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NATURAL ENVIRONMENT RESEARCH COUNCIL

Office of the Deputy Prime Minister
Creating sustainable communities

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

Humberside (comprising East Riding of Yorkshire, North Lincolnshire, North East Lincolnshire and City of Kingston upon Hull).

Commissioned Report CR/04/227N

BRITISH GEOLOGICAL SURVEY

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

Humberside (comprising East Riding of Yorkshire, North Lincolnshire, North east Lincolnshire and City of Kingston upon Hull)

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

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Front cover

Excavator working bed of sand from recent Blown Sand (Recent) at Cove Farm Quarry near Haxey.

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1 Introduction

This report is one of a series prepared by the British Geological Survey for various administrative areas in England for the Office of the Deputy Prime Minister's research project *Mineral Resource Information in Support of National, Regional and Local Planning.*

The accompanying map relates to the area of East Yorkshire and Humberside 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 be incorporated into a regional GIS which will provide a *Summary of the Mineral Resources of the North East 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 discussion on specific planning proposals for minerals extraction or on proposals, which may sterilise resources.

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 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 sand and gravel, crushed rock aggregate, chalk, fuller's earth, brick clay, building stones, coal and hydrocarbons.

1.1 RESOURCES AND RESERVES

Mineral resources are natural concentrations of minerals or bodies of rock (or fluids such as oil and gas) that are, or may become, of potential interest as a basis for the economic extraction of a mineral product. They exhibit physical and/or chemical properties that make them suitable for

specific uses and are 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 markets decline or expand, product specifications change, recovery 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.

Mineral resources defined on the map delineate areas within which potentially workable mineral may occur. These areas are not of uniform potential and also take no account of planning constraints that may limit their working. The economic potential of individual sites can only be proved by a detailed evaluation programme. Such an investigation is also an essential precursor to submitting a planning application for mineral working. Extensive areas are shown as having no mineral resource potential, but some isolated mineral workings may occur in these areas. The presence of these operations generally reflects local or specific situations.

1.2 ENVIRONMENTAL DESIGNATIONS

The map shows the extent of selected, nationally-designated planning constraints as defined for the purposes of this study. These 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:

2 Area of Outstanding Natural Beauty – Lincolnshire Wolds (part)

3 National nature conservation designations – National Nature Reserves (NNR) and Sites of Special Scientific Interest (SSSI)

4 International nature designations – Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Ramsar sites

5 Scheduled Monuments

Mineral development may also be constrained by many 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 appropriate Mineral Planning Authority.

2 Sand and gravel

Sand and gravel are defined on the basis of particle size rather than composition. In current commercial practice, following the introduction of new European standards from 1st January 2004, the term ‘gravel’ (or more correctly coarse aggregate) is used for general and concrete applications to define particles between 4 and 80 mm, and the term 'sand' for material that is

finer than 4 mm, but coarser than 0.063 mm. For use in asphalt 2 mm is now the break point between coarse and fine aggregate. Most commercial sand and gravel is composed of particles that are rich in silica (quartz, quartzite and flint), but other rock types may occur locally.

Between 1995 and 2003 annual production of land-won sand and gravel in Humberside (the East Riding of Yorkshire & North & North East Lincolnshire) has varied between 625,000 and 756,000 tonnes. Recent production is shown on the graph and permitted reserves are estimated at about 4.9 million tonnes (Yorkshire and the Humber Regional Aggregates Working Party). Landings of marine-dredged sand and gravel, principally at Hull, are in the range 166,000 to 205,000 tonnes a year.

Sand and gravel resources occur in a variety of geological environments. In Humberside these resources occur within superficial deposits, subdivided into river sand and gravel, glaciofluvial, glaciolacustrine, head gravel, blown sand and beach deposits.

