	1.81	1.7	3.1
Total			6.27		17.2

NOTES ON THE RESOURCE BLOCKS

The resource sheet is divided into seven resource blocks. Blocks A to F encompass the principal potentially workable sand and gravel-bearing deposits, whereas block G, which is split into three sub-blocks for convenience of description, incorporates the remainder. The block boundaries have been delineated with the aim of grouping together deposits of broadly similar composition and grade: geological boundaries have usually facilitated such divisions.

Blocks A to D conform readily with the above criteria. Blocks B and C might have been considered as one except that the combined area would have been excessive. Blocks E and F contain a variety of deposits which are of limited areal extent; the delineation of these two blocks is therefore a compromise in order to achieve parcels of mineral of a convenient size.

The block boundaries exclude the urban areas of Leslie, Markinch and Glenrothes which are not assessed. Although much of the unassessed land north of the Leven appears undeveloped on the topographic base to the resource map, in reality most of the area between Balgeddie [256 028] and Balfarg [284 033] is built upon.

Block A This block incorporates nearly all the glacial sand and gravel mapped at the surface, north of the River Eden. It also includes deposits of fluvioglacial sand and gravel east of Collessie [286 132] and north of Ladybank [305 100] considered to be reworked glacial sand and gravel. Both deposits are similar in lithology and grading within block A, and the geological boundaries between them are somewhat arbitrary, especially between Giffordtown [290 111] and Barham [317 127]. Consequently glacial and fluvioglacial sand and gravel are assessed together. The southern limit of the block within fluvioglacial sand and gravel coincides with geographically convenient public roads and footpaths.

The deposits are in the form of a fan, with its roots at Collessie [286 132] at the mouth of the Lindores Gap. The surface of the glacial sand and gravel is generally moundy with many hollows, many of them lined with peat or alluvium, for example, north of Kinloch [282 122]. South of the A91 trunk road at Cornhill [280 132] an esker, known locally as Birnie Hill, forms a narrow ridge extending for over 1.2 km, and is composed of coarse gravel. The fluvioglacial sand and gravel surface, although more subdued than in the glacial sand and gravel, is gently undulating with a number of prominent hollows, for example at Pitlair [319 121].

With the exception of the depressions containing peat and alluvium, and a few outcrops of till and rock between Ballantager [309 138] and Barham [317 127] sand and gravel is exposed at the surface throughout the block.

Based on eight assessment boreholes and three sections the mean thickness of mineral is 5.4 m (Table 8). All the boreholes proved the complete drift succession to bedrock. Sections 21 SE 14 and 31 SW 9 are considered to have sampled most of the mineral sequence; only section 21 SE 15 in the Corrour Quarry [296 111] may have failed to sample a significant thickness of mineral. The major meltwater channel supplying material is believed to have been the Lindores Gap; consequently the deposits are generally thickest in proximity to Collessie and demonstrate progressive thinning towards the extremities of the block. The greatest recorded thicknesses were 7.9, 8.9 and 9.0 m in boreholes 21 SE 12 and 31 SW 10 and section 21 SE 14. The mean grading of mineral from boreholes and sections is fines 4 per cent, sand 44 per cent and gravel 52 per cent (Figure 4), the figure for gravel being exceeded only in block F of this resource sheet area.

The gravel fraction displays considerable uniformity throughout: coarse gravel predominates over fine or cobble gravel except in the southern and eastern fringes of the block. Boulders, up to a maximum diameter of 650 mm, were observed in working pits, notably the Collessie Quarry. Although cobbles were most abundant in exposures 21 SE 14, 21 SE 15 and 31 SW 9 (Table 8) this almost certainly reflects the different sampling techniques used for boreholes and exposed sections, because in the former cobbles tend to be comminuted or forced outside the drilling mechanism. Although sand is always present in the matrix of the deposits and in scattered discrete seams, only at the southern and eastern extremities of the block does sand comprise more than 50 per cent of the deposit as a whole, for example in section 31 SW 9 and boreholes 31 SW 12 and 31 SW 19. A decrease in gravel content with depth was observed in section 31 SW 9 and boreholes 31 SW 10 and 31 SW 19.

Table 8 Block A: Data from sample points and the assessment of resources

Sample point Borehole or section	Recorded thickness			Mean grading percentage							Descriptive category (see diagram in Appendix C)
	Mineral	Overburden	Waste partings	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}$ $-\frac{1}{4}$mm	Medium sand $+\frac{1}{4}$ -1mm	Coarse sand $+1$ -4mm	Fine gravel $+4$ -16mm	Coarse gravel $+16$ -64mm	Cobbles and boulders $+64$mm	
	m	m	m								
FLUVIOGLACIAL AND GLACIAL SAND AND GRAVEL											
21 SE 8	3.4	0.3	–	6	11	17	14	22	29	1	G
21 SE 10	6.0	1.2	–	6	8	18	22	23	23	0	SG
21 SE 11	5.0	0.2	–	5	7	15	15	22	33	3	G
21 SE 12	7.9	0.2	–	5	7	16	22	25	22	3	G
21 SE 14*	9.0+	–	–	2	4	10	9	15	36	24	G
21 SE 15*	5.5+	–	–	2	7	22	11	19	34	5	G
31 SW 9*	4.2+	–	–	1	13	31	9	12	22	12	SG
31 SW 10	8.9	0.2	–	4	8	20	14	23	28	3	G
31 SW 11	2.9	0.4	–	4	11	23	15	21	25	1	SG
31 SW 12	3.1	1.1	–	6	17	26	13	20	18	0	SG
31 SW 19	3.7	0.4	–	6	18	36	13	17	10	0	SG
Mean	5.4	0.4	–	4	9	20	15	20	26	6	G

*Section in a sand and gravel working

Statistical assessment of fluvioglacial and glacial sand and gravel

Total area of mineral	12.32 km^2
Area of worked out sand and gravel	0.79 km^2
Mean thickness of overburden	0.4 m
Mean thickness of mineral	5.4 m
Estimated volume of mineral	67 million m^3 ± 30% or 20 million m^3
Estimated yield of sand and gravel per hectare	54 thousand m^3

Three quarries in the block were being worked at the time of survey (p.27) and there are numerous sites of former small-scale extraction. No operator is taking material from below the water table, which was more than 9 m below surface at the Collessie Quarry (section 21 SE 14), more than 12 m below ground surface in borehole 21 SE 11, but only 4.2 m below surface in section 31 SW 9. For seven assessment boreholes which struck water, the mean depth to water is 4.9 m. Till is exposed sporadically in the floors of the Collessie and Angle Park No.3 quarries, indicating that the amount of mineral left unworked is not substantial. In all boreholes except 21 SE 10, potentially workable sand and gravel overlies till. In places, for example in borehole 21 SE 10 and around Barham [317 127] sand and gravel rests directly on bedrock.

The estimated yield of all potentially workable material is 54 000 m^3 per hectare, equivalent to 67 million m^3 ± 30 per cent for the block as a whole.

Block B This block lies to the south of block A. Its southern margin corresponds with the geological boundary separating fluvioglacial sand and gravel from the alluvium of the River Eden. To the east the block boundary coincides with the mapped limit of fluvioglacial sand and gravel, but a detached deposit east of the incised valley of the Rankeilour Burn (which exposes underlying till and sandstone bedrock) is also included. To the west the block is defined by the geological boundary between late-Glacial alluvium and fluvioglacial sand and gravel, the latter comprising most of the potentially workable material in block B.

Fluvioglacial sand and gravel forms a broad flattish terrace inclined towards the River Eden. Locally the surface is gently undulating and peat-filled hollows occur, for example in Heggie's Muir Wood at [317 105], but with a lesser frequency than in block A.

Mineral is found at surface beneath soil over most of the block, the exceptions being the scattered hollows containing peat or silty alluvium as for example at Jennystown [324 111], the valley of the Rankeilour Burn, and several localities within the grounds of Rankeilour House where bedrock and till crop out.

On the basis of ten assessment boreholes and one section, the mean thickness of mineral in the block is 4.5 m. The greatest recorded thicknesses were 6.3 m in

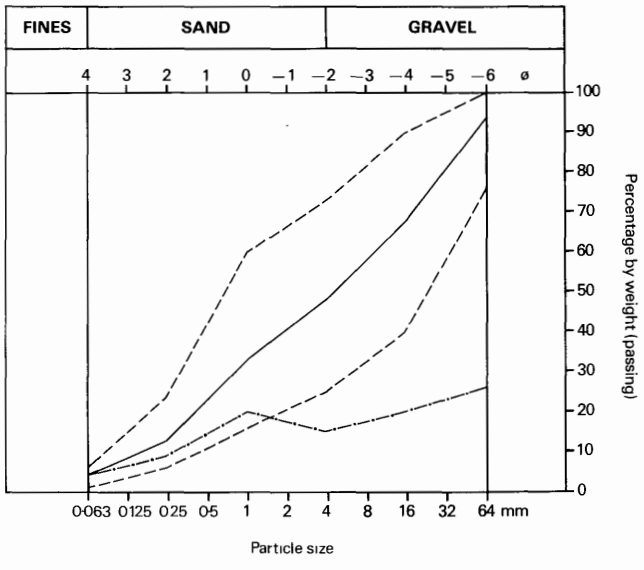

Figure 4 Grading characteristics of resources in the fluvioglacial and glacial sand and gravel (block A); the continuous line shows the cumulative weighted mean; the broken lines define the envelope within which the cumulative mean gradings of individual deposits fall; the frequency distribution of the mean grading is shown by a dashed and dotted line.

Table 9 Block B: Data from sample points and the assessment of resources

Sample point Borehole or section	Recorded thickness			Mean grading percentage							Descriptive category (see diagram in Appendix C)
	Mineral	Overburden	Waste partings	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}$ $-\frac{1}{4}$mm	Medium sand $+\frac{1}{4}$ -1mm	Coarse sand $+1$ -4mm	Fine gravel $+4$ -16mm	Coarse gravel $+16$ -64mm	Cobbles and boulders $+64$mm	
	m	m	m								
FLUVIOGLACIAL SAND AND GRAVEL											
20 NE 34	5.5	0.2	–	8	49	37	4	2	0	0	S
21 SE 9	4.9	0.4	–	13	30	24	8	12	13	0	CSG
21 SE 13	4.6	0.4	–	4	20	33	17	18	8	0	SG
30 NE 51	5.1	0.9	–	24	59	14	2	1	0	0	VCS
30 NW 58*	3.6+	0.6	–	1	47	46	3	2	1	0	S
30 NW 59	2.6	0.6	–	9	49	37	3	2	0	0	S
31 SW 13	4.3	0.4	–	2	40	44	5	7	2	0	PS
31 SW 14	6.3	0.4	–	11	46	30	6	5	2	0	CPS
31 SW 15	3.3	0.3	–	2	30	37	13	13	5	0	PS
31 SW 16	6.0	0.4	–	13	59	26	1	1	0	0	CS
31 SW 17	2.8	0.4	–	7	27	49	10	7	0	0	PS
Mean	4.5	0.5	–	9	43	33	6	6	3	0	PS

*Section in a sand and gravel working

Statistical assessment of fluvioglacial sand and gravel

Total area of mineral	9.91 km^2
Area of worked out sand and gravel	0 km^2
Mean thickness of overburden	0.5 m
Mean thickness of mineral	4.5 m
Estimated volume of mineral	45 million m^3 ± 20% or 9 million m^3
Estimated yield of sand and gravel per hectare	45 thousand m^3

borehole 31 SW 14 and 6.0m in borehole 31 SW 16, between Ladybank and Jennystown (Table 9). All boreholes except 30 NW 51 and 31 SW 16 proved the succession to bedrock. The former was abandoned on a boulder in late-Glacial estuarine deposits and the latter was aborted due to an obstruction in till: in both cases mineral would be unlikely to be present below the termination depth.

In boreholes 20 NE 34, 21 SE 13, 30 NW 51, 30 NW 59, 31 SW 15 and 31 SW 16, the basal unit of fluvioglacial sand and gravel ranges from 0.4 to 2.8m in thickness, and proved to be non-mineral. In boreholes 21 SE 9, 31 SW 13 and 31 SW 17 along the north edge of the block sand and gravel overlies till. In the remaining borehole, 31 SW 14, mineral is underlain by late-Glacial estuarine deposits of silt and silty clay.

The mean grading of mineral from borehole and section samples is fines 9 per cent, sand 82 per cent and gravel 9 per cent (Table 9 and Figure 5). Fine sand is the most abundant component (for definition see the table in Appendix C), constituting 43 per cent of the mineral in the block. Boreholes 21 SE 9, 21 SE 13 and 31 SW 15 contain between 18 and 26 per cent of gravel, otherwise coarse aggregate forms a minor proportion of the mineral in block B. The deposits, with few exceptions, fine with depth to such a degree that in boreholes 20 NE 34, 30 NW 51, 30 NW 59 and 31 SW 13, 14, 15 and 16, the basal mineral unit comprises more than 80 per cent fines and fine sand, indicative of deposition in standing water. Apart from 1.8m of 'clayey' sand with plant remains proved in borehole 21 SE 9, which was sited in a small depression in the post-Glacial surface on a deposit classified as alluvium, all potentially workable material in the block is fluvioglacial sand and gravel.

Sand and gravel was formerly worked on a small scale on the outskirts of Ladybank, and to a small extent at numerous other localities, for example at Gravelpit Wood [311 103]. Currently (1980) sand is being extracted from a pit at Ramornie (p.27) where the maximum depth of working is between three and four metres.

Boreholes 31 SW 13, 15 and 17 in the north-eastern part of block B struck water approximately 8m below surface. Elsewhere, groundwater was encountered 5m or less below surface, the shallowest water level being

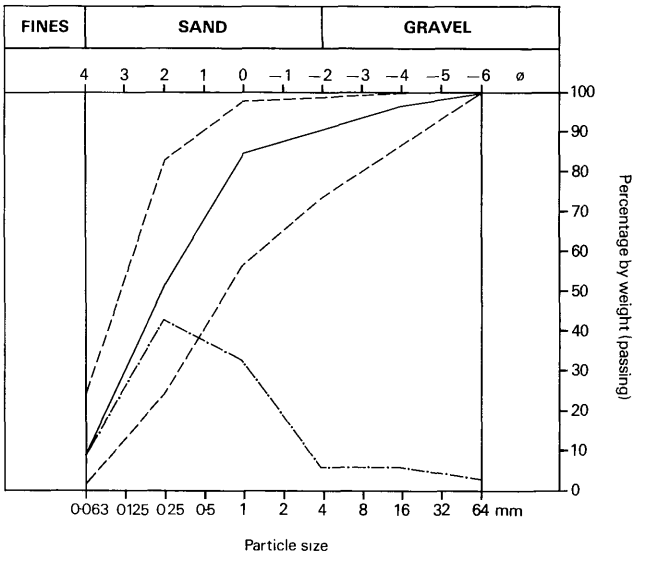

Figure 5 Grading characteristics of resources in the fluvioglacial sand and gravel (block B); for explanation, see Figure 4.

1 m below ground in borehole 20 NE 34. For example, in section 30 NW 58 in the Ramornie Quarry, water was proved 4.2 m below ground surface, just beneath the pit floor.

The estimated yield of all potentially workable sand and gravel is 45 000 m^3 per hectare, equivalent to 45 million m^3 ± 20 per cent for the block as a whole.

Block C The boundary between block C and block A, which lies to the north-east, coincides with the line separating lacustrine alluvium from glacial sand and gravel. To the east where blocks C and B abut, the boundary follows the contact between lacustrine alluvium and fluvioglacial sand and gravel. The separation of blocks B and C is arbitrary as both display many similarities in respect of their mineral characteristics. To the south the block is bounded by the alluvium of the River Eden or the river itself where alluvium is absent. Elsewhere the block boundary coincides with the mapped extent of exposed mineral. Mineral in the block is classified as lacustrine alluvium, late-Glacial alluvium, fluvioglacial sand and gravel, and glacial sand and gravel, the last-named referring to the buried deposits of uncertain origin in boreholes 21 SE 5 and 7.

The broad terrace of block B continues westwards into block C but the geology becomes more complex. Two terrace levels have been identified: the higher and older is mapped as fluvioglacial sand and gravel; the lower and younger, as a result of radiocarbon dating, is designated late-Glacial alluvium. In addition, there is a large elongate depression approximately 3 km by 1.5 km, marking the site of the artificially-drained former Rossie Loch. Within the confines of the former loch, potentially workable sand and gravel is present beneath peat and silt, boreholes 21 SW 2, 21 SE 5 and 21 SE 7 proving 1.7, 0.4 and 6.1 m respectively of overburden on mineral. The area of the former loch is shaded pale pink on the resource map, as the mean thickness of overburden exceeds 1 m. Elsewhere in the block sand and gravel is exposed at surface, any cover of soil or made ground (not separately identified) averaging less than 1 m in thickness.

Based on seven assessment boreholes, one water borehole and one temporary section, the mean thickness of mineral in the block is 3.1 m (Table 10). All boreholes but one reached bedrock; in 21 SE 5 the determination of rockhead could not be confirmed, as the borehole may have been terminated on a large boulder in till. Temporary section 21 SE 16 at the Rossie Drain revealed 5.4 m of mineral interbedded with 0.4 m of peat and clay. The greatest recorded thicknesses of mineral from assessment boreholes are 4.7 m in 20 NE 27, 3.9 m in 20 NE 33 and 5.1 m in 21 SE 5. Sand and gravel is thinnest to the west and south-west of the site of Rossie Loch.

In boreholes 20 NE 33, 21 SW 1 and 21 SW 2 the basal unit of fluvioglacial sand and gravel ranges in thickness from 0.9 to 4.3 m and is judged non-mineral. In borehole 21 SE 5 two deposits, each of which contains mineral in the upper part, became silty and not potentially workable towards their bases. In borehole 20 NE 27 fluvioglacial sand and gravel overlies late-Glacial estuarine deposits of silty clay. Till underlies mineral in boreholes 21 SE 2, 6 and 7.

The mean grading of mineral is fines 13 per cent, sand 74 per cent and gravel 13 per cent (Table 10 and Figure 6). In common with block B the most abundant fraction is fine sand, comprising 45 per cent of the mineral in boreholes. With the exceptions of 2.8 m of sandy gravel in borehole 21 SE 5, 2.2 m of gravel in borehole 21 SE 7 and 4.7 m grading as pebbly sand in borehole 20 NE 27, gravel forms a negligible constituent. However, on the evidence of boreholes 21 SE 5 and 7 it is possible that part of the site of Rossie Loch, especially towards the east and north-east, is underlain by gravel.

Table 10 Block C: Data from sample points and the assessment of resources

Sample point	Recorded thickness			Mean grading percentage							Descriptive category (see diagram in Appendix C)
Borehole or section	Mineral	Overburden	Waste partings	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}$ $-\frac{1}{4}$mm	Medium sand $+\frac{1}{4}$ -1mm	Coarse sand $+1$ -4mm	Fine gravel $+4$ -16mm	Coarse gravel $+16$ -64mm	Cobbles and boulders $+64$mm	
	m	m	m								
LACUSTRINE AND LATE-GLACIAL ALLUVIUM, FLUVIOGLACIAL AND GLACIAL SAND AND GRAVEL											
20 NE 27	4.7	0.6	–	4	28	44	10	10	4	0	PS
20 NE 33	3.9	0.3	–	16	74	9	1	0	0	0	CS
21 SW 1	1.7	0.8	–	25	59	12	3	1	0	0	VCS
21 SW 2	1.9	1.7	–	24	52	22	1	0	1	0	VCS
21 SE 2	1.6	0.5	–	No grading data available							
21 SE 5	5.1	0.4	1.0	9	44	21	8	9	8	1	PS
21 SE 6	1.4	0.4	–	27	42	23	5	3	0	0	VCS
21 SE 7	2.2	6.1	–	4	13	17	13	24	29	0	G
21 SE 16*	5.4+	0.3	0.4	No grading data available							
Mean	3.1	1.2	–	13	45	23	6	7	6	0	CPS

*Temporary section

Statistical assessment of lacustrine and late-Glacial alluvium, fluvioglacial and glacial sand and gravel

Total area of mineral	10.00 km^2
Mean thickness of overburden	1.2 m
Mean thickness of mineral	3.1 m
Estimated volume of mineral	31 million m^3 ± 43% or 13 million m^3
Estimated yield of sand and gravel per hectare	31 thousand m^3

In common with block B, borehole results for this block show that the surface deposits become finer with depth, and that parts of the deposits in boreholes 20 NE 33, 21 SW 1 and 21 SE 5 comprise more than 80 per cent of fines and fine sand, suggestive of deposition in standing water.

There are no active mineral workings in block C. All boreholes encountered water, at depths ranging from 0.8 to 4 m below ground surface: the mean depth to water is 2.7 m.

The estimated yield of all potentially workable sand and gravel is 31 000 m^3 per hectare, equivalent to 31 million m^3 ± 43 per cent for the block as a whole.

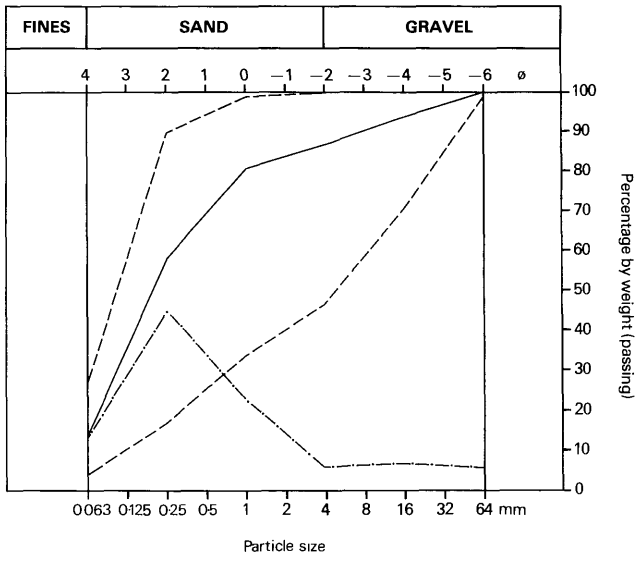

Figure 6 Grading characteristics of resources in the lacustrine and late-Glacial alluvium, fluvioglacial and glacial sand and gravel (block C); for explanation , see Figure 4.

Block D The northern boundary of this block corresponds with the mapped extent of late-Glacial alluvium and fluvioglacial sand and gravel on the south side of the River Eden, except in the vicinity of Dunshelt [249 104] where the Eden itself is taken as the limit. To the south, the boundary coincides with the extent of continuously exposed mineral, except near Darnoe at [257 084] and at Kirkton of Cults [347 098] where small isolated mounds of glacial sand and gravel have been included.

Block D is the analogue of blocks B and C on the opposite bank of the Eden. Most of the mineral deposits take the form of broad terrace-like features which, as in block C, have been divided into an upper, older deposit mapped as fluvioglacial sand and gravel and a lower, younger terrace defined as late-Glacial alluvium. The two surfaces have been identified between Dunshelt and Orkie Miln [300 080] but eastwards the features merge and most of the mineral is classified as fluvioglacial sand and gravel. Moundy deposits at Kirkton of Cults and a series of small mounds near Falklandwood [249 087] forming a beaded esker, are mapped as glacial sand and gravel, but there are no sample points. Several widely-separated boreholes proved potentially workable sandy till, which has been excluded from the calculation of volumes owing to its sporadic occurrence.

Mineral generally occurs at the surface throughout the block and is present beneath peat north-east of Myreside at [267 080]. However, near Dunshelt pit 21 SW 4 proved 1.8 m of silt and clay, believed to be late-Glacial estuarine deposits, and near Maryfield [268 087] till and bedrock crop out. Between Lathrisk Home Farm [274 083] and Riggs [289 078] a long, low ridge is composed of till and near Easter Lathrisk [285 082] silty clay was recorded in shallow temporary sections during the field survey. Sand and gravel is present at Lathrisk but borehole 20 NE 28 revealed that it is too thin to be potentially workable, and an area where mineral is thought to be absent and which may be more or less extensive than indicated, is shown on the resource map. Till and bedrock crop out at a number of localities near Pitlessie [33 09] and Kirkton of Cults. Pit 20 NE 40 proved 2.2 m of material classified as waste; however, as the pit bottomed in mineral, having penetrated 0.5 m of silty fine sand, it is probable that the total thickness of sand exceeds 1 m.

Based on eight assessment boreholes and four shallow pits, the mean thickness of all mineral late-Glacial alluvium, fluvioglacial sand and gravel, glacial sand and gravel and till in block D is 3.9 m, (Table 11). All boreholes proved bedrock. Pits 20 NE 38 and 30 NW 61 reached till. Though pits 20 NW 9 and 20 NE 36 were terminated in mineral, they were sited in areas where sand and gravel is likely to be thin. Only pit 30 NW 67, for which no grading information is available, may have failed to penetrate a substantial thickness of mineral; accordingly it has been excluded from the calculation of mean thickness. The thickest deposits of mineral are 10.1 m in 30 NW 54, 6.9 m in 31 SW 18, 6.2 m in 30 NW 52 and 5.8 m in 20 NE 25 (Table 11). However, if potentially workable till is excluded, the mean thickness is 2.9 m and the greatest recorded thicknesses are 6.2 m in 30 NW 52, 6.0 m in 30 NW 54, 4.0 m in 20 NE 25 and 3.4 m in 20 NE 25.

In boreholes 20 NW 2, 20 NE 23, 20 NE 25, 20 NE 28, 20 NE 30, 30 NW 52 and pits 20 NE 38 and 30 NW 61, mineral (excluding potentially workable till) rests on till. In boreholes 21 SW 3, 30 NW 54 and 31 SW 18, the basal unit of fluvioglacial sand and gravel is non-mineral. In 30 NW 53, 1.4 m of 'very clayey' sand overlies 9.5 m of late-Glacial estuarine silt and clay.

The mean grading of mineral is fines 9 per cent, sand 77 per cent and gravel 14 per cent (Table 11 and Figure 7). If potentially workable till is excluded, the corresponding figures are 7 per cent fines, 84 per cent sand and 9 per cent gravel, analogous to the results for block B as a whole. Like blocks B and C the most abundant mineral component is fine sand. Excluding potentially workable till, boreholes 20 NE 23 and 20 NE 25, and pits 20 NW 9 and 30 NW 61 proved 1.4, 3.0, 1.0 and 1.5 m respectively of sandy gravel or 'clayey' sandy gravel, classified as fluvioglacial sand and gravel. Borehole 20 NE 30 penetrated 1.0 m of sandy gravel (glacial sand and gravel). Otherwise the mineral deposits in block D are predominantly sandy.

In boreholes 20 NE 25, 20 NE 30, 30 NW 54 and 31 SW 18, a proportion of the till was sufficiently sandy to grade as mineral, but it should be noted that below the water table the drilling method results in a washing action which artificially depresses the level of fines in silty or clayey samples. The sandy till is a reflection of the local bedrock which over much of block D is a very friable fine- to medium-grained sandstone.

There are no active quarries in block D, but sand and gravel was formerly worked on a small scale near Dunshelt and at three localities close to Falklandwood. Eight assessment boreholes encountered water at depths varying from 1.4 to 4.0 m: the mean depth is 2.6 m.

The estimated yield of all potentially workable sand and gravel, but excluding mineral till, is 29 000 m^3 per hectare, equivalent to 33 million m^3 ± 39 per cent for the block as a whole.

Table 11 Block D: Data from sample points and the assessment of resources

Sample point Borehole or section	Recorded thickness			Mean grading percentage							Descriptive category (see diagram in Appendix C)
	Mineral	Overburden	Waste partings	Fines $-\frac{1}{16}$	Fine sand $+\frac{1}{16}$ $-\frac{1}{4}$mm	Medium sand $+\frac{1}{4}$ -1mm	Coarse sand $+1$ -4mm	Fine gravel $+4$ -16mm	Coarse gravel $+16$ -64mm	Cobbles and boulders $+64$mm	
	m	m	m	mm							
LATE-GLACIAL ALLUVIUM, FLUVIOGLACIAL AND GLACIAL SAND AND GRAVEL											
20 NW 2	1.7	0.4	–	17	67	13	1	1	1	0	CS
20 NW 9*	1.8+	0.3	–	10	42	24	7	9	8	0	CPS
20 NE 23	3.4	0.6	–	7	30	30	10	12	11	0	PS
20 NE 25	4.0	0.5	–	7	30	29	11	12	9	2	PS
20 NE 30	1.3	0.9	–	15	32	30	10	10	3	0	CPS
20 NE 36*	1.7+	0.3	–	5	43	41	10	1	0	0	S
20 NE 38*	1.6	0.3	–	2	40	48	6	3	1	0	S
21 SW 3	2.6	0.2	–	10	71	18	1	0	0	0	CS
30 NW 52	6.2	0.7	0.9	4	52	40	3	1	0	0	S
30 NW 54	6.0	0.6	–	8	51	37	3	1	0	0	S
30 NW 61*	1.5	0.4	–	16	31	20	6	11	9	7	CSG
31 SW 18	3.1	0.9	–	1	32	59	6	2	0	0	S
Mean	2.9	0.5	–	7	44	34	6	5	3	1	PS
TILL											
20 NE 25	1.8	–	–	13	61	25	1	0	0	0	CS
20 NE 30	2.1†	–	0.1	7	22	28	15	13	15	0	SG
30 NW 54	4.1	–	0.1	9	38	17	7	11	11	7	SG
31 SW 18	3.8	–	–	16	46	10	4	6	11	7	CSG
Mean	3.0	–	–	12	40	18	7	8	10	5	CSG
ALL DEPOSITS											
Mean	3.9	0.5	–	9	44	27	6	6	6	2	PS

*Shallow pit
†Includes 1 m of glacial sand and gravel

Statistical assessment of late-Glacial alluvium, fluvioglacial and glacial sand and gravel

Total area of mineral	11.55 km^2
Mean thickness of overburden	0.5 m
Mean thickness of mineral	2.9 m
Estimated volume of mineral	33 million m^3 ± 39% or 13 million m^3
Estimated yield of sand and gravel per hectare	29 thousand m^3

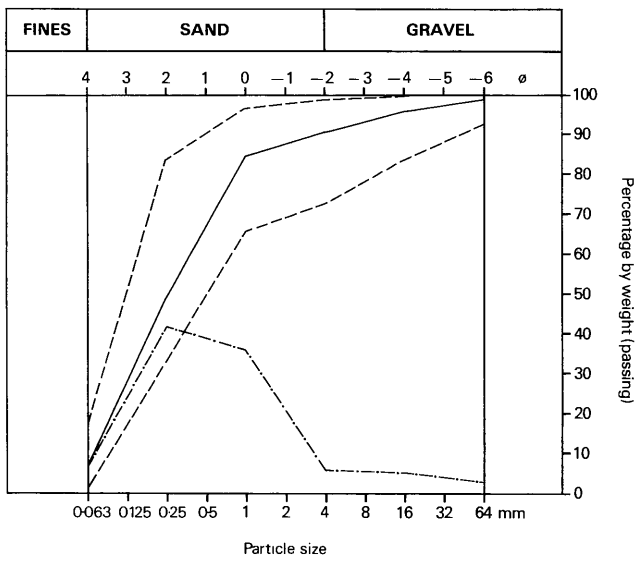

Figure 7 Grading characteristics of resources in the late-Glacial alluvium, fluvioglacial and glacial sand and gravel (block D); for explanation, see Figure 4.

