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Mineral Resource Information in Support of National, Regional and Local Planning

Nottinghamshire (comprising City of Nottingham and Nottinghamshire)

British Geological Survey Commissioned Report CR/02/23/N

D J Harrison, P J Henney, D G Cameron, D E Highley S F Hobbs, N A Spencer, S Holloway, G K Lott, K A Linley and E L Bartlett

Keyworth, Nottingham 2002

BRITISH GEOLOGICAL SURVEY
TECHNICAL REPORT CR/02/23/N

Mineral Resources Series

Mineral Resource Information for Development Plans: Nottinghamshire (comprising City of Nottingham and Nottinghamshire)

D J Harrison, P J Henney, D G Cameron, D E Highley S F Hobbs, N A Spencer, S Holloway, G K Lott, K A Linley and E L Bartlett

This report accompanies the 1:100 000 scale map: Nottinghamshire (comprising City of Nottingham and Nottinghamshire)

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INTRODUCTION

This report is one of a series prepared by the British Geological Survey for various administrative areas in England for the Department for Transport, Local Government and the Regions' research project *Mineral Resource Information in Support of National, Regional and Local Planning.*

The accompanying map relates to the county of Nottinghamshire and delineates the mineral resources of current, or potential, economic interest in the area and the sites where minerals are or have been worked. It also relates these to national planning designations, which may represent constraints on the extraction of minerals.

Three major elements of information are presented;

- the geological distribution and importance of mineral resources
- the extent of mineral planning permissions and the location of current mineral workings, and
- the extent of selected, nationally-designated planning constraints

This wide range of information, much of which is scattered and not always available in a consistent and convenient form, is presented on a digitally-generated summary map on the scale of 1:100 000. This scale is convenient for the overall display of the data and allows for a legible topographic base on which to depict the information. However, all the data are held digitally at larger scales using a Geographical Information System (GIS), which allows easy revision, updating and customisation of the information together with its possible integration with other datasets. The information will form part of a Summary of the Mineral Resources of East Midlands Region.

The purpose of the work is to assist all interested parties involved in the preparation and review of development plans, both in relation to the extraction of minerals and the protection of mineral resources from sterilisation. It provides a knowledge base, in a consistent format, on the nature and extent of mineral resources and the environmental constraints, which may affect their extraction. An important objective is to provide baseline data for the long term. The results may also provide a starting point for discussions on specific planning proposals for mineral extraction or on proposals, which may sterilise resources.

It is anticipated that the maps 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 Agency, the Environment Agency, the Countryside Agency and English Nature), environmental interests and the general public.

Basic mineral resource information is essential to support mineral exploration and development activities, for resource management and land-use planning, and to establish baseline data for environmental impact studies and environmental guidelines. It also enables a more sustainable pattern and standard of development to be achieved by valuing mineral resources as national assets.

The mineral resources covered are coal, sand and gravel, crushed-rock aggregate, clay and shale, including fireclay, building stone, hydrocarbons, gypsum and secondary aggregates.

Resources and reserves

Mineral resources are natural concentrations of minerals, or bodies of rock that are, or may become, of potential economic interest as a basis for the extraction of a commodity. They will exhibit physical and/or chemical properties that make them suitable for specific uses and be present in sufficient quantity to be of intrinsic economic interest. Areas that are of potential economic interest as sources of minerals change with time as new uses are developed, product specifications change, recover technology is improved or more competitive sources become available.

That part of a mineral resource, which has been fully evaluated and is commercially viable, to work is called a mineral reserve. In the context of land-use planning, the term mineral reserve should strictly be further limited to those minerals for which a valid planning permission for extraction exists (i.e. permitted reserves). Without a valid planning consent, no mineral working can take place and consequently the inherent economic value of the mineral resource cannot be released and resulting wealth created. The ultimate fate of mineral reserves is to be either physically worked out or to be made non-viable by changing economic circumstances.

A SUMMARY OF THE INFORMATION PRESENTED ON THE MAP

Crushed rock aggregate

A variety of hard rocks are, when crushed, suitable for use as aggregates. Their technical suitability for different applications depends on their physical characteristics, such as crushing strength and resistance to impact and abrasion. Higher quality aggregates are required for coating with bitumen for road surfacing, or for mixing with cement to produce concrete. For applications, such as constructional fill and drainage media, with less demanding specifications, lower quality materials are acceptable.

Nottinghamshire has very limited resources of rock suitable for use as crushed rock aggregate.

