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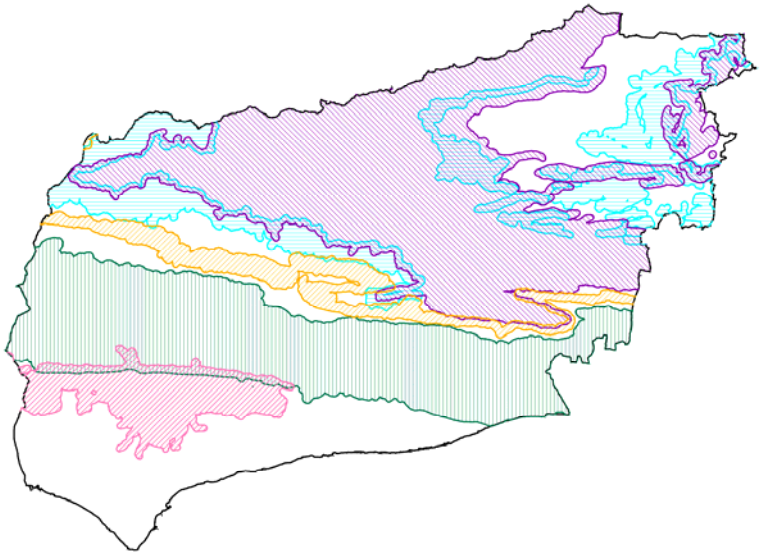
NATURAL ENVIRONMENT RESEARCH COUNCIL

Minerals Safeguarding Areas and Mineral Consultation Areas for West Sussex

Economic Minerals Programme

Open Report OR/07/026



BRITISH GEOLOGICAL SURVEY

ECONOMIC MINERALS PROGRAMME

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Minerals Safeguarding Areas and Mineral Consultation Areas for West Sussex

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SD Hannis, EJ Steadman, KA Linley and R Newsham

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P Hopson

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British Geological Survey offices

BGS Central Enquiries Desk

Tel 0115 936 3143 Fax 0115 936 3276

email enquires@bgs.ac.uk

Kingsley Dunham Centre, Keyworth, Nottingham NG12 5GG

Tel 0115 936 3241 Fax 0115 936 3488

email sales@bgs.ac.uk

Murchison House, West Mains Road, Edinburgh EH9 3LA

Tel 0131 667 1000 Fax 0131 668 2683

email scotsales@bgs.ac.uk

London Information Office at the Natural History Museum (Earth Galleries), Exhibition Road, South Kensington, London SW7 2DE

Tel 020 7589 4090 Fax 020 7584 8270

Tel 020 7942 5344/45 email bgslondon@bgs.ac.uk

Columbus House, Greenmeadow Springs, Tongwynlais, Cardiff CF15 7NE

Tel 029 2052 1962 Fax 029 2052 1963

Forde House, Park Five Business Centre, Harrier Way, Sowton EX2 7HU

Tel 01392 445271 Fax 01392 445371

Maclean Building, Crowmarsh Gifford, Wallingford OX10 8BB

Tel 01491 838800 Fax 01491 692345

Geological Survey of Northern Ireland, Colby House, Stranmillis Court, Belfast BT9 5BF

Tel 028 9038 8462 Fax 028 9038 8461

www.bgs.ac.uk/gsni/

Parent Body

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon SN2 1EU

Tel 01793 411500 Fax 01793 411501

www.nerc.ac.uk

Website www.bgs.ac.uk

Shop online at www.geologyshop.com

List of abbreviations

BGS	British Geological Survey
BRITPITS	BGS's database of mines and quarries
CLG	Communities and Local Government
DPD	Development Plan Documents
DTLR	Department of Transport, Local Government and the Regions (predecessor of CLG and Department for Transport)
ESRI	Company which supplies the GIS software used in this project
GIS	Geographical Information System
IMAU	Industrial Minerals Assessment Unit (Mineral Assessment Reports)
LDD	Local Development Documents
LDF	Local Development Framework
MCA	Mineral Consultation Area
MPA	Mineral Planning Authority
MPG	Minerals Planning Guidance
MPS	Mineral Planning Statement (replaces some MPGs)
MSA	Mineral Safeguarding Area
MWDF	Minerals and Waste Development Framework
NERC	Natural Environmental Research Council
ODPM	Office of the Deputy Prime Minister (predecessor of CLG)
PPS	Planning Policy Statement
WSCC	West Sussex County Council

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Summary

This report describes work carried out by the British Geological Survey on behalf of West Sussex County Council to delineate its Minerals Safeguarding Areas and Mineral Consultation Areas. This is in accordance with the methodology outlined in *"A guide to mineral safeguarding in England"* (McEvoy et al., 2007), which is in line with the Communities and Local Government document, Mineral Policy Statement 1: Planning and Minerals. This was released in November 2006 and it introduces the obligation on all Mineral Planning Authorities to define Minerals Safeguarding Areas.

