British Geological Survey

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Mineral Resource Information for Development Plans
Bedfordshire: Resources and Constraints

D E Highley and D G Cameron

BRITISH GEOLOGICAL SURVEY

TECHNICAL REPORT WF/95/2
Mineral Resources Series

Mineral Resource Information for Development Plans
Bedfordshire: Resources and constraints

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This report accompanies the 1;100 000 scale map: Bedfordshire Mineral Resources

Cover photograph
Working face of quarry in Woburn Sands, Pratts Quarry, Arnold & Sons, Leighton Buzzard. 1987. British Geological Survey Photographs. No A14484.

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INTRODUCTION

This report has been prepared to be used in conjunction with the Mineral Resources Map of Bedfordshire. The principal aim of the report and its associated map is to show the broad distribution of mineral resources of current or potential economic interest in Bedfordshire and to relate these to selected, nationally-recognised planning constraints on extraction of minerals. The work is intended to assist in the consideration and preparation of development plan policies in respect of mineral extraction and the protection of important mineral resources.

Development plans set out the main considerations on which planning applications are determined, and they therefore form the essential framework of the planning system. The importance of the development plan system in planning decisions is emphasised by Section 54A of the Town and Country Planning Act 1990, which requires that planning applications and appeals be determined in accordance with the development plan, unless material considerations indicate otherwise. The planning system is therefore a plan-led system.

Development plan preparation must take account of Government guidance. This is primarily set out in Planning Policy Guidance notes (PPGs), Mineral Planning Guidance notes (MPGs) and Regional Planning Guidance notes (RPGs). These provide advice on a range of general and specific issues.

The 'development plan' includes structure plans, which contain strategic planning policies, and local plans, containing detailed policies and proposals, or unitary development plans, which combine both functions. In addition, relevant authorities must produce local plans on minerals and waste.

Information on mineral resources is required to assist the production of mineral local plans by the identification of important resources and the planning constraints which may affect such resources. This information is also necessary for the preparation of structure, local and unitary plans, both in relation to mineral development and the prevention of the sterilisation of important mineral resources.

Three major elements of information are presented and described:

- the geological distribution and importance of mineral resources
- the extent of mineral planning permissions and the location of current mineral workings
- the extent of selected planning constraints (national statutory designations)

The map thus brings together a wide range of information, much of which is scattered and not always available in a consistent and convenient form. It is anticipated that the map and report will also provide valuable background data for a much wider audience, including the different sectors of the minerals industry, other agencies and authorities (e.g. The Planning Inspectorate, the NRA, the Countryside Commission and English Nature), environmental interests and the general public.

Mineral resource classification

Mineral resources are natural concentrations of minerals which might now, or in the foreseeable future, be of economic value. However, the identification and delineation of mineral resources is imprecise as it is limited by the quantity and quality of data currently available and involves predicting what might or might not become economic to work in the future. The pattern of demand for minerals is continually evolving due to changing

economic, technical and environmental factors. The economic potential of mineral resources is not static, therefore, but changes with time.

The map of Bedfordshire shows the extent of **inferred resources**, that is, those mineral resources that can be defined from available geological information. They have neither been evaluated by drilling or other sampling methods, nor had their technical properties characterised on any systematic basis. In addition, the mineral resources shown on the map take no account of the planning constraints that may limit their working.

That part of a **mineral resource** which has been fully evaluated and is commercially viable to work is called a **reserve** or **mineral reserve**. The relationship between **inferred resources** shown on the map and evaluated and commercial deposits (**reserves**) is described in more detail in Appendix 3. In the context of land-use planning, however, the term **reserve** should strictly be limited to those minerals for which a valid planning permission for extraction exists (i.e. **permitted reserves**).

The map has been produced by the collation and interpretation of data held by the British Geological Survey. The geological lines are taken, with some generalisations, from available BGS 1:63 630 or 1:50 000 scale maps, with some modifications based on modern local surveys which are as yet unpublished. The published maps are based on 1:10 560 or 1:10 000 scale surveys, which cover the whole county, but the quality, detail and reliability of the surveys varies greatly, even within one sheet, although generally, the more recent the survey, the more reliable it is likely to be.

Mineral workings and planning permissions

The location and name of mineral workings, together with the main mineral commodities produced, are shown on the map and in Appendix 1.

The extent of mineral planning permissions is shown on the Mineral Resources Map. They cover active mineral workings, former mineral workings and, occasionally, unworked deposits. The planning permissions data were obtained from Bedfordshire County Council, and this material has been verified by the County Council.

The present physical and legal status of individual permissions is not qualified on the map or in the report. The areas shown may, therefore, include inactive sites, where the permission has expired due to the terms of the permission, i.e. a time limit, and inactive (dormant) sites where the permission still exists. Sites which have been restored have not been separately identified. A planning permission may extend beyond the mapped resource as it may make provision for operational land, including plant and overburden tips, or it may extend to an easily identified or ownership boundary. Information on the precise status and extent of individual planning permissions should be sought from the Mineral Planning Authority.

Environmental designations

The map shows the extent of selected, nationally-designated planning constraints as defined for the purposes of this study. These constraints are defined on a common national basis and therefore represent a consistent degree of constraint across the country. No interpretation should be made from the map with regard to the relative importance of the constraints, either in relation to mineral development proposals or in relation to each other. Users should

consult policy guidelines issued by the relevant Government department, statutory agency or local authority.
The constraints shown on the map are:

- Areas of Outstanding Natural Beauty (AONB)
- National Nature Reserves (NNR)
- Sites of Special Scientific Interest (SSSI)
- Scheduled Monuments

Mineral development may also be constrained by other factors not shown on the map including local landscape designations, considerations relating to the protection of other resources, such as groundwater, and local amenity or environmental concerns such as noise, traffic and visual impact. These have been excluded because the constraint is not defined on a national basis or the information is not generally available. The extent or degree of relevance of such constraints can be ascertained from the relevant statutory agency or the Mineral Planning Authority (Appendix 2).

AONBs have been digitised from maps obtained from the Countryside Commission and English Nature provided digital data on SSSIs and NNRs. Information on the location of Scheduled Monuments has been obtained in digital form from English Heritage, and this has had to be edited and the grid references converted to a form that is suitable for use by BGS Cartographic Services.