Block E

This block straddles the watershed between the rivers Eden and Leven. To the north-east and east the block boundary coincides with the mapped extent of glacial and fluvioglacial sand and gravel, except that beneath Star Moss [306 042] it coincides with an inferred boundary separating mineral from barren ground. To the north-west the block has been arbitrarily defined to include several discrete sand and gravel deposits. To the south-west and south the block extends to the boundary of Glenrothes New Town or follows the limit of exposed sand and gravel, except that it is arbitrarily closed off near Northhall [301 024] where the outcrop of glacial sand and gravel narrows to about 100 m.

In broad terms the mineral in block E comprises a flattish spread of fluvioglacial sand and gravel centred on Lochmuir Wood [296 039], and contained to the north and south by moundy deposits of glacial sand and gravel in the form of two belts aligned east-south-east. West of the northern belt and the A92 and A912 roads lie a number of prominent, isolated, elongate mounds of sand and gravel. Between Nether Drums [276 060] and Forthar Mill [286 058] are the remnants of a fluvioglacial terrace, and also a small patch of glacial sand

and gravel contained in till and exposed in the valley of the Purin Burn at [272 063]. There are several broad shallow peat-filled depressions within the main outcrop of fluvioglacial sand and gravel. Outwith these basins, mineral is present at the surface throughout much of the block, except in the north-west where discrete mounds of sand and gravel overlie till.

On the basis of eleven assessment boreholes, the mean thickness of all potentially workable material in block E is 7.6 m: the greatest thicknesses were 12.3 m in 20 NE 26, 11.8 m in 20 SE 365, 22.0 m in 20 SE 367 and 16.5 m in 30 SW 147 (Table 12). For eight boreholes in glacial sand and gravel and three boreholes in fluvioglacial sand and gravel the mean thicknesses of mineral are 10.3 and 5.7 m respectively. Boreholes 20 NE 26 and 31, 30 SW 146, 147 and 150 proved the complete drift sequence to bedrock; boreholes 20 SE 363, 365 and 30 SW 151 were stopped by boulders in till, and at the last-mentioned site it is conceivable that mineral may be present within till below the depth reached, as shown nearby in block F by shallow pit 30 SW 168. Boreholes 20 SE 362 and 366 were terminated due to excessive thickness of waste beneath mineral, and borehole 20 SE 367 reached the maximum depth of drilling still in mineral.

Table 12 Block E: Data from sample points and the assessment of resources

Sample point / Borehole or section	Recorded thickness			Mean grading percentage							Descriptive category (see diagram in Appendix C)
	Mineral	Overburden	Waste partings	Fines $-\frac{1}{16}$	Fine sand $+\frac{1}{16}$ $-\frac{1}{4}$mm	Medium sand $+\frac{1}{4}$ -1mm	Coarse sand $+1$ -4mm	Fine gravel $+4$ -16mm	Coarse gravel $+16$ -64mm	Cobbles and boulders $+64$mm	
	m	m	m	mm							
GLACIAL SAND AND GRAVEL											
20 NE 26	12.3	0.4	–	6	32	33	9	10	8	2	PS
20 SE 362	8.3	0.5	–	6	48	38	4	3	1	0	S
20 SE 363	4.6	0.4	–	11	14	20	16	16	17	6	CSG
20 SE 367	22.0+	3.0	–	5	23	25	12	13	15	7	SG
30 SW 146	6.1	0.4	–	3	30	57	2	2	3	3	PS
30 SW 147	16.5*	1.5	–	8	68	20	2	1	1	0	S
30 SW 150	2.2	0.8	–	6	58	34	2	0	0	0	S
30 SW 151	10.2	0.5	–	10	63	20	3	2	2	0	CS
Mean	10.3	0.9	–	7	41	28	7	7	7	3	PS
FLUVIOGLACIAL SAND AND GRAVEL											
20 NE 31	3.1	0.3	–	10	63	27	0	0	0	0	CS
20 SE 365	11.8	–	–	6	61	31	1	0	0	1	S
20 SE 366	2.1	0.5	–	4	24	43	14	9	6	0	PS
30 SW 165†	1.1+	1.0	–	5	70	22	2	1	0	0	S
Mean	5.7	0.5	–	6	59	31	2	1	1	0	S
ALL DEPOSITS											
Mean	7.6	0.8	–	7	44	29	6	6	6	2	PS

*Not including 1.2 m of potentially workable till
†Shallow pit, excluded in the calculation of mean thickness

Statistical assessment of potentially workable glacial and fluvioglacial sand and gravel deposits

Total area of mineral	7.10 km^2
Area of worked out sand and gravel	0 km^2
Mean thickness of overburden	0.6 m
Mean thickness of mineral	7.6 m
Estimated volume of mineral	54 million m^3 ± 83% or 45 million m^3
Estimated yield of sand and gravel per hectare	76 thousand m^3

Statistical assessment of the glacial sand and gravel

Total area of mineral	3.03 km^2
Mean thickness of overburden	0.9 m
Mean thickness of mineral	10.3 m
Estimated volume of mineral	31 million m^3 ± 56% or 17 million m^3
Estimated yield of sand and gravel per hectare	103 thousand m^3

Statistical assessment of the fluvioglacial sand and gravel

Total area of mineral	4.07 km^2
Mean thickness of overburden	0.5 m
Mean thickness of mineral	5.7 m
Estimated volume of mineral	23 million m^3 (speculative)
Estimated yield of sand and gravel per hectare	57 thousand m^3

Borehole 20 SE 363 was sunk 60 m inside the boundary of Glenrothes New Town but has been included in block E for assessment. Although sited close to a boundary between glacial and fluvioglacial sand and gravel, the lithology of the mineral proved in the borehole is clearly akin to the former. Shallow pit 20 SE 373 penetrated a sequence of cobble and boulder gravel, classified as alluvium (of the Coul Burn), but in an area mapped as fluvioglacial sand and gravel. The deposit is probably localised and the pit, which was abandoned due to boulders, has been excluded from the assessment of resources.

The mean grading of mineral for all deposits is fines 7 per cent, sand 79 per cent and gravel 14 per cent, with fine sand the most abundant fraction (Table 12 and Figure 8). The corresponding figures for boreholes in glacial sand and gravel are fines 7 per cent, sand 76 per cent and gravel 17 per cent, for fluvioglacial sand and gravel, fines 6 per cent, sand 92 per cent and gravel 2 per cent (Table 12 and Figures 9 and 10).

A conspicuous aspect of the glacial sand and gravel in block E, in contrast to block A, is the heterogeneity between adjacent boreholes, for example 20 SE 367 and 30 SW 147. The moundy sand and gravel at Purin [269 061] is also much more gravelly than the moundy deposits around Pittillock [279 050]. Individual boreholes also display considerable variability of grading, particularly 30 SW 147 and 151. Considerably more uniformity exists in the fluvioglacial sand and gravel.

There are now no working pits in block E, although until quite recently sand and gravel was extensively worked at Kirkforthar Feus. Groundwater level in the glacial sand and gravel, on the evidence of assessment boreholes, is extremely variable; of the three boreholes in which the water-table was struck, the depths ranged from 2.7 to 19.5 m. In the fluvioglacial sand and gravel between Kirkforthar Feus and Star [311 033], boreholes 20 SE 365 and 366 and shallow pits 20 SE 372 and 30 SW 165 struck water at depths between 1.4 and 6.0 m: the mean depth is 3.7 m. Where peat is present, however, the water level may be anticipated to be much shallower.

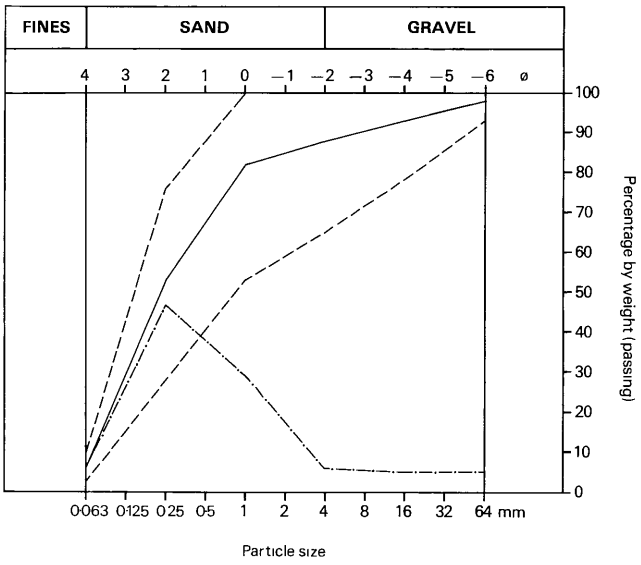

Figure 8 Grading characteristics of resources in the fluvioglacial and glacial sand and gravel (block E); for explanation, see Figure 4.

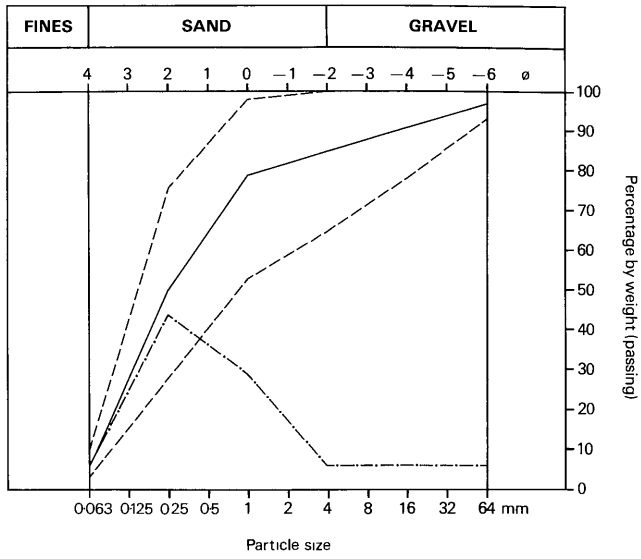

Figure 9 Grading characteristics of resources in the glacial sand and gravel (block E); for explanation, see Figure 4.

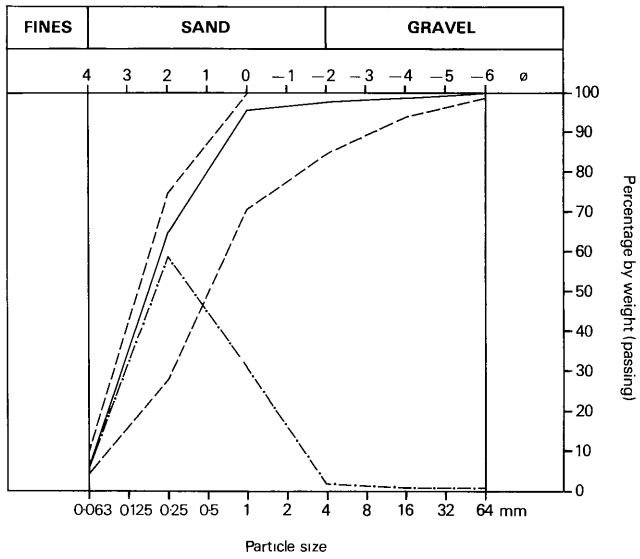

Figure 10 Grading characteristics of resources in the fluvioglacial sand and gravel (block E); for explanation, see Figure 4.

In borehole 20 SE 362, a thin basal unit of glacial sand and gravel proved to be non-mineral. Similarly in borehole 20 SE 365 the basal 0.1 m of fluvioglacial sand and gravel was non-mineral. In borehole 20 SE 366, 2.1 m of pebbly sand overlay 16.2 m of silt, classified as glaciolacustrine deposits. Borehole 20 SE 367 was still in mineral at 25 m, the maximum depth of drilling. Otherwise potentially workable sand and gravel was found to overlie till in boreholes 20 NE 26, 20 NE 31, 30 SW 146, 147, 150 and 151. The uppermost 1.2 m of till in borehole 30 SW 147 proved to be potentially workable, but this thickness has been excluded from the calculation of mean thickness because the till is generally considered to be non-mineral.

The estimated yield of all potentially workable sand and gravel, but excluding mineral till, is 76000 m^3 per hectare, equivalent to 54 million m^3 ± 83 per cent for the block as a whole. For glacial sand and gravel, the estimated yield is 103 thousand m^3 per hectare, equivalent to 31 million m^3 ± 56 per cent, and for fluvioglacial sand and gravel the corresponding results are 57 thousand m^3 per hectare, equivalent to 23 million m^3.

Block F

The block is bounded on the west by the urban areas of Markinch and Glenrothes and to the south and east by the limits of the resource sheet. To the north the block in part adjoins block E; elsewhere on the north side the boundary has been drawn to encompass deposits of sand and gravel lying west of Kennoway and additionally an area in which potentially workable till may occur. Assessments are offered for all potentially workable material including till and for all potentially workable sand and gravel.

Most of the mineral deposits in block F fall into three geographical and geological units:

a Glacial sand and gravel and potentially workable till on the northern valley side of the Back Burn
b Fluvioglacial sand and gravel on the valley floor of the Back Burn
c Fluvioglacial sand and gravel, and alluvium forming terraces of the River Leven.

The above tripartite division does not hold good within the townships of Kennoway and Windygates where the geology is complicated by a drainage system and associated sand and gravel deposits aligned north–south. The interfluve between the Back Burn and River Leven is a till-draped bedrock ridge which extends from Markinch to Windygates.

North of the Back Burn glacial sand and gravel is present at surface between Newton Hall [333 020] and Kennoway Den. In addition potentially workable till may be present either at surface or at depth between Brunton Barns [306 021] and at [337 027]. However, the northern extent is imprecisely known and an inferred boundary is shown on the resource map.

In the valley floor of the Back Burn, in the fluvioglacial sand and gravel, and in the glacial sand and gravel on Harbour Hill [316 018], sand and gravel is generally present at surface, or beneath thin overburden, as in borehole 30 SW 153. The alluvium of the Back Burn may comprise sand and gravel locally, but is classified as overburden, which conceals mineral classified in boreholes as fluvioglacial sand and gravel.

Within the valley of the Leven, the river has created a complex of terraces with associated fluvial deposits, classified as alluvium and fluvioglacial sand and gravel, which are compositionally similar, although the former was not sampled by drilling. Mineral is generally present at surface on the terrace flats, but not on the back slopes which often expose the underlying till.

Prominent, narrow ridges (eskers) composed of sand and gravel, dominate the landscape of Windygates and the southern part of Kennoway. They include Maiden Castle [349 015], at [350 012], Pepper Hill [349 002] and the unnamed ridge on which borehole 30 SW 159 was sited. The valley of the Kennoway Burn contains thin terraced deposits of sand and gravel. Other small patches of sand and gravel occur near Bellfield Cottages [317 011] and Balcurvie Smallholdings [3401]. Elsewhere in block F till, and sporadically rock, crop out at surface.

Based on eight assessment and two commercial boreholes, the mean thicknesses of mineral in the block is 4.3 m; the greatest thickness were 12.9 m in 30 SW 159 on the Windygates esker and 5.8 m in borehole 30 SW 157 (Table 13). If potentially workable till is excluded, the mean thickness is 4.5 m.

Table 13 Block F: Data from sample points and the assessment of resources

Sample point / Borehole or section	Recorded thickness: Mineral	Overburden	Waste partings	Mean grading percentage: Fines	Fine sand	Medium sand	Coarse sand	Fine gravel	Coarse gravel	Cobbles and boulders	Descriptive category (see diagram in Appendix C)
				$-\frac{1}{16}$	$+\frac{1}{16}$	$+\frac{1}{4}$	+1	+4	+16	+64mm	
	m	m	m	mm	$-\frac{1}{4}$mm	−1mm	−4mm	−16mm	−64mm		
GLACIAL AND FLUVIOGLACIAL SAND AND GRAVEL											
30 SW 89	2.8	3.1	–	No grading data available							
30 SW 103	5.3	1.7	–	No grading data available							
30 SW 149	2.3	0.3	–	7	9	12	12	15	35	10	G
30 SW 153	1.7	1.6	–	6	9	24	17	18	16	10	SG
30 SW 154	3.3	0.2	–	15	13	15	12	16	18	11	CG
30 SW 157	3.4	0.4	–	9	11	15	15	19	28	3	G
30 SW 159	12.9+	0.2	–	8	9	8	11	20	25	19	G
Mean	4.7	0.5	–	9	10	12	12	19	24	14	G
TILL											
30 SW 148	1.8	3.7	–	20	25	18	11	12	10	4	VCSG
30 SW 155	2.1	1.8	–	19	41	18	3	5	9	5	CPS
30 SW 157	2.4	–	–	14	20	11	9	12	15	19	CG
30 SW 158	4.8	0.5	1.0	25	32	16	6	6	8	7	VCSG
Mean	2.8	–	–	21	29	16	7	8	10	9	VCSG
ALL DEPOSITS											
Mean	4.3	1.4	–	13	16	13	11	15	20	12	CG

Statistical assessment of till, glacial and fluvioglacial sand and gravel and alluvium

Total area of mineral	7.61 km^2
Mean thickness of overburden	1.4 m
Mean thickness of mineral	4.3 m
Estimated volume of mineral	33 million m^3 ± 59% or 19 million m^3
Estimated yield of sand and gravel per hectare	43 thousand m^3

Statistical assessment of glacial sand and gravel and alluvium

Total area of mineral	5.86 km^2
Mean thickness of overburden	1.1 m
Mean thickness of mineral	4.5 m
Estimated volume of mineral	26 million m^3 ± 83% or 22 million m^3
Estimated yield of sand and gravel per hectare	45 thousand m^3

Boreholes 30 SW 89, 103, 148, 155, 156 and 157 proved the complete drift sequence to bedrock. Rock obstructions in till forced the termination of boreholes 30 SW 149, 153, 154, 158; mineral till or glacial sand and gravel may exist at greater depths at these sites. Commercial boreholes indicate that a buried, till-filled, elongate depression in bedrock is present near borehole 30 SW 149, and may be traced by means of borehole data from [273 014] to Balgonie [320 006]. Borehole 30 SW 159 was abandoned in sand and gravel due to boulder obstruction. In borehole 30 SW 148 mineral till lay directly on sandstone which almost certainly influenced the till composition; otherwise in all assessment boreholes in block F the deposit underlying the basal mineral unit was till.

The mean grading of mineral is fines 13 per cent, sand 40 per cent and gravel 47 per cent (Table 13 and Figure 11). If potentially workable till is excluded, the corresponding figures are 9 per cent fines, 34 per cent sand and 57 per cent gravel (Table 13 and Figure 12), the greatest gravel proportion for any block in this resource sheet.

The gravelly nature of the terrace deposits of the Leven are in marked contrast to the alluvial deposits of the River Eden, described under block G. The mean thickness of fluvioglacial sand and gravel in boreholes 30 SW 149, 154 and 157 is 3.0 m. From an examination of boreholes proving mineral till, namely 30 SW 148, 155, 157 and, 158, it is apparent that only parts of the till sequence may be expected to be mineral, and to be either 'clayey' or 'very clayey' in nature.

Although sand and gravel was formerly worked on a small scale at several localities, there are no active workings in block F. No assessment boreholes proved groundwater (levels) within glacial or fluvioglacial sand and gravel or alluvium, although several struck water in till. However, low-lying deposits in the valleys of the River Leven and the Back and Kennoway Burns would almost certainly contain water.

The estimated yield of all potentially workable sand and gravel, including mineral till, is 43 000 m^3 per hectare, equivalent to 33 million^3 ± 59 per cent for the block as a whole. For resources in the alluvium, fluvioglacial and glacial sand and gravel, the yield of potentially workable sand and gravel is 45 000 m^3 per hectare, equivalent to 26 million m^3 ± 83 per cent for the whole block.

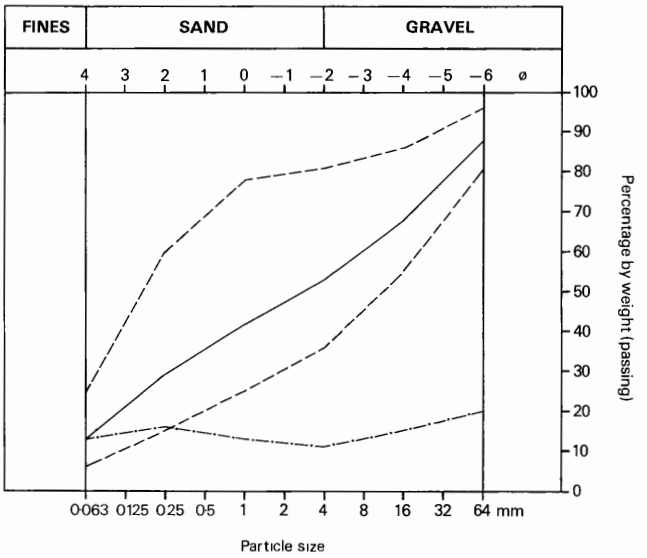

Figure 11 Grading characteristics of resources in the fluvioglacial sand and gravel and till (block F); for explanation, see Figure 4.

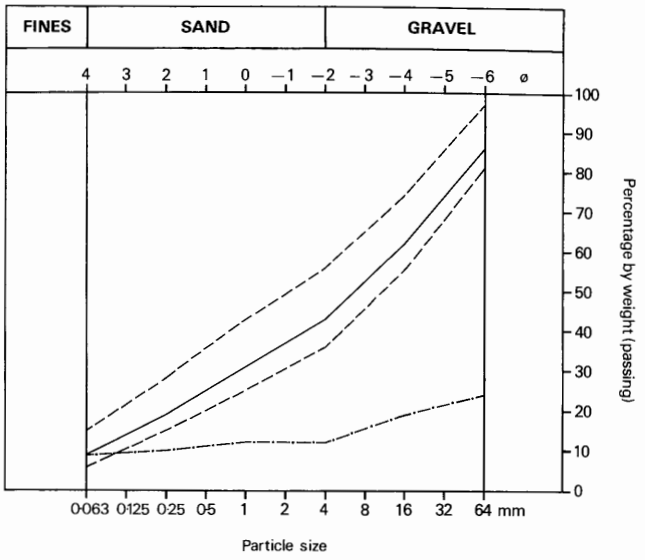

Figure 12 Grading characteristics of resources in the fluvioglacial sand and gravel (block F); for explanation, see Figure 4.

Block G

That part of the assessment area neither included in blocks A to F nor falling within the built-up area of Leslie, Glenrothes and Markinch (which is not assessed) is designated block G. For convenience of description the block has been divided geographically into three sub-blocks G_1 to G_3. Inferred assessments are offered for parts of the sub-blocks; otherwise deposits within block G are too small to have justified investigation at this level of assessment (Tables 7 and 14).

Sub-block G_1 This sub-block includes much of the Lomond Hills, part of the valley containing the alluvial flat of Loch Leven and of the River Leven between Auchmuirbridge [218 011] and Leslie, and the low ground on the northern flanks of the Lomond Hills. Over most of the Lomond Hills bedrock or till is at surface. No potentially workable sand and gravel occurs above 215 m above Ordnance Datum, the highest deposits being two patches near West Conland [257 043] for which no assessment is made.

The largest deposits of sand and gravel in terms of extent in the sub-block are found on the fringes of Leslie, principally at Balsillie Laws [248 023], as scattered deposits of moundy sand and gravel on the north side of the Leven, around Farmlands [232 014], and also as extensive thin spreads of sand west of Auchmuirbridge. Sand and gravel was formerly worked at Balsillie Laws and at Roaring Hill [254 024] until 1979, and the deposits have been described by Browne (1977), but the sites have since been restored to agriculture. On the evidence of boreholes 20 SW 17, 20 SW 18 and 20 SE 361 which proved respectively 1.5, 9.6 and 6.9 m of mineral grading as sandy gravel (excluding 0.8 m of potentially workable till in 20 SE 361), the moundy deposits of glacial sand and gravel near Leslie would have a mean thickness of 6.0 m, from which an estimated volume of 7.7 million m^3 may be inferred. It is probable that this volume is an overestimate, because from field evidence the thickest parts of the deposits are believed to be at Balsillie Laws, where two of the three data points were situated.

Table 14 Block G: Data from sample points

Sample point Borehole or section	Recorded thickness			Mean grading percentage							Descriptive category (see diagram in Appendix C)
	Mineral	Overburden	Waste partings	Fines $-\frac{1}{16}$ mm	Fine sand $+\frac{1}{16}$ $-\frac{1}{4}$mm	Medium sand $+\frac{1}{4}$ -1mm	Coarse sand $+1$ -4mm	Fine gravel $+4$ -16mm	Coarse gravel $+16$ -64mm	Cobbles and boulders $+64$mm	
	m	m	m								
SUB-BLOCK G_1 — all potentially workable deposits											
20 NW 4*	1.4+	0.3	0.5	13	38	33	2	9	5	0	CPS
20 NW 6*	1.5	0.3	–	2	13	23	23	17	15	7	SG
20 SW 16	1.8	1.0	–	5	39	46	8	2	0	0	S
20 SW 17	1.5+	0.5	–	10	14	18	18	22	17	1	CSG
20 SW 18	9.6	0.4	–	8	13	20	22	14	15	8	SG
20 SE 361	7.7	0.7	–	7	19	16	15	17	19	7	SG
SUB-BLOCK G_2 — all potentially workable deposits											
30 NW 55	2.4	2.1	1.0	35	46	16	2	1	0	0	VCS
30 NW 57	3.8	0.4	–	6	40	43	3	4	4	0	PS
30 SW 169*	1.2	0.3	–	4	51	12	12	9	12	0	PS
SUB-BLOCK G_3 — all potentially workable deposits											
20 NE 24	6.7	0.5	3.3	5	60	28	4	3	0	0	S
20 NE 32	1.2	0.4	–	8	38	40	9	5	0	0	PS

*Shallow pit

West of Auchmuirbridge deposits of mainly fine sand form a thin drape on the valley sides above the alluvial plain, but as the mean thickness is considered to be less than 1 m no assessment is offered. Borehole 20 SW 16 proved 1.0 m of made ground and silt on 1.8 m of sand on 16.7 m of silt and clay. Peat greater than 1 m thick on sand is found in places. On the basis of one borehole an inferred assessment of 2.2 million m^3 is offered for the lacustrine alluvium of the former Loch Leven. The flood plain of the River Leven is known to be gravelly in places but the information is insufficient for an assessment to be made.

North of the Lomond Hills adjacent to the Ballingall Burn, a gravelly esker ridge 900 m long [277 088] is estimated to stand on average 3 m above the general till surface. Shallow pit 20 NW 6 proved 1.5 m of sandy gravel (fluvioglacial sand and gravel). The alluvium of the Ballingall Burn is considered too silty to be mineral. From available information on the glacial and fluvioglacial sand and gravel a volume of 0.2 million m^3 may be inferred (Table 7).

Shallow pit 20 NW 4, sited on the alluvium of the Arraty Burn, near Chancefield [232 081], proved 1.4 m of sand and 'clayey' sandy gravel. From this information a volume of mineral of 0.2 million m^3 may be inferred. Elsewhere in sub-block G_1, the alluvium is generally considered to be too silty or clayey to be mineral. A terraced deposit of sand and gravel at Strathmiglo, mapped as late-Glacial alluvium, is largely built on and is not assessed. Small patches of late-Glacial alluvium, glacial and fluvioglacial sand and gravel, near Corston Tower [207 098], Easter Cash at [235 099] and Falklandwood [249 087] are too small to be assessed.

Sub-block G_2 The sub-block comprises a generally upland tract bounded on three sides by blocks D, E and F. The ground rises from the Howe of Fife and from the valley of the Kennoway Burn to the highest point, Down Law [343 072], 242 m above Ordnance Datum.