The work involved the provision of maps showing the extent of individual mineral resources in West Sussex and creating Minerals Safeguarding Areas and Mineral Consultation Areas for each mineral resource. These were provided in digital form for use within a geographical information system.

1 Introduction

West Sussex County Council (WSCC) commissioned the British Geological Survey (BGS) to delineate its Mineral Safeguarding Areas (MSAs) and Mineral Consultation Areas (MCAs). This will assist the review of their Minerals Local Plan documents to fit into the new Minerals and Waste Development Framework (MWDF).

1.1 PLANNING CONTEXT

WSCC is in the process of producing their MWDF. This will replace their current Minerals Local Plan. This review is in accordance with reforms to the planning system under the Planning and Compulsory Purchase Act 2004 and specifically, guidance within Planning Policy Statement 12: Local Development Frameworks (ODPM, 2004). Box 1 outlines the general policy, planning and guidance for the safeguarding of minerals.

Box 1 Policy and planning for safeguarding minerals

National policy

Minerals Policy Statement 1: Planning for Minerals (CLG, 2006) outlines the national policy for safeguarding minerals resources. It requires Mineral Planning Authorities in England to define **Mineral Safeguarding Areas** in their local development framework documents. In two-tier planning areas, **Mineral Consultation Areas** may also be defined and these should be based on the Mineral Safeguarding Areas. Where Mineral Consultation Areas are shown, consultation between the district and county is compulsory when a non-mineral planning application falls within those areas. Mineral Safeguarding Areas and Mineral Consultation Areas should be shown on the adopted proposal maps at the county and district level, indicating where there are significant mineral resources subject to safeguarding policies.

Key documents

Minerals Policy Statement 1: Planning for Minerals including Annex 2: Brick clay and Annex 3: Natural building and roofing stone (CLG, 2006)
Minerals Policy Statement 1: Practice guide (CLG, 2006)
Minerals Planning Guidance 15: Provision of silica sand in England (ODPM, 1996)

Local planning

Planning Policy Statement 12: Local Development Frameworks (OPDM, 2004) outlines the policies that should be taken in to account by local planning authorities in the preparation of local development frameworks and minerals and waste development documents. The local development framework (LDF) comprises local development documents (LDDs), which include development plan documents (DPDs). These, together with the regional spatial strategy (RSS), provide the essential framework for planning in a local planning authority's area. The key development plan documents are:

- Core strategy, which may include a key diagram spatially outlining the broad strategy;
- Site specific allocations of land;
- Adopted proposals map, which illustrates the spatial extent of policies on an Ordnance Survey map or similar; and
- Area action plans (where needed);

Each Mineral Planning Authority is required to prepare minerals and waste development plan documents as part of their MWDF. The minerals core strategy development plan document "*should take account of the need to contribute appropriately to national, regional and local requirements at acceptable social, environmental and economic costs*", (Para 2.11).

In relation to minerals and waste development plan documents, the adopted proposals map must include *"Areas of significant mineral resources subject to safeguarding policies and Mineral Consultation Areas"*. In two-tier Planning Authority areas, district planning authorities must also include "*safeguarded areas and Mineral Consultation Areas"* on their adopted proposals maps. (Annex A2 and Para 2.22).

Key document Planning Policy Statement 12: Local Development Frameworks (ODPM, 2004) (continued)

(continued)

Guidance

Mineral Safeguarding Areas should be based upon the best available geological and minerals resource information (Minerals Policy Statement 1: Practice guide, Para 32). 'A guide to mineral safeguarding in England' has been published with the support of the Communities and Local Government. This provides guidance on how current mineral safeguarding policy can be complied with. The guide outlines a step by step methodology for defining Mineral Safeguarding Areas.

Key document

A guide to mineral safeguarding in England (McEvoy et al., 2007)

1.2 KEY DEFINITIONS

Boxes 2 and 3 provide explanations of some of the important terms used throughout the report. A list of abbreviations used commonly in this report can be found on page i.

Box 2 Mineral Safeguarding Areas (MSAs)

MSAs are areas of known mineral resources that are of sufficient economic or conservation value to warrant protection for generations to come. The level of information used to prove the existence of a mineral resource can vary from geological mapping to more in depth geological investigations.

Defining MSAs carries no presumption for extraction and there is no presumption that any areas within MSAs will ultimately be environmentally acceptable for mineral extraction. Areas of Search, Preferred Areas, and Specific Sites are designated for that purpose; to indicate to mineral operators and others the places where mineral extraction is most likely to take place.

The purpose of MSAs is to ensure that mineral resources are adequately and effectively considered in land-use planning decisions, so that like other finite resources, they are not needlessly sterilised, compromising the ability of future generations to meet their needs. Mineral Safeguarding Areas will make relevant parties aware of the presence of mineral resources and will make specific local planning policies applicable to those areas.