MINERAL RESOURCES

Introduction

The mineral resources of Bedfordshire reflect the nature and properties of the various sedimentary rocks exposed at or near the surface (Table 1). These sediments were deposited under a variety of environmental and climatic conditions over a period of some 190 million years or so. They consist predominantly of Jurassic mudstones or clays in the northern half of the county, and sands, clays and chalk of Cretaceous age in the south. Superficial deposits of Quaternary age, including till (boulder clay) and glacial sand and gravel, together with younger river sediments, blanket the bedrock formations over large areas.

With changing economic conditions, the relative importance of different mineral-based industries has also changed. For example, the production of phosphatic nodules for fertiliser use from various Cretaceous formations ceased in the early part of the 20th Century. However, the county has recently emerged as the principal source of fuller's earth in Britain, although the extraction of this rare clay is believed to date back to Roman times.

By the early part of the 20th Century, a brick industry of national importance had been established in the Marston Vale. Its importance was primarily due to the availability of extensive deposits of carbonaceous clays of the Jurassic Lower Oxford Clay which, being partially self-firing, allowed bricks to be produced at low cost. However, other factors, such as good rail communications, were also important to the development of the industry. Similarly, the large-scale working of the Woburn Sands around Leighton Buzzard commenced about a century ago when rail and canal links made the products accessible to a

wider market. The availability of suitable raw materials, rail communications and proximity of major markets were also important factors in the location of the cement industry at Dunstable, where the clay-rich Lower Chalk was formerly valued as a natural mix for cement manufacture. However, its importance as a cement-making raw material has declined markedly because of the higher energy costs associated with its use; consequently the cement works in the vicinity of Dunstable were closed in the 1970s. The Kensworth chalk quarry, which started production in 1964, is unusual in that it supplies cement works in Warwickshire, to which the chalk is pumped by slurry pipeline.

Table 1 Mineral resources of Bedfordshire

Age	Geological Unit	Commodity/Use
Quaternary	River gravels	Sand and gravel for aggregate
	Glacial sand and gravel	Sand and gravel for aggregate
Cretaceous	Middle and Upper Chalk	Chalk for cement manufacture
	Lower Chalk.	Chalk for lime
		Chalk for cement manufacture
	Totternhoe Stone	Building stone
	Gault	Clay for bricks
	Woburn Sands Formation	Sands (for building, asphalting and concreting)
		Silica sands for industrial use
		Fuller's earth
		Phosphate
Jurassic	Lower Oxford Clay	Clay for bricks

Note: italics signify commodity no longer produced

Sand and gravel

Sand and gravel resources have been divided into two broad categories:

- Superficial or 'drift' deposits of Quaternary age, subdivided into river gravels, and glacial sand and gravel
- Bedrock or 'solid' deposits represented by the Cretaceous, Woburn Sands Formation

This division reflects the different form of the deposits, their likely workable extent and grading, and thus their importance as aggregate resources. Sand and gravel production in Bedfordshire between 1973 and 1993 is shown in Figure 1.

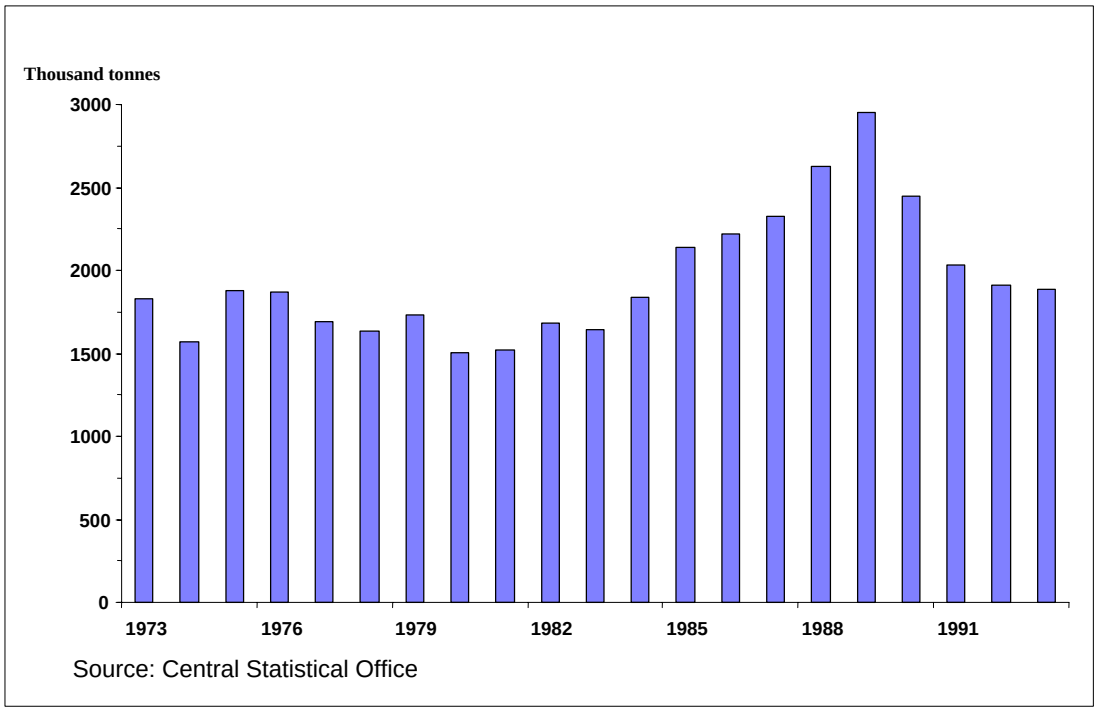

Figure 1 Sand and gravel production in Bedfordshire 1973–1993

River gravels

River gravels correspond to the 'river terrace deposits' of the source maps, and are mainly developed along the rivers Great Ouse and Ivel (Figure 2). In many places the sand and gravel may be covered by a thin overburden of silt and clay (alluvium), and extensive deposits have been sterilised by urban development, notably around Bedford. River gravels by their nature tend to have been naturally processed by running water, which is an efficient mechanism for separating the different size fractions of the sediment being transported. As a result, beds of sand and gravel are likely to be relatively consistent in terms of particle-size distribution with fewer 'fines' (silt and clay) and non-durable gravel than glacial deposits. In composition, river gravels will depend on the nature of the bedrock and glacial units being eroded within the river's catchment.