Limestone and dolomite

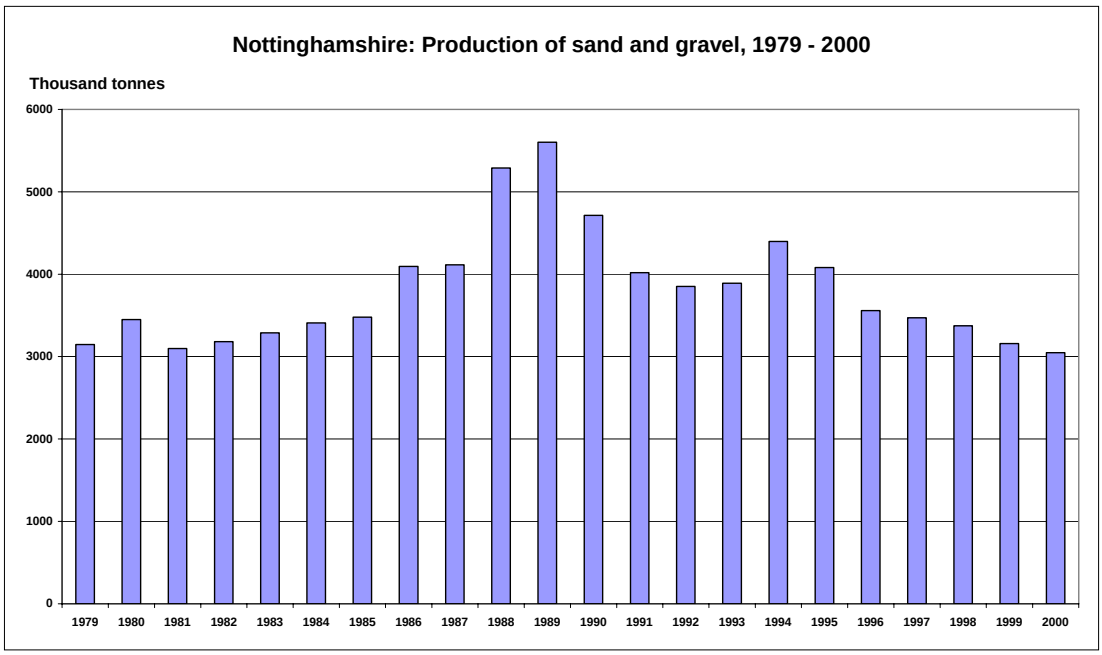
Dolomites and dolomitic limestones of the Cadeby Formation (Magnesian Limestone) of Permian age occur on the western margin of the county. They are very variable lithologically but are mostly porous, weak and friable. They have insufficient strength to produce good quality aggregate but are sometimes suitable for granular sub-base roadstone, drainage media and fill. Their production for aggregate use ceased on any substantial scale in the early 1990s, but resources remain to the north of Mansfield. One quarry near Linby produces aggregate materials.

In north Nottinghamshire the Cadeby Formation is over 50m thick and is predominantly composed of pale buff dolomite with mudstone partings, whereas

towards Nottingham the formation is much thinner and the rock grades into a sandy, yellow-brown dolomitic limestone interbedded with mudstone.

Sand and gravel

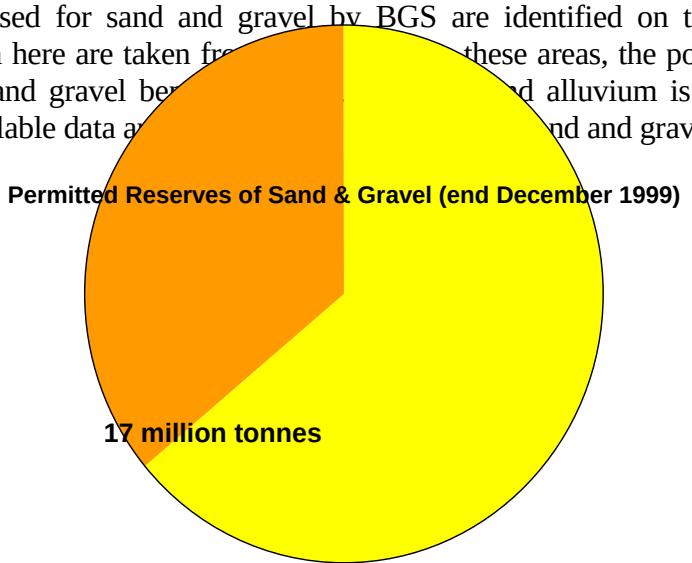
Sand and gravel are defined on the basis of particle size rather than composition. In current usage, the term ‘gravel’ is used for material that is coarser than 5 mm, with a maximum size of 40 mm, and the term ‘sand’ for material that is finer, but coarser than 0.075 mm. Most sand and gravel is composed of particles that are rich in silica (quartz, quartzite and flint), but other rock types, mainly limestone, may occur locally. The principal uses of sand are as fine aggregate in concrete, mortar and asphalt. The main use of gravel is as coarse aggregate in concrete. Substantial quantities of sand and gravel may also be used for constructional fill. Nottinghamshire is the leading sand and gravel producer in the East Midlands with an output of 3.0 million tonnes in 2000. Recent production is in shown on the graph.