All Mineral Planning Authorities, both unitary and two-tier authorities, must include policies and proposals to safeguard mineral resources within MSAs and show them in their Development Plan Documents (DPDs), to alert prospective applicants for planning permission to the existence of valuable mineral resources and to show where specific local mineral safeguarding policies apply. In two-tier authorities, the Mineral Planning Authorities must pass information on the location of MSAs to the district councils and districts are obliged to ensure that they are shown in appropriate district Local Development Documents (LDDs).

Source: 'A guide to mineral safeguarding areas in England' (McEvoy et al., 2007)

Box 3 Mineral Consultation Areas (MCAs)

MCAs are a mechanism that aims to ensure that in two-tier authority areas consultation takes place between county and district planning authorities when mineral interests could be compromised by non-mineral development. The definition of MCAs is not obligatory, but consultation within an MCA is. They are a useful additional method of supporting mineral safeguarding by facilitating discussion between respective authorities.

MCAs also give an additional measure of safeguarding to sites relating to minerals infrastructure, such as wharves and railheads that cannot be protected by MSAs which should only be defined to protect the resource itself.

MCAs can be updated more easily than MSAs as their statutory basis is outside that of the development framework. They can therefore be responsive to the latest information on geology and mineral economics. A regularly updated and used set of MCAs can complement the protection of mineral interest facilitated by MSAs.

Source: 'A guide to mineral safeguarding areas in England' (McEvoy et al., 2007)

2 Project objectives

The objectives of the project are:

- To provide a five-year band 2 seat licence to WSCC for the BGS mineral resource digital data.
- To supply paper maps and Adobe PDF documents to WSCC showing the mineral resources, Mineral Safeguarding Areas and Mineral Consultation Areas within the MPA. These maps will be based on BGS geological line work, amended where appropriate based on information obtained from the regional geologist and consultation with industry and other stakeholders including WSCC.
- To provide 'ESRI' shapefiles defining the Mineral Safeguarding Areas and Mineral Consultation Areas for use in a GIS to WSCC.
- To produce a short report documenting methodologies used, a review of the consultation process and reasoning behind decisions to include or exclude certain resources for safeguarding.

2.1 LIMITATIONS

Box 4 Mineral resource classification and data quality

Mineral resources are natural concentrations of minerals which might now, or in the foreseeable future, be of economic value. 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, but it changes with time.

The mineral resource maps are derived from geological linework forming part of the national 1:50 000 scale digital coverage DiGMapGB-50 from the British Geological Survey (BGS). This dataset is based on surveys carried at 6-inch or 1:10 000 scales, and acquired at different times. Whilst every effort has been made to ensure consistency of approach across the county, the level of detail reflects in part the age of the mapping, with more recent surveys placing greater emphasis on subdivision and characterisation of the superficial deposits.

3 Method

This section provides an overview of the method used to delineate MSAs and MCAs for WSCC.

MSAs and MCAs were defined in West Sussex in accordance with the methodology outlined in 'A guide to mineral safeguarding in England' (McEvoy et al., 2007). Part 1 of the guide outlines a six-step approach to creating an effective system of mineral safeguarding. The scope of this project is limited to steps 1-3 and 6 (Box 5) and is related to producing the spatial maps. Creation of the associated policies (steps 4 and 5) are beyond the scope of this report. Decisions relating to the sizes and shape of MSAs have been fully justified in this report. A summary of the geological units included or excluded from the MSAs can be found in Appendix 3.

Box 5 Step by step approach to creating an effective safeguarding system for minerals		
Step 1	Assess what is the best geological and resource information available.	Use the best geological and mineral resource information. Refine resources in discussion with industry. Account for sterilisation by proximal development.
Step 2	Decide which minerals within the MPA may become of economic importance in the foreseeable future.	
Step 3	Decide how the physical extent of the resource areas to be safeguarded should be determined.	
Step 6	Decide whether MCAs should be defined in addition to MSAs to ensure that mineral interests are taken into account when considering proposals for non-minerals development.	

Source: A guide to mineral safeguarding in England (McEvoy et al., 2007)

The following steps were used as a basis for the project:

3.1 An assessment of the best available geological knowledge

3.2 Consultation with industry

3.3 Determination of proximal development buffers

3.4 Final decisions for defining MSAs

3.5 Defining MCAs

3.1 ASSESSMENT OF THE BEST AVAILABLE GEOLOGICAL KNOWLEDGE

This was conducted in accordance with Step 1 of 'A guide to mineral safeguarding in England' (McEvoy et al., 2007) in order to identify the current and possible future economic mineral resources within West Sussex.