The largest mineral occurrences in sub-block G_2 are moundy deposits of glacial sand and gravel between Rameldry Den [327 067] and Drummy Wood [322 053]. Although shown as exposed sand and gravel on the resource map, the deposits comprise two distinct lithologies. Around Rameldry [325 065] the glacial sand and gravel consists mainly of fine sand and silt with rare pebbles. Borehole 30 NW 55 proved 5.1 m of glacial sand and gravel of which 2.4 m is mineral, grading 'very clayey' sand. South of northing 057, the deposits are more gravelly and often in the form of esker ridges. Borehole 30 NW 57 proved 3.8 m of mineral grading as pebbly sand and shallow pit 30 SW 169 revealed 1.2 m of pebbly sand. On the basis of two boreholes and two pits, the mean thickness of mineral for the deposit as a whole is 2.2 m, from which a volume of 3.8 million m^3 may be inferred.

On the evidence of borehole 30 NW 56, which revealed a predominantly silty sequence, the alluvial flat now occupied by the Rameldry Burn is considered to be non-mineral. The Kennoway Burn has deposited a tract of alluvium downstream from Star [311 033]. Although shallow pit 30 SW 174 proved 1.8 m of mineral of which 1.2 m graded as gravel, this is believed to be atypical of the deposit as a whole which is likely to be too thin or too silty to be judged potentially workable.

Sub-block G_3 This sub-block incorporates the flanks of the Ochil Hills above Strathmiglo, Auchtermuchty and Collessie, and that part of the Howe of Fife around Springfield [342 119] not included in blocks A, B or D. The flood plain of the River Eden downstream from Dunshelt is also included. At Strathmiglo the limit of the sub-block coincides with the River Eden.

Two boreholes were drilled on the flood plain of the Eden. Borehole 20 NE 24 proved 6.7 m of sand and pebbly sand with 3.3 m of intervening waste, mainly silt. This thickness of mineral is believed to be atypical, and

probably is the result of sedimentation in a pre-existing hollow. Borehole 20 NE 32, which revealed 1.2 m of pebbly sand, is considered to be more representative of the alluvial mineral deposits. At the site of a new sewage treatment works [275 093], 1.8 m of mainly fine sand was recorded in a temporary section. Exposures in the banks of the Eden south-west of Shiells [283 090] revealed 2.0 m of fine sand. An inferred boundary is drawn across the deposit, east of Nochnary [265 097], because upstream from that point consistently silty or clayey deposits were recorded during the field survey. Downstream from Ramornie Mill [326 092], although small higher terrace remnants are gravelly, most of the alluvium is silty; accordingly these deposits are not considered potentially workable. For the alluvium between Nochnary and Kingskettle [309 083] the estimated mean thickness of mineral is 1.7 m, from which a volume of 3.1 million m^3 may be inferred.

Deposits of alluvium east-south-east of Fernie Castle [316 148], south of Pitlour [209 112] and in the flood plain of the Eden at Strathmiglo are considered, on field survey evidence, to be excessively silty. Isolated patches of glacial sand and gravel near Over Rankeilour [329 136] and Fernie Castle are too small to be assessed.

Urban Areas

Field survey and boreholes indicate that extensive sand and gravel deposits occur at Glenrothes in the vicinity of Balbirnie Park [287 023], Cadham [278 021] and Whinnyhill Plantation [262 022], and additionally in Leslie and in the northern part of Markinch. Most of the deposits have now been built upon, except for Balbirnie Park and some farmland adjacent to Viewforth Plantation [290 030].

Borehole 20 SE 364 sunk in Balbirnie Park proved 5.0 m of 'very clayey' pebbly sand on very stony till. Section 20 SE 368, 360 m to the north-west in Balbirnie Mains sand and gravel pit, proved 1.9 m of head ('very clayey' sandy gravel) on 5.5 m of gravel. Evidence from temporary sections and boreholes drilled for Glenrothes Development Corporation in Balbirnie Park confirms that the deposits are variable and that till may be interbedded with sand and gravel. Prominent mounds of sand and gravel at Fir Hill [292 024] and Viewforth Plantation, and an esker ridge at Whinnyhill Plantation probably have similar compositions to section 20 SE 368.

South of the River Leven, in the neighbourhood of Queensway [279 012], boreholes indicate the presence of buried deposits of sand and gravel, interbedded with till.

CONCLUSIONS

The sand and gravel resources of the survey area have been described systematically and the results of the assessment summarised in Tables 6 and 7. It must be emphasised that the survey concerns the estimation of resources rather than reserves and that the assessment of the workability of deposits is judged solely in terms of the four arbitrary criteria stated in the introduction to this report. No account is taken of prevailing environmental or economic considerations and the quoted volumetric estimates bear no simple relationship to the amount of sand and gravel that could be extracted in practice. The chief aim of the survey is to provide a factual, geologically-based assessment of the sand and gravel against which the economic, social and environmental costs in developing, or constraints in preserving, the resources can be weighed.

Bearing in mind that more detailed exploration and evaluation is required to establish the whereabouts of reserves, it is possible nonetheless to indicate, with some degree of certainty, those resources which may command attention in the short to medium term.

If it is assumed that working will not be undertaken below the water table, as is current practice, the accessible resources in blocks C and D which are significant in terms of mineral-bearing area but not so in terms of volume, are further reduced. The mean depth to water, based on boreholes, in blocks C and D is 2.7 m and 2.6 m respectively, compared with mean sand and gravel thicknesses of 3.0 m and 2.9 m. Gravel content in blocks C and D is low; in the former the mean figure of 13 per cent is inflated by the results from two boreholes on the site of the Rossie Loch where the deposits are mainly below water table; in the latter the mean gravel content is only 9 per cent.

The deposits in blocks B, E and F have more to recommend them in terms of exploitation potential than the material in blocks C and D, but it is exceedingly difficult to place these three resource blocks in any order of aggregate potential. However, the salient points of each can be stated. In block B, where the deposits are predominantly sandy, much of the resource lies above the water table and the yield per hectare would be reasonably high. In block E, which has the lowest mineral-bearing area of blocks A to F, but the greatest mean thickness on the basis of assessment boreholes and consequently a high potential yield per hectare, the mineral has a mean gravel content, based on boreholes, of 14 per cent, but the grading within the deposits is very variable. This is especially so within the glacial sand and gravel which constitutes the bulk of the resource lying above the water table. Composite samples III and IV from two boreholes in block E gave average physical and mechanical test results when compared with the five other composite test samples from the area.

In block F, the total estimated volume of mineral is derived from the compilation of data from differing deposits. A proportion of the resource in this block comprises potentially workable till which is unlikely to warrant exploitation in the short to medium term. The mean gravel content in block F, based on assessment boreholes, is 47 per cent, an amount exceeded only in block A. However, composite samples V and VI, the former from a borehole in the Windygates esker and the latter from boreholes in fluvioglacial sand and gravel deposited by the River Leven, gave poor physical and mechanical test results, compared with the other composite samples. It must be emphasised, however, that an insufficient number of tests was conducted in the course of this assessment for any categorical statement on aggregate quality to be made, and also that only the 10 to 14 mm size range was tested. Much of the sand and gravel in block F lies above the water table.

From a comparison of mean thickness, area of mineral, depth to water table, particle size analysis, physical and mechanical test results, it is clear that the sand and gravel deposits in block A are generally superior to those in blocks B, C, D, E and F, particularly in terms of volume and gravel content and quality.

Deposits of sand and gravel in block G are likely to be only of local interest, with the exception of the Balsillie Laws area, north and west of Leslie, although composite sample VII from there gave poor physical and mechanical test results.

LIST OF WORKINGS

In 1980 five sand and gravel pits, listed below, were operational, either continuously or intermittently. At no site was material being dug below the water table, the usual intention being to restore the ground to agriculture subsequent to mineral extraction. All known sizeable areas of former working are delimited on the map accompanying the report.

Site	*Grid Reference*	*Operator*	*Mode of Operation*	*Deposit Worked*	*Block*
Collessie	294 124	Fife Sand and Gravel Co. Ltd.	Continuous	Glacial sand and gravel	A
Corrour (formerly Angle Park No.1)	296 111	Forestry Commission	Intermittent	Glacial sand and gravel	A
Angle Park No.3	308 123	Angle Park Sand and Gravel Co. Ltd.	Continuous	Glacial sand and gravel	A
Ramornie	313 093	Angle Park Sand and Gravel Co. Ltd.	Continuous	Fluvioglacial sand	B
Balbirnie Mains	284 026	Rothes Aggregates Ltd.	Intermittent	Glacial sand and gravel	Glenrothes urban area

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APPENDIX A

FIELD AND LABORATORY PROCEDURES

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

The mineral shown on each 1:25 000 sheet is divided into resource blocks. The arbitrary size selected, 10 km^2, is a compromise to meet the aims of the survey by providing sufficient sample points in each block. As far as possible the block boundaries are determined by geological boundaries so that, for example, glacial and river terrace gravels are separated. Otherwise division is by arbitrary lines, which may bear no relationship to the geology. Exceptionally, other schemes for subdividing the resource sheet area (for example, the use of 'resource sub-blocks') may be used where these are considered to be more appropriate.

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

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

Other methods of drilling and sampling are occasionally employed, for example the Minuteman power auger rig, and downhole tests such as U4 and SPT may be carried out. The Minuteman, which is small and portable, is normally used when access to land with shell rigs would be difficult to arrange and when information is requested quickly.

The auger tool comprises a continuous-'flight' 76-mm (3-inch) spiral auger; the use of this equipment, as with all 'open-hole' drilling methods, inevitably leads to the mixing and contamination of the sampled material. Thus, data relating to depth and composition cannot always be accurately determined.

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

Detailed records may be consulted at the appropriate office of the Institute: the address is shown on page ii of this report, next to the preface.

APPENDIX B

STATISTICAL PROCEDURE

Statistical assessment

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

2 The simple methods used in the calculations are consistent with the amount of data provided by the survey (Hull, pp. 192–193 *in* Thurrell, 1981). Conventional symmetrical confidence limits are calculated for the 95 per cent probability level, that is, there is a 5 per cent or one in twenty chance of a result falling outside the stated limits.

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

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

4 The above relationship may be transposed such that

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

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

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

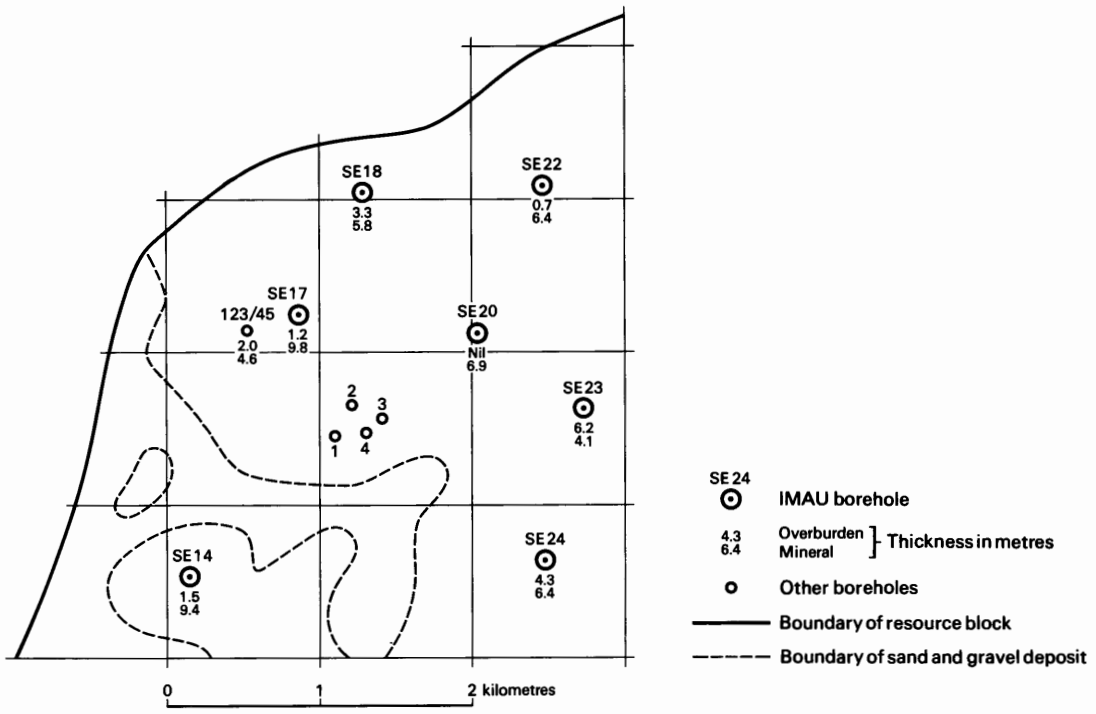
For groups of closely spaced boreholes a discretionary weighting factor may be applied to avoid bias (see note on weighting below). The standard deviation for mean thickness $S_{\bar{l}_m}$, expressed as a proportion of the mean thickness, is given by

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

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

6 The sampled area in each resource block is coloured pink on the map. Wherever possible, calculations relate to the mineral within mapped geological boundaries (which may not necessarily correspond to the limits of deposit). Where the area

Example of resource block assessment: map of fictitious block, calculation and results.



Block calculation 1:25 000 block: Fictitious

Area
Block: 11.08 km²
Mineral: 8.32 km²

Mean thickness
Overburden: 2.5 m
Mineral: 6.5 m

Volume
Overburden: 21 million m³
Mineral: 54 million m³

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

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

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

Calculation of confidence limits

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

$\Sigma(wl_m - \overline{wl_m})^2 = 15.82$
$n = 8$
t = 2.365

L_r is calculated as

$$1.05\,(t/\overline{wl_m})\sqrt{[\Sigma(wl_m - \overline{wl_m})^2/n(n-1)]} \times 100$$
$$= 1.05 \times (2.365/6.5)\sqrt{[15.82/(8 \times 7)]} \times 100$$
$$= 20.3$$
$$\simeq 20 \text{ per cent.}$$

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 usually small relative to those in thickness. The relationship $S_A/S_{\bar{l}_m} \leqslant \frac{1}{3}$ is assumed in all cases. It follows from equation [2] that

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

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_l, 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_l is calculated as

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

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

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

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

11 The application of this procedure to a fictitious area is illustrated in the diagram which accompanies this Appendix.

Inferred assessment

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 $\frac{1}{16}$ mm) and coarser than pebbles (more than 64 mm in diameter). Because deposits containing more than 10 per cent fines are not embraced by this system a modified binary classification based on Willman (1942) has been adopted.

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

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

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

Thus it is possible to classify the mineral into one of twelve descriptive categories (illustrated at the end of this appendix). 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 the note on lithological description in Appendix D).

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

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

The boundary at 64 mm distinguishes pebbles from cobbles. The term 'gravel' is used loosely to denote both pebble-sized and cobble-sized material.

The size distribution of borehole samples is determined by sieve analysis, which is presented by the laboratory as logarithmic cumulative curves (see, for example, British Standard 1377: 1975). In this report the grading is tabulated on the borehole record sheets (Appendix E), the intercepts corresponding with the simple geometric scale $\frac{1}{16}$ mm, $\frac{1}{4}$ mm, 1 mm, 4 mm, 16 mm and so on as required. Original sample grading curves are available for reference at the appropriate office of the Institute.

Each bulk sample is described subjectively by a geologist at the borehole site. Subsequently, the descriptive categories of the mineral for each borehole are modified according to the results obtained from the mean particle size analysis of the samples.

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 type, comprises 5 to 25 per cent of the whole. Where the accessory material accounts for less than 5 per cent of the whole, but is still readily apparent, the phrase 'with some' has been used. Rare constituents are referred to as 'trace'.

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

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

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

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

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

Well-rounded: 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.

Classification of gravel, sand and fines

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

I Gravel
II 'Clayey' gravel
III 'Very clayey' gravel
IV Sandy gravel
V 'Clayey' sandy gravel
VI 'Very clayey' sandy gravel
VII Pebbly sand
VIII 'Clayey' pebbly sand
IX 'Very clayey' pebbly sand
X Sand
XI 'Clayey' sand
XII 'Very clayey' sand

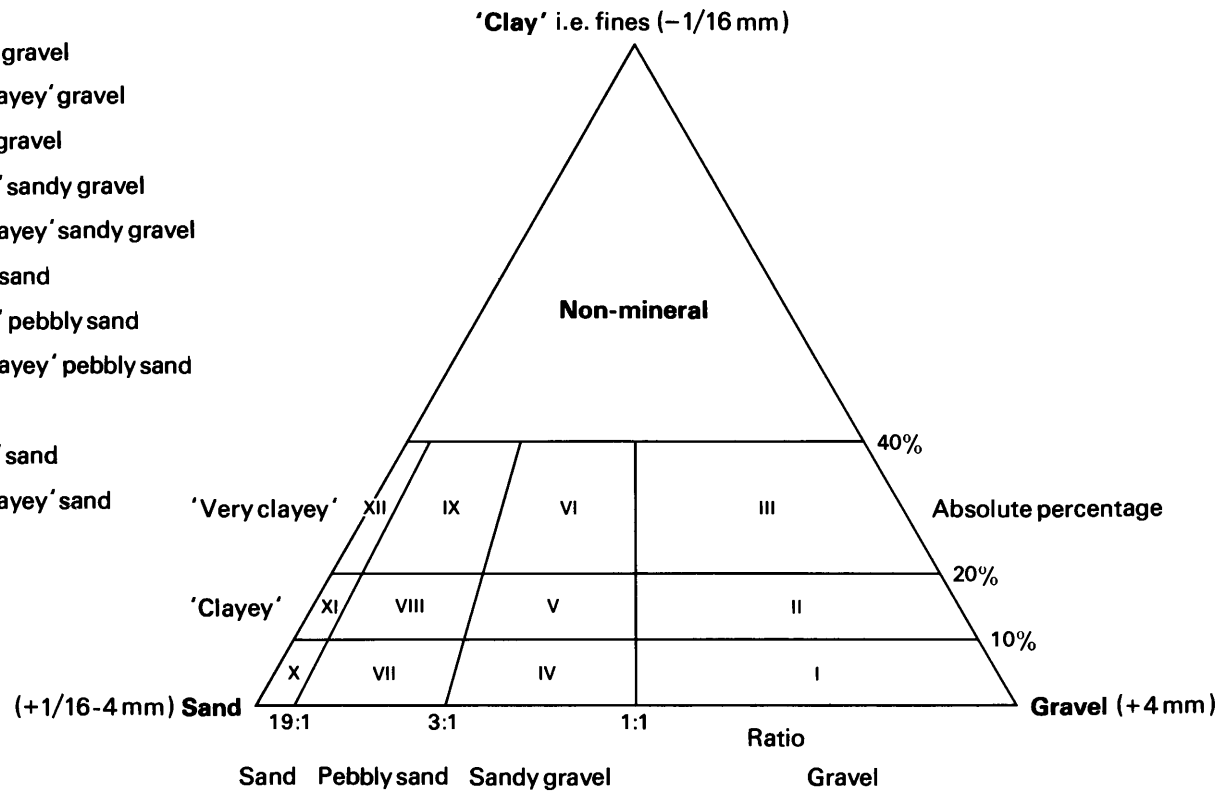


Diagram showing the descriptive categories used in the classification of sand and gravel

APPENDIX D

EXPLANATION OF THE ASSESSMENT RECORDS

Annotated example

NO 20 NE 25[1] 2630 0821[2] Darnoe, Falkland[3] BLOCK D

Surface level + 43 m (+ 141 ft)[4]
Groundwater level + 40 m[5]
250 mm percussion[6]
May 1980

Overburden[7] 0.5 m
Mineral 6.0 m
(inc. 0.2 m waste)
Bedrock 1.0 m +[9]

LOG

Geological classification	Lithology	Thickness[8] m	Depth m
	Soil, sandy	0.5	0.5
Fluvioglacial sand and gravel[10]	a Sand[11] Gravel: rare fine towards base Sand: fine with medium and rare coarse, subangular with some well rounded, quartz with rare feldspar Fines: silt bands, grey-brown	1.0	1.5
	b Sandy gravel Gravel: fine and coarse with cobbles, rounded to well rounded, andesitic lava, red and cream sandstone, quartzite, quartz, schistose grit Sand: fine and medium with coarse, subangular to subrounded, quartz with feldspar and rock Fines: silt, more common at top	3.0	4.5
Till	Clay, reddish brown with sandstone clasts	0.2	4.7
	c 'Clayey' sand Sand: disaggregated sandstone, fine with medium sand, mainly quartz Fines: mainly silt, pale reddish beige	1.8	6.5
Upper Devonian	Sandstone, fine grained with millet seed grains and vertical grain size variation, soft, thinly bedded, cream to buff	1.0+	7.5

GRADING

	Mean for deposit[15] percentages			Depth below surface (m)[12]		percentages[13]							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	$-1/16$	$+1/16-1/4$	$+1/4-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
a	10	89	1	0.5	1.5	10	55	29	5	1	0	0	
b	6	65	29	1.5	2.5	11	33	28	9	14	5	0	†[14]
				2.5	3.5	3	17	22	11	19	21	7	+
				3.5	4.5	4	16	41	18	12	9	0	†
				Mean		6	22	30	13	15	12	2	
c	13	87	0	4.7	6.5	13	61	25	1	0	0	0	†
a to c	9	76	15	Mean		9	40	28	8	8	6	1	
a & b	7	71	22	Mean		7	30	29	11	12	9	2	

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

1 Registration number
Each Industrial Minerals Assessment Unit (IMAU) borehole, section and shallow pit is identified by a registration number. This consists of two statements.

1 The number of the 1:25 000 sheet on which the datum point lies, for example NO 20.
2 The quarter of the 1:25 000 sheet on which the datum point lies and its number in a series for that quarter, for example NE 25.
Thus the full registration number is NO 20 NE 25. Usually this is abbreviated to 20 NE 25 in the text.

2 The National Grid reference
All National Grid references in this publication lie within the 100 km square NO. Grid references are given to eight figures, accurate to within 10 km for sample point locations. (In the text, six-figure grid references are used for more approximate locations, for example, for farms and villages).

3 Location
The position of the sample point 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 sample point is given in metres above Ordnance Datum. Measurements were made in metres, approximate conversions to feet are given in brackets. Sites of boreholes and sections were levelled from either spot heights or bench marks, the precision of the figure reflecting the nature of the point of origin. The surface levels of shallow pit sites were estimated from contours on 1:10 000 and 1:10 560 sheets and are probably accurate to plus or minus two metres; such elevations are prefixed by the letter 'c'.

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 Method and date of sampling
Modified shell and auger rigs were used for the drilling of boreholes in this survey. The drilling method, the external diameter of the casing used, and the month and year of completion of sampling are given. Where appropriate other methods of sampling are stated (for example, sampling by hand).

7 Overburden, mineral, waste and bedrock
Mineral is sand and gravel which, as part of a deposit falls within the arbitrary definition of potentially workable material (see p. 1). The summary of mineral thicknesses may include waste partings: the aggregated waste thickness is given in brackets and has been excluded in the assessment of resources. Consequently mineral thicknesses given in Tables 8 to 14 may not correspond precisely with the logs. Bedrock is the 'formation', 'country rock' or 'rockhead' below which potentially workable sand and gravel will not normally be found. However, it is noteworthy that in the Howe of Fife, some of the sandstone is so friable that it could grade as mineral. 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.

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

10 Geological classification
The geological classification is given wherever possible.

11 Lithological description
Where sand and gravel 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 sand and gravel. A new sample commenced whenever there is an appreciable lithological change within the sand and gravel or 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.

14 Bailed samples
Fully representive sampling of sand and gravel is difficult to achieve, particularly where groundwater levels are high. Comparison between boreholes and adjacent exposures suggests that in boreholes the proportion of sand may be higher and the proportion of fines and of coarse (+16 – 64 m) and cobble gravel (+64 m) may be lower. Samples obtained by the bailing technique (that is, from deposits below the water table) are indicated thus:†

15 Mean grading
The grading of the full thickness of the mineral deposit identified in the log is the mean of the individual sample gradings weighted by the thicknesses represented. The classification used is shown in the Table in Appendix C. Where two or more distinct mineral units form continuous sequences the mean gradings of these are also given under each unit.

APPENDIX E

INDUSTRIAL MINERALS ASSESSMENT UNIT BOREHOLE, SECTION AND SHALLOW PIT RECORDS

NO 20 NW 2 2477 0942 Woodmill, Dunshelt BLOCK D

Surface level + 44 m (+ 144 ft)
Water struck at + 42 m
250 mm percussion
May 1980

Overburden 0.4 m
Mineral 1.7 m
Waste 5.2 m
Bedrock 0.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, fine sandy loam	0.4	0.4
Late-Glacial alluvium	'Clayey' sand Gravel: fine and coarse, subrounded, andesite and red sandstone Sand: fine with some medium and rare coarse, subangular to subrounded with rare well rounded and frosted, mainly quartz Fines: silt, disseminated	1.7	2.1
Till	Clay, sandy, silty, stony, firm, reddish brown, with clasts up to 300 mm, including dolerite, red and cream sandstone	3.9	6.0
	Clay, sandy, stony, soft, grey-brown, with many sandstone clasts	1.3	7.3
Upper Devonian	Sandstone, calcareous, medium grained, with numerous red and rare green clay pebbles. Colour is mottled light brown and yellow	0.4+	7.7

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	−1/16	+1/16−1/4	+1/4−1	+1−4	+4−16	+16−64	+64
17	81	2	0.4	1.4	8	85	7	0	0	0	0
			1.4	2.1	31	40	21	3	3	2	0
			Mean		17	67	13	1	1	1	0

NO 20 NW 3 2284 0911 Easter Cash, Strathmiglo BLOCK G_1

Surface level c + 60 m (c + 197 ft)
Water not struck
Pit
August 1979

Waste 1.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	Sandy gravel, slightly clayey Gravel: coarse and fine, angular to rounded Sand: fine, medium and coarse, quartz and rock	0.2	0.5
Till	Clay, sandy, stony, quite firm, reddish brown, with rare cobble size clasts	1.2+	1.7

NO 20 NW 4 2279 0811 Chancefield by Falkland BLOCK G_1

Surface level c + 87 m (c + 285 ft)
Water not struck
Pit
August 1979

Overburden 0.3 m
Mineral 1.9 m +
(inc. 0.5 m waste)

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Alluvium	a Sand with trace of fine gravel Sand: fine with medium and rare coarse, mainly quartz with feldspar and rock Fines: disseminated silt, buff	0.6	0.9
	Silt, grey-brown, with rootlets	0.5	1.4
	b 'Clayey' sandy gravel Gravel: fine with coarse, mainly subangular to subrounded, mainly friable fine grained sandstone of local origin and rare igneous rocks Sand: medium and fine with rare coarse, angular to subrounded, quartz with some rock and feldspar Fines: disseminated silt, pale grey	0.8+	2.2

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	− 1/16	+1/16–1/4	+1/4–1	+1–4	+4–64	+16–64	+64
a	8	92	0	0.3	0.9	8	57	33	2	0	0	0
b	16	60	24	1.4	2.2	16	25	33	2	16	8	0
a&b	13	73	14	Mean		13	38	33	2	9	5	0

NO 20 NW 5 2305 0969 Easter Cash, Strathmiglo BLOCK G_1

Surface level c + 55 m (c + 180 ft)
Water not struck
Pit
August 1979

Waste 1.3 m
Bedrock 0.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, sandy, silty, stony, reddish brown, with rare cobble size clasts and small irregular sandy lenses	0.6	0.9
	Clay, silty, stony, bright reddish brown, clasts mainly sandstone	0.4	1.3
Upper Devonian	Sandstone, fine grained, reddish purple, thinly bedded, broken	0.2+	1.5

NO 20 NW 6 2363 0905 Easter Cash Farm Cottages BLOCK G_1

Surface level c + 55 m (c + 180 ft)
Water struck at c + 53 m
Pit
August 1979

Overburden 0.3 m
Mineral 1.5 m
Waste 0.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	Sandy gravel, poorly sorted Gravel: fine and coarse with cobbles and rare boulders, subrounded to well rounded, sandstone common Sand: coarse and medium with fine, mainly subangular, quartz, rock and feldspar Fines: clayey from 0.3 to 0.9 m	1.5	1.8
Till	Clay, silty, stony, purple to reddish brown	0.3+	2.1

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	from	to	− 1/16	+ 1/16 − 1/4	+ 1/4 − 1	+ 1 − 4	+ 4 − 16	+ 16 − 64	+ 64
2	59	39	0.3	1.8	2	13	23	23	17	15	7

NO 20 NW 9 2497 0881 Falklandwood, Falkland BLOCK D

Surface level c + 45 m (c + 148 ft)
Water not struck
Pit
October 1979

Overburden 0.3 m
Mineral 1.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	a 'Clayey' sandy gravel, upper part disturbed Gravel: fine and coarse, subrounded to well rounded, andesite, sandstones, porphyry, dolerite Sand: fine and medium with coarse, mainly subangular, quartz, rock and feldspar Fines: silt with clay, disseminated and clay-bound seam near 1.0 m, light reddish brown	1.0	1.3
	b Sand with pebbles Gravel: fine, subrounded, porphyry, sandstone, andesite Sand: fine with medium and rare coarse, subangular, quartz with rock, feldspar and mica Fines: some silt, in seams, light reddish brown	0.8+	2.1

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	− 1/16	+ 1/16–1/4	+1/4–1	+1–4	+4–16	+16–64	+64
a	14	56	30	0.3	1.3	14	27	20	9	15	15	0
b	4	94	2	1.3	2.1	4	61	28	5	2	0	0
a&b	10	73	17	Mean		10	42	24	7	9	8	0

NO 20 NW 10 2494 0860 Falklandwood, Falkland BLOCK G_1

Surface level c + 51 m (c + 167 ft)
Water not struck
Pit
August 1979

Waste 1.4 m
Bedrock 0.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, silty, stony, firm, reddish brown	1.1	1.4
Upper Devonian	Clay-rock, mudstone, silty, unbedded, very soft, mottled yellow, orange, reddish brown and pale grey-green, very weathered	0.4+	1.8