The sand and gravel resources Nottinghamshire fall into two main categories:

- Superficial, or drift deposits, subdivided into river and glaciofluvial sand and gravel.
- Bedrock, or solid sand, deposits represented by the Triassic, Sherwood Sandstone Group

The areas assessed for sand and gravel by BGS are identified on the map and the resources shown here are taken fr these areas, the possible concealed extent of sand and gravel be d alluvium is shown. Outside these areas, available data a nd and gravel is defined.



River sand and gravel (river terrace deposits and sub-alluvial)

Source: East Midlands Regional Aggregates Working Party

The main sources of these materials in Nottinghamshire are Pleistocene and Recent age deposits in the valleys of the Trent and Idle, where generally clean, well-bedded sand and gravel rest on weathered bedrock. Resources occur in both raised river terrace sequences flanking the modern floodplains and in flood plain terrace deposits associated with, and underlying, present day alluvium. This sequence of deposits is best developed along the River Trent, with a succession of terrace deposits formed at heights up to 35 m above OD, representing accumulations of sand and gravel in response to falling sea level in post-glacial times.

Thickness varies from between less than 1 m up to maximum values of around 10 m. The gravel content is highly variable and medium-grained sand generally forms at least 50 per cent of the deposits. Sand from the Trent valley deposits is generally coarser, with a more angular particle shape than typical sands from the River Idle deposits.

Glaciofluvial deposits

These are sands and gravels that have been deposited by glacial meltwaters. On more recent BGS maps they are now more commonly described as glaciofluvial and fluvioglacial deposits, a more accurate description of their origin. The sequence of these deposits is complex, with mappable units commonly exhibiting intricate relationships. Bodies of sand and gravel may occur as sheet or delta-like layers above till deposits or as elongate, irregular lenses within the till sequence. Areas of wholly concealed, and thus unknown, bodies of sand and gravel may occur under spreads of till (boulder clay) and other drift deposits, although this is not thought to be a major problem in Nottinghamshire. Glaciofluvial deposits are worked at East Leake in the south of the county and around Retford in north Nottinghamshire. These

East Leake (Lings Farm), RMC Roadstone. Glacially-derived sands processed for concrete aggregate.

deposits are volumetrically minor sources of sand and gravel compared to the deposits found in the Trent and Idle valleys

Bedrock sands

The sandstones and conglomerates of the Triassic Sherwood Sandstone Group, in particular the Nottingham Castle Sandstone Formation or "Bunter Sandstone" are worked at several sites in Nottinghamshire, from Nottingham northwards to Scrooby and Bawtry. This material is mainly friable, loosely consolidated and easily worked. It is largely composed of a fine sand with generally <2% gravel and is generally more suitable for building sand and asphalting than the 'sharper' alluvial sands which are used for concreting. Where more gravel is present or conglomeratic horizons occur, the clasts are mainly rounded and subrounded quartz and quartzite pebbles, with subordinate Carboniferous sandstone fragments. Sands within the Lenton Formation at the base of the Sherwood Sandstone are not shown because of their generally fine-grained nature.

Blown sand

This is generally composed of a fine- to medium-grained sand with a mean fines (<75 micron) content of around 8%. The sand comprises subrounded to well rounded quartz grains. These deposits are believed to be largely of very late Quaternary age and result from aeolian reworking of fluvial and fluvioglacial sands. Deposits are generally thin and occur as both recognisable dunes and as thin linear spreads of sand, mainly in northern and eastern Nottinghamshire. These deposits are of minor importance as a resource.