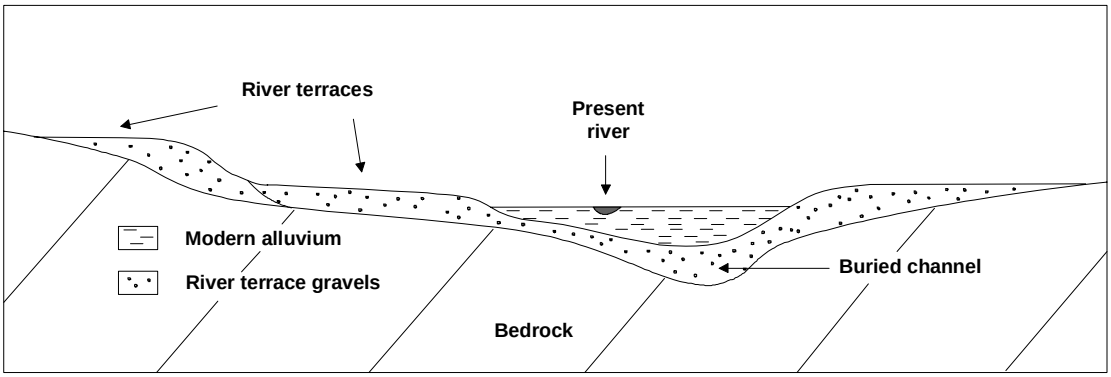

Figure 2 Sketch section across a river valley showing the relationship of alluvium to river terrace sand and gravel deposits (not to scale)

The River Ouse gravels are generally dominated by pebbles of Jurassic limestone and flint derived from glacial deposits. Those of the River Ivel are flint-dominant, being derived both from glacial deposits and direct from the flint-bearing chalk of its headwaters. On both rivers, the lateral extent and maximum thickness of river sand and gravel increases downstream, and gravels probably occur beneath the alluvium along most of the course of both rivers. From general considerations, and a very limited amount of borehole information, the deposits generally do not appear to exceed 3–4 m in thickness, and 5 m would seem to be exceptional. River deposits in other parts of the county, such as those in the valley of the River Kym in the north of the county, are thinner and of limited lateral extent, and thus of little potential value.

Glacial sand and gravel

These include deposits laid down by a variety of glacial and glacio-fluvial processes associated with ice sheets, glaciers and their meltwaters. They are likely to be of variable composition, with a large amount of fines, and may contain significant amounts of chalk, which may make them unsuitable for use in concrete. Otherwise, the gravels are mainly dominated by flints, with minor amounts of quartz, quartzite, limestone and sandstone. Glacial gravels are almost invariably closely associated with till, either forming sheet-like deposits overlying till, or as concealed lenticular bodies (generally channel fills) within or beneath till (Figure 3). In the latter cases, it is impossible to predict the extent of gravels beneath till without field surveys involving drilling and/or geophysics.

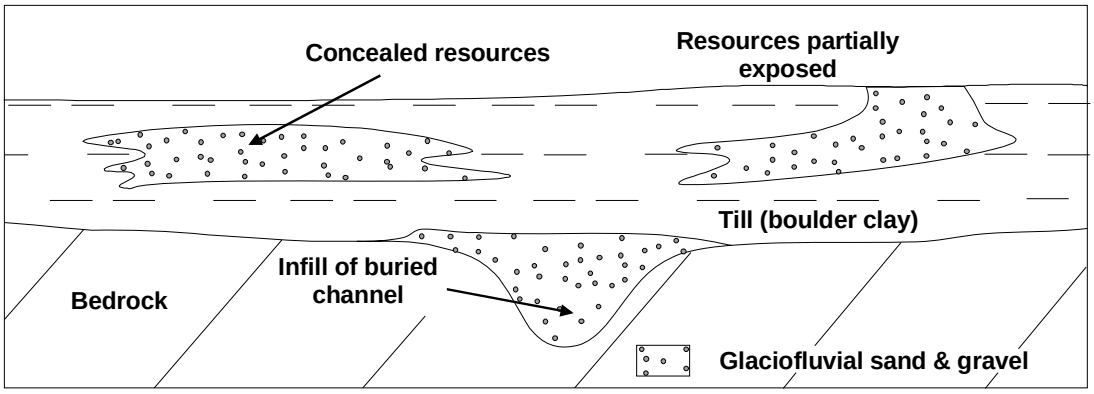

Figure 3 Sketch section to illustrate the presence of concealed resources of glacial sand and gravel within glacial till (not to scale)

The most extensive deposits of glacial sand and gravel are those west of Biggleswade. A 'buried channel' infilled with thick drift deposits is well authenticated to the south, between Clifton and Hitchin, which continues northwards beneath the mapped outcrop of glacial sand and gravel. However, the glacial deposits filling the channel appear to be mainly fine-grained.

Known outcrops of glacial sand and gravel which are very small in area are omitted from the map. A number of somewhat larger patches of glacial sand and gravel occur, particularly to the north–east of Leighton Buzzard, where the presence of concealed deposits of sand and gravel beneath till is also likely. Although worked locally at Harlington for building sand and hoggin, these isolated deposits are not an important aggregate resource.

Bedrock deposits

The Woburn Sands Formation (Lower Greensand), which crops out from Leighton Buzzard eastwards to the Potton district, is an important resource of bedrock sands. The sands are fine to coarse grained and, although devoid of gravel, constitute an important source of construction sand, and locally, where of higher purity, silica (industrial) sand. The map shows the outcrop of the whole formation, together with the extensive areas which are concealed beneath an overburden of superficial deposits (glacial and river gravels, and till). To the south–east the Woburn Sands dip beneath the Gault clay (Figure 4).