NO 20 NE 23 2544 0911 Queen's Seat, Dunshelt BLOCK D

Surface level + 42 m (+ 138 ft)
Groundwater level + 39 m
250 mm percussion
May 1980

Overburden 0.6 m
Mineral 3.4 m
Waste 2.6 m
Bedrock 0.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy silty loam, dark brown	0.6	0.6
Late-Glacial alluvium	a Pebbly sand, with peat layers at 1.1 and 2.3 m Gravel: fine with rare coarse, rounded, quartzite, quartz, felsite and basalt Sand: fine and medium with coarse, subangular with well rounded, mainly quartz with some feldspar Fines: silt, disseminated and in seams, in lower part	2.0	2.6
Fluvioglacial sand and gravel	b Sandy gravel Gravel: coarse and fine, mainly well rounded, andesite, red and cream sandstone, schistose grit Sand: fine and medium with coarse, mainly subangular Fines: some silt, disseminated, grey	1.4	4.0
Till	Clay, silty, stony, firm to stiff, reddish brown, with clasts up to 200 mm, including dolerite, red sandstone and quartzite	2.6	6.6
Upper Devonian	Sandstone with pale green clay pebbles and mudstone bands. Sandstone is fine to medium grained with trace of vertical grain size variation, mottled brown and cream, soft with harder ribs	0.7+	7.3

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	− 1/16	+ 1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64	
a	9	82	9	0.6	1.6	3	36	43	8	10	0	0	
				1.6	2.6	15	36	32	8	7	2	0	†
				Mean		9	36	38	8	8	1	0	
b	5	52	43	2.6	4.0	5	22	18	12	17	26	0	†
a&b	7	70	23	Mean		7	30	30	10	12	11	0	

NO 20 NE 24 2695 0935 Nochnary, by Falkland BLOCK G_3

Surface level + 36 m (+ 118 ft)
Groundwater level + 34 m
250 mm percussion
May 1980

Overburden 0.5 m
Mineral 3.6 m
Waste 3.3 m
Mineral 3.1 m
Waste 5.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Alluvium	a Sand with thin peat layers and clay bands Gravel: fine, only in top metre Sand: mainly fine with medium and rare coarse, subangular, quartz with feldspar and rock Fines: disseminated silt and clay seams grey-brown	3.6	4.1
	Silt, sandy at top, rare clayey laminae; plant remains common, in seams	2.1	6.2
	Silt, grey-black due to abundant organic remains	1.0	7.2
	Clay, silty, brown, with plant remains	0.2	7.4
Fluvioglacial sand and gravel	b Sand Gravel: rare fine Sand: fine with medium and rare coarse, subangular to subrounded, quarts, feldspar and rock Fines: rare silt, mid-brown and rare seams of silty clay, reddish brown	2.0	9.4
	c Pebbly sand Gravel: fine with rare coarse, rounded, red sandstone, breccia and grit, andesite Sand: fine and medium with coarse, subangular to subrounded, quartz, feldspar and rock	1.1	10.5
Till	Clay, sandy firm, reddish brown with numerous cobble size clasts of sandstone, conglomerate and andesite. Below 13.8 m, fine grained, cream, siliceous sandstone is common	5.3+	15.8
	Borehole terminated owing to slow progress		

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	− 1/16	+ 1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64	
a	6	93	1	0.5	1.5	5	45	37	10	3	0	0	
				1.5	2.5	7	74	18	1	0	0	0	†
				2.5	3.5	7	74	17	2	0	0	0	†
				3.5	4.1	6	87	7	0	0	0	0	†
				Mean		6	68	21	4	1	0	0	
b	3	97	0	7.4	8.4	3	69	27	1	0	0	0	†
				8.4	9.4	2	50	46	2	0	0	0	†
				Mean		3	59	36	2	0	0	0	
c	2	79	19	9.4	10.5	2	37	34	8	17	2	0	†
a to c	5	91	4	Mean		5	60	28	4	3	0	0	
b & c	3	90	7	Mean		3	51	35	4	6	1	0	

NO 20 NE 25 2630 0821 Darnoe, Falkland BLOCK D

Surface level + 43 m (+ 141 ft)
Groundwater level + 40 m
250 mm percussion
May 1980

Overburden 0.5 m
Mineral 6.0 m
(inc. 0.2 m waste)
Bedrock 1.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.5	0.5
Fluvioglacial sand and gravel	a Sand Gravel: rare fine towards base Sand: fine with medium and rare coarse, subangular with some well rounded, quartz with rare feldspar Fines: silt bands, grey-brown	1.0	1.5
	b Sandy gravel Gravel: fine and coarse with cobbles, rounded to well rounded, andesitic lava, red and cream sandstone, quartzite, quartz, schistose grit Sand: fine and medium with coarse, subangular to subrounded, quartz with feldspar and rock Fines: silt, more common at top	3.0	4.5
Till	Clay, reddish brown with sandstone clasts	0.2	4.7
	c 'Clayey' sand Sand: disaggregated sandstone, fine with medium sand, mainly quartz Fines: mainly silt, pale reddish beige	1.8	6.5
Upper Devonian	Sandstone, fine grained with millet seed grains and vertical grain size variation, soft, thinly bedded, cream to buff	1.0+	7.5

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
a	10	89	1	0.5	1.5	10	55	29	5	1	0	0	
b	6	65	29	1.5	2.5	11	33	28	9	14	5	0	†
				2.5	3.5	3	17	22	11	19	21	7	†
				3.5	4.5	4	16	41	18	12	9	0	†
				Mean		6	22	30	13	15	12	2	
c	13	87	0	4.7	6.5	13	61	25	1	0	0	0	†
a to c	9	76	15	Mean		9	40	28	8	8	6	1	
a & b	7	71	22	Mean		7	30	29	11	12	9	2	

NO 20 NE 26 2661 0579 Purin, Freuchie BLOCK E

Surface level + 194 m (+ 636 ft)
Water not struck
250 mm percussion
May 1980

Overburden 0.4 m
Mineral 12.3 m
Waste 10.4 m
Bedrock 0.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, pebbly	0.4	0.4
Glacial sand and gravel	a 'Clayey' sandy gravel Gravel: coarse and fine with rare cobbles, subangular and subrounded, elongate and flakey pebbles common, siltstone, buff and red sandstone, dolerite Sand: fine and medium with coarse, angular to subrounded, quartz, feldspar and rock Fines: disseminated silt and clay from rotten pebbles	3.0	3.4
	b Pebbly sand Gravel: coarse and fine and rare cobbles, subangular to subrounded, sandstones, dolerite, basalt, siltstone, schistose grit Sand: fine and medium with coarse, angular to subrounded, quartz with feldspar and rock Fines: rare silty bands, grey-brown, then light brown	9.3	12.7
Till	Clay, silty, stony, with cobble size clasts, mainly dolerite with andesite, cream sandstone and ironstone. Colour is grey-brown	2.8	15.5
	Clay, silty, stony, firm, reddish brown, with clasts up to 210 mm including dolerite, cream sandstone, with quartzite, micaceous sandstone	7.6	23.1
Dolerite	Dolerite, medium grained, weathered, rather brittle	0.7+	23.8

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	− 1/16	+ 1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
a	11	60	29	0.4	1.4	10	25	23	10	18	14	0
				1.4	2.4	13	13	19	16	23	16	0
				2.4	3.4	10	36	32	5	8	9	0
				Mean		11	25	25	10	16	13	0
b	4	79	17	3.4	4.4	6	44	41	5	3	1	0
				4.4	5.4	8	35	23	8	9	10	7
				5.4	6.4	7	34	30	6	7	8	8
				6.4	7.4	7	38	36	7	6	6	0
				7.4	8.4	4	20	27	12	12	15	10
				8.4	9.4	1	35	38	9	9	8	0
				9.4	10.4	2	38	49	8	3	0	0
				10.4	11.4	4	36	30	12	11	7	0
				11.4	12.7	2	25	53	10	10	0	0
				Mean		4	34	36	9	8	6	3
a & b	6	74	20	Mean		6	32	33	9	10	8	2

NO 20 NE 27 2771 0978 Bowhouse Farm, Dunshelt BLOCK C

Surface level + 42 m (+ 138 ft)
Groundwater level + 39 m
250 mm percussion
May 1980

Overburden 0.6 m
Mineral 4.7 m
Waste 2.7 m
Bedrock 1.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.6	0.6
Fluvioglacial sand and gravel	Pebbly sand, more gravelly at top Gravel: fine with coarse, well rounded, andesite, agglomerate, red sandstone, quartz, quartzite, schistose grit Sand: medium with fine and coarse, subangular to subrounded, quartz, feldspar and rock Fines: silt, buff	4.7	5.3
Late-Glacial raised estuarine deposits	Clay, silty, laminated, reddish brown	0.4	5.7
Till	Clay, very sandy, reddish brown, with clasts up to 270 mm, including dolerite, andesite, cream sandstone	2.3	8.0
Upper Devonian	Sandstone with green clay pebbles. Sand grains are mainly fine grained, subangular to subrounded with some millet-seed grains	1.2+	9.2

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages							
Fines	Sand	Gravel			Fines	Sand			Gravel			
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
4	82	14	0.6	1.5	5	11	30	15	24	15	0	
			1.5	2.5	4	30	37	16	10	3	0	
			2.5	3.5	4	30	53	7	5	1	0	†
			3.5	4.5	3	22	62	6	5	2	0	†
			4.5	5.3	5	47	37	6	5	0	0	†
			Mean		4	28	44	10	10	4	0	

NO 20 NE 28 2747 0833 Lathrisk Home Farm, Falkland BLOCK D

Surface level + 43.49 m (+ 142.7 ft)
Water not struck
250 mm percussion
May 1980

Waste 3.3 m
Bedrock 0.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.5	0.5
	Soil, sandy	0.2	0.7
Fluvioglacial sand and gravel	Sand Gravel: rare fine, well rounded, quartz Sand: fine and medium with rare coarse, quartz with feldspar and rock Fines: silt	0.8	1.5
Till	Clay, silty, sandy, stony, reddish brown, with cobble and gravel size clasts including andesite, sandstones, quartzite	1.8	3.3
Upper Devonian	Sandstone, fine grained with traces of vertical grain size variation, composed of subangular to subrounded and millet seed grains. Cream coloured and very soft	0.7+	4.0

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	−1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
6	93	1	0.7	1.5	6	48	44	1	1	0	0

NO 20 NE 29 2759 0605 Nether Drums, Freuchie BLOCK E

Surface level + 100 m (+ 328 ft)
Groundwater level + 98 m
250 mm percussion
May 1980

Waste 16.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.6	0.6
Till	Clay, sandy, silty, stony, firm, but sandier to 1.7 m. Reddish brown in colour, but mottled grey between 9.7 and 10.5 m. Clasts up to 150 mm, dolerite most common, also granodiorite, dark red hard sandstone with red siltstone pebbles, and yellow sandstone with green clay pebbles	15.8+	16.4
	Borehole terminated owing to rock obstruction		

NO 20 NE 30 2848 0728 Unthank, Freuchie BLOCK D

Surface level + 42 m (+ 138 ft)
Groundwater level + 40 m
250 mm percussion
May 1980

Overburden 0.9 m
Mineral 1.3 m
Waste 5.4 m
Mineral 2.2 m
(inc. 0.1 m waste)
Bedrock 0.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Late-Glacial alluvium	Silt, sandy, reddish brown, with peat layer at 0.9 m	0.4	0.9
	a 'Clayey' pebbly sand Gravel: fine with coarse, rounded to well rounded, mainly andesite with quartzite, dolerite and quartz Sand: fine and medium with coarse, mainly subrounded, quartz with feldspar and rock Fines: silt, disseminated and as seams at top, buff	1.3	2.2
Till	Silt, sandy, clayey with stones. Sandier at top and below 5.0 m. Clasts, often subrounded, include andesitic lavas, yellow fine grained sandstone, porphyry, dolerite	5.4	7.6
Glacial sand and gravel	b Sandy gravel Gravel: coarse and fine, subrounded to well rounded, andesite with sandstone and quartz Sand: medium and fine with coarse, subrounded to well rounded, quartz, feldspar and rock Fines: some silt, grey-brown	1.0	8.6
	Clay and silt, reddish brown	0.1	8.7
Till	c Sandy gravel, but fines lost by washing action Gravel: fine and coarse, mainly rounded, andesite, cream sandstone, vein-quartz Sand: medium and fine with coarse, subangular to well rounded, quartz feldspar and rock Fines: mainly silt, light brown	1.1	9.8
Upper Devonian	Sandstone, fine grained, silty in part, soft, thinly bedded, grains mainly subrounded, some evidence of grain size variation between adjacent laminae	0.8+	10.6

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
a	15	72	13	0.9	2.2	15	32	30	10	10	3	0	
b	6	59	35	7.6	8.6	6	21	25	13	15	20	0	†
c	7	70	23	8.7	9.8	7	23	31	16	12	11	0	†
a to c	10	67	23	Mean		10	26	28	13	12	11	0	
b & c	7	65	28	Mean		7	22	28	15	13	15	0	

NO 20 NE 31 2840 0581 Forthar Mill Farm, Freuchie BLOCK E

Surface level + 83 m (+ 272 ft)
Water not struck
250 mm percussion
May 1980

Overburden 0.3 m
Mineral 3.1 m
Waste 12.3 m
Bedrock 1.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	Sand, with silty seams increasing with depth Sand: fine with medium and rare coarse, mainly subrounded, quartz with rare feldspar and rock Fines: silt, in seams and disseminated	3.1	3.4
Till	Clay, sandy, silty, stony, reddish brown. Clasts up to 200 mm, include andesite, porphyry, red and buff sandstones	10.9	14.3
	Clay, sandy, silty, stony, mid to dark brown. Clasts include red and cream siliceous sandstones, dolerite and sandstone with green clay pebbles	1.4	15.7
Lower Carboniferous	Siltstone and mudstone, sandy, blue-grey and grey-brown	1.0+	16.7

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	− 1/16	† 1/16 − 1/4	+1/4–1	+1–4	+4–16	+16–64	+64
10	90	0	0.3	1.3	9	74	16	1	0	0	0
			1.3	2.3	12	61	27	0	0	0	0
			2.3	3.4	8	54	38	0	0	0	0
			Mean		10	63	27	0	0	0	0

NO 20 NE 32 2930 0837 Easter Lathrisk, by Kingskettle BLOCK G_3

Surface level + 36 m (+ 118 ft)
Water struck, artesian
250 and 200 mm percussion
May 1980

Overburden 0.4 m
Mineral 1.2 m
Waste 10.4 m
Bedrock 1.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Alluvium	Pebbly sand Gravel: fine, mainly rounded quartz Sand: fine and medium with coarse, subangular, quartz with some feldspar and rock Fines: rare silty seams, grey-brown	1.2	1.6
Late-Glacial raised estuarine deposits	Clay, silty, laminated, light reddish brown, with rare sand and fine gravel stringers	6.6	8.2
Glacial sand and gravel	Sandy gravel Gravel: cobble and coarse with fine, mainly rounded andesite Sand: fine and medium with coarse, subrounded to angular, quartz, feldspar and rock Fines: some silt, reddish brown	0.4	8.6
Till	Clay, silty, sandy, firm to stiff, reddish brown, with clasts mainly coarse gravel size, including andesite, porphyry, sandstones, felsite	3.4	12.0
Upper Devonian	Sandstone, hard due to secondary iron, fine grained with seams of fine and medium with coarse, some millet seed grains, thinly bedded	1.2+	13.2

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
8	87	5	0.4	1.6	8	38	40	9	5	0	0

NO 20 NE 33 2835 0899 Shiells, by Ladybank BLOCK C

Surface level + 42 m (+ 138 ft)
Groundwater level + 39 m
250 and 200 mm percussion, and rotary
July 1980

Overburden 0.3 m
Mineral 3.9 m
Waste 9.3 m
Bedrock 3.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.3	0.3
Fluvioglacial sand and gravel	a 'Clayey' sand Gravel: absent below 1.9 m, fine, subangular to rounded, quartz and andesite Sand: fine with medium and rare coarse, angular to rounded, quartz with rock, feldspar and mica Fines: silt, disseminated, buff to reddish grey-brown	2.9	3.2
	b 'Very clayey' sand Sand: fine, angular to subrounded, quartz with mica Fines: silt	1.0	4.2
	Silt, grey, with thin brown clay seams	0.9	5.1
Late-Glacial raised estuarine deposits	Clay, silty, pale brown and reddish brown	3.4	8.5
	Clay, silty, laminated, reddish brown, with rare pebbles, drop stones	0.4	8.9
Till	Sand, silty, clayey with innumerable sandstone clasts	4.6	13.5
Upper Devonian	Sandstone, medium to fine grained, locally coarse, generally soft, yellow or cream, with greenish grey clay pebbles up to 30 mm between 15.4 and 15.7 m and below 16.3 m. Traces of cross bedding throughout	3.8+	17.3

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
a	12	88	0	0.3	1.2	10	67	21	1	1	0	0	
				1.2	2.2	13	74	12	1	0	0	0	
				2.2	3.2	13	85	2	0	0	0	0	
				Mean		12	76	11	1	0	0	0	
b	26	74	0	3.2	4.2	26	73	1	0	0	0	0	†
a & b	16	84	0	Mean		16	74	9	1	0	0	0	

NO 20 NE 34 2974 0957 Drumtenant, Ladybank BLOCK B

Surface level + 40 m (+ 131 ft)
Groundwater level + 39 m
250 mm percussion
July 1980

Overburden 0.2 m
Mineral 5.5 m
Waste 4.6 m
Bedrock 1.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Fluvioglacial sand and gravel	a Sand with pebbles Gravel: fine, mainly subangular, quartz and quartzite with andesite and felsite Sand: fine and medium with coarse, subangular to subrounded, quartz, feldspar and rock Fines: silt, disseminated, more common between 0.2 and 1.2 m, grey	4.5	4.7
	b 'Clayey' sand Sand: fine with medium, mainly angular and subangular, quartz with rock and feldspar Fines: disseminated silt and seam of laminated silty clay at 4.7 m, grey	1.0	5.7
	Silt with some fine sand at top, micaceous, grey	1.1	6.8
Late-Glacial raised estuarine deposits	Clay, reddish brown, tenaceous, with rare silty laminae, and numerous drop stones up to cobble size, some striated, foraminifera recorded at c 7.0 m	0.6	7.4
Till	Clay, sandy, silty, stony, firm to stiff, becoming sandier with depth. Clasts comprise mainly andesite and cream sandstone	2.9	10.3
Upper Devonian	Sandstone, medium grained, mottled yellow and greenish grey, locally purplish brown, with green clay clasts up to 10 mm, and some greenish grey finely micaceous layers. Traces of bedding and rare felsitic pebbles	1.1+	11.4

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	$-1/16$	$+1/16-1/4$	$+1/4-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
a	7	91	2	0.2	1.2	12	44	34	7	3	0	0	
				1.2	2.2	5	30	57	6	2	0	0	†
				2.2	3.2	4	30	53	9	4	0	0	†
				3.2	4.7	6	62	30	1	1	0	0	†
				Mean		7	44	42	5	2	0	0	
b	15	85	0	4.7	5.7	15	70	15	0	0	0	0	†
a & b	8	90	2	Mean		8	49	37	4	2	0	0	

NO 20 NE 35 2563 0839 Falklandwood Farm Cottages BLOCK G_1

Surface level c + 48 m (c + 157 ft)
Water not struck
Pit
August 1979

Waste 1.6 m
Bedrock 0.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	Sand, very fine, cream	0.5	0.8
Till	Clay, sandy, stony, quite soft, reddish brown	0.8	1.6
Upper Devonian	Sandstone, fine grained, soft, cream	0.3+	1.9

NO 20 NE 36 2643 0899 Maryfield, by Falkland BLOCK D

Surface level c + 42 m (c + 138 ft)
Water not struck
Pit
August 1979

Overburden 0.3 m
Mineral 1.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	Sand with rare fine gravel below 0.8 m Sand: mainly fine to 0.8 m then medium with fine and some coarse, mainly subangular to subrounded, quartz with feldspar and rock Fines: disseminated silt above 0.8 m, pale buff then light reddish brown	1.7+	2.0

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
5	94	1	0.3	0.8	8	71	21	0	0	0	0
			0.8	2.0	3	32	49	14	2	0	0
			Mean		5	43	41	10	1	0	0

NO 20 NE 38 2568 0807 Falklandwood Farm Cottages BLOCK D

Surface level c + 48 m (c + 157 ft)
Water struck at c + 46 m
Pit
August 1979

Overburden 0.3 m
Mineral 1.6 m
Waste 0.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	Sand with pebbles Gravel: fine with trace of coarse, subangular to subrounded, quartzite, schistose grit, siltstone Sand: medium and fine with rare coarse, subangular to subrounded, mainly quartz with some rock and feldspar Fines: some disseminated silt and rare thin clay seams, pale grey to buff	1.6	1.9
Till	Clay, sandy, silty, stony, reddish brown	0.1+	2.0

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-1/16$	$+1/16-1/4$	$+1/4-1$	+1–4	+4–16	+16–64	+64
2	94	4	0.3	1.9	2	40	48	6	3	1	0

NO 20 NE 39 2695 0597 Purin, Freuchie BLOCK E

Surface level c + 143 m (c + 469 ft)
Water not struck
Pit
August 1979

Overburden 0.3 m
Mineral 1.9 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	Pebbly sand, 'clayey' to 0.8 m Gravel: fine and coarse with rare cobbles up to 200 mm, mainly subrounded to well rounded, mainly sandstone, siltstone, shale and dolerite Sand: fine, medium and coarse, angular to rounded, quartz, rock and feldspar Fines: disseminated silt, mainly from 0.3 to 0.8	1.9+	2.2

NO 20 NE 40 3743 0754 Newton of Lathrisk, Freuchie BLOCK D

Surface level c + 43 m (c + 141 ft) Waste 2.2 m +
Water struck at c + 41 m
Pit
October 1979

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Late-Glacial alluvium	Clay, silty, sandy, illsorted, mottled reddish brown	0.9	1.2
	Clay, silty, laminated, stiff, buff, with thin peat layer at base	0.5	1.7
	Sand, fine, very silty, buff	0.5+	2.2

NO 20 NE 42 2749 0618 Nether Drums, Freuchie BLOCK E

Surface level c + 96 m (c + 315 ft) Waste 1.9 m +
Water not struck
Pit
October 1979

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	Sand with some pebbles near base Gravel: fine and coarse, well rounded Sand: fine with some medium, mainly subangular, quartz with rock Fines: a little silt	0.6	0.9
	Clay, silty, laminated, reddish brown	0.6	1.5
Till	Clay, sandy, stony, reddish brown	0.4+	1.9

NO 20 NE 44 2812 0531 Pittillock, Freuchie BLOCK E

Surface level c + 102 m (c + 335 ft) Waste 1.7 m +
Water not struck
Pit
August 1979

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	'Clayey' sand with pebbles, composed of alternating seams of clean fine sand with pebbles and claybound pebbly sand	0.8	1.1
Till	Clay, sandy, stony, quite firm, reddish brown	0.6+	1.7

NO 20 SW 16 2059 0085 East Bowhouse, by Leslie BLOCK G_1

Surface level + 108 m (+ 354 ft)
Groundwater level + 105 m
250 mm percussion
June 1980

Overburden 1.0 m
Mineral 1.8 m
Waste 16.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.4	0.4
Lacustrine alluvium	Silt, sandy, with rootlets, grey-brown	0.6	1.0
	Sand with pebbles Gravel: fine Sand: medium and fine with coarse, subangular to subrounded, quartz Fines: thin silt laminae; colour light brown to 2.0 m, then grey	1.8	2.8
Late-Glacial alluvium (?)	Silt, sandy, grey	3.2	6.0
Glaciolacustrine deposits (?)	Silt, clayey, laminated below 7.8 m, grey with red-grey sandy laminae	9.0	15.0
	Clay, silty, laminated, brown, with reddish brown sand and silt laminae	4.5+	19.5
	Borehole terminated owing to excessive overburden		

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages							
Fines	Sand	Gravel			Fines	Sand			Gravel			
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
5	93	2	1.0	2.0	4	43	43	8	2	0	0	
			2.0	2.8	6	33	51	8	2	0	0	†
			Mean		5	39	46	8	2	0	0	

NO 20 SW 17 2318 0142 Farmlands, Leslie BLOCK G_1

Surface level + 136 m (+ 446 ft)
Water not struck
250 mm percussion
June 1980

Overburden 0.5 m
Mineral 1.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.5	0.5
Glacial sand and gravel	Sandy gravel Gravel: fine and coarse, with cobbles and boulders increasing with depth, rounded to well rounded, dolerite, cream and light brown sandstone Sand: coarse, medium and fine, angular to rounded, quartz, rock and feldspar Fines: clay and silt, upper part of deposit slightly claybound. Also one thin clay seam	1.5+	2.0
	Borehole terminated owing to boulder obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	from	to	– 1/16	+ 1/16 – 1/4	+1/4–1	+1–4	+4–16	+16–64	+64
10	50	40	0.5	1.5	10	14	18	20	22	16	0
			1.5	2.0	9	14	17	15	23	18	4
			Mean		10	14	18	18	22	17	1

NO 20 SW 18 2465 0229 Balsillie, Leslie BLOCK G_1

Surface level + 144 m (+ 472 ft)
Water not struck
250 mm percussion
June 1980

Overburden 0.4 m
Mineral 9.6 m
Waste 0.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.4	0.4
Glacial sand and gravel	Sandy gravel Gravel: coarse and fine with cobbles up to 150 mm, subangular to subrounded, dolerite and soft sandstone with rare siltstone, coal, quartz quartzite Sand: coarse, medium and fine, subangular to subrounded, quartz and rock Fines: disseminated silt and seams of silty clay to 3.4 m, thereafter a little silt. Secondary calcitic cement from 9.8 to 10.0 m. Colour is brown.	9.6	10.0
Till	Clay, sandy, grey, with clasts up to cobble size, mainly dolerite with rare sandstone	0.5+	10.5
	Borehole terminated owing to rock obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand		Gravel			
			from	to	− 1/16	+ 1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
8	55	37	0.4	1.4	13	15	18	15	15	19	5
			1.4	2.4	8	14	16	10	9	19	24
			2.4	3.4	13	18	16	16	16	21	0
			3.4	4.4	8	9	20	28	18	17	0
			4.4	5.4	4	5	25	31	12	17	6
			5.4	6.4	9	8	17	32	21	9	4
			6.4	7.4	5	8	21	36	13	17	0
			7.4	8.4	6	21	21	15	13	12	12
			8.4	9.5	5	17	26	17	10	3	22
			9.5	10.0	10	23	17	13	20	17	0
			Mean		8	13	20	22	14	15	8

NO 20 SE 361 2524 0248 Roaring Hill, Leslie BLOCK G_1

Surface level + 118.03 m (+ 387.2 ft)
Water struck at + 113.4 m
250 mm percussion
June 1980

Overburden 0.7 m
Mineral 7.7 m
? Bedrock 0.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.7	0.7
Glacial sand and gravel	a Sandy gravel, gravel from 2.7 to 4.6 m Gravel: coarse and fine with cobbles, rounded to well rounded, sandstones, dolerite, quartzite, basalt, siltstone, andesite, quartz, granite Sand: medium and fine with coarse, subangular to rounded, quartz and rock with feldspar Fines: disseminated silt and clay, deposit partly claybound. Below 4.6 m much lost by washing action. Colour is orange-brown to light brown	6.9	7.6
Till	b 'Clayey' sandy gravel, disaggregated by drill action Gravel: fine with coarse, mainly subangular to rounded, mainly sandstones, dolerite, quartzite, siltstone Sand: fine with medium and coarse, angular to rounded, quartz and rock with feldspar Fines: disseminated silt, much lost by washing action. Colour is pale brown	0.8	8.4
Dolerite (?)	Dolerite, extremely hard, only sand size fragments recovered	0.1+	8.5
	Borehole terminated owing to rock obstruction		

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	6	50	44	0.7	1.7	13	29	22	16	12	8	0	
				1.7	2.7	9	15	23	11	12	24	6	
				2.7	3.7	6	10	12	12	18	21	21	
				3.7	4.6	5	13	14	10	17	25	16	
				4.6	5.6	2	22	15	13	16	27	5	†
				5.6	6.6	2	14	20	23	20	21	0	†
				6.6	7.6	4	19	11	21	20	21	4	†
				Mean		6	18	17	15	16	21	7	
b	16	57	27	7.6	8.4	16	31	12	14	18	9	0	†
a & b	7	50	43	Mean		7	19	16	15	17	19	7	

NO 20 SE 362 2763 0457 Pittillock, Freuchie BLOCK E

Surface level + 161 m (+ 528 ft)
Water not struck
250 mm percussion
May 1980

Overburden 0.5 m
Mineral 8.3 m
Waste 14.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.5	0.5
Glacial sand and gravel	a Sand with pebbles Gravel: fine, rounded, red and cream fine grained sandstone and grey micaceous siltstone Sand: fine with medium and rare coarse, but mainly fine below 4.5 m, subangular to rounded, quartz, rock and feldspar Fines: silt, disseminated and concentrated in seams, marked increase below 5.5 m	5.5	6.0
	b Pebbly sand Gravel: from 6.0 to 8.0 m, fine with coarse, subangular to subrounded, mainly dolerite with quartz, quartzite and basalt Sand: fine and medium with coarse, mainly subangular, quartz, feldspar and rock Fines: silty seams and brown clay lamina at 6.8 m	2.8	8.8
	Silt and clay, laminated, reddish brown	0.2	9.0
Till	Clay, sandy, silty, stony, firm, mid-brown, with clasts up to 250 mm, mainly dolerite and basalt, with quartzite, yellow, grey sandstone, dark red sandstone with red siltstone pebbles, red micaceous siltstone, schistose grit, fossiliferous calcareous mudstone	14.0+	23.0
	Borehole terminated owing to excessive overburden		