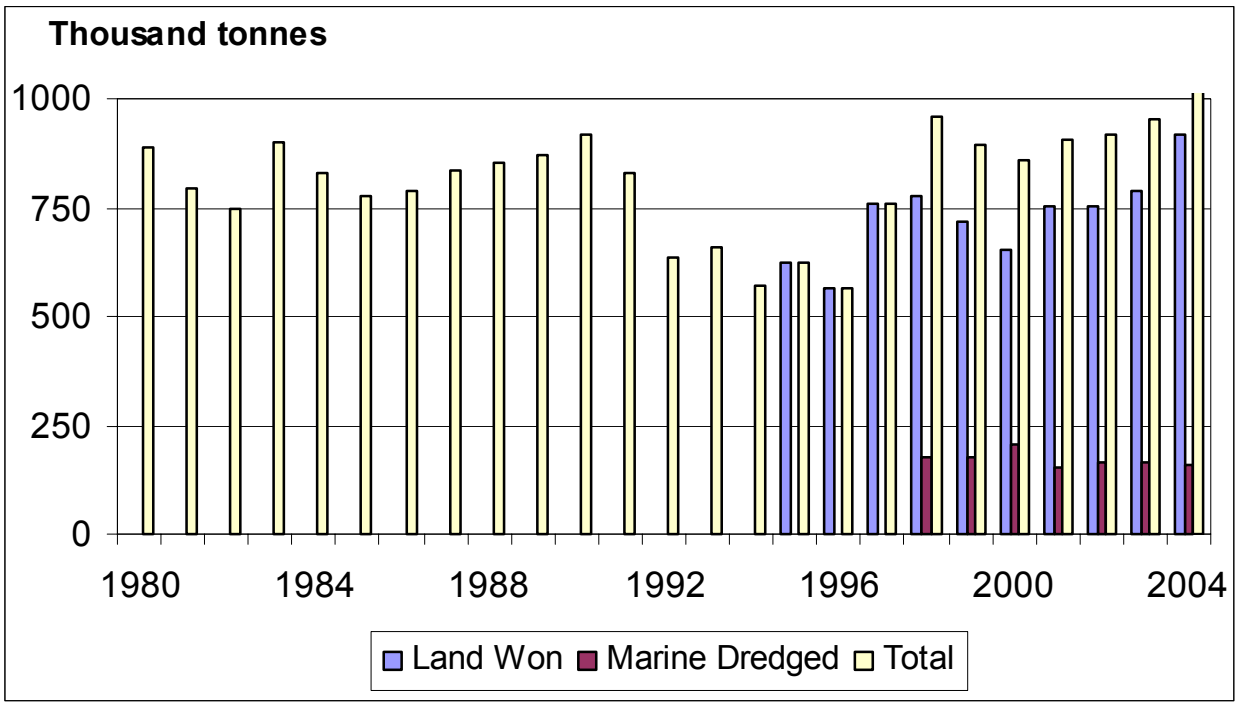

Figure 1 Sales of sand and gravel in East Yorkshire and Humberside 1979-2004. (Source Annual Mineral Raised Inquiry, Office for National Statistics)

2.1 SUPERFICIAL DEPOSITS

The areas assessed for sand and gravel by BGS resource surveys are identified on the map. Resources shown here are taken from these maps and, in these areas, the possible extent of sand and gravel concealed beneath other material is shown. These indicated resources were defined be overburden to mineral ratios. Outside these areas, available data are more limited. Generally, only exposed sand and gravel is defined, although sub-alluvial inferred resources of sand and gravel occurring beneath modern river flood plains may be extensive in some places. Narrow (< 200 m) spreads of sub-alluvial deposits are mainly excluded from the map. Their limited width is likely to preclude economic working of any sand and gravel present.

2.1.1 Glaciofluvial deposits

These are deposits mapped as the products of deposition by glacial meltwaters and are nowadays commonly labelled on BGS maps as glaciofluvial deposits (as opposed to 'glacial' 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 and other superficial deposits. The most extensive deposits in the area occur between the western limit of the chalk crop and the east coast and from Bridlington in the north to Waltham in the south.

The distribution of these deposits is strongly controlled by topography as they occupy the floor and lower slopes of valleys draining the Wolds, northeastwards towards the former ice front. In the Humber area these deposits include the Kelsey Hill Beds, a sequence of brown, coarse-grained sands and gravels characterised by an abundant and diverse fossil fauna, of both marine and freshwater molluscs. The sand and gravel are inter-bedded with silts and clays, occasionally laminated, together with sheets of till and have a total thickness of about 15 m. The Kelsey Hill Beds are worked at Mill Hill, near Keyingham where a 4.5 m thick bed is extracted to produce washed sand and gravel for use in general construction. Here pebble lithologies are very variable, including quartzite, flint, chalk, Carboniferous and Jurassic limestones and sandstones, dolerite and other igneous and metamorphic rocks.

The deposits around Pocklington form the Pocklington Gravel Formation, and these gravels contain an abundance of chalk and flint pebbles, with some Jurassic limestones and in one place a large amount of ironstone pebbles (ca. 10 per cent). Average clast composition is 75 per cent well-rounded chalk, 15 per cent sub-angular flint, plus 10 per cent accessory lithologies. The deposit is about 1 m thick on average. South of the Humber, significant deposits of glaciofluvial sand and gravel occur between Habrough and Laceby, where up to 15 m of well sorted sand with interbedded chalk and flint gravels overlie tills.. The high chalk, shell and coal contents of some of these deposits may restrict their use as concreting aggregate.

Figure 2. Crosslands Lane Quarry, North Cave. Vale of York Gravels.

Between Winteringham and Winterton, glaciofluvial deposits form elongate ridges and mounds on top of till, and up to 7 m of well sorted gravel, composed mainly of chalk with minor flint and sandstone pebbles, is reported from an old pit.

2.1.2 Glaciolacustrine deposits

During the Devensian glaciation, ice occupying the present coastal zone blocked the eastward-draining valleys including the Humber Gap between Brough and Winterton and thus impounded 'Lake Humber' in the southern part of the Vale of York. Deposits associated with this glacial lake, termed glaciolacustrine deposits, occur to the west and south west of the Chalk crop. An extensive area of glaciolacustrine deposits occurs to the west of Pocklington, running down to the Humber at North Ferriby and across into the Ancholme Valley. These deposits, originally termed the '25-foot drift' as they lie at an average height of about 25 feet OD, fill and conceal the former valleys and landscape. The deposits of the 25-foot drift are predominantly laminated clay and silt with sand deposits occurring below, flanking and overlying them. The lower part of the 25-foot drift consist in most places of sand, which is fine-grained and is commonly silty and clayey, with locally abundant coal particles. Thicknesses of up to 10 m are recorded but generally the lower sand is not more than 5 m thick. Sand deposits also occur marginal to the silt and clay and thin out against peripheral slopes and pass laterally into the adjacent laminated clays. The marginal sand is fine- to, rarely, medium-grained, commonly silty and clayey with abundant coal particles and a few small pebbles and is generally not more than 3 m thick. The upper sand is not more than 2.5 m thick and is discontinuous, forming low ridges and mounds. It is fine-grained, increasingly silty and clayey towards the edges and contains thin beds and lenses of clay. In some areas the sand contains coal particles. Glaciolacustrine deposits are shown on the map, but they are generally too fine grained to be used for concrete aggregate for which there is the largest demand.