Secondary aggregates

The term 'secondary aggregates' is used to describe a range of materials which may be used as alternatives to primary aggregates (subject to considerations of quality and contamination), but which arise as wastes from a variety of activities (such as mineral extraction and industrial processing). In general secondary aggregates are only suitable for less demanding applications, and their production and use may not always be environmentally or economically desirable.

Power station ash

Coal-fired power stations burn pulverised coal and the main residue is a fine-grained powder called Pulverised Fuel Ash. Nottinghamshire is a major source of power station ash from the County's four coal-fired power stations. Power station ash is the largest source of secondary aggregates in the County and around 0.5 Mt of ash is sold annually for use as a secondary aggregate. Its largest applications are as structural fill for civil engineering and as a cement additive, although the coarse-grained Furnace Bottom Ash is used mainly in the manufacture of concrete building blocks.

Colliery spoil

Colliery spoil is the waste from mining and processing coal. It consists mainly of mudstone and siltstone and is a source of potential secondary aggregates. In Nottinghamshire, however, all the waste is disposed of within local spoil heaps which

have been largely reclaimed/restored and are not available as a source of secondary aggregates.

Construction and demolition wastes

These materials are excluded from this study as their arisings are highly variable in location, type and duration.

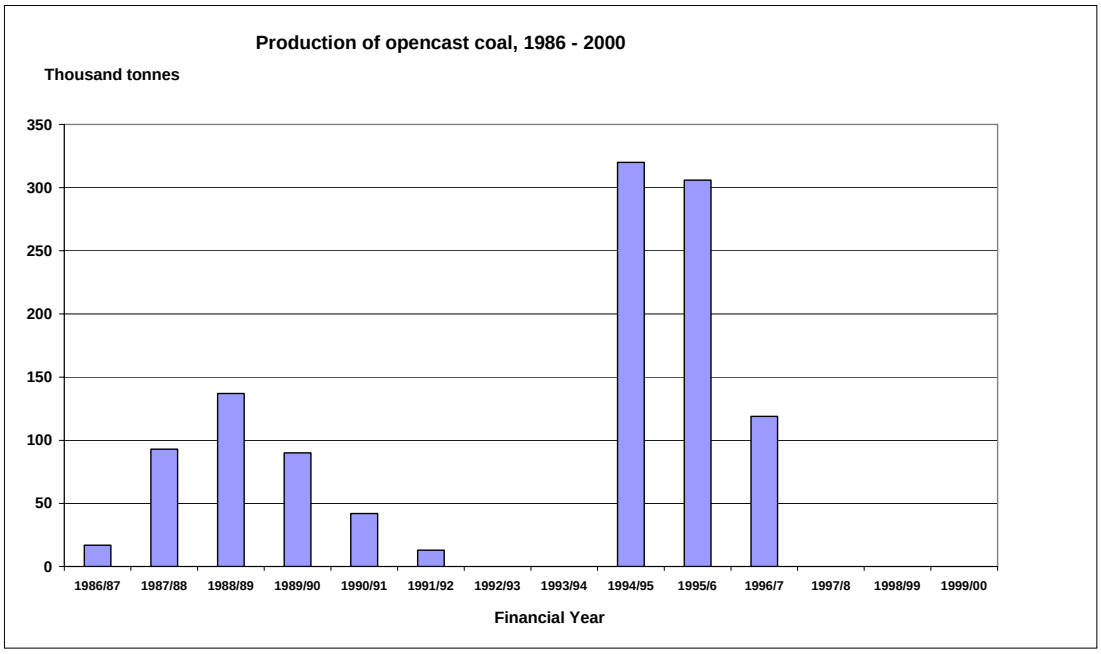
Coal

Clipstone Colliery, UK Coal Mining Ltd

Coal bearing strata are principally confined to the Lower and Middle Coal Measures (Upper Carboniferous) rocks of Nottinghamshire. In general the coal bearing horizons dip from the exposed coalfield in SW Nottinghamshire gently towards the ENE under central and eastern Nottinghamshire. Within the coalfield there is a general increase in calorific value, caking properties and rank from south to north and with increasing depth of burial. Chlorine contents also show a general increase eastwards, particularly in coals associated with marine bands, which can also show high sulphur values. The resources consist largely of bituminous coal with the majority of the coals are bright or 'soft' coals but some contain distinct hard bands rich in durain. The Nottinghamshire coalfield is also characterised by generally thick seams with flat roofs that are flat lying over large areas and are not unduly affected by faults and which lie at only moderate depths. Seams worked include the Top (Barnsley) Hard, the Parkgate, High Hazles and Clowne, Low Main and Deep Soft. Some of the 'bright' coals of the 'Hard' seams are of coking quality but the majority is extracted as steam coal and for household use.