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	− 1/16	+ 1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
a	6	93	1	0.5	1.5	8	51	38	2	1	0	0
				1.5	2.5	6	50	42	2	0	0	0
				2.5	3.5	6	64	30	0	0	0	0
				3.5	4.5	2	21	71	4	2	0	0
				4.5	5.5	5	72	20	2	1	0	0
				5.5	6.0	14	70	12	1	3	0	0
				Mean		6	53	38	2	1	0	0
b	6	84	10	6.0	7.0	3	25	40	16	11	5	0
				7.0	8.0	7	53	24	5	11	0	0
				8.0	8.8	7	40	52	1	0	0	0
				Mean		6	38	38	8	8	2	0
a & b	6	90	4	Mean		6	48	38	4	3	1	0

NO 20 SE 363 2887 0321 Tofthill Plantation, Markinch BLOCK E

Surface level + 95.9 m (+ 315 ft)
Water not struck
250 mm percussion
June 1980

Overburden 0.4 m
Mineral 4.6 m
Waste 1.9 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy with pebbles	0.4	0.4
Glacial sand and gravel	a Gravel Gravel: coarse and fine with cobbles up to 130 mm, subrounded, sandstone, dolerite, basalt, with quartzite and coal Sand: coarse and medium with fine, angular to rounded, quartz, feldspar and rock Fines: disseminated silt and clay, light brown	2.4	2.8
	b 'Clayey' sandy gravel Gravel: fine and coarse, with cobbles from 2.8 to 3.5 m, subangular to subrounded, sandstone, dolerite, quartzite, coal Sand: fine and medium with coarse, subangular to subrounded, quartz, feldspar and rock Fines: some disseminated silt and clayey partings, deposit clay-bound from 2.8 to 3.5 m	2.2	5.0
Till	Clay, sandy, stony, reddish brown, with clasts up to 200 mm, mainly dolerite with andesite, sandstone and coal	1.9+	6.9
	Borehole terminated owing to rock obstruction		

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	7	44	49	0.4	1.4	7	10	17	15	19	32	0
				1.4	2.4	7	9	17	17	19	19	12
				2.4	2.8	9	10	19	20	22	20	0
				Mean		7	10	17	17	20	24	5
b	15	58	27	2.8	3.5	17	9	15	13	15	12	19
				3.5	4.5	13	22	36	15	10	4	0
				4.5	5.0	16	24	20	14	15	11	0
				Mean		15	18	26	14	13	8	6
a & b	11	50	39	Mean		11	14	20	16	16	17	6

NO 20 SE 364 2866 0235 Balbirnie Park, Markinch

Surface level + 96 m (+ 315 ft)
Water not struck
250 mm percussion
June 1980

Overburden 0.5 m
Mineral 6.0 m
(inc. 1.0 m waste)
Waste 2.6 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.5	0.5
Glacial sand and gravel	'Very clayey' pebbly sand, non-mineral from 4.5 to 5.5 m Gravel: coarse and fine, with cobbles up to 170 mm below 4.5 m, angular to well rounded, mainly dolerite, with dark grey sandstone Sand: fine with medium and coarse, mainly subangular, quartz with coal Fines: silt, disseminated and in seams below 4.5 m. Excessive fines from 4.5 to 5.5 m. Colour is light brown	6.0	6.5
Till	Clay, stony, silty, sandy, mid-brown, with numerous clasts up to boulder size, mainly dolerite with light brown fine grained sandstone, purple hard sandstone, granite, andesite, rhyolite and coal	2.6+	9.1
	Borehole terminated owing to rock obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
30	65	5	0.5	1.5	22	63	8	1	3	3	0
			1.5	2.5	35	56	2	2	1	4	0
			2.5	3.5	26	63	10	1	0	0	0
			3.5	4.5	35	63	1	0	1	0	0
			4.5	5.5		Waste					
			5.5	6.5	34	40	9	4	5	8	0
			Mean		30	57	6	2	2	3	0

NO 20 SE 365 2951 0438 Kirkforthar Feus, Freuchie BLOCK E

Surface level + 96 m (+ 315 ft)
Water struck at + 90 m
250 percussion
May 1980

Mineral 11.8 m
Waste 0.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Fluvioglacial sand and gravel	a Sand Sand: fine with medium and rare coarse, subrounded to rounded, quartz, feldspar, rock and rare coal Fines: a little silt, disseminated. Colour is light to reddish brown then buff	10.0	10.0
	b 'Clayey' pebbly sand Gravel: rare cobbles of dolerite, sandstone and quartzite Sand: fine with medium, subrounded, quartz with feldspar and coal Fines: silt and clay, reddish brown	1.8	11.8
	Clay, laminated, red, with rare clasts of dolerite	0.1	11.9
Till	Clay, sandy, stony, grey to grey-brown, with clasts up to 150 mm, mainly dolerite, also conglomerate and quartzite	0.4+	12.3
	Borehole terminated owing to rock obstruction		

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	− 1/16	+ 1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64	
a	4	96	0	0.0	1.0	4	53	43	0	0	0	0	
				1.0	2.0	4	66	28	2	0	0	0	
				2.0	3.0	2	56	42	0	0	0	0	
				3.0	4.0	3	58	38	1	0	0	0	
				4.0	5.0	5	76	19	0	0	0	0	
				5.0	6.0	8	82	10	0	0	0	0	
				6.0	7.0	5	61	34	0	0	0	0	†
				7.0	8.0	5	65	30	0	0	0	0	†
				8.0	9.0	1	47	51	1	0	0	0	†
				9.0	10.0	1	49	49	1	0	0	0	†
				Mean		4	61	34	1	0	0	0	
b	18	74	8	10.0	11.0	20	55	11	0	0	0	14	†
				11.0	11.8	15	67	17	1	0	0	0	†
				Mean		18	60	14	0	0	0	8	
a & b	6	93	1	Mean		6	61	31	1	0	0	1	

NO 20 SE 366 2968 0367 Lochmuir Wood, Markinch BLOCK E

Surface level + 94 m (+ 308 ft)
Groundwater level + 88 m
250 mm percussion
May 1980

Overburden 0.5 m
Mineral 2.1 m
Waste 16.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, gravelly	0.5	0.5
Fluvioglacial sand and gravel	Pebbly sand Gravel: fine and coarse, subangular to subrounded, dolerite, red and yellow sandstone, metamorphic rock Sand: medium with fine and coarse, subangular to rounded, quartz, feldspar and rock Fines: rare silt, light brown	2.1	2.6
Glaciolacustrine deposits	Silt, laminated with fine sand laminae between 8.0 and 13.0 m, light brown to 3.2 m then colour laminated, brown, grey-brown and light reddish brown	16.2	18.8
Till	Clay, sandy with stones, grey, clasts angular to subangular, mainly dolerite with sandstone and quartzite	0.3+	19.1
	Borehole terminated owing to excessive overburden		

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
4	81	15	0.5	1.5	2	15	51	12	12	8	0
			1.5	2.6	5	31	39	15	6	4	0
			Mean		4	24	43	14	9	6	0

NO 20 SE 367 2958 0286 Newton, Markinch BLOCK E

Surface level + 102.03 m (+ 334.7 ft)
Groundwater level + 82.5 m
250 mm percussion
June 1980

Overburden 3.0 m
Mineral 22.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.4	0.4
	Soil, sandy loam	0.8	1.2
Head	Clay, sandy, stony, red-brown, subangular to subrounded, clasts up to 30 mm, including red and yellow sandstone, dolerite, quartzite, coal. Becomes sandier at depth with rare gravel stringers	1.8	3.0
Glacial sand and gravel	a Sandy gravel Gravel: fine and coarse with cobbles up to 100 mm, subrounded to rounded, dolerite with red and yellow sandstone, vein-quartz, quartzite Sand: fine, medium and coarse, subangular to subrounded, quartz, feldspar and rock Fines: rare thin silty clay seams. Colour is red-brown	5.4	8.4
	b Pebbly sand, cemented layer at 8.4 m Gravel: fine, subrounded, sandstone and rare coal Sand: fine and medium with coarse, subrounded to well rounded, quartz, feldspar and rock Fines: silt, disseminated and as rare laminae, increasing below 10.4 m. Light brown	3.2	11.6
	c Sandy gravel Gravel: coarse and fine with cobble, up to 100 mm, subrounded to rounded, dolerite, red and yellow sandstone, also andesite, quartzite, vein-quartz, felsite, siltstone and mudstone Sand: fine, medium and coarse; coarse increasing with depth at the expense of fine which is prevalent at top, angular to subrounded, quartz and feldspar Fines: rare silt, light brown to buff	13.4+	25.0

(... continued)

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	+¼–1	+1–4	+4–16	+16–64	+64	
a	6	53	41	3.0	4.0	4	11	18	18	18	9	22	
				4.0	5.0	5	12	18	19	21	25	0	
				5.0	6.0	7	22	29	16	13	13	0	
				6.0	7.0	7	25	33	18	10	7	0	
				7.0	8.4	6	9	14	13	20	23	15	
				Mean		6	15	21	17	17	16	8	
b	8	87	5	8.4	9.4	4	41	42	8	5	0	0	
				9.4	10.4	5	54	38	2	1	0	0	
				10.4	11.6	15	37	33	7	4	4	0	
				Mean		8	43	38	6	3	2	0	
c	3	57	40	11.6	12.6	2	30	13	6	6	14	29	
				12.6	13.6	5	33	13	3	5	13	28	
				13.6	14.6	3	61	35	1	0	0	0	
				14.6	15.7	6	26	49	1	0	2	16	
				15.7	16.7	8	22	28	8	15	19	0	
				16.7	17.7	5	30	39	6	7	13	0	
				17.7	18.7	3	17	22	15	16	16	11	
				18.7	19.7	4	5	13	25	24	24	5	
				19.7	20.7	1	3	47	16	12	21	0	†
				20.7	21.7	2	21	26	13	15	23	0	†
				21.7	22.7	1	13	14	26	23	23	0	†
				22.7	23.7	1	6	9	23	25	33	3	†
				23.7	25.0	1	3	13	18	28	29	8	†
				Mean		3	20	25	12	14	18	8	
a to c	5	60	35	Mean		5	23	25	12	13	15	7	

NO 20 SE 368 2843 0263 Balbirnie Mains Pit Section

Surface level + 98.88 m (+ 324.4 ft) Mineral 7.5 m +
Section dry
Sampled by hand
September 1980

LOG

Geological classification	Lithology	Thickness m	Depth m
Head	a 'Very clayey' sandy gravel Gravel: coarse and fine with cobbles and rare boulders, mainly subangular, mainly dolerite with red and cream sandstone, quartz Sand: fine with medium and some coarse, angular to rounded, quartz, rock and feldspar Fines: disseminated silt with some clay, reddish brown. Discontinuous silt seam 50 mm above base	1.9	1.9
Glacial sand and gravel	b Pebbly sand Gravel: fine and coarse, rounded to well rounded, sandstone, dolerite, quartz, coal Sand: fine with medium and rare coarse, mainly subangular, quartz with rock and feldspar Fines: rare silt and some clay adhering to pebbles, light brown	0.6	2.5
	c Gravel Gravel: cobble, coarse and fine, with boulders up to 300 mm, subrounded to well rounded, red and yellow sandstones, dolerite, andesite, quartz, some siltstone, shale and rotten igneous rock Sand: coarse with medium and rare fine, subangular to rounded, quartz, rock and feldspar Fines: some reddish clay coating grains to 4.5 m, then little, grey-brown	4.0	6.5
	d Sand, cemented with calcium carbonate at top Sand: medium with fine and rare coarse, angular to rounded, quartz with rock and feldspar Fines: little, buff	1.0+	7.5

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	27	50	23	0.0	1.9	27	27	16	7	9	14	0
b	6	85	9	1.9	2.5	6	46	34	5	5	4	0
c	4	27	69	2.5	3.5	4	1	5	23	16	22	29
				3.5	4.5	4	2	8	19	28	19	20
				4.5	5.5	3	1	6	9	10	32	39
				5.5	6.5	5	2	5	26	22	22	18
				Mean		4	2	6	19	19	24	26
d	2	95	3	6.5	7.5	2	22	66	7	3	0	0
a to d	10	46	44	Mean		10	14	19	13	13	17	14
b to d	4	45	51	Mean		4	10	19	16	15	17	19

NO 20 SE 372 2853 0406 Gateside, Kirkforthar BLOCK E

Surface level c + 96 m (c + 315 ft)
Water struck at c + 95 m
Pit
October 1979

Waste 1.9 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, silty, quite soft, mottled grey, brown and orange, with low stone content	1.1	1.4
	Clay, silty, quite soft, grey-brown, with low stone content	0.5+	1.9

NO 20 SE 373 2818 0348 Balfarg BLOCK E

Surface level c + 100 m (c + 328 ft)
Water not struck
Pit
October 1979

Overburden 0.4 m
Mineral 1.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Alluvium	'Clayey' pebbly sand with cobbles and boulders of dolerite Gravel: fine, coarse, cobble and boulder, mainly subrounded, dolerite common Sand: fine, medium and coarse, subangular to subrounded, quartz and rock Fines: disseminated silt and clay	1.0+	1.4

NO 20 SE 374 2873 0307 North Lodge, Balbirnie Park

Surface level c + 101 m (c + 331 ft)
Water not struck
Pit
October 1979

Overburden 0.3 m
Mineral 1.2 m
Waste 0.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	Sandy gravel Gravel: fine and coarse, mainly rounded, cream fine grained and reddish brown coarse grained sandstones, dolerite, siltstone Sand: medium and fine with coarse, subangular to subrounded, quartz with feldspar and rock Fines: a little silt, light brown	1.2	1.5
Till	Clay, silty sandy, quite gravelly, with some boulders, reddish brown	0.5+	2.0

(... continued)

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			From	to	−1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
2	71	27	0.3	1.5	2	25	34	12	16	11	0

NO 21 SW 1 2318 1073 Reedieleys, Auchtermuchty BLOCK C

Surface level + 49 m (+ 161 ft)
Groundwater level + 45 m
250 mm percussion
July 1980

Overburden 0.8 m
Mineral 1.7 m
Waste 5.0 m
Bedrock 0.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy loam	0.8	0.8
Fluvioglacial sand and gravel	'Very clayey' sand Sand: medium with some fine and rare coarse, subangular, quartz and feldspar Fines: disseminated silt, increasing with depth, also thin silt seams, reddish brown	1.7	2.5
	Silt, laminated with thin clay and sand seams	1.4	3.9
Till	Clay, very sandy, red, with clasts up to 100 mm, of red sandstone and dolerite, the former increasing with depth	3.6	7.5
Upper Devonian	Sandstone, fine to medium grained, pink, fairly hard, fissured	0.8+	8.3

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages							
Fines	Sand	Gravel			Fines	Sand			Gravel			
			from	to	−1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64	
25	74	1	0.8	1.8	19	59	16	5	1	0	0	
			1.8	2.5	34	61	5	0	0	0	0	†
			Mean		25	59	12	3	1	0	0	

NO 21 SW 2 2452 1101 Myres Castle, Dunshelt BLOCK C

Surface level + 42 m (+ 138 ft)
Groundwater level + 39 m
250 and 200 mm percussion
July 1980

Overburden 1.7 m
Mineral 1.9 m
Waste 8.1 m
Bedrock 0.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.4	0.4
Lacustrine alluvium	Silt, sandy, clayey, reddish brown, with rare rootlets and trace of fine gravel	1.3	1.7
Fluvioglacial sand and gravel	'Very clayey' sand Sand: fine with medium and trace of coarse, subangular to subrounded, quartz, feldspar and rock Fines: disseminated silt and clayey silt laminae, increasing below 3.5 m, reddish brown to brown to 2.8 m, then grey-brown	1.9	3.6
	Silt, laminated, with sandy partings about 2 mm thick, red to 5.0 m, then reddish brown	4.3	7.9
Till	Clay, sandy, red, with clasts up to 50 mm, mainly red and yellow sandstones and dolerite	3.8	11.7
Upper Devonian	Sandstone, medium grained, red-brown, with red clay pebbles	0.5+	12.2

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages							
Fines	Sand	Gravel			Fines	Sand			Gravel			
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
24	75	1	1.7	2.7	26	51	21	1	0	1	0	
			2.7	3.6	22	55	22	1	0	0	0	†
			Mean		24	52	22	1	0	1	0	

NO 21 SW 3 2451 1011 Cash Mill, Dunshelt BLOCK D

Surface level + 44.31 m (+ 145.4 ft)
Water struck at + 42.5 m
250 mm percussion
July 1980

Overburden 0.2 m
Mineral 2.6 m
Waste 3.7 m
Bedrock 0.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy loam	0.2	0.2
Fluvioglacial sand and gravel	Sand Sand: fine with medium and rare coarse, subangular to subrounded, quartz, feldspar and rock Fines: silt, marked increase below 2.2 m, light brown to dark brown	2.6	2.8
	Silt, clayey, laminated, red, with sandy partings	2.3	5.1
	Sand with frequent clayey silt seams; sand is medium with fine and coarse, subangular, quartz, feldspar and rock, brown	0.5	5.6
Till	Clay, sandy, stony, firm, red, with subangular to subrounded clasts, mainly red with yellow and pink sandstones, dolerite	0.9	6.5
Upper Devonian	Sandstone, medium grained, hard, light brown, with rare clay pebbles	0.8+	7.3

(... continued)

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages							
Fines	Sand	Gravel			Fines	Sand			Gravel			
			from	to	− 1/16	+ 1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64	
10	90	0	0.2	1.2	9	65	24	2	0	0	0	
			1.2	2.2	6	78	15	1	0	0	0	
			2.2	2.8	17	70	12	1	0	0	0	†
			Mean		10	71	18	1	0	0	0	

NO 21 SW 4 2429 1004 Cash Mill, Dunshelt BLOCK D

Surface level c + 46 m (c + 151 ft)
Water not struck
Pit
August 1979

Waste 2.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Late-Glacial raised estuarine deposits	Silt, clayey, laminated in lower part, reddish brown with films of fine sand	1.8+	2.0

NO 21 SE 2 2696 1002 Bowhouse Farm, Water Bore BLOCK C

Surface level c + 41 m (c + 135 ft)
Groundwater level c + 38 m
Water bore (method unknown)
1963

Overburden 0.5 m
Mineral 1.6 m
Waste 3.4 m
Bedrock 34.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Late-Glacial alluvium	Sand	0.3	0.8
	Sand and gravel	1.3	2.1
Till	Clay, stony, reddish brown, with cobble size clasts of whin (?dolerite or andesite)	3.4	5.5
Upper Devonian	Mainly sandstone, bedded, fine to medium grained, greenish grey, with fish scales	34.7+	40.2

NO 21 SE 5 2561 1165 Owl Plantation, Rossie BLOCK C

Surface level + 42 m (+ 138 ft)
Groundwater level + 40 m
250 and 200 mm percussion
July 1980

Overburden 0.4 m
Mineral 2.3 m
Waste 1.0 m
Mineral 2.8 m
Waste 2.5 m
?Bedrock 0.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, dark brown sandy loam	0.4	0.4
Lacustrine alluvium	a 'Clayey' sand with rare gravel from 0.6 to 1.1 m and plant remains from 1.1 to 1.2 m Gravel: fine, subangular, andesite, quartz Sand: medium and fine with coarse to 1.2 m, then fine with medium, angular to subrounded, quartz with rock and feldspar Fines: disseminated silt, especially from 0.4 to 0.6 m, clayey silt with plant remains from 1.1 to 1.2 m, grey	2.3	2.7
	Silt, grey with organic remains including sphagnum	0.6	3.3
	Silty clay with sand films, reddish brown	0.4	3.7
Glacial sand and gravel	b Sandy gravel Gravel: fine and coarse with cobbles, subangular to well rounded, quartz, quartzite, red sandstone, andesite, schistose grit, granite, greenstone Sand: medium with fine and coarse, but fine predominant below 5.7 m, angular to rounded, pink and clear quartz with rock, feldspar and mica Fines: mainly silt seams, at the top and about 6.5 m, reddish grey	2.8	6.5
	Silt, laminated, light reddish grey	0.1	6.6
Till	Clay, silty, sandy, stony, firm, reddish brown, clasts include red sandstone and conglomerate andesite, basalt, porphyry	2.4	9.0
Upper Devonian (if *in situ*)	Sandstone, fine to medium grained with rare quartz pebbles, rare mica, pale pink	0.4+	9.4
	Borehole terminated owing to rock obstruction		

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	−1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64	
a	13	86	1	0.4	1.2	17	31	39	11	2	0	0	
				1.2	2.2	11	73	15	1	0	0	0	†
				2.2	2.7	9	83	8	0	0	0	0	†
				Mean		13	60	22	4	1	0	0	
b	6	63	31	3.7	4.7	8	29	33	11	13	6	0	†
				4.7	5.7	1	9	17	12	25	32	4	†
				5.7	6.5	9	66	7	7	8	3	0	†
				Mean		6	33	20	10	16	14	1	
a & b	9	73	18	Mean		9	44	21	8	9	8	1	

NO 21 SE 6 2583 1053 Daubs, Dunshelt BLOCK C

Surface level + 40 m (+ 131 ft)
Water struck at + 37 m
250 mm percussion
July 1980

Overburden 0.4 m
Mineral 1.4 m
Waste 1.8 m
Bedrock 1.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy loam	0.4	0.4
Late-Glacial alluvium	'Very clayey' sand, with pebbles Gravel: fine, subangular to subrounded, dolerite and sandstone Sand: fine with medium and some coarse, quartz, feldspar and rock Fines: disseminated silt and clay, brown to 1.0 m, red to 1.8 m	1.4	1.8
Till	Clay, sandy, stony, firm, red, with clasts up to 250 mm, including sandstones and dolerite	1.8	3.6
Upper Devonian	Sandstone, medium grained, partly soft, light brown-green	1.3+	4.9

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	−1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
27	70	3	0.4	1.8	27	42	23	5	3	0	0

NO 21 SE 7 2640 1112 Ranges Strip, Rossie House BLOCK C

Surface level + 38 m (+ 125 ft)
Groundwater level + 37 m
250 and 200 mm percussion
July 1980

Overburden 6.1 m
Mineral 2.2 m
Waste 3.8 m
Bedrock 1.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, peaty	0.3	0.3
Peat	Peat, black and brown with tree roots (oak) to 1.6 m, grey-green to 3.0 m. Frequently silty and contains rare thin sand seams	2.7	3.0
Lacustrine alluvium	Silt, clayey with thin sand seams, grey	0.8	3.8
	Silt and clay, laminated, with thin organic layers, grey	2.3	6.1
Glacial sand and gravel	Gravel Gravel: coarse and fine, subangular to subrounded, dolerite with sandstone, vein-quartz and andesite Sand: medium with coarse and fine Fines: disseminated silt and clay, deposit slightly clay-bound, but fines lost due to washing action	2.2	8.3
Till	Clay, sandy, firm, red with clasts up to 75 mm, mainly dolerite and sandstone, the latter increasing with depth	3.8	12.1
Upper Devonian	Sandstone, fine to medium grained, purple	1.2+	13.3

(continued ...)

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages							
Fines	Sand	Gravel			Fines	Sand			Gravel			
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
4	43	53	6.1	7.1	2	13	20	11	25	29	0	†
			7.1	8.3	5	12	15	14	24	30	0	†
			Mean		4	13	17	13	24	29	0	

NO 21 SE 8 2721 1205 Drumley, by Collessie BLOCK A

Surface level + 40.97 m (+ 134.4 ft)
Groundwater level + 37.2 m
250 and 200 mm percussion
July 1980

Overburden 0.3 m
Mineral 3.4 m
Waste 3.2 m
Bedrock 1.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	Gravel Gravel: coarse with fine and cobbles up to 240 mm, subrounded to rounded, dolerite, cream and red sandstone, quartz, quartzite, basalt, schistose grit Sand: medium, coarse and fine, mainly angular to subrounded, quartz with rock and feldspar Fines: silt, deposit slightly 'dirty'	3.4	3.7
Till	Clay, sandy, silty, stony, quite firm, reddish brown, clasts mainly cream sandstone and andesite	3.2	6.9
Upper Devonian	Sandstone, fine, medium and coarse grained, with some quartz and green clay pebbles, thinly bedded, light green to buff	1.9+	8.0

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages							
Fines	Sand	Gravel			Fines	Sand			Gravel			
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
6	42	52	0.3	1.5	9	12	15	14	24	26	0	
			1.5	2.5	4	8	16	12	19	41	0	
			2.5	3.7	5	11	19	16	21	24	4	†
			Mean		6	11	17	14	22	29	1	

NO 21 SE 9 2796 1091 Easter Kilwhiss, Giffordtown BLOCK B

Surface level + 44 m (+ 144 ft)
Water struck (perched) at + 40 m
250 mm percussion
July 1980

Overburden 0.4 m
Mineral 4.9 m
Waste 0.9 m
Bedrock 1.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.4	0.4
Alluvium	a 'Clayey' sand, with pebbly stringers below 2.0 m, also rootlets from 1.6 to 2.0 m Gravel: fine and coarse, subangular to subrounded, red and yellow sandstones, quartz, quartzite, schist Sand: fine with medium and rare coarse, angular to rounded, quartz with rare feldspar and rock Fines: silt, disseminated, abundant between 1.6 and 2.0 m, dark brown to 0.7 m, rusty brown to 0.9 m, light brown then off-white to 1.6 m, then grey-brown	1.8	2.2
Fluvioglacial sand and gravel	b 'Clayey' sandy gravel Gravel: coarse and fine with cobbles, subangular to well rounded, red and yellow sandstones, quartz, andesite, quartzite, schist Sand: medium with coarse and fine, angular to well rounded, quartz with rock and feldspar Fines: silt and clay, deposit slightly clay-bound, below 4.8 m fines lost due to washing action	3.1	5.3
Till	Clay, very sandy, soft, reddish brown, with clasts mainly of yellow sandstone and andesite	0.9	6.2
Upper Devonian	Sandstone, fine to medium grained, with seams rich in green clay pebbles, yellowish grey and buff	0.6	6.8
	Mudstone, sandy with seams of micaceous sandstone, reddish brown and pale green	0.3	7.1
	Sandstone, very fine grained, micaceous, soft, buff	0.2+	7.3

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
a	18	80	2	0.4	0.9	10	53	36	1	0	0	0
				0.9	1.6	10	69	21	0	0	0	0
				1.6	2.2	34	37	22	2	2	3	0
				Mean		18	53	26	1	1	1	0
b	10	51	39	2.2	3.2	8	26	23	8	10	25	0
				3.2	4.2	10	8	20	15	21	26	0
				4.2	5.3	13	9	28	15	25	10	0 †
				Mean		10	14	24	13	19	20	0
a & b	13	62	25	Mean		13	30	24	8	12	13	0

NO 21 SE 10 2827 1292 Cornhill, Collessie BLOCK A

Surface level + 52 m (+ 171 ft)
Groundwater level + 48 m
250 and 200 mm percussion
July 1980

Overburden 1.2 m
Mineral 6.0 m
Waste 6.8 m
Bedrock 0.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground, hard core, fill and soil	1.2	1.2
Glacial sand and gravel	Sandy gravel, slightly clayey to 3.4 m Gravel: coarse and fine with cobbles in upper part, mainly subrounded to well rounded, andesite, red sandstone, quartz, schistose grit Sand: coarse with medium and some fine, becoming less coarse below 6.4 m, mainly angular to subrounded, quartz, rock and feldspar Fines: silt and clay, deposit slightly clay-bound to 3.4 m, then little, mid-brown	6.0	7.2
Till	Clay, sandy, stony, firm, very sandy and red from 11.0 m. Clasts up to 150 mm, mainly dolerite and sandstone with andesite, sandstone common towards base	6.8	14.0
Upper Devonian	Sandstone, fine to medium grained, with mica, some pink feldspar and rare very small green clay pebbles, buff	0.5+	14.5

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages							
Fines	Sand	Gravel			Fines	Sand			Gravel			
			from	to	− 1/16	+ 1/16 − 1/4	+1/4–1	+1–4	+4–16	+16–64	+64	
6	48	46	1.2	2.2	9	8	13	21	27	22	0	
			2.2	3.4	9	10	17	16	23	25	0	
			3.4	4.4	5	5	16	24	26	24	0	
			4.4	5.4	5	3	15	34	25	18	0	
			5.4	6.4	3	9	21	23	17	27	0	†
			6.4	7.2	4	17	30	14	16	19	0	†
			Mean		6	8	18	22	23	23	0	

NO 21 SE 11 2874 1174 Stonybriggs, Giffordtown BLOCK A

Surface level + 50 m (+ 164 ft)
Water not struck
250 and 200 mm percussion
July 1980

Overburden 0.2 m
Mineral 5.0 m
Waste 6.1 m
Bedrock 0.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, pebbly	0.2	0.2
Glacial sand and gravel	Gravel Gravel: coarse and fine with cobble and boulder, subangular to well rounded, mainly andesite with red sandstones, quartz, quartzite, felsite Sand: coarse and medium with fine, mainly angular and subangular, quartz, rock and feldspar Fines: disseminated silt and clay, deposit slightly 'dirty' to 2.2 m, mid-brown	5.0	5.2
Till	Clay, silty, sandy, stony, firm, reddish brown with clasts up to 130 mm mainly of andesite, yellow, buff and orange fine grained sandstones. Sandstone abundant below 10.2 m	6.1	11.3
Upper Devonian	Mudstone, pale green and red, with thin seams of sandy siltstone	0.4	11.7
	Mudstone, blocky, red, silty in part	0.1	11.8
	Mudstone, alternating red and green, with thin seams of medium grained sandstone containing green clay pebbles	0.2+	12.0
	Borehole terminated for technical reasons		