2.1.3 River Sand and Gravel (Terrace and Sub-alluvial deposits)

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 Rivers Trent, Ouse, Ancholme, Hull, Eau and Derwent with a succession of deposits formed, representing accumulations of sand and gravel in response to falling sea level in post - glacial times. River Terrace deposits are not widespread in the region, being localised to the upper reaches of the River Eau, south of Scunthorpe and on the banks of the Gypsey Race, west of Bridlington. The terrace deposits east of the Trent have been described as comprising mainly sand with a few scattered pebbles although some gravel is present at depth. The terrace rests on the silts and clays of the 25-foot drift of the Vale of York and continues under peat and alluvium. It is probable that further "terrace" deposits are buried under recent alluvium, blown sand and warp in the lower reaches of these watercourses. Pebble lithologies include coal fragments, quartzites, sandstones and limestones.

Sub-alluvial gravels are encountered beneath the alluvium of the major valleys throughout the region. The extent of alluvium in this region has been modified in places by land management practices, including the construction of drainage channels and the deposition of Warp (laminated silt and clay) during periods of artificially controlled flooding. The deposits are compositionally similar to the river terrace deposits, indeed some are their downstream equivalents where they pass below OD. They were mainly laid down during periods of deep downcutting during the ultimate Devensian cold phase when sea-levels fell to at least -100 m OD. The subsequent rise in sea level enabled silting up of these river channels producing thick overlying alluvial deposits (silty clays and peat). The deposits rest on an irregular channelled surface and are thus of very variable thickness; locally 20 m of deposits are present (e.g. Trent and Ouse valleys), but they

are commonly thinner, generally less than 4 m, and occur beneath thick overburden. These deposits are always saturated and require wet working.

2.1.4 Head Gravels

These comprise gravelly deposits that have been involved in mass movement downslope to their present position. Such movement commonly takes place under cold climatic conditions when vegetation is sparse and frozen ground leads to increased run off. The gravel is commonly mixed with other lithologies present on the slope and so the resulting lithologies are very variable; most contain significant clay contents and are only suitable for working as hoggin. The clast composition reflects that of the parent material. The deposits often accumulate as lobes or fans, which are then dissected by subsequent down cutting.

2.1.5 Blown sand

These deposits are generally composed of fine- to medium-grained sand with a mean fines (<0.063 mm) content of around 8 per cent. The sand comprises sub-rounded to well-rounded quartz grains. These deposits are believed to be largely of late Quaternary age resulting from aeolian reworking of fluvial and glaciofluvial sands, particularly those associated with the Vale of York drift deposits, including the Beighton Sands Formation. The most favourable sites for blown sand accumulation are along the lower slopes of major west-facing escarpments. Thickness is very variable, with up to 6 m being recorded around Messingham and Fonaby but generally thickness is less than 2 m, with extensive areas of sand less than 0.3 m thick. The Blown Sand deposits are mainly worked as a source of silica sand around Messingham (see above) and at Haxey for mortar sand production.

Figure 3. Recent blown sand deposits at Cove Farm Quarry

Blown Sand also occurs along the coast south of Grimsby and Cleethorpes and at Spurn Head. These deposits are largely Recent in age, resulting from aeolian reworking of adjacent dry beaches. Deposits are generally thin, mostly less than 2 m, but locally up to 5 m thick and occur mainly as dunes but also as thin linear spreads of sand.

2.1.6 Beach sand and gravel

Included in this category are deposits marked on BGS maps as 'Shoreface and Beach Deposits', 'Storm Beach Deposits' and a variety of other beach deposits. Typically these occur as accumulations of sand and gravel restricted to the modern coast and a relatively narrow belt of country adjacent to it. In this region, however, with its long history of coastal changes and migrations, such deposits can also be identified up to 6 km inland from the present coastline. Along the coast from Holderness to Spurn Head the Shoreface Deposits consist mostly of sand and gravelly sand, with gravel dominating towards the top of the beach. At North Somercotes, Storm Beach and associated deposits are up to 9 m thick, composed of sand and shingle, with lag gravels set in a clay matrix, whilst at Spurn Head, up to 20 m of such deposits are recorded. These deposits reflect the long and complex history evolution of the coast in this region.

3 Crushed rock aggregates

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.

The area has limited resources of rock suitable for use as crushed rock aggregate (see text for Chalk and Limestone). Reported production of crushed rock was 52,000 tonnes in 2003 and consists of limestone. Crushed rock is imported by rail to Hull from the UK and also by sea from Norway.

4 Chalk

Chalk is a relatively soft, fine-grained, white limestone consisting mostly of the debris from planktonic algae. The Chalk is of Upper Cretaceous age and occurs extensively in eastern and southern England where it forms an important resource of ‘limestone raw materials’. In the East Riding of Yorkshire, North Lincolnshire and North East Lincolnshire the Chalk is the dominant bedrock and is harder and contains less moisture than the Chalk in southern England; hence it is of value as aggregate, but only for less demanding applications, such as fill and sub-base roadstone.