Although UK domestic production of coal has declined in recent years, Nottinghamshire remains one of the most important coal mining counties in the UK with four deep mines in operation (Clipstone, Harworth, Welbeck and Thoresby) and a total deep mine production of some 4 Mt. A significant deep coal reserve has been identified by UK Coal on the Nottinghamshire/Lincolnshire border, the so-called Witham Prospect Area which may be developed should the economic circumstances warrant and if an environmentally acceptable proposal can be made.

Opencast operations have been carried out in SE Nottinghamshire within the exposed coalfield, however, no opencast coal is currently being extracted in Nottinghamshire.



Hydrocarbons

Conventional oil and gas

Nottinghamshire has been intensively explored for oil and gas since before the Second World War. This is illustrated by the large number of exploration wells in the county (see inset map). Exploration has resulted in the discovery of eleven oil fields to date, seven fields are still producing. Production is shown in Table 1. Exploration to date indicates that the best potential for the discovery of oilfields lies in the east of the county. Large parts of the county are currently licensed for oil and gas exploration (see inset map) and it is likely that there will be further small oil discoveries in the future.

Table 1 Nottinghamshire oilfields

Name of oilfield	Operator	Discovery date	Production started	Production ceased	Total production (tonnes)
Apley Head	BP	1960	1966	1979	3,252
Beckingham	BP	1959	1964		293,369
Beckingham West	Pentex	Jul-1985	Oct-87	Still producing	15,000
Bothamsall	BP	1958	1958	?1981	331,943
Caunton	BP	?1943	1943	1965	37,644
Eakring*	BP	Jun-1939	1939	1973	880,756
Egmanton	BP	1955	1955		433,020
Farley's Wood	ROC Oil	Mar-1983	Jul-85	Still producing	33,000
Langar	BP		1958	1959	85
Kelham Hills	BP	?1941	1941	1965	292,086

Kirklington	Pentex	Dec-1985	Mar-91	Still producing	4,000
Rempstone	Pentex	Dec-1985	Jun-91	Still producing	24,000
South Leverton	BP	1960	1960		49,337
Total					2,397,492

* includes Duke's Wood (sometimes described as a separate field)

Coal mine methane

Mine gas is currently drained from Harworth colliery, which has an unusually high make of gas during mining. The drained gas is recovered and used to power an 18 MW(e) CHP power plant which generates electricity for use on site, with any surplus for sale to the regional electricity company

Abandoned mine methane

The artificial voids left in abandoned coal mines form excellent potential reservoirs for coal mine gas and have high levels of permeability. Pumps have recently been installed to extract coal mine gas from the abandoned colliery workings at Steetley Colliery near Worksop. The produced gas contains around 70% methane and is a valuable fuel which is being used to generate electricity on site. Production started in March, 1999. There is potential to expand coal mine methane production to other abandoned mines in Nottinghamshire.

Coalbed methane

The term coalbed methane is used here to refer to the extraction of methane via boreholes from coal seams other than in abandoned or active coal mines. The levels of coalbed methane in the coal seams of Nottinghamshire are relatively low. Average measurements are 1.79 m^3 tonne of coal in south Nottinghamshire and 5.13 m^3/tonne in north Nottinghamshire. Thus the prospects for coalbed methane development from virgin coal seams in Nottinghamshire are not particularly good at the moment. Coalbed methane potential in Nottinghamshire may also be adversely affected by the widespread mining of the thicker coal seams. However, mining does have a positive side for coalbed methane extraction. The process of longwall mining creates a zone of enhanced permability in the strata surrounding the extracted seam, up to about 150 m above the seam and 40-50 m below it. Coalbed methane production might be improved in this zone if it contains significant coal seams that have not been mined.

Building stone

A wide range of rock types is used as a source of building stone. The suitability of particular rock types depends not only on aesthetic qualities, such as colour and textural consistency but also on factors such as strength and durability, and commercial considerations such as the size of block or slab that can be extracted. A continuing supply of building stone from a variety of sources is important for new build and conservation work. Building stone operations range from small sites supplying local markets, to larger concerns that trade across Britain and sometimes overseas.