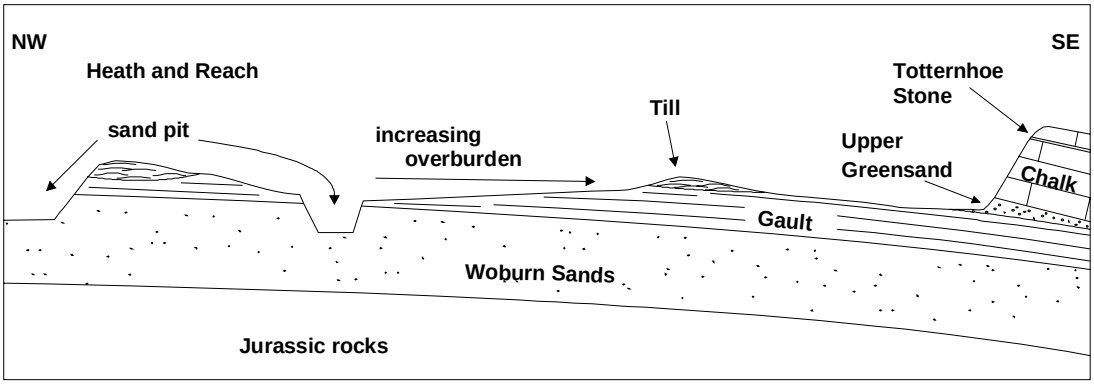

Figure 4 Sketch cross section showing the general relationship of the Woburn Sands and the overlying Gault, Upper Greensand and Chalk (not to scale)

The Woburn Sands Formation may be up to 120 m thick in the Woburn area, but is more generally between 30 and 60 m in thickness. The sands show marked variations in quality and particle-size distribution from place to place. The vertical and areal distribution of these different qualities of sand are generally poorly known and cannot be defined on the map. Parts of the Woburn Sands may be too fine-grained to be of value. Extraction is currently centred on the Leighton Buzzard and Potton areas, the latter being an important source of building and asphalting sand. At Leighton Buzzard the upper part of the formation is worked in numerous quarries for building and asphalting sand and the finer types of concreting sand, as well as sands for concrete roofing tile manufacture. Silica (industrial) sands are also produced from near the top of the Woburn Sands. Near Clophill the sands are worked on a small scale for building sand, fill and for use as a decorative facing for bricks.

The higher quality 'Silver Sands', which are up to 15 m thick and restricted to a relatively small area adjacent to the village of Heath and Reach, supply the sand for specialised uses such as foundry sands, fillers, horticultural applications and water filtration purposes. Coarse-grained, well-rounded quartz sands are particularly valued for water treatment and are produced by selective screening of sands from a number of quarries. Construction and silica sands are normally derived from the same quarry, where their production is interdependent.

The Woburn Sands extend beneath increasingly thick overburden of Gault clay and till to the south-east of Leighton Buzzard (Figure 4). There, the sands are worked beneath substantial thicknesses of overburden. The higher value silica sands permit higher overburden thicknesses to be removed. The sand resource in this area has been defined on the map to include sand under an approximate 20 m thickness of overburden. However, the regional water table level may also place a limit on extraction, either because pumping to lower the water table beneath the quarry floor becomes uneconomic or aquifer protection measures apply. Only the Grovebury Road quarry is currently worked by 'wet' methods, involving extracting the sands by suction dredge from below the water table.

Clay

The major source of brick clay in Bedfordshire is the Lower Oxford Clay (or Peterborough Member of the Oxford Clay Formation), known locally as ‘knotts’. It comprises some 14–23 m of bituminous shales and calcareous mudstones. It contains some 5 % finely divided carbonaceous matter, which burns off during firing, and so significantly reduces the costs of brick manufacture. Other advantages include the thickness and uniform composition of the deposit, and a comparatively high plasticity which allows the clay to be pressed into moulds by a semi-dry process. Overall, these properties are ideal for the production of bricks on a large scale and at relatively low cost. The bricks are referred to as ‘Flettons’, so-called because the semi-dry process used in their manufacture was pioneered at the village of that name near Peterborough in Cambridgeshire in 1881. The weathered mantle of the Lower Oxford Clay, known as 'callow', and the more calcareous Middle and Upper Oxford clays are unsuited to the production of bricks by the Fletton process and are, where present, removed as overburden, some of which may be used for sealing landfill sites.

Brick clay resources in Bedfordshire are very large. The base of the Lower Oxford Clay has been mapped throughout the county, but the top is more difficult to define and has only been surveyed in parts of Marston Vale. Elsewhere the outcrop of the upper boundary has been inferred on the basis of likely geological structure, assuming a uniform thickness of about 20 m of Lower Oxford Clay throughout the county. Although this line is necessarily approximate, the evidence suggests that the Lower Oxford Clay occurs extensively close to the surface in the north of the county, although it is exposed only in river valleys. Between these, the Lower Oxford Clay is covered by significant thicknesses of superficial deposits, mainly till. Consequently, because of this overburden, and the limited thickness of the Lower Oxford Clay over much of its outcrop, the most promising area for future development remains the Marston Vale, and it is within this area that resources should be protected against sterilisation. Current permitted reserves of Lower Oxford Clay in the Marston Vale are large and sufficient for some 70 years. South of the current workings, the Lower Oxford Clay is present beneath increasing thicknesses of overburden.

The Lower Oxford Clay has been extensively worked in the Marston Vale, south of Bedford, where Fletton bricks are produced at the large Stewartby and smaller Kempston works. Extraction is on a large scale and the resulting voids are of regional importance for waste disposal. However, there has been a significant reduction in brickmaking capacity in the Vale during the last two decades and a number of brickworks have closed. Brick clay production in Bedfordshire declined from 2.6 million tonnes in 1980 to 0.64 million tonnes in 1992. Nevertheless, the remaining two brickworks, together with those near Peterborough (Cambridgeshire), supplied about 30 % of Britain's brick output in 1991. Products include stock bricks and a wide range of facing bricks.