Chalk is currently extracted from thirteen quarries in the region, for industrial purposes, including lime production, steel manufacture, cement manufacture, chalk whiting (industrial fillers) and for constructional purposes and agricultural use. Many of the quarries are relatively small but large-scale extraction occurs at South Ferriby (cement), Melton Ross (for industrial applications, including lime) and Lund, Melton Whiting Works, Queensgate and Rushton Parva (chalk whiting for paper and plastics). The main producing sites are Melton Ross with an output of over 1.5 million tonnes/year and South Ferriby (Middlegate Lane) with an output of some 900,000 tonnes/year. The Yorkshire Wolds are marked by numerous small disused quarries

where the Chalk has been dug for local use as agricultural lime and hardcore. The Chalk is overlain by extensive drift deposits which thicken towards the east.

The Chalk is divided into five distinct formations; the Ferriby Chalk, with a red-coloured chalk at the base – the Hunstanton Formation, or Red Chalk; the Welton Chalk, the Burnham Chalk and the Flamborough Chalk. The most obvious differences between the formations are in the occurrence of flint. The Ferriby and Flamborough chalks are flint-free, while the Welton and Burnham chalks are characterised by flint nodules and bands. Most of the Chalk contains numerous partings of calcareous mudstone (marl), which are most common in the Ferriby and Flamborough chalks. Thin and widely spaced mudstone bands are a feature of the Welton and Burnham chalks. The numerous mudstone partings in the Ferriby and Flamborough chalk lead to higher alumina, iron and silica contents and this part of the sequence is thought to be mainly of medium purity (>93% $CaCO_3$). The middle part of the sequence (The Welton and Burnham chalks) is generally of higher purity (>97% $CaCO_3$), although the silica content is variable depending on the flint content. The Burnham and Flamborough chalks are concealed beneath superficial deposits, which thicken towards the coast.

5 Limestone

Apart from the Chalk the only other limestone resource in the region is the Lincolnshire Limestone Formation of Middle Jurassic age. This unit has long been a source of building stone, but in adjacent parts of Lincolnshire it is also a valuable resource of crushed rock aggregate. Crushed Lincolnshire Limestone provides aggregates that are of relatively low strength and with poor resistance to frost damage (they have moderate or high values of water absorption). They are, therefore, generally only suitable for use as constructional fill or as a sub-base roadstone material.

The formation has been worked in the past for cement manufacture near Kirton in Lindsey and small amounts of limestone aggregates are produced in the area.

6 Silica sand

Silica (industrial) sands contain a high proportion of silica (SiO_2) in the form of quartz and are used for purposes other than as construction aggregates. They are essential raw materials for the glass and foundry castings industries, but also have a wide range of other industrial applications, including in ceramics and chemicals manufacture, for water filtration media and in sports and horticultural applications. They are produced from both loosely consolidated sand deposits and by crushing weakly cemented sandstones. Unlike construction sands, which are used for their physical properties alone, silica sands are valued for a combination of chemical and physical properties. These include a high silica content in the form of quartz and, more importantly, an absence of impurities, particularly clay, iron oxides and refractory minerals such as chromite. Silica sands typically have a narrow grain size distribution, generally in the range 0.5 mm to 0.1 mm, although coarser grades are required for some applications. For most applications, silica sands have to conform to very closely defined specifications and consistency in quality is of critical importance. Particular uses often require different combinations of properties. Consequently, different qualities of silica sand are usually not interchangeable in use. Silica sands command a higher price than construction sands. This allows them to serve a wider geographical market.

Silica sand processing is of varying degrees of complexity and depends on the end use of the sand. It typically requires a high capital investment in plant. Processing is aimed at modifying both the physical and chemical properties of the sand to meet user specifications. The ease with which contaminants (such as iron-bearing impurities and clay) can be removed, together with the level of losses incurred in removing oversize and undersize fractions from a sand, has a major bearing on its potential use. Within the UK, deposits of silica sand occur in only limited areas and quantities, and the special characteristics of silica sand extraction, in particular the cost of processing, means that the industry has a restricted distribution.

Silica sand production in North Lincolnshire is based on the Blown Sand deposits of Quaternary age around Messingham, North Lincolnshire. Sand working has taken place in the area since the 1930s, mostly working the full thickness of sand of around 3.5 m, although current working removes only the upper 2 m of sand above the water table. The sand is very uniform in grain size and consists of sub-rounded particles of quartz with a limonite coating. Silica sand is quarried in the Messingham area for coloured glass manufacture in Yorkshire, which is the major market, and foundry sand which is now a minor market. Other markets include horticultural sand and bagged sand for block paving. The Blown Sand deposits are also worked nearby at Haxey for mortar sand production. Here the Blown Sand is worked in conjunction with underlying river terrace deposits.

7 Evaporite minerals

Evaporite minerals, including rock salt (halite, NaCl) and, more rarely, potash (potassium chloride, KCl) are precipitated during the evaporation of seawater. The arid conditions that existed in north-east England during Permian times resulted in several cycles of evaporite deposition. The most extensive led to the deposition of the Boulby Halite Formation which includes, at the top the Boulby Potash Member. The sub-surface extent of the Boulby Halite and the Boulby Potash and their conjectured western limits are shown on the map.

The Boulby Potash and Boulby Halite are worked at the Boulby Mine in the North York Moors National Park to the north. They are not extracted in East Yorkshire and are unlikely to be so in the foreseeable future. However, at Atwick near Hornsea, cavities in salt-bearing strata have been specifically created for the storage of natural gas. The development of the site started in the mid-1970s and gas is stored in nine teardrop-shaped cavities (in the Fordon Evaporites at a stratigraphically lower level than the Boulby Halite) at depths of around 1800 m. The cavities were leached with seawater and the resulting brine dispersed offshore through a sub-sea pipeline. The total usable space is 3,495 GWh and the cavities can deliver gas at the rate of 193 GWh/day. The high flow capacity of salt cavities makes them ideal for meeting peak demands and daily balancing needs. There may be continuing interest in the salt resources of the area for the development of gas storage facilities.