- All relevant BGS published literature relating to West Sussex was reviewed by an economic geologist. This included the most recent geological maps, the economic geology section of the accompanying sheet memoirs or sheet descriptions and an Industrial Minerals Assessment Unit report. The published BGS 'County Mineral Resource Map' for West Sussex (Figure A1) and the relevant regional geology series were also used.

- Present economic resources and potential future resources were re-examined and discussed in detail with the regional geologist and other expert economic geologists at the BGS.
- Based on the assessment of the best available geological knowledge, four mineral resources were considered of economic importance in the foreseeable future in West Sussex, thus warranting safeguarding for future generations. Proposed Mineral Safeguarding Maps were produced for each resource and these were used as the basis for consultation with industry (Figures A2 - A5). Resources identified were:
    i) unconsolidated sand and gravel,
    ii) brick clay,
    iii) chalk; and
    iv) consolidated bedrock deposits (crushed rock aggregate and building stone).
- The consultation maps produced show the mineral resources extended 5 km beyond the MPA boundary. This is to ensure that resources just outside the county boundary would not be potentially sterilised by non-mineral developments close to the county border. It also enables a broader view of the size of possible adjacent deposits.

> *"Importantly, mineral resources do not stop at administrative boundaries and MPAs should attempt to consider resources which straddle other MPAs"* (Page 15).
>
> A guide to mineral safeguarding in England (McEvoy et al., 2007)

3.2 CONSULTATION WITH INDUSTRY

> *"MSAs can be defined objectively using the best available geological and mineral resource information…including that made available by industry…areas will generally need to be refined in discussion with the industry and other stakeholder"* (Para. 32).
>
> Minerals Policy Statement 1: Practice guide (CLG, 2006)

The identification and delineation of mineral resources changes with time and is dependant on economic influences, advances in technology and environmental factors. Consultation is important as commercial operators often have the best local knowledge about the quality and viability of currently exploited geological formations which may be considered mineral resources. An outline of the consultation process is provided below:

- A list of mineral operators and other stakeholders within the area was supplied by WSCC. This was compared with BGS's 'BRITPITS' database of active and non-active pits.
- Notification of the project was provided to these mineral operators by email or letter (Appendix 1).
- A subsequent email or letter (Appendix 2) was provided along with the relevant proposed mineral safeguarding maps (Figures A2 – A5) inviting operators to comment and discuss criteria for the delineation of MSAs and MCAs.
- Where possible, consultation appointments were arranged between BGS staff and industry in order to gain local information which may be used to refine MSAs and to

provide local knowledge on which resources might become economic in the future. These appointments took the form of telephone discussions and/or on-site meetings.

- Additional information received through consultation enabled the project to supplement the best available geological knowledge. Comments received during the consultation exercise have been incorporated in the text describing the individual mineral resources in the economic geology sections 5.2, 6.2, 7.2 and 8.2.

3.3 DETERMINATION OF PROXIMAL DEVELOPMENT BUFFERS

> *"…It should be kept in mind that, in addition to proposed development within an MSA, incompatible development that is allowed close to a MSA may also lead to sterilisation of part of the resource"* (Para 32).
>
> Minerals Policy Statement 1: Practice guide (CLG, 2006)

In order to safeguard a mineral resource in its entirety, and to account for the inexact nature of mapped geological boundaries, MSAs can be extended beyond the mineral resource boundary. This can be achieved by applying a buffer to the mineral resource outline. The purpose of the buffer is to safeguard the mineral resource from proximal development. The process used to determine suitable buffer sizes in West Sussex is described as follows:

- On the basis of the examples provided in the case study section of 'A guide to mineral safeguarding in England' (McEvoy et al., 2007), a proximal development buffer size of 250 m was proposed for all mineral resources in West Sussex.
- The proximal development buffer size was discussed during consultation with industry for each specific resource. Based on mineral extraction techniques used in West Sussex the proposed buffer of 250 m was considered suitable.
- The use of buffering in the delineation of MSAs resulted in a dataset that crossed the county boundary in some places. Therefore the resultant MSA dataset was clipped to the extent of the county.

3.4 FINAL DECISIONS FOR DEFINING MINERAL SAFEGUARDING AREAS

Where appropriate the comments from industry consultation were incorporated and discussed with the BGS regional geologist and WSCC. Final decisions for MSAs delineation were made by WSCC in discussion with the BGS project team. It was important to ensure that the reasoning behind inclusion or exclusion of certain mineral resources could be fully justified. These decisions are specific to each mineral resource and are described more fully in sections 5.3, 6.3, 7.3 and 8.3. MSA maps were produced based on the outcome of these decisions as follows:

- The digital linework for the mineral resources identified and refined through this project were extracted from the existing mineral resource counties digital dataset and from DiGMapGB-50 and clipped to 5 km beyond the county boundary (described in section 3.1).
- Each mineral resource was buffered by 250 m to avoid sterilisation by proximal development (described in section 3.3).
- The final dataset was clipped to the county boundary.
- Maps showing the MSA for each individual resource were produced (Figures A6 - A9). These are displayed together for the final map (Figure A10).