The Gault clay has an extensive outcrop in the south of the county. It is a difficult clay to use in brickmaking because of its high shrinkage resulting from a high smectite content. The clay was used on a small scale, until recently, at Arlesey for the production of simulated hand-made bricks. Although the Gault has not been defined on the Mineral Resources Map because of its limited economic importance, resources are large in relation to demand. Small quantities of this clay are produced for brickmaking elsewhere and it may have possible industrial applications.

Chalk

Chalk is a soft, friable, white limestone which consists predominantly of coccoliths, the microscopic plates of planktonic algae. The Chalk, of Upper Cretaceous age, occurs widely in eastern and southern Britain. It has an extensive outcrop in the southern part of the county where it attains a total thickness approaching 200 m. Much of the outcrop of the Upper Chalk on the higher parts of the Chilterns is covered by deposits of Clay-with-flints and other materials which are not shown on the map. The basal 40–50 m, below the Totternhoe Stone, is known as the Chalk Marl and is characterised by a high clay content, particularly towards the base. It was formerly worked at Sundon and Houghton Regis for cement manufacture, for which it was suitable without further addition of clay. Above the Totternhoe Stone, the Chalk is of higher purity. At Kensworth the Middle Chalk and basal beds of the Upper Chalk are extracted on a large scale for cement manufacture. The crushed and slurried chalk, from which the flints and hard chalk have been removed, is pumped by pipeline to Rugby and Southam in Warwickshire, where it is mixed with clay for cement manufacture. Planning permission has recently been granted to deepen the quarry by 36 m. This will not entail any appreciable lateral extension to the quarry, but will effectively double its life from 21 to 41 years at current rates of extraction.

At Totternhoe, the chalk is worked for limemaking and fill and the harder Totternhoe Stone is extracted on a small scale as a source of building stone for restoration work.

Fuller’s earth

Fuller's earth is a rare clay with a restricted distribution in Britain. It consists essentially of the mineral calcium smectite which formed from the decomposition of volcanic ash in a marine environment. Fuller's earth was originally used in the cleansing or 'fulling' of woollen cloth but the clay’s unique combination of properties have led to a wide variety of more modern applications. These include bonding foundry sands, civil engineering applications, refining edible oils, use in papermaking and as pet litter.

There has been a long history of fuller's earth working in Bedfordshire, perhaps dating back to Roman times. Recent large-scale extraction in the Woburn area began in 1950 and has continued to the present. Fuller's earth was discovered at Clophill in 1934 and worked on a trial basis in the 1950s and 1960s, but large scale production did not begin until 1987. Bedfordshire now supplies over 50 % of UK fuller's earth production. The fuller's earth occurs in lenticular beds, up to 3.5 m in thickness, in isolated deposits in the Woburn Sands. The deposits tend to occur where the Woburn Sands are thicker than average, and substantial thicknesses of sand overburden may have to be removed to expose the beds.

Minor occurrences of fuller's earth have been found elsewhere in the county, but none are of economic interest. The Gault clay has an enhanced smectite content compared with many clays and whilst not a true fuller's earth, may have some potential as a source of low-grade absorbent clay for less demanding applications.

Limestone

Jurassic limestones are exposed in the valley of the Great Ouse in the north–west of the county. The Great Oolite has been worked on a small scale in the past, near Pavenham. The limestone may be suitable for building stone.

Hydrocarbons

Because of the absence of suitable source rocks at depth, Bedfordshire has a low potential for the discovery of conventional hydrocarbons (free oil and gas held in the pore spaces of reservoir rocks such as sandstones or limestones). This is reflected in the lack of oil exploration activity in the county. In addition, although there are few deep boreholes in Bedfordshire, the information available suggests that there is no coalbed methane potential.

MINERAL RESOURCES AND ENVIRONMENTAL DESIGNATIONS

The character of the landscape reflects the nature and structure of the underlying rocks, the erosive forces to which they have been subjected and the soil and vegetation that they support. It is constantly changing due, in the longer term, to geomorphological processes, and in the shorter term, to economic and social pressures. Mineral extraction can produce irrevocable, but not necessarily harmful, change to a locality over a relatively short timescale. In order to ensure that such changes are both sustainable and non-injurious to the environment, the most important landscapes and habitats, such as AONBs and SSSIs, are given a greater degree of protection from mineral working. The necessity for mineral extraction in such areas has to be justified by a most rigorous examination of the merits of the proposal. This examination should consider the public interest in the development of the resources and the social desirability of employment, as well as the need to protect the environment. There is no prohibition on working minerals in such areas.

The resolution of conflicts between mineral resource development and other considerations is undertaken through the development plan framework and a balanced appraisal of the various issues associated with particular developments. The Mineral Resources Map of Bedfordshire provides a synthesis of available information which can be revised and updated as additional data becomes available. It is hoped that it will assist local and national Government, the minerals industry and other interests in the consideration and production of policies included in development plans.

The Chilterns Area of Outstanding Natural Beauty is almost entirely confined to the chalk outcrop and includes the Kensworth chalk quarry near Dunstable. There are also a number of Sites of Special Scientific Interest, a significant proportion of which are themselves former and existing mineral workings, including the Kensworth quarry and sand workings in the vicinity of Leighton Buzzard. The remainder comprise marsh, woodland, heath and downland areas over the clay vales, the sands and the chalk hills. There are two National Nature Reserves located on the Chalk outcrop. Scheduled Monuments are widely scattered over the county, although there is a significant concentration on the sand and gravel resource near Bedford.