8 Brick clay

‘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, clay pipes and decorative pottery. 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 the properties of the fired brick such as strength and frost resistance and, importantly, its architectural appearance.

Both bedrock and superficial deposits have been used in the past to provide the raw material for brick and tile manufacture, but activities are now scattered and small in scale. The major brick clay resource in the region is the Triassic Mercia Mudstone Group which until recently was exploited on a large scale for brickmaking near Epworth in North Lincolnshire. Production of facing bricks used to total about 35 million bricks a year. The brickworks at Belton closed in 2001 but smaller amounts of brick clay are still produced (about 25,000 tonnes per year) and are trucked to the Birtley Works in Gateshead. The outcrop of the Mercia Mudstone is shown only in the Isle of Axholme. North of this it is covered by thick superficial deposits. Several small clay pits on both banks of the Humber, notably at Broomfleet, work alluvium and tidal flat deposits for the manufacture of a range of roofing tiles. The clays are extensive and are only shown in the vicinity of the worked deposits. The alluvial clays are approximately 8 m thick and are crushed and blended before use.

At South Ferriby large volumes of the Upper Jurassic Ancholme Clay are exploited for cement making. The overlying Chalk is extracted with the clay and mixed in the ratio of 3 parts chalk to 1 part clay to form the raw feed for the kilns which produce 750,000 tonnes of cement clinker annually, requiring around 300,000 tonnes of clay raw material.

Some laminated glaical lake clays have been worked for fill materials in the area between Newton upon Derwent and Wilberfoss at the northwest margin of the map. Resources of glacial lake clays are not shown on the map.

9 Building stone

Historically the area has produced a variety of building stones for local use, however, many important buildings are constructed of stones imported into the area from adjacent counties. The oldest rocks that have been used for building are the distinctive grey-green to orange-brown, shelly, ooidal ironstones of the Frodingham Ironstone Member (Lower Jurassic) used around the Scunthorpe area.

In the Middle Jurassic the buff coloured, oolitic and shelly limestones of the Lincolnshire Limestone Formation (Inferior Oolite Group) have been extensively used locally, with quarries north of the Humber at Brough, Newbald, Brantingham and South Cave (Cave Oolite) and south of the Humber between Winteringham, Hibaldstow and Kirton-in-Lindsey. Limestones are poorly developed in the overlying Great Oolite Group but, south of the Humber, have been worked for building from the Blisworth Limestone (formerly the Snitterby Limestone).

The mudstone-dominated Upper Jurassic succession has few lithologies suitable for building purposes, however at Elsham a thin sandstone development in the Kimmeridge Clay has been locally worked.

The Upper Cretaceous Chalk has been used widely across its outcrop for local building, north of the Humber at Hessle, Towthorpe, Boynton and Flamborough and to the south in the Horkstow and Thornton Curtis areas.

From Bridlington and Hornsea to Easington, on the Holderness peninsular, and along the Humber coast to the south, cobblestones taken from Quaternary glacial moraines were widely used in the past as a vernacular building material.

10 Ironstone

Iron has been extracted on a large scale from the Frodingham Ironstone of Lower Jurassic age in the Scunthorpe-West Halton area. The ironstone is extremely low grade (averaging 25 per cent

Fe). Production from the Frodingham Ironstone, which formed the basis for the steel industry of Scunthorpe, only ceased in 1988. Extraction was by both surface and underground mining.

The Frodingham Ironstone consists principally of an iron-rich, fossiliferous, oolitic lime-mudstone, typically around 9 m in thickness. Around nearly 300 million tonnes of ironstone have been extracted for ironmaking.

Technological and economic changes within the UK iron and steel industry have led to the demise of the sedimentary ironstones as a source of iron ore and it is unlikely that the ironstones of the region will have any future commercial value. For this reason they are not shown as a resource on the map. However, there remain planning permissions granted for the extraction of ironstone and overlying minerals. They give an indication of the maximum extent of working.

11 Peat

Peat is an unconsolidated deposit of plant remains in a water-saturated environment such as a bog or fen. Bogs occur in areas where they are dependent on rainfall for supply of water and the vegetation is characterised by acid tolerant plant communities of which the genus *Sphagnum* moss is dominant. The two main types of bog are (i) raised bogs, characteristic of flat underlying topography and found on low plains and broad valley floors and (ii) blanket bogs, which occur mainly in upland areas where conditions are suitably cool and wet. Many lowland raised bogs have been designated as sites of international and national conservation importance. Amateur and professional gardeners use 98 per cent of the peat extracted in the UK as a growing medium. There are extensive peat deposits in the region, up to 4 m thick, but most are buried under Recent alluvium, warp and tidal flat deposits. Three sites are listed as extracting peat within the region, at Swinefleet Moors, Rawcliffe Moors and Goole Moors.