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
5	37	58	0.2	1.2	8	8	13	13	23	35	0
			1.2	2.2	9	10	17	17	24	23	0
			2.2	3.2	2	6	15	11	13	39	14
			3.2	4.2	4	6	18	20	23	29	0
			4.2	5.2	3	6	11	16	28	36	0
			Mean		5	7	15	15	22	33	3

NO 21 SE 12 2957 1267 Bastion, Collessie BLOCK A

Surface level + 51.48 m (+ 168.9 ft)
Groundwater level + 46.4 m
250 mm percussion
July 1980

Overburden 0.2 m
Mineral 7.9 m
Bedrock 0.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, gravelly	0.2	0.2
Glacial sand and gravel	Gravel Gravel: coarse and fine, with cobbles common to 4.2 m, subangular to subrounded, dolerite and sandstone with andesite, basalt, quartzite metamorphic rocks and granite Sand: coarse, medium and fine, subangular to subrounded, quartz, feldspar and rock Fines: silt, diminishes below 1.2 m, dark brown	7.9	8.1
Upper Devonian	Sandstone, coarse grained, hard, reddish purple, rare quartz pebbles from 10 to 30 mm and some small clay clasts	0.3+	8.4

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages							
Fines	Sand	Gravel			Fines	Sand			Gravel			
			from	to	−1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64	
5	44	51	0.2	1.2	10	7	17	8	21	26	11	
			1.2	2.2	7	8	15	23	27	20	0	
			2.2	3.2	4	11	17	14	19	24	11	
			3.2	4.2	6	14	10	15	25	30	0	
			4.2	5.2	5	6	17	21	25	26	0	
			5.2	6.2	1	3	14	31	35	16	0	†
			6.2	7.2	2	2	7	37	33	19	0	†
			7.2	8.1	2	5	28	24	21	16	4	†
			Mean		5	7	16	22	25	22	3	

NO 21 SE 13 2917 1023 Edenstown, Ladybank BLOCK B

Surface level + 46 m (+ 151 ft)
Groundwater level + 42 m
250 and 200 mm percuassion
June 1980

Overburden 0.4 m
Mineral 4.6 m
Waste 7.0 m
Bedrock 1.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Fluvioglacial sand and gravel	Sandy gravel Gravel: fine with coarse, with rare cobbles up to 100 mm between 2.4 and 4.0 m, subrounded to well rounded, quartz, andesite, quartzite, sandstone, schistose grit Sand: medium with fine and coarse, proportions vary with depth, angular to well rounded, quartz, rock and feldspar Fines: disseminated silt, light reddish brown	4.6	5.0
	Silt, sandy, light reddish brown, with rare pebbles	1.0	6.0
Till	Clay, sandy, reddish brown, with clasts up to 180 mm, mainly andesite and sandstone	4.3	10.3
	Clasts of buff sandstone and sandstone with green clay pebbles in a matrix of reddish brown sandy silty clay	1.7	12.0
Upper Devonian	Siltstone, sandy, micaceous, very soft, slightly greenish grey, with seams of red mudstone	0.5	12.5
	Sandstone, very fine grained, micaceous, grey-white, red mudstone as seams and filling joints. Near base sandstone contains rare green clay pebbles	0.5+	13.0

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages							
Fines	Sand	Gravel			Fines	Sand			Gravel			
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
4	70	26	0.4	1.4	9	31	28	16	13	3	0	
			1.4	2.4	3	8	38	20	23	8	0	
			2.4	3.4	2	7	32	17	22	20	0	
			3.4	4.0	3	16	33	16	22	10	0	
			4.0	5.0	2	36	33	17	12	0	0	†
			Mean		4	20	33	17	18	8	0	

NO 21 SE 14 2994 1217 Collessie Pit Section, Melville BLOCK A

Surface level + 49 m (+ 161 ft)
Section dry
Sampled by hand
September 1980

Mineral 9.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Glacial sand and gravel	Gravel, with rare sand stringers Gravel: cobble and coarse with fine, with boulders up to 650 mm (not sampled) mainly subrounded to rounded, quartz, quartzite, conglomerate, sandstone, porphyry, granite, andesite, schistose grit, felsite Sand: coarse and medium with fine, angular to well rounded, quartz and rock with feldspar Fines: little, grey-brown, slightly reddish Basal three metres obscured by scree	9.0 +	9.0

GRADING

Mean for deposit percentages

Fines	Sand	Gravel
2	23	75

Depth below surface (m)		percentages						
		Fines	Sand			Gravel		
from	to	− 1/16	+ 1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
0.0	1.0	2	4	11	10	16	38	19
1.0	2.0	1	5	6	9	14	34	31
2.0	3.0	2	3	6	7	14	34	34
3.0	4.0	1	4	11	11	17	35	21
4.0	5.0	1	2	13	8	14	51	11
5.0	6.0	2	4	10	11	16	31	26
6.0	9.0		No data available					
Mean		2	4	10	9	15	36	24

NO 21 SE 15 2969 1113 Corrour Pit Section, Cairnfield Muir BLOCK A

Surface level + 49 m (+ 161 ft)
Section dry
Sampled by hand
September 1980

Mineral 5.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
Fluvioglacial sand and gravel	Gravel Gravel: coarse and fine with cobbles in upper part, subrounded to rounded, conglomerate, red sandstone, porphyry, quartzite, andesite, quartz, granite, schistose grit Sand: medium with coarse and fine, mainly angular to subrounded, pink and clear quartz, rock and feldspar Fines: little, light reddish grey-brown Basal metre obscured by scree	5.5+	5.5

(... continued)

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
2	40	58	0.0	0.9	2	5	12	17	17	43	4
			0.9	1.7	2	5	9	10	18	32	24
			1.7	2.5	4	7	23	10	22	34	0
			2.5	3.5	2	8	18	9	22	41	0
			3.5	4.5	2	9	43	11	14	21	0
			4.5	5.5		No data available					
			Mean		2	7	22	11	19	34	5

NO 21 SE 16 2795 1018 Rossie Drain BLOCK C

Surface level c + 44 m (c + 144 ft)

Overburden 0.3 m
Mineral 5.8 m +
(inc. 0.4 m waste)

Temporary section (Pipe line trench)

LOG

Geological classification	Lithology	Thickness m	Depth m
Peat	Peat	0.3	0.3
Lacustrine alluvium	Sand, coarse to medium, flat bedded, white	1.2	1.5
Peat	Peat, discontinuous	0.1	1.6
Late-Glacial alluvium	Sand, coarse to medium, cross bedded, white	2.4	4.0
	Clay, silty, brown, with laminae of fine to medium grained white sand	0.2	4.2
	'Clayey' sand, pebbly at base Sand: fine, medium and coarse, brown then grey	0.8	5.0
Late-Glacial raised estuarine deposits	Clay, stony, laminated in part, grey then brown, with plant remains at top (radiocarbon date 13,636 ± 130BP)	0.1	5.1
Glacial sand and gravel	Sand and gravel	1.0+	6.1

NO 30 NW 51 3087 0917 Heatherinch, Ladybank BLOCK B

Surface level + 38.41 m (+126.0 ft)
Groundwater level + 36.2 m
250 and 200 mm percussion
June 1980

Overburden 0.9 m
Mineral 5.1 m
Waste 7.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground and soil	0.4	0.4
Alluvium	Sand, fine with rare pebbles	0.3	0.7
	Silt, sandy, with plant remains	0.2	0.9
Fluvioglacial sand and gravel	a Sand, with pebbles Gravel: fine with rare coarse, subrounded, quartz, andesite Sand: fine and medium with rare coarse, fining downwards, angular to subangular, quartz with rock and feldspar Fines: little	1.5	2.4
	b 'Very clayey' sand Sand: fine with rare medium, angular to subrounded, quartz with rock and feldspar Fines: silt and clay, disseminated and as seams below 3.5 m, reddish grey-brown	3.6	6.0
	Silt, with fine sand and rare reddish brown clay laminae	0.5	6.5
Late-Glacial raised estuarine deposits	Clay, silty, laminated, reddish brown, with sand films between 6.5 and 8.0 m. Foraminifera recorded at 9.0 m	5.0	11.5
	Clay with some silt, reddish brown. Foraminifera recorded at 12.0 and 13.0 m	1.7	13.2
	Dolerite boulder	0.2+	13.4
	Borehole terminated owing to rock obstruction		

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	− 1/16	+ 1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64	
a	7	90	3	0.9	1.9	6	38	50	3	3	0	0	
				1.9	2.4	8	50	26	12	3	1	0	†
				Mean		7	42	42	6	3	0	0	
b	31	69	0	2.4	3.0	19	74	6	1	0	0	0	†
				3.0	4.0	29	70	1	0	0	0	0	†
				4.0	6.0	36	63	1	0	0	0	0	†
				Mean		31	67	2	0	0	0	0	
a & b	24	75	1	Mean		24	59	14	2	1	0	0	

NO 30 NW 52 3045 0807 Bankton Park, Kingskettle BLOCK D

Surface level + 40.83 m (+ 134.0 ft)
Groundwater level + 37.2 m
250 mm percussion
June 1980

Overburden 0.7 m
Mineral 7.1 m
(inc. 0.9 m waste)
Waste 0.4 m
Bedrock 1.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy loam	0.7	0.7
Fluvioglacial sand and gravel	a Sand, with rare pebbles Gravel: fine Sand: fine with medium and rare coarse, subangular, quartz and feldspar Fines: little, light brown	1.8	2.5
	Silt, sandy, with rare clay seams and sandy partings, red	0.9	3.4
	b 'Clayey' sand Sand: fine with medium and rare coarse, subangular, quartz and feldspar Fines: disseminated silt, reddish brown	1.0	4.4
	c Sand, with rare fine gravel Sand: fine and medium with rare coarse, subangular to subrounded, quartz, feldspar and rock, also coal Fines: little	3.4	7.8
Till	Clay, sandy, stony, red, clasts mainly sandstone and dolerite	0.4	8.2
Upper Devonian	Sandstone, fine to medium grained, very soft, creamy yellow, marked grain size variation	1.2+	9.4

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	3	95	2	0.7	1.7	4	58	33	3	2	0	0	
				1.7	2.5	2	59	34	3	2	0	0	
				Mean		3	59	33	3	2	0	0	
b	14	85	1	3.4	4.4	14	51	30	4	1	0	0	†
c	2	97	1	4.4	5.4	1	31	60	7	1	0	0	†
				5.4	6.4	4	59	33	2	2	0	0	†
				6.4	7.8	2	52	45	1	0	0	0	†
				Mean		2	48	46	3	1	0	0	
a to c	4	95	1	Mean		4	52	40	3	1	0	0	

NO 30 NW 53 3137 0864 Balmalcolm Farm, Kingskettle BLOCK G_3

Surface level + 35.20 m (+ 115.5 ft)
Groundwater level + 33.8 m
250 mm percussion
June 1980

Overburden 0.3 m
Mineral 1.4 m
Waste 9.8 m
Bedrock 2.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.3	0.3
Alluvium	'Very clayey' sand, with several thin peat layers Sand: fine with medium and rare coarse, subangular, quartz, feldspar and rock Fines: silt and clay, disseminated, and as laminae from 0.5 to 1.0 m and below 1.3 m	1.4	1.7
Late-Glacial raised estuarine deposits	Silt and clay, faintly laminated, with rare sand films, reddish brown, unfossiliferous	9.5	11.2
Till	Clay, very sandy, red, with clasts up to 100 mm, including yellow sandstone, dolerite, andesite, basalt, quartz, quartzite	0.3	11.5
Upper Devonian	Sandstone, fine to medium grained, very soft, yellow, with marked vertical grain size variation	2.1+	13.6

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
28	71	1	0.3	1.7	28	44	26	1	1	0	0

NO 30 NW 54 3251 0919 Ramornie Mill, Pitlessie BLOCK D

Surface level + 35.52 m (+ 116.5 ft)
Groundwater level + 34.1 m
250 mm percussion
June 1980

Overburden 0.6 m
Mineral 10.7 m
(inc. 0.6 m waste)
Bedrock 0.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.6	0.6
Fluvioglacial sand and gravel	a Sand with rare gravel Gravel: fine, subangular to subrounded, quartz, felsite, quartzite, schistose grit, coal Sand: fine with medium and rare coarse, subangular to well rounded, quartz with feldspar, rock and coal Fines: little, reddish mid-brown	5.0	5.6
	b 'Very clayey' sand Sand: fine with medium, subangular with rounded, quartz with rock and feldspar Fines: silt, disseminated, and in seams in lower part, light brown	1.0	6.6
	Silt, rusty brown	0.4	7.0
	Clay, silty, laminated, reddish brown	0.1	7.1
Till	c 'Very clayey' pebbly sand Gravel: fine and coarse with rare cobbles, mainly subangular, cream sandstone, andesite, quartz Sand: fine with medium and rare coarse subrounded to rounded, quartz with rock and feldspar Fines: disseminated silt, but much lost by washing action	1.1	8.2
	Clay, silty, sandy, with clasts, reddish brown	0.1	8.3
	d Sandy gravel, with lumps of very sandy till recovered below 9.5 m Gravel: coarse, fine and cobble, mainly subangular, cream sandstone, andesite, quartz Sand: fine with medium and some coarse, subrounded to rounded, quartz with rock and feldspar Fines: mainly silt, reddish brown, but largely lost due to washing action	3.0	11.3
Upper Devonian	Sandstone, fine grained, very soft, off-white, with marked vertical grain size variation	0.3+	11.6

(... continued)

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64	
a	2	96	2	0.6	1.6	2	53	39	4	2	0	0	
				1.6	2.6	2	57	32	6	3	0	0	
				2.6	3.6	1	37	56	4	2	0	0	†
				3.6	4.6	2	51	44	2	1	0	0	†
				4.6	5.6	5	63	31	1	0	0	0	†
				Mean		2	53	40	3	2	0	0	
b	35	65	0	5.6	6.6	35	43	21	1	0	0	0	†
c	22	69	0	7.1	8.2	22	51	15	3	4	5	0	†
d	4	59	37	8.3	9.3	4	40	28	12	14	2	0	†
				9.3	10.3	4	32	13	5	9	23	14	†
				10.3	11.3	4	25	13	10	16	16	16	†
				Mean		4	32	18	9	13	14	10	
a to d	8	79	13	Mean		8	45	29	5	5	5	3	
a & b	8	91	1	Mean		8	51	37	3	1	0	0	
c & d	9	62	29	Mean		9	38	17	7	11	11	7	

NO 30 NW 55 3288 0641 Rameldry BLOCK G_2

Surface level + 135.5 m (+ 445 ft)
Water struck (perched) at + 130.3 m
250 mm percussion
June 1980

Overburden 2.1 m
Mineral 1.0 m
Waste 1.0 m
Mineral 1.4 m
Waste 4.8 m
Bedrock 0.6 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground and soil	0.4	0.4
Glacial sand and gravel	Silt and sand with scattered subangular pebbles and also coaly layers, deposit is ill-sorted, possibly disturbed from 0.4 to 1.1 m, silt seams up to 100 mm thick below 1.5 m, sand is clay cemented in part	1.7	2.1
	'Very clayey' sand with rare coal pebbles Sand: fine with some medium and rare coarse (coal), subangular to rounded, quartz with rock, feldspar and coal Fines: silt with clay, disseminated and in seams up to 100 mm thick, mid to reddish brown	1.0	3.1
	Silt and fine sand, bedded, with soliflucted gravelly layer 100 mm thick at 3.9 m, light reddish brown	1.0	4.1
	'Very clayey' sand with rare pebbles Gravel: fine, subrounded, red and cream sandstone Sand: fine with medium and rare coarse, mainly subangular, quartz with feldspar and rock Fines: silt mainly in seams and above 4.6 m	1.4	5.5
Till	Clay, sandy, stony, firm, reddish brown with clasts up to 280 mm, including andesite, dolerite, red fine and coarse grained and cream fine grained sandstone, siltstone, coal and microgranite	4.8	10.3
Upper Carboniferous	Siltstone, micaceous, dark grey, appears burnt, with *Lingula* and burrow traces (*Chondrites* type)	0.6+	10.9

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	− 1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
35	64	1	2.1	3.1	31	56	12	1	0	0	0
			3.1	4.1		Waste					
			4.1	5.5	38	41	18	2	1	0	0
			Mean		35	46	16	2	1	0	0

NO 30 NW 56 3205 0594 Damsfold, by Kettlebridge BLOCK G_2

Surface level + 104.37 m (+ 342.4 ft)
Groundwater level + 103.2 m
250 and 200 mm percussion
June 1980

Waste 13.2 m
Bedrock 0.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.5	0.5
Alluvium	Sand, silty, with pebbles and silt seams containing plant remains below 0.8 m	0.5	1.0
Late-Glacial alluvium	Silt with coaly and micaceous layers, also rare sandstone pebbles, becomes colour laminated at depth, mid to brownish grey	6.1	7.1
Glacial sand and gravel	Pebbly sand Gravel: fine with coarse, angular to well rounded, but mainly subangular, dolerite, andesite, quartz, red and cream sandstones, schist, coal Sand: fine, medium and coarse, angular to rounded, quartz and rock Fines: some silt, mostly lost due to washing action	0.8	7.9
Till	Clay, stony, stiff to 10.3 m then sandy and firm, clasts include greenish grey hard sandstone, basalt, cream sandstone, dolerite	5.3	13.2
Upper Carboniferous	Sandstone, soft, with thin carbonaceous and micaceous seams, very pale blue-grey	0.8+	14.0

NO 30 NW 57 3275 0541 Milldeans Wood, by Kennoway BLOCK G_2

Surface level + 120.4 m (+ 395 ft)
Water struck at + 114.7 m
250 mm percussion
June 1980

Overburden 0.4 m
Mineral 3.8 m
Waste 5.3 m
Bedrock 0.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy loam	0.4	0.4
Glacial sand and gravel	a Pebbly sand Gravel: coarse and fine, with rare cobbles, subrounded, soft sandstone and dolerite Sand: fine with medium and some coarse, subangular to subrounded, quartz, feldspar, rock and coal Fines: disseminated silt and rare silty clay seams between 1.1 and 1.4 m	2.0	2.4
	b Sand with rare pebbles Sand: medium with fine and rare coarse, subangular, quartz, feldspar, rock and coal Fines: little, light brown	1.8	4.2
Till	Clay, silty, sandy, stony, firm, grey-brown to 5.0 m then red-brown, with clasts up to 150 mm, mainly dolerite and sandstone, with coal, siltstone, andesite and quartz	5.3	9.5
Upper Carboniferous	Volcanic agglomerate, fine grained, crushed, with abundant secondary calcium carbonate infilling	0.3+	9.8

(... continued)

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	9	77	14	0.4	1.4	8	54	22	5	5	6	0
				1.4	2.4	9	34	35	5	7	10	0
				Mean		9	43	29	5	6	8	0
b	3	96	1	2.4	3.4	5	36	57	2	0	0	0
				3.4	4.2	1	36	61	0	2	0	0
				Mean		3	36	59	1	1	0	0
a & b	6	86	8	Mean		6	40	43	3	4	4	0

NO 30 NW 58 3156 0919 Ramornie Pit Section, Minnie's Green, Ladybank BLOCK B

Surface level + 38.6 m (+ 127 ft)
Water struck at + 34.4 m
Sampled by hand
September 1980

Overburden 0.6 m
Mineral 3.6 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy with pebbles	0.6	0.6
Fluvioglacial sand and gravel	a Pebbly sand Gravel: fine with coarse, subangular to rounded, andesite, red sandstone, quartz, quartzite and felsite Sand: medium with coarse and fine, mainly subangular, quartz with feldspar and rock Fines: little, light brown	0.5	1.1
	b Sand with rare pebbles Gravel: fine, rounded, porphyry, vein quartz, quartzite, dolerite, granodiorite Sand: fine and medium with rare coarse, angular to rounded, quartz with feldspar, rock and mica Fines: little, light brown	3.1+	4.2

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	1	83	16	0.6	1.1	1	13	53	17	12	4	0
b	1	99	0	1.1	2.3	1	51	47	1	0	0	0
				2.3	3.2	1	79	18	1	1	0	0
				3.2	4.2	1	32	66	1	0	0	0
				Mean		1	53	45	1	0	0	0
a & b	1	96	3	Mean		1	47	46	3	2	1	0

NO 30 NW 59 3164 0961 Ramornie Mains, Ladybank BLOCK B

Surface level + 42.3 m (+ 139 ft)
Groundwater level + 37.2 m
250 mm percussion and rotary
July 1980

Overburden 0.6 m
Mineral 2.6 m
Waste 8.8 m
Bedrock 1.6 m+

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.3	0.3
	Soil, sandy	0.3	0.6
Fluvioglacial sand and gravel	a Sand with pebbles Gravel: fine with rare coarse, subangular to rounded, andesite, schistose grit, quartz, quartzite, felsite Sand: medium and fine with rare coarse, angular to rounded, quartz with rock and feldspar Fines: some silt, light brown	2.0	2.6
	b 'Very clayey' sand Sand: fine with some medium, angular to rounded, quartz with some rock, feldspar and mica Fines: disseminated silt, increasing downwards, light brown	0.6	3.2
	Silt, sandy, micaceous, grey-brown	1.7	4.9
	Silt and clay, laminated, reddish brown	0.2	5.1
	Silt, grey-brown	0.9	6.0
Late-Glacial raised estuarine deposits	Clay with some silt, reddish brown, colour laminated	1.3	7.3
Till	Clay, very sandy, light reddish brown and buff, with clasts up to 100 mm of sandstone and dolerite	1.5	8.8
	Silt, very sandy, stony, pale yellow, with clasts almost all of sandstone	3.2	12.0
Upper Devonian	Sandstone, medium to fine grained, yellow or cream, soft, but with dark brown, hard layers between 13.3 and 13.5 m	1.6+	13.6

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	+¼–1	+1–4	+4–16	+16–64	+64	
a	5	92	3	0.6	1.6	4	29	56	6	5	0	0	
				1.6	2.6	6	56	36	1	1	0	0	†
				Mean		5	43	45	4	3	0	0	
b	23	77	0	2.6	3.2	23	72	5	0	0	0	0	†
a & b	9	89	2	Mean		9	49	37	3	2	0	0	

NO 30 NW 61 3055 0724 Holekettle, Kettlebridge BLOCK D

Surface level c + 51 m (c + 167 ft)
Water not struck
Pit
August 1979

Overburden 0.4 m
Mineral 1.5 m
Waste 0.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Fluvioglacial sand and gravel	'Clayey' sandy gravel, illsorted Gravel: fine and coarse with cobble, angular to well rounded, mainly friable cream sandstone with dolerite Sand: fine with medium and some coarse, angular to rounded, quartz with rock Fines: disseminated silt, light orange brown	1.5	1.9
Till	Clay, very sandy, stony, soft, mid-brown	0.2+	2.1

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-1/16$	$+1/16-1/4$	$+1/4-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
16	57	27	0.4	1.9	16	31	20	6	11	9	7

NO 30 NW 65 3244 0632 Rameldry BLOCK G_2

Surface level c + 119 m (c + 390 ft)
Water not struck
Pit
October 1979

Waste 2.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Head	Clay, silty, stony, soft, reddish brown, clasts mainly white and red sandstone with dolerite	1.0	1.3
Glacial sand and gravel	Silt with scattered pebbles and abundant woody material, vertically orientated, slightly reddish mid-grey	0.5	1.8
Till	Clay, stony, stiff, reddish brown	0.2+	2.0

NO 30 NW 67 3339 0947 Crossgates, Pitlessie BLOCK D

Surface level c + 39m (c + 128 ft)
Water not struck
Pit
August 1979

Overburden 1.1 m
Mineral 1.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil and made ground, including charcoal	1.1	1.1
Fluvioglacial sand and gravel	Sand with rare pebbles and cobbles Sand: fine with medium, mainly subangular to subrounded, quartz with feldspar and rock Fines: silt, mainly in seams	1.2+	2.3

NO 30 NW 70 3353 0652 Honeyhall, Rameldry BLOCK G_2

Surface level c + 138 m (c + 453 ft)
Water not struck
Pit
October 1979

Overburden 0.6 m
Mineral 1.2 m
Bedrock 0.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	Silt, reddish brown	0.3	0.6
	Sand with angular clasts of sandstone and grey siltstone. Sand is fine and medium, mainly subangular quartz, mostly white, but partly clayey and mottled yellow and reddish brown	1.2	1.8
Upper Carboniferous	Siltstone, micaceous, mid to dark grey	0.4+	2.2

NO 30 SW 89 3190 0144 Bellfield, by Milton of Balgonie BLOCK F

Surface level + 53 m (+ 174 ft)

Hand diamond
1907

Overburden 3.1 m
Mineral 2.8 m
Waste 3.3 m
Bedrock 101.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Alluvium	Clay with peat	0.9	1.2
	Sand	0.9	2.1
	Clay, blue	1.0	3.1
Fluvioglacial sand and gravel	Sand and gravel	2.8	5.9
Till	Clay, sandy with stones, less sandy below 8.0 m	3.3	9.2
Upper Carboniferous	Sandstone, siltstone and shale with coal and seatearth	101.8+	111.0

NO 30 SW 103 3114 0164 Dalginch, by Markinch BLOCK F

Surface level + 54 m (+ 177 ft)

Method unknown
1944

Overburden 1.7 m
Mineral 5.3 m
Waste 24.0 m
Bedrock 31.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Peat and alluvium	Peat with some grey silt and clay	1.4	1.7
Fluvioglacial sand and gravel	Sand and gravel, pebbles mainly well rounded, include Carboniferous sandstone and andesitic lavas	5.3	7.0
Till	Clay, sandy, stony, brown, very sandy at top, with cobble size clasts including dolerite, quartzite, sandstone, limestone, rhyolite and felsite	24.0	31.0
Upper Carboniferous	Sandstone, siltstone and shale with coal and seatearth	31.8+	62.8

NO 30 SW 146 3069 0466 Sandy Hill, Kirkforthar BLOCK E

Surface level + 104.5 m (+ 343 ft)
Water struck (perched) at + 99.9 m
250 mm percussion
May 1980

Overburden 0.4 m
Mineral 6.1 m
Waste 1.2 m
Bedrock 0.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.4	0.4
Glacial sand and gravel	a Sand, with coaly layers below 2.4 m and rare fine gravel below 4.4 m Sand: medium with fine and rare coarse, mainly subrounded, quartz with feldspar, rock and coal Fines: little, pale brown	5.1	5.5
	b Gravel, illsorted Gravel: coarse with fine and cobbles, subangular to rounded, dolerite, lavas and sandstone Sand: fine with medium and coarse, angular to rounded, quartz, rock and feldspar Fines: mainly silt, disseminated, light brown	1.0	6.5
Till	Clay, sandy, silty, stony, reddish brown	1.2	7.7
Lower Carboniferous	Mudstone, very calcareous, with limy seams, burnt, dark grey, with abundant crinoids, brachiopods, bryozoans and corals	0.4+	8.1

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
a	2	98	0	0.4	1.4	1	28	70	1	0	0	0
				1.4	2.4	1	25	74	0	0	0	0
				2.4	3.4	2	17	80	1	0	0	0
				3.4	4.4	1	31	68	0	0	0	0
				4.4	5.5	4	51	41	3	1	0	0
				Mean		2	31	66	1	0	0	0
b	7	44	49	5.5	6.5	7	28	10	6	9	20	20
a & b	3	89	8	Mean		3	30	57	2	2	3	3

NO 30 SW 147 3054 0264 Cuinin Hill, Star BLOCK E

Surface level + 135.52 m (+ 444.6 ft)
Water not struck
250 mm percussion
June 1980

Overburden 1.5 m
Mineral 17.7 m
Waste 2.8 m
Bedrock 1.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	Sandy gravel Gravel: fine and coarse with rare cobbles, subangular to rounded, dolerite, sandstone, felsite, andesite Sand: medium with fine and coarse, angular to rounded, quartz and rock Fines: little	0.5	0.8
	Clay, sandy, stony, illsorted, reddish brown, with clasts, mainly rounded, including dolerite, sandstone and quartz	0.7	1.5
	a Pebbly sand Gravel: fine and coarse, subangular to well rounded, dolerite, sandstone, andesite and quartz Sand: fine and medium with coarse, subangular to rounded, quartz with rock, feldspar, and mica below 3.5 m Fines: silty seams at 2.0 m and disseminated silt below 5.2 m, light brown	4.0	5.5
	b 'Very clayey' sand Sand: fine with some medium and trace of coarse, mainly subangular, quartz with coal and rare rock and feldspar Fines: disseminated silt, increasing to 7.7 m, then little, pale brown	3.0	8.5
	c Sand, 'clayey' from 11.5 to 12.5 m Sand: fine with medium and rare coarse, subangular, quartz with coal and rare feldspar, rock and mica Fines: silt seams between 11.5 and 12.5 m, 30 mm seam between 13.5 and 14.5 m and 100 mm seam at 16.9 m, pale buff	9.0	17.5
	d 'Very clayey' sand Sand: fine with rare medium, subangular, quartz Fines: disseminated silt, light brown	0.5	18.0
Till	e 'Very clayey' sandy gravel, thin gravelly seams interbedded with silt containing scattered subangular pebbles Gravel: fine and coarse, mainly subrounded to well rounded, dolerite, andesite, quartz, sandstone, felsite Sand: fine with medium and coarse, angular to rounded, quartz, rock and feldspar Fines: silt and clay, mainly in seams, but also disseminated, brown and reddish brown	1.2	19.2
	Clay, sandy, stony, grey-brown, with clasts up to 170 mm, including dolerite, sandstone and quartz	2.8	22.0
Lower Carboniferous	Non-igneous tuff, with coal and sandstone fragments, pale grey, hard	1.3+	23.3