SELECTED BIBLIOGRAPHY

For further information on national planning policy, users should consult the following:

- Planning Policy Guidance Notes
- Minerals Planning Guidance Notes
- Regional Planning Guidance Notes and Circulars

published by HMSO for the Department of the Environment.
Information from the following documents and maps was used in the compilation of the map:

a) British Geological Survey 1:50 000 or 1:63 360* scale New Series geological map sheets

Sheet	name	surveyed	published	
186	Wellingborough	1940–47	1958	reprinted (1974)
187	Huntingdon	1930–39	1950	reprinted (1975)
203	Bedford	1886–96	1900*	out of print
204	Biggleswade	1930–34	1949	reprinted (1976)
220	Leighton Buzzard	1967–90	1992	
221	Hitchin	1988–92	in preparation	
238	Aylesbury	1898–1912	1946	reprinted (1990)
239	Hertford	1911–21	1924*	reprinted (1978)

b) British Geological Survey Sheet Memoirs

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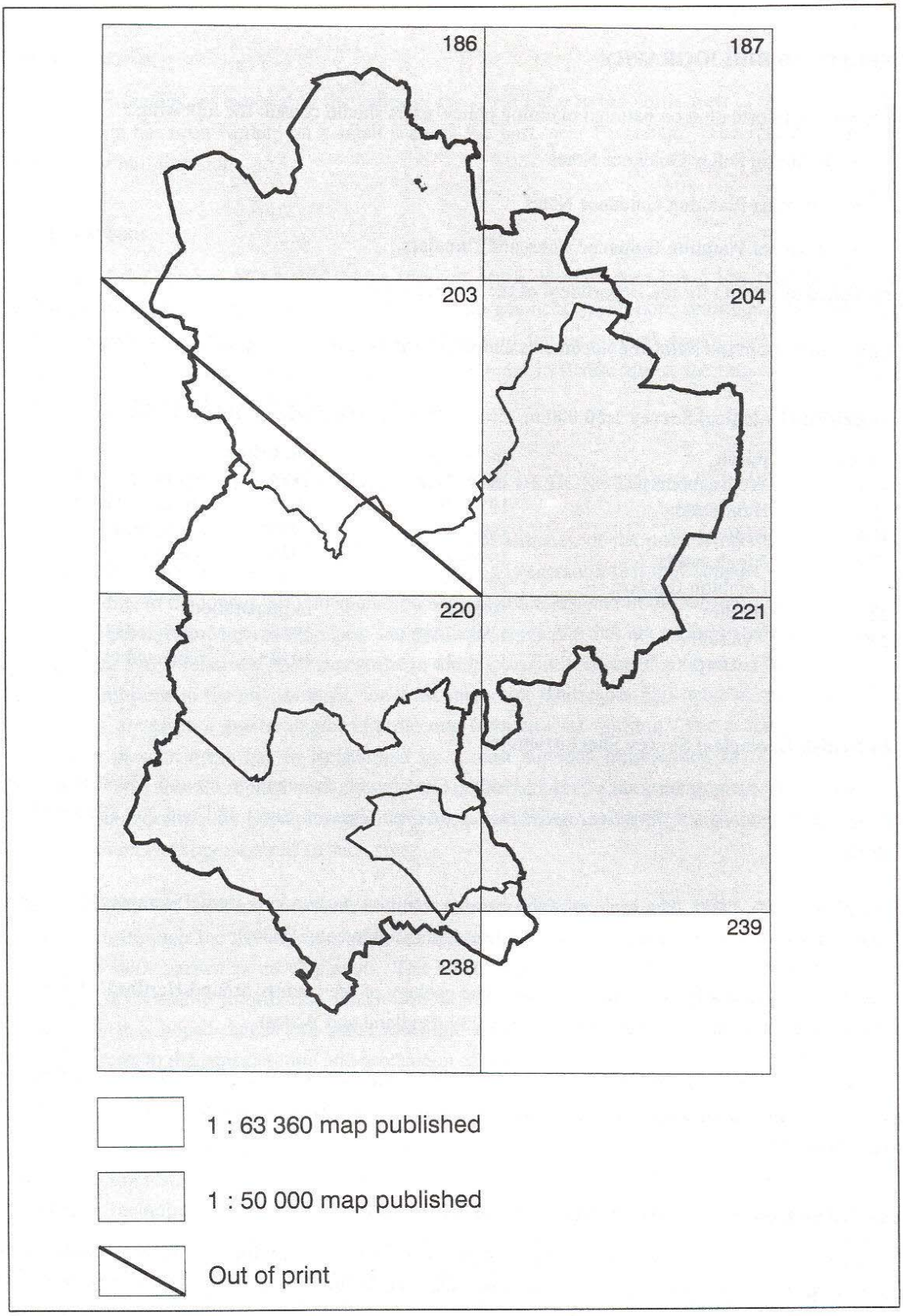

Figure 5 Availability of British Geological Survey 1:50 000 or 1:63 360 scale New Series geological map coverage of Bedfordshire

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APPENDIX 1 MINERAL WORKINGS IN BEDFORDSHIRE (1994)

Pit Name	Location	Operator	Commodity
Kensworth	Dunstable	Rugby Portland Cement	Chalk
Totternhoe	Dunstable	Totternhoe Lime and Stone Co. Ltd	Chalk
Arlesey	Arlesey	Butterley Brick	Common Clay and Shale
Kempston Hardwick	Bedford	London Brick Co. Ltd	Common Clay and Shale
Quest	Stewartby	London Brick Co. Ltd	Common Clay and Shale
Aspley Wood	Woburn Sands	Redland Minerals	Fuller's Earth
Clophill	Clophill	Laporte Absorbents	Fuller's Earth
Potton	Sandy	ARC-Central	Sand and Gravel
Sandy Heath	Sandy	Redland Aggregates	Sand and Gravel
Cainhoe	Clophill	RMC-St Albans Sand and Gravel	Sand and Gravel
Bryant's Lane	Leighton Buzzard	LB Silica Sand	Sand and Gravel
Chamberlains Barn	Leighton Buzzard	Arnold Sands Ltd	Sand and Gravel
Grovebury Road	Leighton Buzzard	CAMAS Aggregates Ltd	Sand and Gravel
Pratts	Leighton Buzzard	Arnold Sands Ltd	Sand and Gravel
Tiddenfoot	Leighton Buzzard	RMC-St Albans Sand and Gravel	Sand and Gravel
Potton	Sandy	Tarmac-Central	Sand and Gravel
Warren Villas	Sandy	RMC-St Albans Sand and Gravel	Sand and Gravel
Willington	Bedford	Redland Aggregates	Sand and Gravel
Clophill	Clophill	London Brick Co. Ltd	Sand and Gravel
Roxton	Roxton	Redland Aggregates	Sand and Gravel
Harlington	Toddington	H Maskel and Son	Sand and Gravel
Stone Lane	Leighton Buzzard	Arnold Sands Ltd	Silica Sand
Churchways	Leighton Buzzard	CAMAS Aggregates Ltd	Silica Sand
Checkley Wood	Leighton Buzzard	CAMAS Aggregates Ltd	Silica Sand
Reach Lane	Leighton Buzzard	ARC-Buckland Industrial Minerals	Silica Sand
Mundays Hill	Leighton Buzzard	CAMAS Aggregates Ltd	Silica Sand
Nine Acres	Leighton Buzzard	Arnold Sands Ltd	Silica Sand
New Trees	Leighton Buzzard	Arnold Sands Ltd	Silica Sand