12 Hydrocarbons

12.1 CONVENTIONAL OIL AND GAS

East Yorkshire occupies a tract of land stretching from the Vale of Pickering-Flamborough Head Fault Zone, southwards across the Market Weighton Axis onto the Eastern England Shelf and to the south of the Humber. Chalk is at crop over most of the area with Triassic strata cropping out over western areas of the region. The Vale of Pickering-Flamborough Head Fault Zone bounds the southern margin of the Cleveland Basin: an important Jurassic and early Cretaceous sedimentary basin. This basin overlies an earlier Carboniferous basin in which Namurian and Westphalian source rocks were deposited and are now concealed at depth beneath the Permian-Mesozoic cover. They are thought to be mature, having produced gas during Mesozoic times. During the Mesozoic the Market Weighton Axis and Eastern England Shelf formed a stable, slowly subsiding area of relatively shallow basement that had a significant affect on the thickness and nature of strata across the region. The south of the East Yorkshire area is peripheral to the northern limits of the main East Midlands oil producing region, within which significant quantities of oil and gas have been generated and exploited.

Mesozoic rocks are relatively thin across the majority of the region, apart from in the north where they are affected by the Vale of Pickering Fault Zone. Mesozoic source rocks known from the North Sea are therefore likely to be thin onshore and not have suffered sufficient burial to generate significant and commercial quantities of hydrocarbons.

East Yorkshire has been extensively explored for oil and gas since the Second World War by a dense network of seismic reflection surveys coupled with over 20 exploration wells. To date, there has been limited success. In the mid 1980s several operators, most notably BP Development Ltd., Candecca Resources (now Roc Oil) and Pentex Oil UK, drilled a number of oil exploration wells in the southern half of the county lying marginal to the East Midlands Oil Province. The majority of the wells were plugged and abandoned as dry, although Crosby Warren was developed and is currently a producing oilfield. Some exploration wells are notable as being suspended oil wells or wells plugged with significant oil and gas shows (see Table 1). They include Brigg and Broughton to the southeast of the Crosby Warren oilfield. The most northerly provings of oil in the region have been in the Alkborough and Broomfleet wells, to the south and north of the Humber respectively.

In 1987 Taylor Woodrow discovered the Caythorpe gasfield in the north of the region. Located in PL234 (currently operated by Warwick), just inland from Bridlington, it is in an area affected by the Vale of Pickering-Flamborough Head Fault Zone and represents the most southerly gasfield sited along the fault zone that includes the cluster of Kirby Misperton, Malton and Marishes gasfields in neighbouring North Yorkshire. Hydrocarbons generated within and migrating out of the centre of the basin may have been trapped in structures that were formed along the fault zone during its development from late Jurassic to early Cretaceous times. Two horizons within Permian strata are productive with the source of the gas thought to be the Coal Measures in the subcrop.

Exploration to date thus indicates that the best potential for the discovery of further hydrocarbons lies in the north and south of the area. Reflecting this, Egdon Resources applied for and were awarded PEDL71, a licence block covering much of the remaining land affected by the Vale of Pickering-Flamborough Head Fault Zone in the north of the region. By December 2003, this large licence area had been rationalised to three smaller licence blocks (PEDL's 071-1, 071-2 and 071-3). Much acreage in the east and south of the region is licensed and operated by Roc Oil. This perhaps reflects the potential for the type of discovery of oil and gas that they have already successfully developed across Lincolnshire and within the East Midland Oil Province. The Roc Oil licenses bordering the coastline might also be to appraise the westerly migration of hydrocarbons out of the southern North Sea Basin. It is likely that such small, focused operators will discover further small gasfields and perhaps oilfields in the future.

Name of field/ exploration well	**Field/ Well Type (oil, gas or expl)**	**Operator at time of discovery/drilling**	**Current operator of licence block (October 2003)**	**Discovery date/well drilled**	**Production started**	**Production ceased**	**Total production to 2003 / well status**
Caythorpe	gas	Taylor Woodrow	Warwick	July 1987	October 1992	Still producing, late 2003	Not available
Crosby Warren	oil	Pentex Oil UK Ltd	Edinburgh Oil & Gas Ltd	1986	1988	Still producing, late 2003	636,770
Alkborough	expl	BP Development Ltd	Eastern Pegasus	1987			Plugged & abandoned, with poor oil

							shows
Amcotts		Elf Oil & Gas (UK) Ltd	Altaquest	1991			Plugged & abandoned
Axholme 1 & 2	expl	Candecca Resources Ltd	Edinburgh Oil & Gas	1973			Plugged & abandoned
Barmston	expl	Burmah Oil (North Sea) Ltd	Egdon Resources	1971			Plugged & abandoned, dry
Belton	expl	Anglo-American Oil Company Ltd	Eastern Pegasus/ Roc Oil	1945			Plugged & abandoned
Brigg	expl	BP Development Ltd	unlicensed acreage	1981			Suspended, potential oil discovery
Broomfleet	expl	BP Development Ltd	Eastern Pegasus	1986			Plugged & abandoned, with oil & gas shows
Broughton	expl	BP Development Ltd	Eastern Pegasus	1984			Plugged, oil well
Burton upon Stather	expl	BP Development Ltd	Edinburgh Oil & Gas	1965			Plugged, oil shows
Butterwick	expl	BP Exploration Company Ltd	Eastern Pegasus/ Roc Oil	1958			Plugged & abandoned
Crowle	expl	BP Development Ltd	Eastern Pegasus/ Roc Oil	1966			Plugged & abandoned
Fordon	expl	BP Development Ltd	Roc Oil	1974			Plugged & abandoned, gas shows