(... continued)

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16	+64
a	4	91	5	1.5	2.5		No data available					
				2.5	3.5	2	39	40	6	6	7	0
				3.5	4.5	2	34	56	6	2	0	0
				4.5	5.5	8	51	37	4	0	0	0
				Mean		4	41	45	5	3	2	0
b	22	78	0	5.5	6.5	19	78	2	1	0	0	0
				6.5	7.5	29	65	4	1	1	0	0
				7.5	8.5	18	79	3	0	0	0	0
				Mean		22	74	3	1	0	0	0
c	5	95	0	8.5	9.5	1	82	15	2	0	0	0
				9.5	10.5	5	79	13	3	0	0	0
				10.5	11.5	2	83	13	2	0	0	0
				11.5	12.5	18	73	9	0	0	0	0
				12.5	13.5	3	67	30	0	0	0	0
				13.5	14.5	4	84	12	0	0	0	0
				14.5	15.5	2	91	7	0	0	0	0
				15.5	16.5	2	86	12	0	0	0	0
				16.5	17.5	4	67	28	1	0	0	0
				Mean		5	79	15	1	0	0	0
d	27	72	1	17.5	18.0	27	69	3	0	1	0	0
e	25	55	20	18.0	19.2	25	29	16	10	12	8	0
a to e	9	88	3	Mean		9	65	20	3	2	1	0
a to d	8	91	1	Mean		8	68	20	2	1	1	0

NO 30 SW 148 3059 0153 Barnslee, Markinch BLOCK F

Surface level + 66.49 m (+ 218.1 ft)
Water not struck
250 mm percussion
June 1980

Overburden 3.7 m
Mineral 1.8 m
Bedrock 0.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground and soil	0.5	0.5
Glacial sand and gravel	'Clayey' gravel Gravel: fine and coarse with cobbles, mainly dolerite and sandstones Sand: fine and coarse with medium, subangular to subrounded, quartz and rock Fines: disseminated silt with clay, light brown	0.3	0.8
Till	Clay, sandy, stony, light brown, with clasts up to 250 mm, mainly dolerite with sandstone, andesite and siltstone	2.9	3.7
	'Clayey' sandy gravel Gravel: fine and coarse with cobbles, subangular to rounded, dolerite and sandstone which becomes abundant below 4.7 m Sand: fine and medium with coarse, angular to rounded, quartz, rock and feldspar Fines: disseminated silt and clay, light brown	1.8	5.5
Upper Carboniferous	Sandstone, medium and coarse grained with small quartz pebbles, loosely cemented, porous, mottled dark red with cream	0.5+	6.0

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
20	54	26	3.7	4.7	22	30	18	11	11	8	0
			4.7	5.5	17	20	17	11	14	13	8
			Mean		20	25	18	11	12	10	4

NO 30 SW 149 3090 0069 Balgonie Engines BLOCK F

Surface level + 47.02 m (+ 154.3 ft)
Water not struck
250 mm percussion
June 1980

Overburden 0.3 m
Mineral 2.3 m
Waste 4.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, gravelly	0.3	0.3
Fluvioglacial sand and gravel	Gravel Gravel: coarse with fine and cobbles up to 250 mm, mainly dolerite and sandstone, often weathered Sand: coarse, medium and fine, subangular to subrounded, quartz, feldspar and rock Fines: disseminated silt	2.3	2.6
Till	Clay, sandy, stony, red-brown, but grey from 4.0 to 5.0 m, with clasts up to 200 mm, mainly dolerite, red and yellow sandstone	4.2+	6.8
	Borehole terminated owing to rock obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	−1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
7	33	60	0.3	1.3	4	7	9	12	14	49	7
			1.3	2.6	10	10	14	12	16	26	12
			Mean		7	9	12	12	15	35	10

NO 30 SW 150 3158 0440 Pyeston, Star BLOCK E

Surface level + 106.7 m (+ 350 ft)
Water struck at + 104.0 m
250 mm percussion
June 1980

Overburden 0.8 m
Mineral 2.2 m
Waste 4.5 m
Bedrock 0.7 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy, wind blown accumulation	0.8	0.8
Glacial sand and gravel	Sand, with rare pebbles at base Sand: fine with medium and rare coarse, subangular to rounded, quartz with some feldspar and rock Fines: silt seams at 1.6 and 2.9 m, rusty brown	2.2	3.0
Till	Clay, sandy, stony, stiff, grey to 4.3 m, red from 4.3 to 5.3 m, grey from 5.3 to 5.9 m, then red. Clasts up to 150 mm, mainly dolerite and sandstones	4.5	7.5
Upper Carboniferous	Sandstone, fine to medium grained, rooty, soft, grey-green	0.7+	8.2

(... continued)

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
6	94	0	0.8	1.8	5	54	39	2	0	0	0
			1.8	3.0	7	63	29	1	0	0	0
			Mean		6	58	34	2	0	0	0

NO 30 SW 151 3151 0229 Dalginch, Star BLOCK E

Surface level + 119.6 m (+ 392 ft)
Water struck at + 110.9 m
250 mm percussion
June 1980

Overburden 0.5 m
Mineral 10.2 m
Waste 2.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, gravelly	0.5	0.5
Glacial sand and gravel	a Pebbly sand Gravel: fine and coarse with rare cobbles, subangular to subrounded, quartzite, dolerite and sandstone Sand: fine and medium with coarse, subangular, quartz, feldspar and rock Fines: some disseminated silt, reddish brown	2.0	2.5
	b 'Very clayey' sand Sand: fine with medium and rare coarse coal, subangular to subrounded, quartz with feldspar, rock and coal Fines: silt, disseminated and rare seams, light brown	3.0	5.5
	c Pebbly sand, sand with illsorted solifluction deposit from 5.7 to 5.85 m Gravel: coarse and fine Sand: fine with medium and rare coarse, subangular to subrounded, quartz with feldspar, rock and coal Fines: silt and clay	1.0	6.5
	d Sand Sand: fine with some medium, subangular to subrounded, quartz with rock, feldspar and coal Fines: little, light brown	2.0	8.5
	e Sand with pebbles Gravel: fine Sand: fine with medium and rare coarse, subangular to subrounded, quartz with feldspar, rock and coal Fines: some disseminated silt, light brown	2.2	10.7
Till	Clay, sandy, stony, firm, grey, clasts mainly sandstone and dolerite, also coal	2.3+	13.0
	Borehole terminated owing to rock obstruction		

(... continued)

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	− 1/16	+ 1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64	
a	6	84	10	0.5	1.5	7	32	34	10	9	8	0	
				1.5	2.5	5	49	41	2	3	0	0	
				Mean		6	40	38	6	6	4	0	
b	22	78	0	2.5	3.5	21	61	18	0	0	0	0	
				3.5	4.5	34	59	7	0	0	0	0	
				4.5	5.5	11	72	16	1	0	0	0	
				Mean		22	64	14	0	0	0	0	
c	5	82	13	5.5	6.5	5	57	20	5	5	8	0	
d	3	97	0	6.5	7.5	3	86	11	0	0	0	0	
				7.5	8.5	2	85	13	0	0	0	0	
				Mean		3	85	12	0	0	0	0	
e	6	91	3	8.5	9.5	6	74	13	3	4	0	0	†
				9.5	10.7	5	61	28	4	2	0	0	†
				Mean		6	66	21	4	3	0	0	
a to e	10	86	4	Mean		10	63	20	3	2	2	0	

NO 30 SW 152 3241 0242 Treaton Strips, Star BLOCK G_2

Surface level + 106.6 m (+ 350 ft)
Water struck (perched) at + 103.1 m
250 mm percussion
June 1980

Waste 4.4 m
Bedrock 1.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, sandy, stony, reddish brown to 3.0 m, then grey-brown. Clasts include dolerite, red and cream sandstones	4.1	4.4
Upper Carboniferous	Sandstone, fine grained, thinly bedded, with iron enriched partings, off-white to rust coloured, weathered and soft to 5.0 m	1.0+	5.4

NO 30 SW 153 3271 0163 Treaton, Star BLOCK F

Surface level + 56.77 m (+ 186.3 ft)
Water struck at + 51.8 m
250 mm percussion
June 1980

Overburden 1.6 m
Mineral 1.7 m
Waste 5.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.5	0.5
Fluvioglacial sand and gravel	Silt, sandy, reddish brown, with rare subrounded pebbles, mainly of dolerite	1.1	1.6
	Sandy gravel Gravel: fine and coarse with cobbles, subangular to subrounded, mainly sandstone with dolerite and coal Sand: medium and coarse with fine, subangular to subrounded, quartz, coal and feldspar Fines: disseminated silt and clay, more common from 1.6 to 2.6 m, grey-brown to brown	1.7	3.3
Till	Clay, sandy, silty, stony, red to 6.0 m, then brown, clasts up to 200 mm, mostly sandstone and dolerite	5.0+	8.3
	Borehole terminated owing to rock obstruction		

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
6	49	45	1.6	2.6	9	11	24	17	18	16	5
			2.6	3.3	2	7	21	17	18	17	18
			Mean		6	9	24	17	18	16	10

NO 30 SW 154 3246 0036 Balfour, Milton of Balgonie BLOCK F

Surface level + 36.04 m (+ 118.2 ft)
Groundwater level + 24.5 m
250 mm percussion
June 1980

Overburden 0.2 m
Mineral 3.3 m
Waste 12.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, gravelly	0.2	0.2
Fluvioglacial sand and gravel	'Clayey' sandy gravel Gravel: coarse and fine with cobbles increasing downwards, subrounded, dolerite with red and yellow sandstones Sand: fine, medium and coarse, subangular to subrounded, quartz and rock Fines: disseminated silt and clay, also seams of red and grey clay, overall colour reddish brown	3.3	3.5
Till	Clay, sandy, stony, stiff, red, but light to reddish brown from 9.0 to 11.0 m, clasts up to 200 mm, predominantly dolerite with sandstone, rare siltstone and coal	12.3+	15.8
	Borehole abandoned owing to rock obstruction		

(... continued)

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	−1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
15	40	45	0.2	1.8	15	12	18	13	17	25	0
			1.8	2.8	19	15	15	14	20	12	5
			2.8	3.5	10	11	10	6	8	12	43
			Mean		15	13	15	12	16	18	11

NO 30 SW 155 3327 0220 Newton Hall, Kennoway BLOCK F

Surface level + 97.1 m (+ 319 ft)
Water not struck
250 mm percussion
June 1980

Overburden 1.8 m
Mineral 2.1 m
Waste 2.9 m
Bedrock 0.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.2	0.2
	Soil, clayey loam	0.5	0.7
Till	Clay, silty, sandy, pebbly, reddish brown, with clasts up to 100 mm, including dolerite, soft sandstone and coal	1.1	1.8
	'Clayey' pebbly sand Gravel: coarse with fine and cobbles below 2.8 m, mainly sandstone Sand: fine with medium and rare coarse, subangular, quartz, feldspar and rock Fines: disseminated silt and clay, deposit clay-bound, also seams of red silt	2.1	3.9
	Clay, sandy, stony, grey-brown then dark grey, with clasts of dolerite and sandstone with coal and shale	2.9	6.8
Upper Carboniferous	Mudstone, silty, very soft, grey-black	0.8+	7.6

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	−1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
19	63	18	1.8	2.8	19	45	20	3	5	8	0
			2.8	3.9	18	40	17	3	4	9	9
			Mean		19	41	18	3	5	9	5

NO 30 SW 156 3368 0121 Bankhead of Balcurvie, Windygates BLOCK F

Surface level + 61.0 m (+ 200 ft)
Water struck at + 55.8 m
250 mm percussion
June 1980

Waste 5.2 m
Bedrock 1.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Head	Clay, sandy, gravelly, light brown, with subrounded clasts up to 10 mm mainly sandstones and dolerite	0.3	0.6
Till	Clay, stony, becoming sandy with depth, reddish brown to 1.0 m, then grey-brown; clasts comprise sandstone with dolerite, some coal and shale	4.6	5.2
Upper Carboniferous	Sandstone, fine grained, soft, surface fissured	1.5+	6.7

NO 30 SW 157 3363 0056 East Meetings, Windygates BLOCK F

Surface level + 33.0 m (+ 108 ft)
Water struck (perched) at + 27.4 m
250 mm percussion
June 1980

Overburden 0.4 m
Mineral 5.8 m
Waste 4.5 m
Bedrock 0.6 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, gravelly	0.4	0.4
Fluvioglacial sand and gravel	a Gravel Gravel: coarse and fine with cobbles, subangular to well rounded, cream and purple sandstone, andesite, dolerite, quartz Sand: coarse and medium with fine, angular to rounded, quartz, rock and feldspar Fines: disseminated silt and clay	2.2	2.6
	b 'Clayey' gravel, comprising dark brown to black clay-bound gravel to 3.0 m, rusty brown 'very clayey' sandy gravel to 3.6 m, and light brown 'clayey' sandy gravel to 3.8 m Gravel: coarse and fine with cobbles up to 200 mm, mainly rounded, dolerite, andesite, sandstone, quartz Sand: coarse, medium and fine, subangular to subrounded, quartz, rock and feldspar Fines: disseminated silt and clay	1.2	3.8
Till	c 'Clayey' gravel Gravel: cobble, coarse and fine, mainly subrounded to rounded, clasts up to 200 mm, dolerite, sandstone, quartz, basalt and andesite Sand: fine with medium and coarse, angular to subrounded, quartz, rock and feldspar Fines: disseminated silt and clay, pale reddish brown and rusty brown	2.4	6.2
	Clay, sandy, stony, firm to stiff, dark grey-brown to 8.0 m then reddish grey-brown; clasts mainly subangular to rounded, include dolerite, sandstones, with quartz, quartzite, siltstone and coal	4.5	10.7
Upper Carboniferous	Tuffaceous sandstone and siltstone, mainly fine grained, grey-black	0.6+	11.3

(... continued)

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	−1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
a	7	39	54	0.4	1.2	7	8	16	15	22	32	0
				1.2	2.6	7	9	15	15	19	32	3
				Mean		7	9	15	15	20	32	2
b	12	44	44	2.6	3.8	12	14	15	15	18	22	4
c	14	40	46	3.8	4.8	15	20	12	8	11	13	21
				4.8	6.2	13	19	11	10	13	17	17
				Mean		14	20	11	9	12	15	19
a to c	11	40	49	Mean		11	14	14	13	16	23	9
a & b	9	41	50	Mean		9	11	15	15	19	28	3

NO 30 SW 158 3413 0247 Newton of Kingsdale, Kennoway BLOCK F

Surface level + 89.7 m (+ 294 ft)
Water struck (perched) at + 85.1 m
250 and 200 mm percussion
June 1980

Overburden 0.5 m
Mineral 5.8 m
(inc. 1.0 m waste)
Waste 5.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.5	0.5
Till	a 'Very clayey' sandy gravel Gravel: coarse and fine with rare cobbles angular to subrounded, dolerite, cream sandstone and quartz Sand: fine with medium and rare coarse, subangular to well rounded, quartz with rock and feldspar Fines: silt and clay, disseminated and in seams, deposit often clay-bound, rusty brown to reddish brown	4.0	4.5
	Clay, sandy, pebbly, rusty to reddish brown, with thin silty clay seams; clasts up to 20 mm, mainly sandstone with quartz	1.0	5.5
	b 'Clayey' sandy gravel Gravel: fine and coarse with rare cobbles, subangular to subrounded, dolerite with sandstones, also andesite and quartz Sand: fine with medium and some coarse, subangular to rounded, quartz and rock Fines: silt and clay, disseminated and in seams, reddish brown	0.8	6.3
	Clay, sandy, stony, quite firm, with clasts up to 240 mm, mainly cream and yellow sandstones and dolerite, light reddish brown to 9.4 m, purplish grey-brown to 10.0 m, then light red	5.2	11.5
	Clay, very sandy, with fragments of pale grey, fine grained, soft sandstone	0.2+	11.7
	Borehole terminated owing to rock obstruction		

(... continued)

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	26	55	19	0.5	0.9	16	31	18	6	7	22	0
				0.9	2.5	31	32	16	7	5	9	0
				2.5	3.5	24	34	15	3	3	5	16
				3.5	4.5	25	35	17	7	8	8	0
				Mean		26	34	16	6	5	9	4
b	17	51	32	5.5	6.3	17	30	14	7	8	5	19
a & b	25	54	21	Mean		25	32	16	6	6	8	7

NO 30 SW 159 3471 0076 Balcurvie, Windygates BLOCK F

Surface level + 41.2 m (+ 135 ft)
Water not struck
250 and 200 mm percussion
June 1980

Overburden 0.2 m
Mineral 12.9 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, pebbly	0.2	0.2
Glacial sand and gravel	a Gravel Gravel: cobble, coarse and fine with boulders up to 300 mm recovered, angular to well rounded, cream, red, purple, ferruginous and feldspathic sandstones and dolerite, with ironstone, schist Sand: coarse, medium and fine, angular to subrounded, quartz, rock, feldspar and mica Fines: disseminated silt and clay, rust to light reddish brown	5.8	6.0
	b 'Clayey' gravel Gravel: coarse, fine and cobble, mainly rounded, cream and red sandstones, dolerite, carbonaceous shale, grey-black sandstone, coal Sand: coarse, fine and medium, subangular to subrounded, quartz and rock with feldspar Fines: disseminated clay and silt, deposit clay-bound, light reddish brown	7.1+	13.1
	Borehole terminated owing to rock obstruction		

(... continued)

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	−1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
a	3	28	69	0.2	1.0	7	14	7	11	19	18	24
				1.0	2.0	10	13	9	13	16	27	12
				2.0	3.0	1	6	9	16	23	25	20
				3.0	4.0	1	5	10	11	25	17	31
				4.0	6.0	1	4	9	10	20	25	31
				Mean		3	7	9	12	21	23	25
b	11	28	61	6.0	7.0	9	9	8	13	21	27	13
				7.0	8.0	8	6	7	9	13	32	25
				8.0	9.0	9	7	6	9	21	30	18
				9.0	10.0	13	11	10	9	19	23	15
				10.0	11.0	13	13	8	13	22	31	0
				11.0	12.0	9	8	6	10	14	31	22
				12.0	12.9	15	13	8	14	25	25	0
				12.9	13.1		No data available					
				Mean		11	10	8	11	19	27	14
a & b	8	28	64	Mean		8	9	8	11	20	25	19

NO 30 SW 162 3054 0346 Broomfield, Star BLOCK G_2

Surface level c + 99 m (c + 325 ft)
Water not struck
Pit
October 1979

Waste 1.7 m
Bedrock 0.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Till	Clay, silty, with stones, bright red, crude bedding in part	0.4	0.6
	Clay, stony, grey	0.3	0.9
	Clay, sandy, stony, grey-brown, with many sandstone clasts	0.8	1.7
Lower Carboniferous	Shale, grey-black, broken and disturbed	0.4+	2.1

NO 30 SW 164 3193 0447 Pyeston, Star BLOCK E

Surface level c + 116 m (c + 381 ft) Waste 2.2 m +
Water not struck
Pit
October 1979

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	Silt with scattered pebbles, cobbles and rare dolerite boulders up to 280 mm, unsorted, reddish brown	1.7	2.0
	Sand, silty, buff, composed of fine grained, angular to subangular quartzite with feldspar	0.2+	2.2

NO 30 SW 165 3113 0349 Star BLOCK E

Surface level c + 96 m (c + 315 ft) Overburden 1.0 m
Water struck at c + 94 m Mineral 1.1 m +
Pit
October 1979

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, peaty, dark brown	0.4	0.4
Fluvioglacial sand and gravel	Silt, sandy, mid grey	0.6	1.0
	Sand with trace of fine gravel Sand: fine with medium and rare coarse, mainly subangular to subrounded, quartz with rock and feldspar Fines: disseminated silt, grey and buff	1.1+	2.1

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
5	94	1	1.0	2.1	5	70	22	2	1	0	0

NO 30 SW 168 3121 0208 Dalginch, Star BLOCK F

Surface level c + 87 m (c + 285 ft)
Water struck at c + 85 m
Pit
October 1979

Waste 2.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, silty, stony, mottled light reddish brown, with some cobble and rare boulder sized clasts	1.3	1.6
	'Clayey' sand with rare pebbles Sand: fine, subangular to subrounded, quartz with feldspar and rock Fines: disseminated silt	0.5+	2.1

NO 30 SW 169 3253 0493 Ballenkirk, by Star BLOCK G_2

Surface level c + 128 m (c + 420 ft)
Water not struck
Pit
October 1979

Overburden 0.3 m
Mineral 1.2 m
Waste 0.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Glacial sand and gravel	Pebbly sand, gravel to 0.7 m then sand Gravel: coarse and fine, rare cobbles, mainly subrounded, dolerite and sandstones Sand: fine with medium and coarse, angular to subrounded, quartz with feldspar and rock Fines: silt disseminated and clay coating grains, to 0.7 m, then little, light brown	1.2	1.5
Till	Clay, silty, stony, stiff, reddish brown	0.3+	1.8

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-1/16$	$+1/16-1/4$	$+1/4-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
4	75	21	0.3	1.5	4	51	12	12	9	12	0

NO 30 SW 171 3232 0300 Burnside, Star BLOCK G_2

Surface level c + 98 m (c + 322 ft)
Water struck at c + 97 m
Pit
October 1979

Waste 2.0 m
Bedrock 0.1 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Till	Clay, sandy, silty, stony, light brown, with cobble and rare boulder size clasts	0.8	1.1
	Clay, stony, stiff, reddish blue-grey, with many fragments of shale	0.9	2.0
Upper Carboniferous	Shale, mid-grey, broken	0.1+	2.1

NO 30 SW 174 3364 0300 Auchtermairnie Farm, Kennoway BLOCK G_2

Surface level c + 85 m (c + 279 ft)
Water struck at c + 83 m
Pit
October 1979

Overburden 0.2 m
Mineral 1.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.2	0.2
Alluvium	Gravel Gravel: coarse and fine with cobbles, subrounded to rounded, sandstones, dolerite, andesite, quartz Sand: medium and coarse with fine, mainly subangular to subrounded, quartz with feldspar and rock Fines: a little disseminated silt at top, buff	1.2	1.4
	Sand with pebbles Sand: fine with medium and some coarse, mainly subrounded, quartz with rock and feldspar Fines: little	0.6+	2.0

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
Fines	Sand	Gravel			Fines	Sand			Gravel		
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	+¼–1	+1–4	+4–16	+16–64	+64
1	47	52	0.2	1.4	1	6	22	19	23	29	0
			1.4	2.0	No data available						

NO 31 SW 9 3123 1221 Angle Park No. 3 Pit Section, near Daftmill Farm BLOCK A

Surface level + 43.5 m (+ 143 ft) Mineral 4.2 m +
Water struck at + 39.3 m
Sampled by hand
September 1980

LOG

Geological classification	Lithology	Thickness m	Depth m
Fluvioglacial sand and gravel	a Gravel Gravel: coarse with cobble and fine, mainly rounded with subangular, porphyry, schistose grit, red sandstone, quartzite, quartz and andesite Sand: coarse and medium with rare fine, angular to rounded, quartz and rock with feldspar Fines: little, grey-brown	1.8	1.8
	b Pebbly sand, sand with pebbly stringers Gravel: fine and coarse, subrounded, quartz, andesite, quartzite, porphyry, granite Sand: medium with fine and some coarse, angular to subrounded, quartz, rock and feldspar Fines: little, reddish grey-brown then grey-brown	2.4+	4.2

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	− 1/16	+ 1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
a	1	18	81	0.0	0.9	0	2	9	7	12	40	30
				0.9	1.8	1	2	8	7	11	45	26
				Mean		1	2	9	7	12	41	28
b	2	80	18	1.8	3.2	2	21	45	10	12	10	0
				3.2	4.2	1	23	54	10	11	1	0
				Mean		2	22	48	10	12	6	0
a & b	1	54	45	Mean		1	13	31	9	12	22	12

NO 31SW 10 3070 1269 Approach Wood, by Letham BLOCK A

Surface level + 50 m (+ 164 ft)
Groundwater level + 41 m
250 and 200 mm percussion
June 1980

Overburden 0.2 m
Mineral 8.9 m
Waste 5.7 m
Bedrock 0.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, gravelly	0.2	0.2
Glacial sand and gravel	a Gravel Gravel: fine with coarse and some cobbles, subrounded to rounded, sandstone and dolerite with andesite, quartzite and vein-quartz Sand: coarse and medium with fine, subangular to subrounded, quartz, feldspar and rock Fines: a little disseminated silt, red to 1.2 m, then brown	3.0	3.2
	b Gravel Gravel: coarse and fine, as above Sand: medium with coarse and some fine, subangular to subrounded, quartz, feldspar and rock Fines: little, brown	4.0	7.2
	c Sandy gravel Gravel: coarse and fine, as above Sand: medium with coarse and some fine to 8.2 m, then increase in fine, subangular to subrounded, quartz, feldspar and rock Fines: some silt, brown	1.9	9.1
Till	Clay, sandy, red, with clasts mainly of dolerite and sandstones, the latter dominant from 14.0 m	5.7	14.8
Upper Devonian	Siltstone, sandy, with clay clasts, soft, red	0.3+	15.1

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	− 1/16	+ 1/16 − 1/4	+1/4–1	+1–4	+4–16	+16–64	+64
a	5	35	60	0.2	1.2	5	9	13	9	24	30	10
				1.2	2.2	6	7	15	16	23	29	4
				2.2	3.2	4	5	17	14	18	34	8
				Mean		5	7	15	13	22	31	7
b	3	45	52	3.2	4.2	3	7	20	16	25	29	0
				4.2	5.2	2	5	25	18	25	25	0
				5.2	6.2	3	6	24	15	21	31	0
				6.2	7.2	4	6	19	17	25	29	0
				Mean		3	6	22	17	24	28	0
c	4	50	46	7.2	8.2	3	9	24	16	25	23	0
				8.2	9.1	5	18	25	8	20	24	0 †
				Mean		4	13	24	12	23	24	0
a to c	4	43	53	Mean		4	8	20	14	23	28	3

NO 31 SW 11 3034 1153 Ladybank Golf Course, Annsmuir BLOCK A

Surface level + 46 m (+ 151 ft)
Groundwater level + 40 m
250 mm percussion
June 1980

Overburden 0.4 m
Mineral 2.9 m
Waste 6.5 m
Bedrock 1.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Made ground	0.4	0.4
Fluvioglacial sand and gravel	Sandy gravel Gravel: coarse and fine with cobbles, mainly subrounded to well rounded, andesite, medium and fine grained red sandstone, quartz, metaquartzite, schistose grit, dolerite and felsite Sand: medium with fine and coarse, angular to well rounded, but mainly subangular, quartz with rock and feldspar Fines: little, light greyish brown	2.9	3.3
Till	Clay, sandy, becoming very sandy, mostly quite soft, reddish brown to 4.5 m, yellow to 6.1 m, red to 6.2 m, then yellow due to abundance of fine-grained sandstone clasts	6.5	9.8
Upper Devonian	Sandstone, buff, fine to medium grained with green clay pebbles, fissured and infilled with till to 10.3 m	1.2+	11.0

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages						
					Fines	Sand			Gravel		
Fines	Sand	Gravel	from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$
4	49	47	0.4	1.6	6	12	19	16	23	24	0
			1.6	2.6	4	8	30	17	22	19	0
			2.6	3.3	1	12	19	11	18	34	5
			Mean		4	11	23	15	21	25	1

NW 31 SW 12 3145 1384 Ballantagar, Letham BLOCK A

Surface level + 43 m (+ 141 ft)
Groundwater level + 42 m
250 mm percussion
June 1980

Overburden 1.1 m
Mineral 3.1 m
Waste 1.5 m
Bedrock 1.3 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, clayey	0.5	0.5
Alluvium	Silt, clayey, grey, with rootlets and rare pebbles	0.6	1.1
Glacial sand and gravel	Sandy gravel Gravel: fine and coarse, rare cobbles, subangular to subrounded, andesite, basalt, sandstone, dolerite, felsite, vein-quartz, rare metamorphic rocks Sand: medium with fine and coarse, subangular to subrounded, quartz, feldspar and rock Fines: disseminated silt and clay, mainly from 1.1 to 2.1 m, silt seam at 4.0 m, light to dark brown	3.1	4.2
Till	Clay, sandy, stony, red, with clasts up to 100 mm, mainly sandstone and dolerite	1.5	5.7
Upper Devonian	Sandstone, medium grained, grey-green, with rare quartz pebbles up to 15 mm and green clay pebbles up to 40 mm	1.3+	7.0

GRADING

Mean for deposit percentages			Depth below surface (m)		percentages							
Fines	Sand	Gravel			Fines	Sand			Gravel			
			from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
6	56	38	1.1	2.1	13	16	24	12	17	18	0	†
			2.1	3.1	1	23	18	16	24	18	0	†
			3.1	4.2	3	12	37	12	19	17	0	†
			Mean		6	17	26	13	20	18	0	

NO 31 SW 13 3171 1149 Annsmuir, by Ladybank BLOCK B

Surface level + 44.25 m (+ 145.2 ft)
Water struck at + 36.3 m
250 mm percussion
June 1980