As at 1/6/94

APPENDIX 2 ADDRESSES FOR FURTHER CONTACT

County Planning Officer Bedfordshire County Council County Hall Cauldwell Street Bedford MK42 9AP Tel: 01234 228091 Fax: 01234 228232	Director of Technical Services South Bedfordshire District Council District Offices High Street North Dunstable Bedfordshire LU6 1LF Tel: 01582 472222 Fax: 01582 474009
Chief Planning Officer Luton Borough Council Town Hall George Street Luton LU1 2BQ Tel: 01582 31291 Fax: 01582 746993	Director of Planning, Development & Amenities Bedford Borough Council Town Hall St. Paul's Square Bedford MK40 1SJ Tel: 01234 221734 Fax: 01234 221606
Director of Technical Services Mid-Bedfordshire District Council 23 London Road Biggleswade Bedfordshire SG18 8ER Tel: 01767 313137 Fax: 01767 316717	National Rivers Authority Thames Region Kings Meadow House Kings Meadow Road Reading RG1 8DQ Tel: 01734 535000 Fax: 01734 500388
The Secretary South–East Regional Aggregate Working Party 14 Buckingham Gate London SW1E 6LB Tel: 0171 931 8777 Fax: 0171 828 9712	National Rivers Authority Anglian Region Kingfisher House Goldhay Way Orton Goldhay Peterborough PE2 5ZR Tel: 01733 371811 Fax: 01733 231840
Countryside Commission John Dower House Crescent Place Cheltenham Gloucestershire GL50 3RA Tel: 01242 521381 Fax: 01242 584270	English Nature Northminster House Northminster Peterborough PE1 1UA Tel: 01733 340345 Fax: 01733 68843
English Heritage Fortress House 23 Savile Row London SW1X 1AB Tel: 0171 973 3000 Fax: 0171 973 3001	

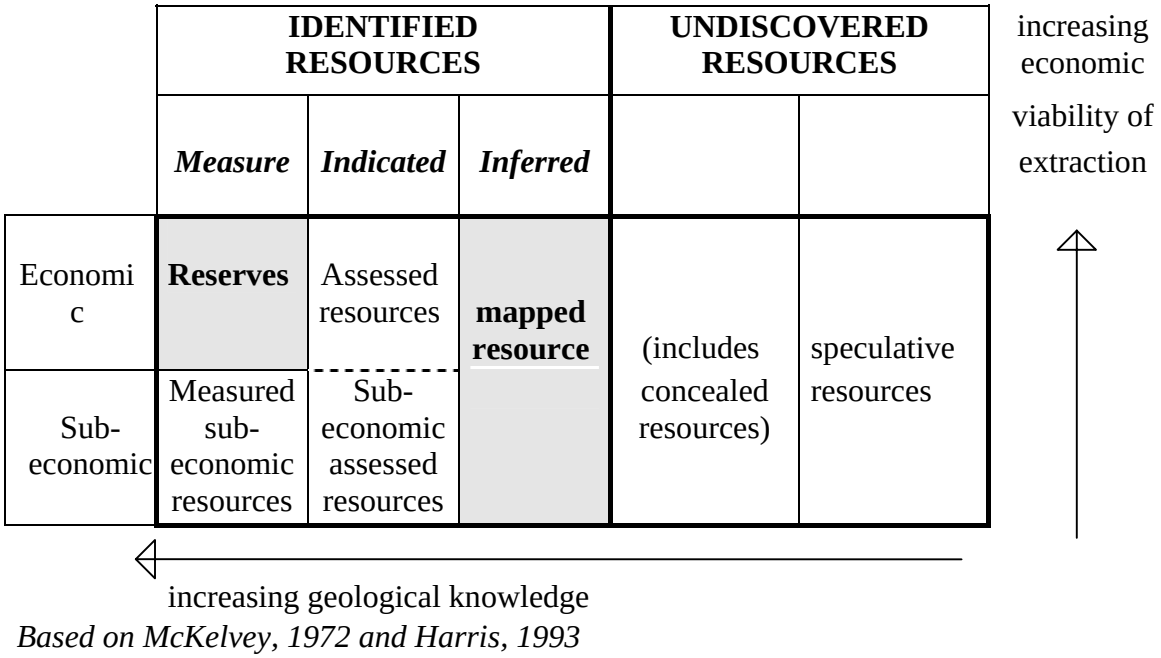
APPENDIX 3 METHODOLOGY

The British Geological Survey (BGS) was commissioned by the Department of the Environment to prepare, on a trial basis, a set of concise statements mainly in map form, to show the broad distribution of mineral resources in selected counties and to relate these to selected, nationally designated planning constraints. The trial study has developed a methodology for the collection and display of data in a consistent and comparable format based on four Mineral Planning Authority (MPA) areas - Bedfordshire, Derbyshire, Staffordshire and the Peak District National Park.

The main element of the trial study was the production of maps, with accompanying concise reports, for each MPA area. All mineral resource and planning constraint information has been captured digitally on a PC-based system using Intergraph Microstation to produce a cartographic database. Data has been captured as a series of files, structured on separate levels so that they can be viewed either independently or in various combinations, as required. Most of the information has been captured digitally from hard copy maps mainly with scales of 1:25 000, 1:50 000 and 1:63 360. The BGS 1:250 000 digital geological dataset has been used in places. Other material was obtained in a variety of digital formats which have had to be converted for use by the Intergraph Microstation System.