- Individual digital ESRI shapefiles for each MSA were provided to WSCC.

3.5 MINERAL CONSULTATION AREAS

> *"MCAs are simply a mechanism which aims to ensure that in two-tier authority areas consultation takes place between county and district planning authorities when mineral interests could be compromised by proposed non-minerals development. The definition of MCAs is not obligatory but consultation within a defined MCA is."* (Page 11).
>
> A guide to mineral safeguarding in England (McEvoy et al., 2007)

Defining MCAs ensures that minerals interests are taken into account when considering proposals for non-minerals development, because consultation is then obligatory between districts and WSCC.

In accordance with Step 6 of 'A guide to mineral safeguarding in England' (McEvoy et al., 2007) WSCC decided that MCAs should be defined in addition to MSAs for the following reasons:

- The districts should already be familiar with the consultation process which they are obliged to follow if an application for non-mineral development is received within an MCA.
- MCAs can be updated more easily than MSAs as their statutory basis exists outside that of the development framework.

In some instances the MCAs may be larger than the MSAs in order to give an additional measure of safeguarding to mineral infrastructure sites such as wharves and railway sidings, which cannot be included in MSAs. WSCC currently has separate safeguarding policies for wharves and railway sidings in the adopted Minerals Local Plan. The use of MCAs for wharves and rail depots will be considered independently by WSCC following the completion of the West Sussex Wharves and Railheads Study. No additional sites outside the MSAs were identified for inclusion in MCAs during consultation with industry. Therefore, in West Sussex, **MCAs for sand and gravel, brick clay, chalk and consolidated bedrock are currently identical in size to MSAs.**

The published version of 'A guide to mineral safeguarding in England' (McEvoy et al., 2007) strongly advises against having MCAs smaller than MSAs, such as by the removal of urban areas. Following discussions with WSCC, the decision was taken to *include* urban areas and planning permissions in the MCAs based on the recommendations of the guide, because:

- If they were excluded, districts would not be required to consult on those areas, and so effectively minerals will not be considered and the resource could potentially be sterilised. Opportunities for prior extraction, location of the development elsewhere, or other options would not be able to be considered.

- Furthermore, a list of exemption criteria set out in policies to accompany the MCAs could avoid any increase in applications within urban areas that require consideration on mineral safeguarding grounds. This list of exemptions would be more flexible and could be more easily updated than the proposals map (for example to reflect expanding urban boundaries or new factors affecting the economics of extraction). 'A guide to mineral safeguarding in England' (McEvoy et al., 2007) contains some suggestions for criteria for exemption which could be outlined in MWDF on Page 18, Figure 4, Note 2.

"Mineral safeguarding should not be curtailed by other planning designations, such as urban areas ... without sound justification" (Page 15).

"Define MCAs for important mineral resources in urban areas... This will facilitate the potential for extracting these valuable or scarce minerals as part of regeneration projects. In such a situation, if an MCA was not shown to extend beneath the urban area, the mineral may not have been considered for prior extraction and hence unnecessarily sterilised" (Page 24).

'A guide to mineral safeguarding in England' (McEvoy et al., 2007)

Maps showing the MCA for each individual resource were produced (Figures A6 - A9). These are displayed together for the final map (Figure A11). Individual digital ESRI shapefiles for each MCA were provided to WSCC.

4 Overview of the economic mineral resources in West Sussex

This section provides a brief summary of the geological mineral resources in West Sussex from an economic perspective. It is intended to provide background to Sections 5 to 8. These sections discuss individual mineral resources in more detail in including the decisions made about mineral safeguarding.

The mineral resources of West Sussex occur in sedimentary rocks ranging from Jurassic to Quaternary in age. Historically, the majority of the sedimentary units within the county have been worked for specific minerals including ironstone, brick and tile clays, cement raw materials, agricultural lime, building stone and aggregate. A geological sketch map (Figure 1) and generalised vertical section (Figure 2) show the geological succession in West Sussex and resources derived from the rocks.