Overburden 0.4 m
Mineral 4.3 m
Waste 3.3 m
Bedrock 0.6 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, pebbly	0.4	0.4
Fluvioglacial sand and gravel	a Pebbly sand Gravel: fine with coarse, subangular to well rounded, quartzite, andesite, quartz Sand: medium with fine and some coarse, angular to well rounded, quartz with rock and feldspar Fines: little, light reddish brown	3.0	3.4
	b Sand with thin pebbly layer at base Gravel: fine, subangular to rounded, red and cream sandstone, quartz Sand: fine with medium, angular to well rounded, quartz with rock and feldspar Fines: disseminated silt, light brown to 4.4 m then light reddish brown	1.3	4.7
Till	Clay, sandy, stony, moderately firm, reddish brown, clasts include dolerite, andesite, cream, yellow and red sandstones	3.3	8.0
Upper Devonian	Sandstone, fine grained, weathered and broken to 8.6 m, then hard, off-white to buff. Marked grain size variation seen in two fragments	0.6+	8.6

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	−1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
a	1	86	13	0.4	1.4	1	19	39	12	19	10	0
				1.4	2.4	1	26	59	7	7	0	0
				2.4	3.4	1	24	67	4	4	0	0
				Mean		1	23	55	8	10	3	0
b	6	94	0	3.4	4.4	5	78	17	0	0	0	0
				4.4	4.7	8	81	10	0	1	0	0
				Mean		6	79	15	0	0	0	0
a & b	2	89	9	Mean		2	40	44	5	7	2	0

NO 31 SW 14 3148 1067 Sunnybraes, Ladybank BLOCK B

Surface level + 42 m (+ 138 ft)
Water struck (perched) at + 39 m
250 and 200 mm percussion
June 1980

Overburden 0.4 m
Mineral 6.3 m
Waste 3.7 m
Bedrock 0.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, peaty, sandy	0.4	0.4
Fluvioglacial sand and gravel	a Pebbly sand Gravel: fine with coarse, subangular to well rounded, quartz, andesite, red sandstone, schistose grit Sand: medium with fine and coarse, angular to well rounded, quartz with rock and feldspar Fines: disseminated silt from 0.4 to 0.7 m, otherwise little, light reddish brown	2.3	2.7
	b Sand, with pebbles Gravel: fine, subrounded, quartz, andesite, red sandstone, schistose grit Sand: fine and medium with rare coarse, angular to well rounded, quartz with rock and feldspar Fines: little, light reddish brown	2.0	4.7
	c 'Very clayey' sand Gravel: rare, fine, subrounded Sand: fine with rare medium and trace of coarse, angular to rounded, quartz with some rock, feldspar and mica Fines: disseminated silt and rare clayey silt seams, reddish brown	2.0	6.7
Late-Glacial raised estuarine deposits	Silt and silty clay, interbedded, laminated, reddish brown	0.6	7.3
Till	Clay, very sandy, quite soft, reddish brown, with cobble size clasts of sandstone and dolerite	3.1	10.4
Upper Devonian	Sandstone, fine grained, yellowish brown, with small green clay pebbles	0.8+	11.2

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	− 1/16	+ 1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64	
a	5	76	19	0.4	0.7	12	27	37	15	9	0	0	
				0.7	1.7	2	28	44	13	10	3	0	
				1.7	2.7	5	24	30	14	16	11	0	
				Mean		5	26	36	14	13	6	0	
b	3	95	2	2.7	3.7	2	44	49	3	2	0	0	†
				3.7	4.7	4	45	45	4	2	0	0	†
				Mean		3	45	46	4	2	0	0	
c	25	75	0	4.7	5.7	26	67	6	1	0	0	0	†
				5.7	6.7	24	75	1	0	0	0	0	†
				Mean		25	70	4	1	0	0	0	
a to c	11	82	7	Mean		11	46	30	6	5	2	0	
a & b	4	85	11	Mean		4	35	41	9	8	3	0	

NO 31 SW 15 3245 1176 Rankeilour Mains, Bow of Fife BLOCK B

Surface level + 42.88 m (+ 140.7 ft)
Water struck at + 35.2 m
250 mm percussion
June 1980

Overburden 0.3 m
Mineral 3.3 m
Waste 4.1 m
Bedrock 0.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, pebbly	0.3	0.3
Fluvioglacial sand and gravel	a Sandy gravel Gravel: fine with coarse, subangular to subrounded, quartz, andesite, red fine grained sandstone, schistose grit Sand: medium with coarse and some fine, angular to well rounded, quartz, rock and some feldspar Fines: little, grey-buff	2.0	2.3
	b Sand, with rare pebbles Gravel: fine, subangular to subrounded, quartz, andesite, quartzite, sandstone Sand: fine with medium and rare coarse, angular to well rounded, quartz, rock and some feldspar Fines: rare silt seams, 10 to 20 mm thick, below 3.0 m buff	1.3	3.6
	Silt with sand seams and rare small pebbles	0.4	4.0
Till	Clay, sandy, quite soft, reddish brown, becoming extremely sandy and pale coloured below 6.5 m. Clasts almost entirely of yellow and off-white fine grained sandstone	3.7	7.7
Upper Devonian	Sandstone, coarse grained, conglomeratic in part, with quartz and green clay pebbles up to 15 mm	0.5+	8.2

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	1	71	28	0.3	1.3	1	9	31	20	25	14	0
				1.3	2.3	1	11	50	21	15	2	0
				Mean		1	10	40	21	20	8	0
b	3	95	2	2.3	3.6	3	60	33	2	2	0	0
a & b	2	80	18	Mean		2	30	37	13	13	5	0

NO 31 SW 16 3243 1097 Jennystown, by Ladybank BLOCK B

Surface level + 42 m (+ 138 ft)
Groundwater level + 37 m
250 and 200 mm percussion
June 1980

Overburden 0.4 m
Mineral 6.0 m
Waste 8.0 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.4	0.4
Fluvioglacial sand and gravel	a Sand, with rare pebbles Gravel: fine, subrounded Sand: fine and medium with rare coarse, subangular to subrounded, quartz, feldspar and rock Fines: a little silt, light to mid-brown	3.0	3.4
	b 'Clayey' sand Sand: fine with medium, subangular to subrounded, quartz with feldspar and rock Fines: disseminated silt, light to mid-brown	2.0	5.4
	c 'Very clayey' sand Sand: fine with trace of medium, subangular, quartz and feldspar Fines: disseminated silt, grey	1.0	6.4
	Silt, clayey, sandy, laminated and colour laminated grey and red	1.4	7.8
Late-Glacial raised estuarine deposits	Clay, with rare silt seams and gravel stringer at 8.5 m, red	1.3	9.1
Till	Clay, sandy, stony, red, very gravelly from 13.5 to 14.4 m; clasts mainly yellow sandstone and dolerite	5.3+	14.4
	Borehole terminated owing to rock obstruction		

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	− 1/16	+ 1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64	
a	5	94	1	0.4	1.4	5	38	51	4	2	0	0	
				1.4	2.4	5	53	40	1	1	0	0	
				2.4	3.4	4	56	40	0	0	0	0	
				Mean		5	48	44	2	1	0	0	
b	15	85	0	3.4	4.4	13	68	19	0	0	0	0	
				4.4	5.4	17	78	5	0	0	0	0	†
				Mean		15	73	12	0	0	0	0	
c	35	65	0	5.4	6.4	35	64	1	0	0	0	0	†
a to c	13	86	1	Mean		13	59	26	1	1	0	0	
a & b	9	90	1	Mean		9	58	31	1	1	0	0	

NO 31 SW 17 3356 1163 Springfield BLOCK B

Surface level + 41 m (+ 135 ft)
Water struck at + 33 m
250 and 200 mm percussion
June 1980

Overburden 0.4 m
Mineral 2.8 m
Waste 4.5 m
Bedrock 0.6 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil, sandy	0.4	0.4
Fluvioglacial sand and gravel	a Pebbly sand Gravel: fine with rare coarse, mainly rounded, andesite, quartzite, quartz Sand: medium with coarse and fine, subangular with rounded, quartz with rock and feldspar Fines: trace, light orange-brown	1.7	2.1
	b 'Clayey' sand, with rare pebbles Gravel: fine, mainly subangular, quartz Sand: fine with medium and rare coarse, angular to subrounded, quartz with rock and feldspar Fines: seams of reddish brown silty clay from 2.1 to 2.5 m, and some disseminated silt	1.1	3.2
Till	Clay, sandy, stony to 6.2 m, soft to 3.8 m, then firm, reddish brown; clasts include red and off-white sandstones, schist, andesite	4.5	7.7
Upper Devonian	Sandstone, very fine grained, mottled buff and light yellowish brown, weathered to 7.9 m, then hard due to calcareous cement	0.6+	8.3

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	−1/16	+1/16 − 1/4	+1/4−1	+1−4	+4−16	+16−64	+64
a	1	88	11	0.4	1.4	1	16	58	13	11	1	0
				1.4	2.1	1	10	66	14	9	0	0
				Mean		1	14	61	13	10	1	0
b	15	84	1	2.1	3.2	15	47	33	4	1	0	0
a & b	7	86	7	Mean		7	27	49	10	7	0	0

NO 31 SW 18 3417 1018 Cults Lodge, Pitlessie BLOCK D

Surface level + 40.75 m (+ 133.7 ft)
Groundwater level + 36.8 m
250 mm percussion
June 1980

Overburden 0.9 m
Mineral 3.1 m
Waste 1.0 m
Mineral 3.8 m
Bedrock 0.5 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil and made ground	0.9	0.9
Fluvioglacial sand and gravel	a Sand, with pebbles Gravel: fine with rare coarse, subangular to subrounded, sandstone, quartz Sand: fine with medium and rare coarse to 1.9 m, then medium with fine and coarse, mainly subangular to subrounded, quartz with rock and feldspar Fines: trace, light orange-brown	3.1	4.0
	Silt, clayey, with sand films, reddish brown	1.0	5.0
Till	b 'Clayey' sandy gravel Gravel: fine and coarse with cobbles, subangular to rounded, dolerite, hard grey sandstone, quartz, andesite, granite Sand: fine with medium and rare coarse, angular to well rounded, quartz with some rock and feldspar Fines: silt, much lost owing to washing action, buff coloured	3.8	8.8
Upper Devonian	Sandstone, fine grained, hard, calcareous, yellow and green clay pebbles up to 60 mm common from 9.1 m	0.5+	9.3

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages							
	Fines	Sand	Gravel			Fines	Sand			Gravel			
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	$+1-4$	$+4-16$	$+16-64$	$+64$	
a	1	97	2	0.9	1.9	1	59	37	2	1	0	0	
				1.9	2.9	1	11	80	6	2	0	0	
				2.9	4.0	1	27	59	10	3	0	0	
				Mean		1	32	59	6	2	0	0	
b	16	60	24	5.0	6.0	24	42	7	2	5	13	7	†
				6.0	7.0	15	50	11	4	6	10	4	†
				7.0	8.0	8	40	10	3	6	16	17	†
				8.0	8.8	15	57	13	6	6	3	0	†
				Mean		16	46	10	4	6	11	7	
a & b	9	77	14	Mean		9	40	32	5	4	6	4	

NO 31 SW 19 3043 1037 Ladybank BLOCK A

Surface level + 45 m (+ 148 ft)
Water struck at + 40 m
250 and 150 mm percussion, and rotary
July 1980

Overburden 0.4 m
Mineral 3.7 m
Waste 6.6 m
Bedrock 0.8 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Fluvioglacial sand and gravel	a 'Clayey' gravel Gravel: fine and coarse, subangular to well rounded, quartz, quartzite, schist, dolerite Sand: medium with coarse and fine, angular to rounded, quartz with rock and feldspar Fines: disseminated silt and clay, mid-brown	1.3	1.7
	b Pebbly sand Gravel: fine with coarse, subangular to well rounded, quartz, quartzite, red sandstone, schistose grit, andesite, felsite Sand: medium with fine and coarse, mainly angular, quartz, with rock and feldspar Fines: little, pale reddish grey	2.4	4.1
Till	Clay, sandy, stony, reddish brown, soft to 4.5 m, firm to 5.1 m, then buff coloured, with abundant sandstone clasts and some andesite	6.6	10.7
Upper Devonian	Mudstone, silty, sandy in places, finely micaceous, soft, red-brown with greenish grey patches	0.4	11.1
	Sandstone, fine grained, cream, in seams 20 to 30 mm thick, interbedded with mudstone, partly sandy and hard, partly soft	0.4+	11.5

GRADING

	Mean for deposit percentages			Depth below surface (m)		percentages						
	Fines	Sand	Gravel			Fines	Sand			Gravel		
				from	to	$-\frac{1}{16}$	$+\frac{1}{16}-\frac{1}{4}$	$+\frac{1}{4}-1$	+1–4	+4–16	+16–64	+64
a	10	40	50	0.4	1.7	10	10	17	13	26	24	0
b	3	82	15	1.7	2.7	3	21	40	15	16	5	0
				2.7	4.1	3	24	51	11	10	1	0
				Mean		3	23	45	13	13	3	0
a & b	6	67	27	Mean		6	18	36	13	17	10	0

NO 31 SW 20 3170 1235 Daftmill, Bow of Fife BLOCK A

Surface level c + 39 m (c + 128 ft)
Water not struck
Pit
August 1979

Overburden 0.3 m
Mineral 1.3 m
Waste 0.4 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.3	0.3
Fluvioglacial sand and gravel	Sandy gravel	0.5	0.8
	Sand and silt, alternating seams, rust brown and grey. Sand is fine and medium	0.8	1.6
	Silt, grey, unbedded	0.4+	2.0

NO 31 SW 22 3326 1019 Pitlessie Mill BLOCK B

Surface level c + 37 m (c + 121 ft)
Water not struck
Pit
August 1979

Waste 2.2 m +

LOG

Geological classification	Lithology	Thickness m	Depth m
	Soil	0.4	0.4
Fluvioglacial sand and gravel	Sand, fine, slightly silty, mainly quartz, rusty brown then buff	0.5	0.9
Till	Clay, sandy, silty, stony, reddish mid-brown	1.3+	2.2

OTHER RECORDS

Registration number	Grid reference
NO 21 SE	
2	2696 1002
16	2795 1018
NO 30 SW	
89	3190 0144
103	3114 0164

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

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INSTITUTE OF GEOLOGICAL SCIENCES

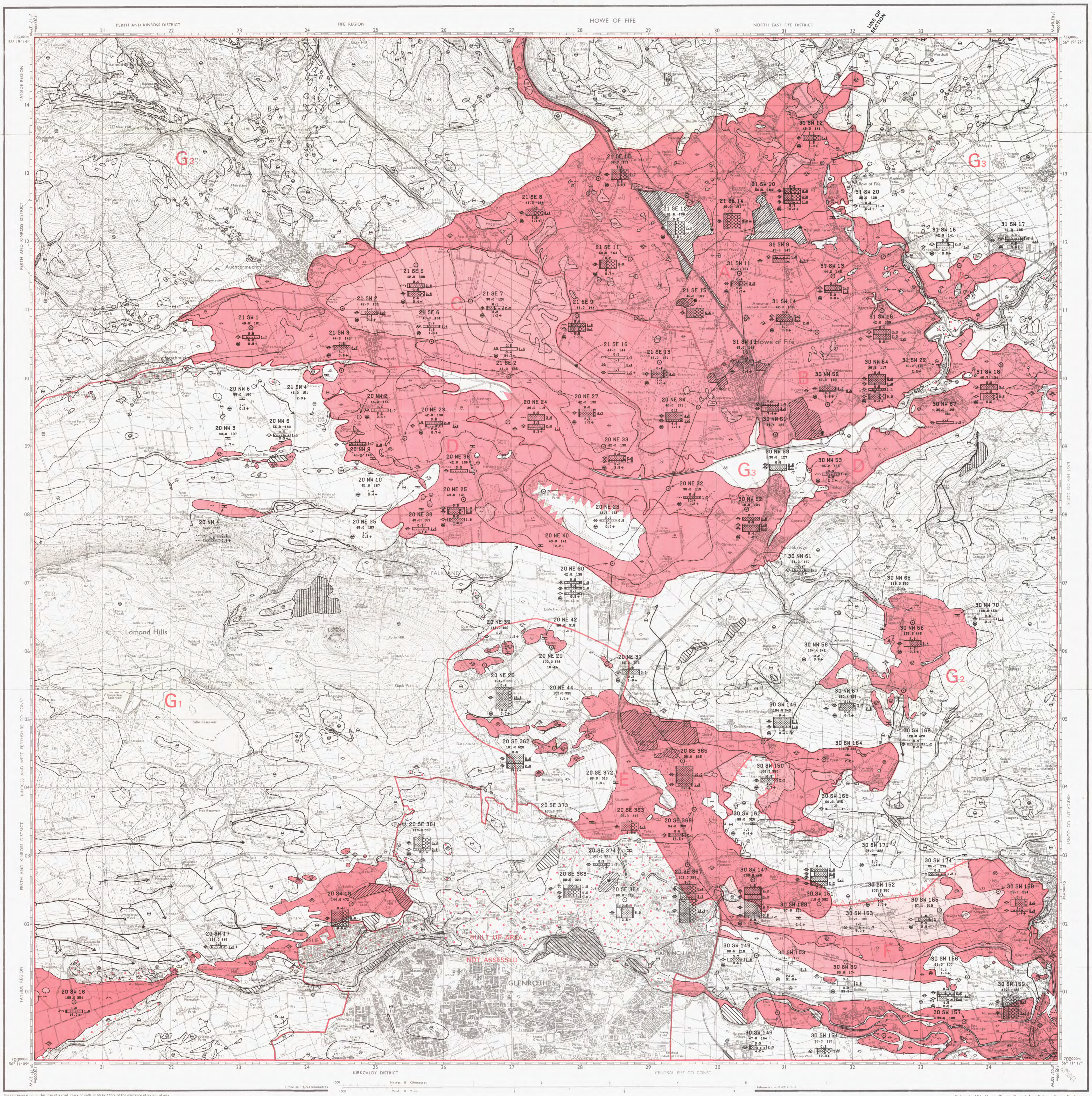
INDUSTRIAL MINERALS ASSESSMENT UNIT

THE SAND AND GRAVEL RESOURCES OF THE COUNTRY AROUND GLENROTHES, FIFE REGION

ORDNANCE SURVEY

Scale 1:25 000 Second Series

SHEET NO 20 & Parts of NO 21, 30 & 31



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

1 mile = 1·6093 kilometres

1 kilometre = 0·6214 mile

Contour values are in metres

Made and published by the Director General of the Ordnance Survey, Southampton.

Compiled from 1:10 560 or 1:10 000 sheets last fully revised 1949-75
Other partial systematic revision 1975-79 has been incorporated
Major roads revised 1976-81

Original geological survey on the six-inch scale by H. H. Howell, between 1858 and 1867. Revised by J. Knox, J. K. Allan, W. Tulloch and N. Martin between 1926 and 1946, G. V. Wilson and J. B. Simpson, District Geologists. Area in One-Inch Geological Sheet 48 revised by M. A. E. Browne and J. I. Chisholm, 1966–69, T. R. M. Lawrie, District Geologist. Partial re-survey by A. M. Aitken in 1979–80, E. G. Poole, District Geologist.

Sand and gravel survey by A. M. Aitken and D. L. Ross in 1980 under the supervision of E. F. P. Nickless. R. G. Thurrell, Head, Industrial Minerals Assessment Unit.

The 1:25 000 Sand and Gravel Resource Sheet published 1981 G. M. Brown, D.Sc., FRS, *Director, Institute of Geological Sciences, incorporating the Geological Survey of Great Britain, the Museum of Practical Geology and Overseas Geological Surveys.*

Borehole graphics drawn by computer using programs written by J. L. McInnes, NERC Computing Service, IGS, Edinburgh

Data quoted for an individual sample point 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 volume and mean grading of the mineral as a whole in each Resource Block are given in the Report

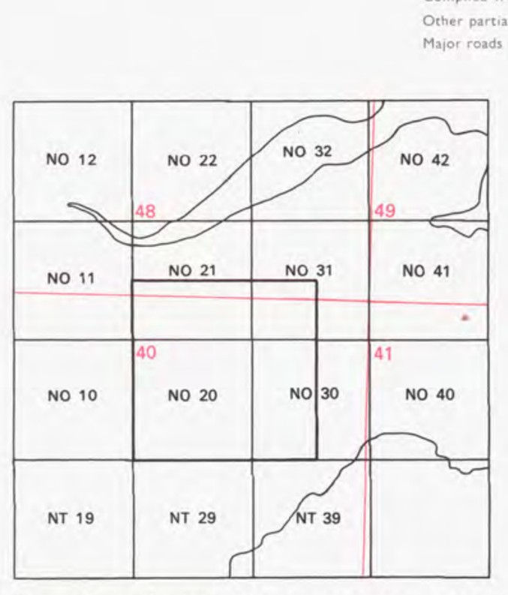
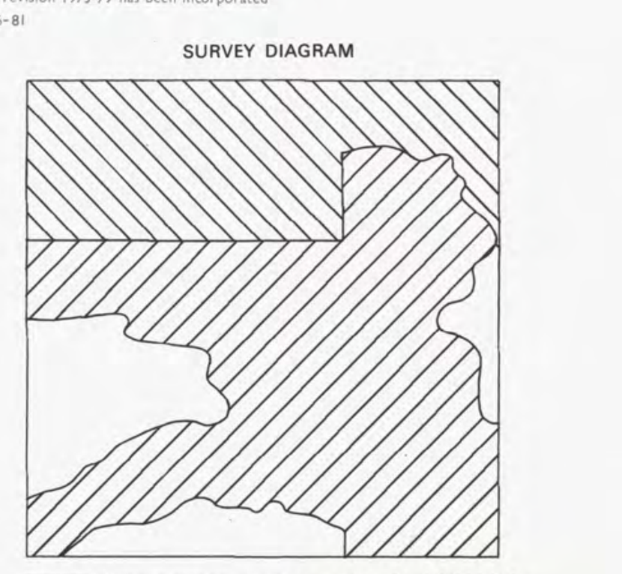


Diagram showing the relation of this sheet with the National Grid squares and the One-Inch Geological Sheets

SURVEY DIAGRAM



Area re-surveyed at the six-inch scale, J. I. Chisholm, 1966–68, and M. A. E. Browne, 1968–69

Area partially re-surveyed by A. M. Aitken, 1979–80

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

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THE SAND AND GRAVEL RESOURCES OF THE COUNTRY AROUND GLENROTHES, FIFE REGION

101

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

EXPLANATION OF SYMBOLS AND ABBREVIATIONS

Landslip L-1

DRIFT

Recent and Pleistocene

Peat P-1

Alluvium (undifferentiated) – silt, clay, sand and gravel A-51

Alluvial cone – clay, sand and gravel, ill sorted AC-3

Lacustrine alluvium – fine to medium sand and silt with clay LA-7

~~**Head and scree** – stony sandy clay (proved mainly in boreholes and excavations)~~ H-40

Late-Glacial alluvium – flattish spreads of fine to medium sand with silt and some gravel, with organic seams LG-1

Late-Glacial raised estuarine deposits – reddish brown silty clay, often laminated, with rare pebbles, overlain locally by fluvioglacial sand and gravel LG-2

Fluvioglacial sand and gravel – terraced and flattish spreads of sand and gravel FL-19

Glacial sand and gravel – moundy glacial meltwater deposits, generally of gravel, but sand in places GS-68

Glaciolacustrine deposits – fine sand, micaceous silt and clay, usually laminated (proved only in boreholes) G-5

Till – typically reddish brown stony silty clay, sandy in places, locally grey-brown in the south TL-13

SOLID

Bedrock, at or near surface – north of the Fernie fault which runs through Auchtermuchty and Collessie, Lower Devonian rocks comprise andesitic lavas and lava conglomerates. The Howe of Fife is underlain by generally soft Upper Devonian sandstones. The Lomond Hills and the vicinity of Leslie comprise Lower Carboniferous sediments intruded by dolerite which crops out extensively there, and to the east between Kirkforthar and Down Law. The youngest sediments are Upper Carboniferous mudstone, limestone, siltstone, sandstone, seatrock and coal which crop out between Markinch and Windygates, and in the neighbourhood of Cadham and Rameldry

Made ground – waste and/or natural earth materials deposited either on the original ground surface or in man-made workings (shown as ⌓ on line of section) MG-3

Worked ground – boundaries as at September 1980. Colour beneath ornament indicates that the mineral has not been exhausted. In the survey area, usually the sand and gravel is worked only above water table WG-5

BOUNDARY LINES

Geological boundary

Geological boundary following back feature of terrace

Line marking back feature of terrace

Inferred boundary between categories of deposit at surface

Inferred boundary between categories of deposit at depth

Resource block boundary

Glacial drainage channel, arrow shows direction of water flow

BOREHOLE AND OTHER DATA

SITE LOCATIONS

Industrial Minerals Assessment Unit (IMAU) borehole

Other borehole

Recorded exposure

Shallow pit

IMAU BOREHOLES

Registration Number → 30 NW 54
Borehole Site → 35.5 117 ← Surface level in metres and feet above O D (Newlyn)
0.6 ← Overburden
Grading Diagram → 5.0 / 1.0 ← Mineral (sand and gravel)
0.5 ← Waste
Geological Classification → 1.1
0.1
3.0
0.3+ ← Bedrock
Thicknesses in metres

Note:
(i) Figures underlined denote thicknesses used in the assessment of resources
(ii) The + sign indicates that the base of the deposit was not reached
(iii) The Geological Classification is given only for mineral and bedrock
(iv) When grading data are not sufficiently detailed or are absent the grading diagram is shown without ornament

Registration Number

Each IMAU borehole is identified by a registration number, e.g. **30 NW 54**. The first numbers and letters refer to the quarter sheet and the final figures to the IGS serial numbers for that quarter. The unique designation for borehole **30 NW 54** is **NO 30 NW 54**

Grading Diagrams

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

Fines ($-\frac{1}{16}$mm) **Sand** ($+\frac{1}{16}-4$mm) **Gravel** ($+4$mm)

The height of the diagram is proportional to the mineral thickness

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

OTHER BOREHOLES

Site investigation boreholes and wells providing ancillary assessment data are located on the map where space permits. These boreholes are registered in the same series as the IMAU boreholes, for example, **30 SW 103**. Owing to the limitations of the computer-drawn graphics program, the true thicknesses of bedrock proved are shown only where they are 99·8m or less: where the thicknesses proved are greater, they are always shown as 99·9m+

EXPOSURE RECORDS

Information from the inspection of exposures is shown in the same way as for IMAU boreholes but they are located by an asterisk, thus ✱. The exposures are registered in the same series as the boreholes, for example **20 NE 35**

SHALLOW PITS

The locations of shallow pits providing ancillary assessment data are shown by a distinctive symbol, thus ⌶. Otherwise information is shown in the same way as for boreholes

CATEGORIES OF DEPOSITS

Exposed, potentially workable sand and gravel CAT-E7

Continuous or almost continuous spreads of potentially workable sand and gravel beneath overburden CAT-C4

Discontinuous spreads of potentially workable sand and gravel exposed or beneath overburden CAT-D2

Sand and gravel not assessed CAT-N1

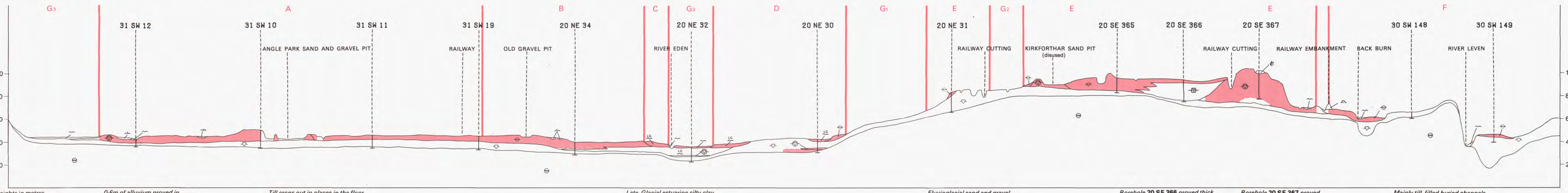
Sand and gravel absent or not potentially workable CAT-A4

RESOURCE BLOCKS

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

GENERALISED HORIZONTAL SECTIONS SHOWING RELATIONSHIPS OF DRIFT DEPOSITS

HORIZONTAL SCALE 1:25 000 VERTICAL EXAGGERATION 12.5×



Heights in metres above Ordnance Datum

*0·6m of alluvium proved in borehole **31 SW 12** is too thin to be recognised at surface*

Till crops out in places in the floor of Angle Park sand and gravel pit

*Late-Glacial estuarine silty clay, exposed in the banks of the River Eden, is confined to the central part of the valley. 0·4m of glacial sand and gravel proved in borehole **20 NE 32** is too thin to be potentially workable*

*Fluvioglacial sand and gravel proved in borehole **20 NE 31** is probably a small remnant of a once more extensive kame terrace*

*Borehole **20 SE 366** proved thick buried glaciolacustrine deposits, the distribution of which is hypothetical*

*Borehole **20 SE 367** proved head, not mapped at the surface, and failed to prove the base of the glacial sand and gravel at the maximum depth of drilling*

Mainly till-filled buried channels in the valleys of the Back Burn and River Leven, are known from commercial boreholes

KEY TO SECTION

Potentially workable sand and gravel, continuous or almost continuous deposits exposed or beneath overburden

Bedrock and waste, including overburden, are uncoloured

Geological boundary

Inferred boundary limiting the extent of potentially workable material

Otherwise symbols and abbreviations as map legend