As the data are held digitally, map output can be on any scale but 1:100 000 has been found to be a convenient size to summarise the information for individual MPAs. This provides a legible topographic base which enables both the broad implications of the information, and sufficiently accurate detail, to be shown. The particular advantage of holding all the information in digital form is that it is comparatively easy to update and revise as additional information becomes available, and also provides scope for producing customised maps of selected information on request. Any future changes in administrative boundaries (e.g. post-local government reorganisation) can be easily accommodated.

Figure 1 Classification of resources



Based on McKelvey, 1972 and Harris, 1993

Classification of reserves and resources

The diagram, Figure 1, is a representation of a conventional method for classifying mineral reserves and resources, based on a system introduced the US Bureau of Mines and the US Geological Survey and adapted by the British Geological Survey. In this conceptual diagram the vertical dimension of the diagram represents the economic viability of the resource and consists simply of two categories, **economic** and **sub-economic**, depending on whether or not it is commercially viable under prevailing economic circumstances. As the costs of extraction and the prices obtained for the mineral may change with time, the division between the two categories is not fixed. This has been well illustrated in recent years in the coal industry where coal reserves in operational mines have moved into the sub-economic category as a direct consequence of these mines being closed.

The horizontal dimension represents degrees of geological knowledge about the resource, from mere speculation about its existence (right-hand side) to thorough assessment and sampling on a systematic basis (left-hand side).

In the present study the County Mineral Resource Maps have been produced by the collation and interpretation of data held by the British Geological Survey. Since the mineral resource data presented are not comprehensive and the quality is variable, the boundaries shown are approximate. Most of the mineral resource information presented is, therefore, at the **inferred resource** level (Figure 1), that is to say, those resources that can be defined from available geological information and which may have some economic potential. They have neither been evaluated by drilling, or other sampling methods, nor had their technical properties characterised on any systematic basis. However, where mineral assessment studies, including drilling and testing, have been carried out, sufficient information may be available to define the extent and quality of the deposits at the **indicated resource** level (Figure 1).

A mineral resource is not confirmed as economic until it is proved by a relatively expensive evaluation programme. This usually involves a detailed measurement of the material available for extraction together with an evaluation of the quality of the material, its market suitability, the revenue its sale will generate and, ultimately, the viability of the deposit. That part of a resource that is both ‘measured’ and ‘economic’, i.e. it has been fully evaluated and is commercially viable to work, is called a **reserve** or **mineral reserve**.

In the context of land-use planning, however, the term **reserve** should strictly be limited to those minerals for which a valid planning permission for extraction exists, i.e. **permitted reserves**. The extent of mineral planning permissions is shown on the Mineral Resources Map. These cover active mineral workings and also inactive (dormant) mineral permissions. Some mineral planning permissions may have remained unworked, and others may have become uneconomic prior to being worked out. In most cases the areas involved are likely to have been worked to some extent in the past, and may now be restored. In addition, parts of the resource areas may have been fully evaluated by the minerals industry, but either have not been subject to a planning application or have been refused permission for extraction. These areas are **unpermitted reserves**.

A **landbank** is a stock of planning permissions and is commonly quoted for aggregates. It is composed of the sum of all **permitted reserves** at active and inactive sites at a given point of time, and for a given area, with the following provisos (DOE, MPG6):

it includes the estimated quantity of reserves with valid planning permission at dormant or currently non-working sites;

it includes all reserves with valid planning permission irrespective of the size of the reserves and production capacity of particular sites;

it does not include estimated quantities of material allocated in development plans but not having the benefit of planning permission; and

it does not include any estimate for the contribution that could be made by marine dredged, imported or secondary materials.

It is important to recognise, however, that some of the permitted reserves contained within **landbanks** have not been fully evaluated with the degree of precision normally associated with the strict use of the term **reserves**, indeed some may not have been evaluated at all.

Mineral workings and planning permissions

The locations and names of mineral workings in Bedfordshire are shown on the maps. The information is derived from the British Geological Survey's Mines and Quarries Database, updated as appropriate from Bedfordshire County Council's records. Letters (e.g. **Sg** = sand and gravel) are used to show the main mineral commodity produced.

The requirement to define past mineral workings presented an initial difficulty, in that no comprehensive and up-to-date source of information was identified. Following discussions with the MPAs and with DoE's agreement, it was agreed to show the extent of mineral planning permissions, which will reflect most activity post-1946. For Bedfordshire, the County Council kindly made planning permissions available in digital form.

The extent of the planning permissions shown on the Mineral Resources Map cover active mineral workings, former mineral workings and, occasionally, unworked deposits. The present physical and legal status of the planning permissions is not qualified on the map. The areas shown may, therefore, included inactive sites, where the permission has expired due to the terms of the permission, i.e. a time limit, and inactive (dormant) sites where the permission still exists. Sites which have been restored are not separately identified. Information on the precise status and extent of individual planning permissions should be sought from Bedfordshire County Council.

Most planning permissions appear on a mapped mineral resource area and thus the underlying resource colour identifies the mineral type. This is not the case in the following circumstances:

- where a planning permission for one mineral overlies another resource area, e.g. locally, brick clay permissions at Arlesey partly underlie chalk and till
- where no resource has been mapped

Planning permissions may fall outside resource areas for the following reasons:

- some old permissions may be for minerals which are no longer of major economic importance and no resource has, therefore, been mapped
- permissions shown partly off resource areas may extend to ownership, or other easily defined boundaries, or to include ground for ancillary facilities such as processing plants, roads and overburden tipping
- isolated workings occurring outside defined resource areas may reflect very local or specific situations not applicable to the full extent of the underlying rock type: brick clay working in Gault clay at Arlesey is an example

The latest data available for the total areas of planning permissions in Bedfordshire, collected for the Department of Environment Minerals Survey of 1988, is shown in Table 1. This information is updated at intervals.

Table 1 Areas of planning permissions for mineral workings in Bedfordshire, 1988

	Commodity	**Total (hectares)**	**%**
	Chalk	192	7.72
	Clay/Shale	1448	58.20
	Sand & Gravel (Construction)	775	31.15
	Other minerals	73	2.93
Total		**2488**	**100**

From: Department of the Environment, Survey of Land for Mineral Workings in England, 1988.