Great Hatfield	expl	BP Development Ltd	Roc Oil	1971			Plugged & abandoned
Hayton	expl	D'Arcy Exploration Ltd	unlicensed acreage	1946			Plugged & abandoned
Hibaldstow	expl	BP Development Ltd	Altaquest	1984			Plugged & abandoned
Hornsea	expl	Texaco Production Services Ltd	Roc Oil	1970			Plugged & abandoned
Langtoft	expl	Home Oil of Canada Ltd	Egdon Resources	1971			Plugged & abandoned
North Dalton		Candecca Resources Ltd	unlicensed acreage	1972			Plugged & abandoned, dry
Pocklington	expl	Candecca Resources Ltd	unlicensed acreage	1973			Plugged & abandoned
Risby	expl	Candecca Resources Ltd	unlicensed acreage	1972			Plugged & abandoned, dry
Roe Carr	expl	NCB/BP Development Ltd	Edinburgh Oil & Gas	1978			Plugged & abandoned
*Rudston 1	expl	Taylor Woodrow Energy Ltd	Egdon Resources	1984			Plugged & abandoned, dry
Seaton Ross	expl	Candecca Resources Ltd	Stratagas	1973			Plugged & abandoned
South Cliffe	expl	Candecca Resources Ltd	unlicensed acreage	1973			Plugged & abandoned
Spaldington	expl	RTZ Oil & Gas (UK) Ltd	Stratagas	1986			Plugged & abandoned

Winestead	expl	Candecca Resources Ltd	Roc Oil	1972			Plugged & abandoned

* Perenco drilled Rudston 2 in 1996, which was plugged and abandoned, with gas shows.

Table 1. East Yorkshire gasfields and exploration wells.

12.2 COAL BED METHANE (CBM) POTENTIAL

Westphalian (Upper Carboniferous) Lower to Middle Coal Measures of the Eastern England coalfield lie concealed at depths of between 500 and 3000 m beneath an easterly dipping Permian to Mesozoic cover in East Yorkshire. These Coal Measures are continuous with, but east of the heavily mined Yorkshire/Nottinghamshire coalfields that contain highly volatile bituminous coals. The Permian subcrop pattern of the Coal Measures suggests that they are folded about a gentle NW-SE trending axis, preserving strata of up to Westphalian C-D age beneath the south and west of the area. Progressively older Coal Measures subcrop to the northeast, however, coal has not been mined in the area. Where measured elsewhere, coals of the Eastern England Coalfield, though not well documented, have a gas seam content of 1.5-5.9 m^3 CH_4 per tonne and are thought to have an average total thickness of around 10 m, with individual seams unlikely to be thicker than 4 m.

In the USA, most CBM production is from coals containing >7 or more m^3 CH_4 per tonne. The lower gas content of the coal suggests that CBM development from virgin coal seams in East Yorkshire is probably not economic at present.

With no operating pits in East Yorkshire, there are no prospects for abandoned or coal mine methane.

A potential future area for development in coalfield areas is Underground Coal Gasification (UCG). This is very much an unproven, new technology, which is under review and test in a number of countries. Areas of suitable deep Coal Measures in North Yorkshire probably exist, notably around York and eastwards, and potential might therefore exist for the development of this resource in the area at some point in the future.

12.3 LICENSING

The Department of Trade and Industry grants licences for exclusive rights to explore and exploit oil and gas onshore within Great Britain. The rights granted by landward licences do not include rights of access, and the licensees must obtain any consent under current legislation, including planning permission. Licensees wishing to enter or drill through coal seams for coalbed methane and abandoned mine methane must also seek the permission of the Coal Authority.

13 Aims and limitations

The purpose of the maps in this series is to show the broad distribution of those mineral resources which may be of current or potential economic interest and to relate these to selected nationally-recognised planning designations. The maps are intended to assist in the consideration and preparation of development plan policies in respect of mineral extraction and the protection of important mineral resources against sterilisation. They bring together a wide range of information, much of which is scattered and not always available in a convenient form.

The maps have been produced by the collation and interpretation of mineral resource data principally held by the British Geological Survey. Information on the extent of mineral planning

permissions has been obtained from the relevant Mineral Planning Authority (MPA). Some of these permissions may have lapsed or expired. The status of individual areas can be ascertained from the appropriate MPA. Location information on national planning designations has been obtained from the appropriate statutory body (Countryside Agency, English Nature and English Heritage). For further information the relevant body should be contacted.

The mineral resource data presented are based on the best available information, but are not comprehensive and their quality is variable. The inferred boundaries shown are, therefore, approximate. Mineral resources defined on the map delineate areas within which potentially workable minerals may occur. These areas are not of uniform potential and also take no account of planning constraints that may limit their working. The economic potential of specific sites can only be proved by a detailed evaluation programme. Such an investigation is an essential precursor to submitting a planning application for mineral working. Extensive areas are shown as having no mineral resource potential, but some isolated mineral workings may occur in these areas. The presence of these operations generally reflect very local or specific situations.