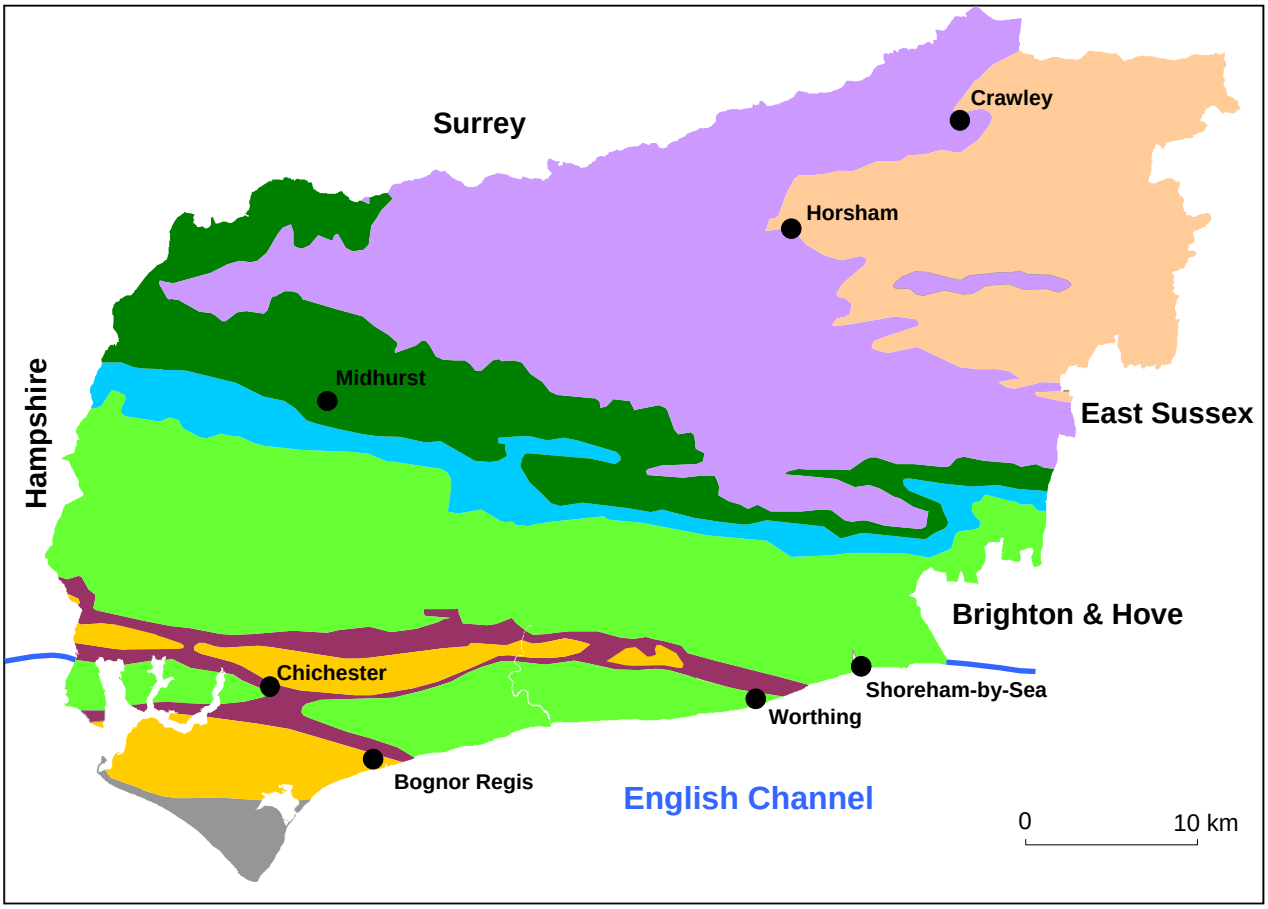

Figure 1 Sketch map showing the solid geology of West Sussex
(For explanation of colours, see Figure 2).

Major extractive industries which still exist in the county include aggregates won from the Quaternary Head and Fan Gravels of the Sussex Coastal Plain around Chichester. These gravels constitute an extensively exploited and locally-important source of **aggregates**.