Limestone

Abbey Quarry, Linby, Trent Stone & Walling; 'Bulwell Stone' in use

The Permian Cadeby Formation (Magnesian Limestone) is quarried on a relatively small scale for building stone (walling stone, ashlar cladding, paving stone, etc) around Mansfield and Linby. Many buildings including Newstead Abbey, Southwell Minster and the Houses of Parliament are built of the stone and there is a small demand for stone for restoration. Many small quarries occur throughout the outcrop, but most are now backfilled. In north Nottinghamshire the pale coloured limestones and sandy dolomites are known as 'Mansfield White', but further south, towards Nottingham, the character of the rock changes and here the brownish dolomitic limestones are coarsely crystalline and known as 'Bulwell' (after the former extensive quarries in the locality) or 'Linby Stone'.

Brick clay and shale, including fireclay

'Brick clay' is the term used to describe clay and shale used predominantly in the manufacture of bricks and, to a lesser extent, roof tiles and clay pipes. These clays may sometimes be used in cement manufacture as a source of constructional fill and for lining and sealing landfill sites. The suitability of a clay for the manufacture of bricks depends principally on its behaviour during shaping, drying and firing. This will dictate properties of the fired brick such as strength and frost resistance and, importantly, its architectural appearance.

Most facing bricks, engineering bricks and related clay-based building products are manufactured in large automated factories. These represent a high capital investment and are increasingly dependent, therefore, on raw materials with predictable and consistent firing characteristics in order to achieve high yields of saleable products. Blending different clays to achieve improved durability and to provide a range of fired colours and textures is an increasingly common feature of the brick industry. Continuity of supply of consistent raw materials is of paramount importance.

The main brick clays in Nottinghamshire are in the Triassic Mercia Mudstone Group (formerly known as the 'Keuper Marl') which crops out extensively in the Midlands. The Group consists of six formations, the Blue Anchor Formation (youngest), Cropwell Bishop Formation (the main gypsum resource), the Edwalton Formation, the Gunthorpe Formation, the Radcliffe Formation and the Sneinton Formation (oldest). Current extraction by the brick industry is confined to the lower part of the Mercia Mudstone Group (beneath the Edwalton Formation), although in the past brick clays have been worked from other parts of the Mercia Mudstone. It has not been possible to separately show the individual formations and the total outcrop of the Mercia Mudstone Group is shown.

Red-brown mudstones and siltstones are worked as brick clays at Dorket Head in northeast Nottingham and at Kirton near Ollerton. The brick clay pits are situated on

steep slopes, capped by resistant sandstones, allowing easy access for extraction with minimal overburden. The presence of small amounts of carbonate minerals in some horizons within the Mercia Mudstones Group produces bricks with a distinctive pale colour. This can form a good substrate for a range of applied facing finishes. Other horizons are also worked to produce bricks with a deeper red colour. Gypsum contamination can cause problems in some parts of the Mercia Mudstone Group.

Fireclays typically occur beneath coal seams and resources are confined to coal-bearing strata. Opencast coal sites provide one of the few viable sources. Resources of fireclay are thus coincident with opencast coal resources. Although originally valued as refractory raw materials, fireclays are now used in the production of buff-coloured facing bricks and pavers. With no opencast coal production in Nottinghamshire, there is no production of fireclay. However, not all fireclays are suitable for buff brick production because of the presence of impurities.

Silica sand

Silica sand is marketed for a wide range of industrial uses rather than for direct application in the construction industry. For most applications silica sands have to conform to very closely defined specifications.

Mansfield (Ratcher Hill) Quarry, Mansfield Sand Co, old face in the Triassic Sherwood Sandstone Group used for silica sand extraction.

The Triassic Sherwood Sandstone Group is an important source of sand, particularly from weakly-cemented parts of the sequence. It is worked mainly as a source of fine aggregate, although in many places the sands are too fine grained for concreting aggregate. The fine grain size and clay content of certain deposits made it ideally suited for use as a naturally-bonded moulding sand but there is little demand for this material today. Fine-grained, weakly cemented Sherwood Sandstone is worked at Ratcher Hill and Oakfield Lane near Mansfield as a source of silica sand for specialist uses including a range of premium products for sports applications, specialist foundry sand and sand for shotblasting, block paving and asphalt.