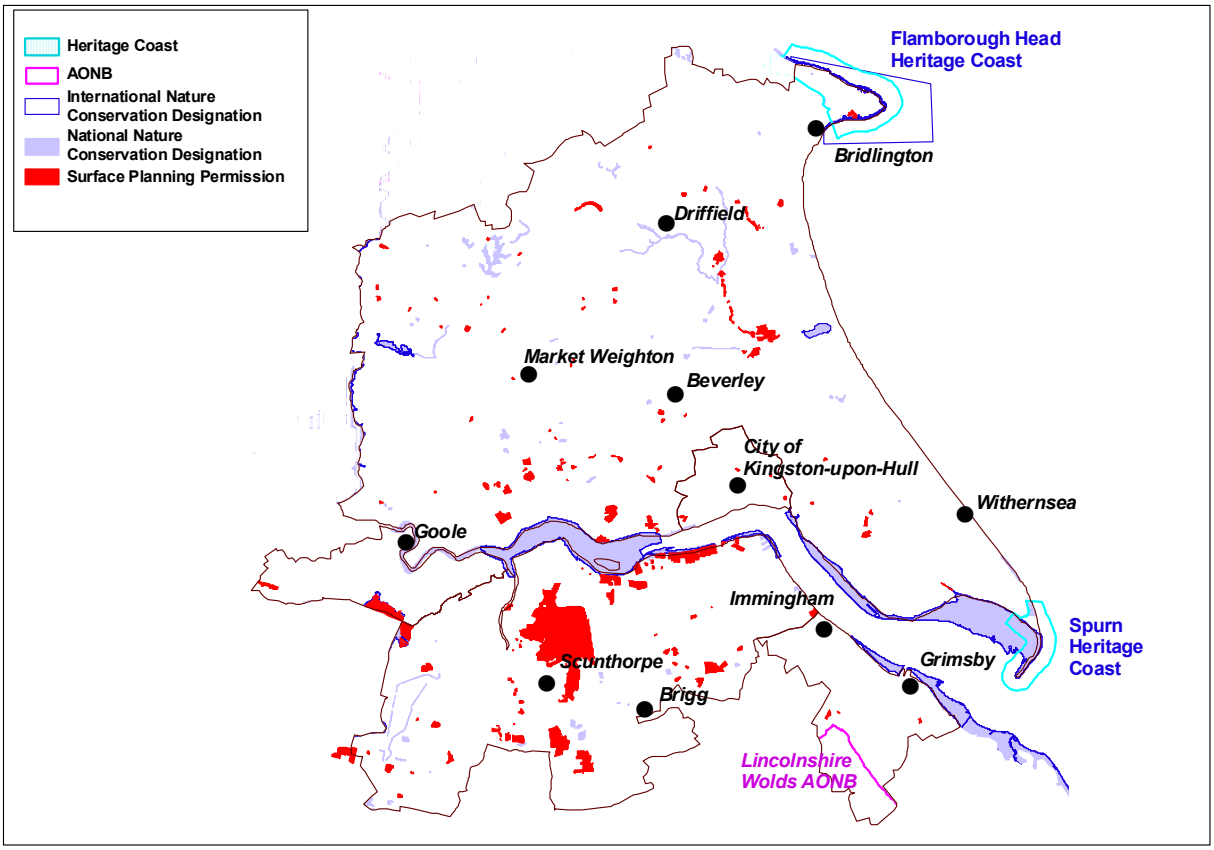

Figure 4. Surface planning permissions and landscape and nature conservation designations in East Yorkshire and North Lincolnshire

The maps are intended for general consideration of mineral issues and not as a source of detailed information on specific sites. The maps should not be used to determine individual planning applications or in taking other decisions on the acquisition or use of a particular piece of land, although they may give useful background information which sets a specific proposal within context.

14 Planning permission for the extraction of minerals

The extent of all known extant and former planning permissions for mineral working is shown on the map, irrespective of their current planning or operational status. The polygons digitised by BGS from Plotting Sheets and other documents supplied by East Riding of Yorkshire and North Lincolnshire councils. In addition, planning permission information was digitally acquired from Ministry of Housing and Local Government maps for the area and incorporated in the data. This data has been checked and amended by the local Authorities shown below. 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.

Contact addresses:

East Riding of Yorkshire Council, Planning, Environmental & Technical Services, County Hall, Beverley HU17 9BA, Tel: 01482 887700 , Fax: 01482 884118, web address: www.east-riding-of-yorkshire.gov.uk

North East Lincolnshire Council, Planning & Transportation Department, Devonshire House, Great Grimsby DN31 1ES, Tel: 01472 300300, Fax: 01472 3245216, web address: www.nelincs.gov.uk

North Lincolnshire Council, Development and Environment Department, Church Square House, PO Box 138, Scunthorpe DN15 6XP, Tel: 01724 297579, Fax: 01724 297886, web address: www.northlincs.gov.uk

Kingston upon Hull City Council, Technical Services Department, Kingston House, Bond Street, Hull HU1 3ER, Tel: 01482 612222, Fax: 01482 612382, web address: www.hullcc.gov.uk

Appendix

TOPOGRAPHIC BASE

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CONSTRAINT INFORMATION

Constraint information published on the accompanying map has been provided from the various agencies listed below; any enquires on the information should be addressed to the relevant agency.

ENGLISH NATURE

Digital SSSI, NNR, SAC, SPA and RAMSAR boundaries © English Nature 2004

Contact address: English Nature, Northminster House, Northminster, Peterborough PE1 1UA. Tel: 01733 455000. Fax: 01733 455103. Web page: www.english-nature.org.uk

ENGLISH HERITAGE

Positions of scheduled monuments at 25th September 2003.

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. © Copyright English Heritage.

Contact address: English Heritage, 23 Savile Row, London W1S 2ET. Tel: 0207 973 3132. Web page: www.english-heritage.org.uk

COUNTRYSIDE AGENCY

Digital AONB boundaries © Countryside Commission 1986 (now Countryside Agency).

Contact address: Countryside Agency, John Dower House, Crescent Place, Cheltenham, Gloucestershire GL50 3RA. Tel: 01242 521381. Fax: 01242 584270. Web page: www.countryside.gov.uk