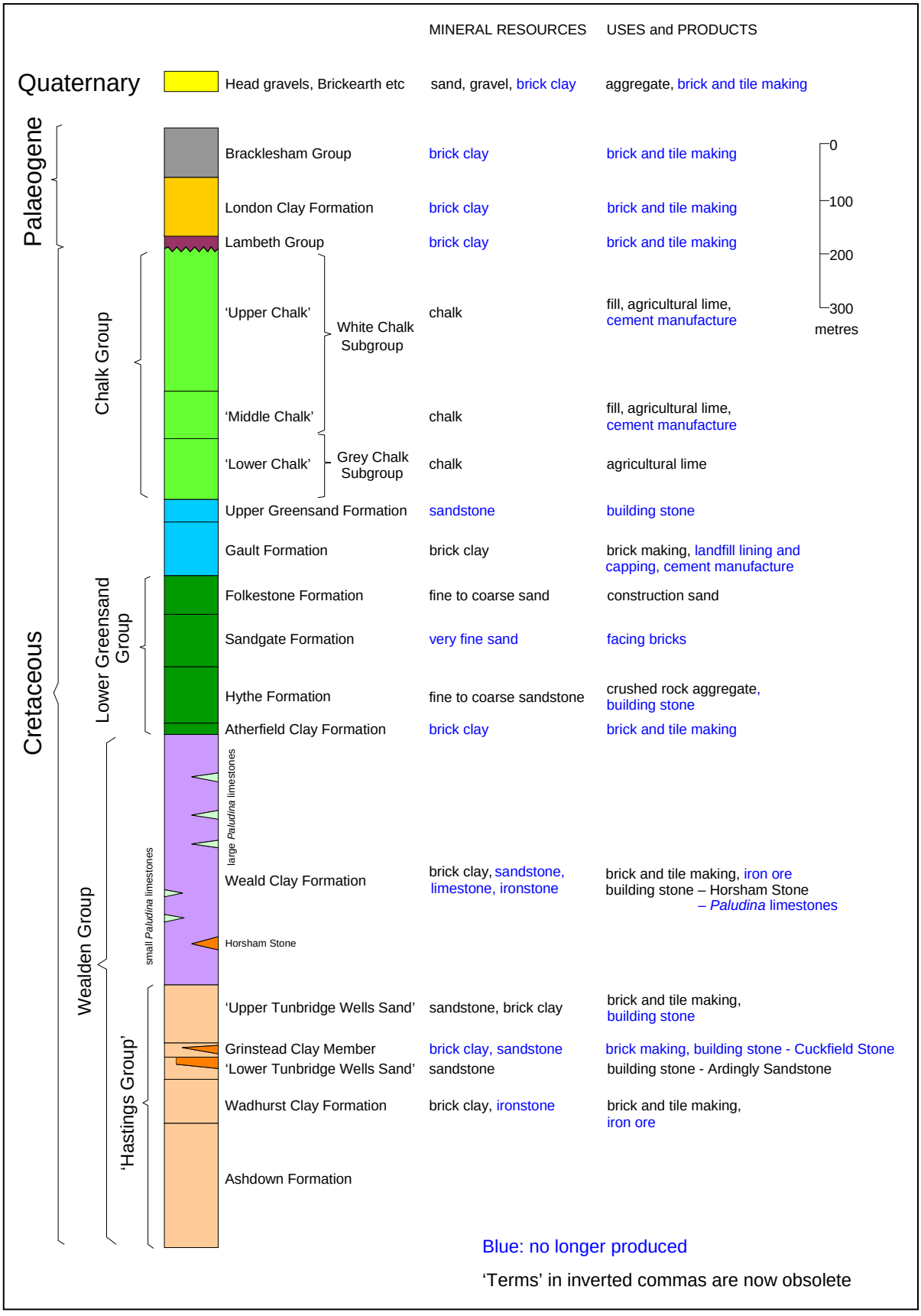

Figure 2 Generalised vertical section showing the rocks of West Sussex and their uses

Sand extracted from the Lower Cretaceous Folkestone Formation across the central part of the county supplies the whole of Sussex and south-eastern Hampshire with **building and concreting sand**.

The Wadhurst Clay and Weald Clay in the northern portion of West Sussex form the basis for an industry manufacturing **bricks and tiles** used in large volumes across south-east England. A small scale brickworks situated on the Gault Formation fabricates handmade bricks for historic restoration works and as such its market areas range from local to international. Larger scale brickworks extract clay from the Gault Formation nearby in Hampshire.

Chalk is worked on a relatively small-scale for **agricultural lime** and **fill**, although it was also recently worked for **cement** until the closure of the Shoreham cement works in 1991. Cement is no longer manufactured in the county but with increasing pressures to reduce carbon footprints of materials, a local supply may become more important in the future.

As in many other areas of England, the **building stone** industry was far more widespread in West Sussex in the past than it is today. A wide variety of Cretaceous sandstones were formerly worked as building stones supplying very localised markets. With changes in building methods and fashions, this industry has contracted to a few small working quarries supplying a specialised market. This industry may be revived with increased necessity for matching stones for restorative works as recommended by English Heritage.

West Sussex is prospective for both oil and gas. There are currently two producing fields, one at Singleton and one at Storrington. Oil and gas has been excluded from this report on request from WSCC.

4.1 MINERAL EXTRACTION IN WEST SUSSEX: REGIONAL AND NATIONAL SUPPLY

Over 70% of the minerals extracted in West Sussex are sand and gravel (Figure 3). This is used in the construction industry, predominantly within West Sussex, but also contributing 6% to the regional supply (Table 1). Clay for brick making makes up about a quarter of all minerals extracted in West Sussex, which is far more significant regionally. Brick clay produced in West Sussex accounts for 46% of the regional supply and 4.3% of the English supply. Comparatively little sandstone is extracted but there is a lack of other alternative harder rock sources in the south east for aggregate uses, so it actually contributes 97% of the regional production. Since the closure of Shoreham cement works in 1991, chalk is now only used very locally within West Sussex for agricultural lime. A much higher proportion of chalk used in the region comes from Kent and elsewhere in the south east.