Gypsum/anhydrite

Gypsum ($CaSO_4.2H_2O$) and anhydrite ($CaSO_4$) are forms of calcium sulphate. They are worked from natural deposits, but may also be derived as by-products of certain industrial processes, notably flue gas desulphurisation (FGD). The amount of natural gypsum extracted in Britain has declined appreciably in recent years due the availability of substantial amounts of high quality synthetic gypsum obtained from FGD plants. Gypsum has many applications but is used principally in the production of plaster and plasterboard. A mixture of gypsum/anhydrite is used as a retarder in cement manufacture.

Natural gypsum

Gypsum and anhydrite occur as beds, or nodular masses, up to a few metres thick. Gypsum is formed by the hydration of anhydrite at or near surface but passes into anhydrite generally at depths of more than 100 m. Nottinghamshire has traditionally been one of the most important sources of gypsum in Britain. The mineral was formerly worked from various horizons in the Triassic Mercia Mudstone Group but is now only extracted from two horizons, the Tutbury and Newark gypsum beds in the Cropwell Bishop Formation near the top of the Group. The Tutbury Gypsum is up to 6 m thick but averages about 2.5 m. It has been extensively worked by underground pillar and stall mining in the southwest of the county near Gotham and East Leake. It is still worked at the Marblaegis mine at East Leake mostly for use in the cement industry, although a small amount is used for plasterboard. Unlike the Tutbury Gypsum, the Newark Gypsum comprises multiple beds and nodular bands of gypsum of variable thickness and purity spread over some 18 m of strata. It can only be worked by opencast methods. The Newark Gypsum can be traced from Cropwell Bishop, where it was formerly worked, to Newark. Here there are two sites, although only one is currently worked. Three different grades of gypsum are produced from the Newark Gypsum, the maim aim being to produce as much high-grade gypsum as possible. This is used to produce special plasters for plaster moulds for pottery manufacture, dentistry, brewing and the filler industry.

Gypsum resources extend beneath overlying Jurassic rocks. In the southwest of the county, where gypsum occurs as a single bed, underground mining is feasible beneath extensive areas of Jurassic rocks. However, where gypsum is worked by opencast methods, extraction is only feasible for a short distance beneath Jurassic rocks.

Synthetic gypsum

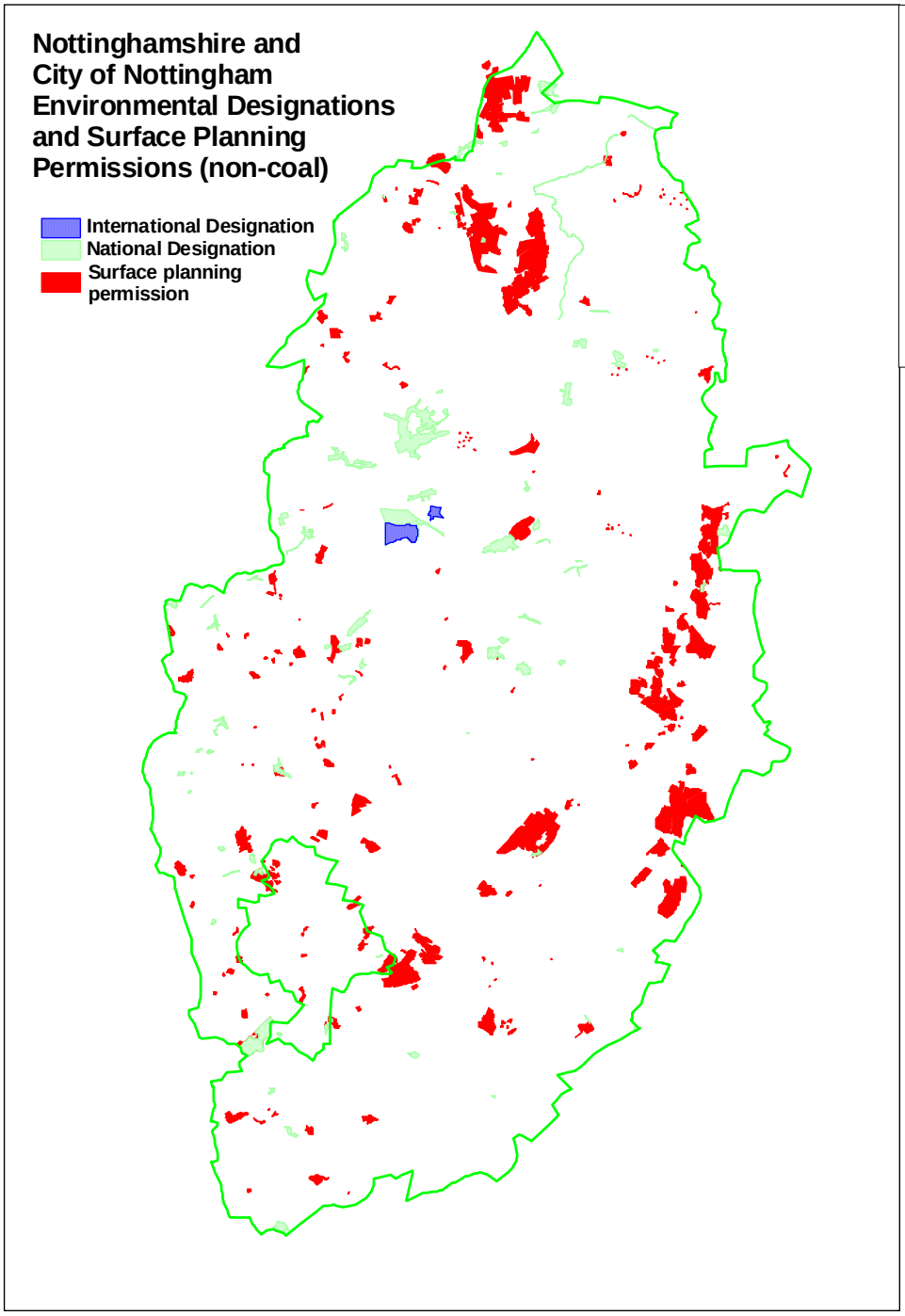
Synthetic gypsum (known as desulphogypsum or FGD gypsum) is produced by the neutralisation of sulphur dioxide contained in flue gases at coal-fired powered stations at two sites in Britain. The largest is the 4000 MW Drax power station in North Yorkshire and the other is the 2000 MW Ratcliffe-on-Soar station in Nottinghamshire. High-purity limestone for use in the process is obtained from Tunstead Quarry at Buxton. The amount of desulphogypsum produced at FGD plants depends on two main factors; the electricity output of the station and the sulphur content of the coal. Total desulphogypsum production in Britain was 825,000 tonnes in 2000, of which 260,000 tonnes was produced in Nottinghamshire. Desulphogypsum is used primarily in the manufacture of plasterboard. Most gypsum used for plasterboard manufacture at the East Leake site is desulphogypsum from the Drax and Ratcliffe-on-Soar power stations. Small amounts of desulphogypsum are also imported in order to meet demand at the East Leake site. There are proposals to fit FGD plants to other coal-fired power stations in Nottinghamshire.

Planning permissions for the extraction of minerals

The extent of all known extant, and non-extant planning permissions for the extraction of minerals is shown on the map, irrespective of their current planning or operational status. The polygons were digitised by BGS from Plotting Sheets and other documents supplied by Nottinghamshire County Council and Nottingham City Council and any queries regarding the sites shown should be directed to these

authorities at the addresses shown below. The polygons cover active, former and restored mineral workings and, occasionally, unworked deposits.

Planning Permissions represent areas where a commercial decision to work mineral has been made, a successful application has been dealt with through the provisions of the Town and Country Planning legislation and the permitted reserve will have been depleted to a greater or lesser extent. The current planning status is not qualified on the map but is available in the underlying database.



Selected national and international designations are shown on the map. The inset map shown above relates these to areas which have been granted planning permission for mineral extraction (except Coal).

Contact addresses:

Nottinghamshire County Council, Environment Department, Trent Bridge House, Fox Road, West Bridgford, Nottingham, NG2 6BJ, Tel: 0115 977 4277, Fax: 0115 977 2418. Web Page www.nottscc.gov.uk.

Nottingham City Council, Development Department, Exchange Buildings North, Smithy Row, Nottingham, NG1 2BS, Tel: 0115 915 5555, Fax: 0115 915 5483. Web Page www.nottinghamcity.gov.uk.

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English Heritage - Positions of Scheduled Monuments at 15 August 2001.

The majority of monuments are plotted using a centred NGR symbol. Consequently the actual area and/or length of a monument protected by the legal constraints of scheduling cannot be represented here. Monuments scheduled since that date are not accounted for. © English Heritage.

Contact address: English Heritage, 23 Savile Row, London, W1S 2ET. Tel: 0207 973 3132,
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Contact address: The Coal Authority, 200 Lichfield Lane, Mansfield, Nottinghamshire, NG18 4RG, Tel: 01623 427162, Fax: 01623 638338.

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