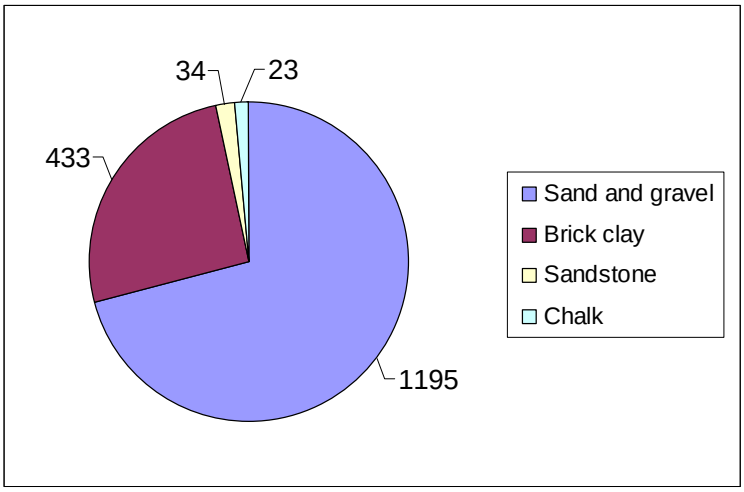

Figure 3 Quantities of minerals quarried in West Sussex, 2005 (thousand tonnes)
Derived from: Annual Minerals Raised Inquiry 2005, Office of National Statistics Business Monitor PA1007

Table 1 Mineral supply from West Sussex to the South East region and England-wide
(thousand tonnes)

Mineral resource	West Sussex production	Regional production	% of regional supply	English production	% of English supply
Sand and gravel	1195	19362	6.2	70838	1.7
Brick clay	433	951	45.5	10074	4.3
Sandstone	34	35	97.1	6910	0.5
Chalk	23	>1363*	<1.7	7105	0.3

* Chalk regional figure is unavailable (those figures that are available have been totalled).

Derived from: Annual Minerals Raised Inquiry 2005, Office of National Statistics Business Monitor PA1007

5 Unconsolidated sand and gravel

This section describes in more detail the unconsolidated sand and gravel mineral resources in West Sussex. It also outlines the reasoning behind inclusion or exclusion of certain areas of the mineral resource for mineral safeguarding.

5.1 GEOLOGICAL DESCRIPTION

Sand and gravel deposit properties are a function of their depositional environment and also the rock type from which the particles were derived. These factors affect the composition and distribution of particle sizes and hence the amount of processing required to achieve a useful, saleable product and thus their relative importance as aggregate resources.

The unconsolidated sand and gravel resources of West Sussex fall broadly into two categories which are very different in character, reflecting their different modes of deposition:

Superficial deposits of Quaternary age, deposited by slope movements, rivers, or tidal action, are predominantly found in the southern part of West Sussex, along the coastal plain. They consist essentially of flint gravel in a fine matrix, with a relatively small sand fraction.

Unconsolidated bedrock sand deposits comprise the Cretaceous sands of the Folkestone Formation. The clean, well sorted sands contain relatively little fine-grained material and also tend not to contain gravel.

The principal aggregate 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.

5.1.1 Superficial deposits

The **Head Gravel** forms an approximately 3 km wide ‘sheet’ extending along the southern margin of the chalk outcrop in the west of West Sussex. It was deposited as a result of a mass down-slope slump of material off the chalk slopes during and subsequent to the last glaciation. It consists of angular flint gravel in a dominantly clayey matrix. In its unprocessed state the material can be used as 'hoggin' (a gravel and clay mixture used for fill and for surfacing rough tracks). Where the clay content is less than 30 per cent, the Head Gravel can be processed to produce coarse aggregates for use mainly in concrete or crushed for road sub-base (although this application is being replaced by crushed limestone imported from Somerset). Processing to remove the clay content is costly, particularly because there are limited local resources of water for washing the gravel.

The **Fan Gravel** is a fluvial (river) deposit emanating from the valleys in the chalk north of Chichester. The deposit broadens into a fan up to 10 m thick to the south-east of Chichester, where it is overlain by brickearth and younger estuarine and marine deposits. The Fan Gravel is composed principally of angular with some well-rounded flint. It is generally much less 'clayey' than the Head Gravel and so requires less processing. It has been extensively worked to the south-east of Chichester and remaining resources are limited.

Raised Storm Beach Deposits occur as a line of low mounds to the east of Chichester lying on top of the Head Gravels. Limited available data shows the deposit to be a 'clayey' sandy gravel principally composed of angular and well-rounded flint.

Raised Beach Deposits are of limited extent and are generally concealed beneath Head Gravel or brickearth. They consist principally of fine sand and flint gravel. They are not known to have been worked in the past.

River Terrace Deposits lie along the margins of rivers and usually consist of well sorted gravel deposits, less than 10 m thick. By inference **sub-alluvial deposits** are extensions of river terrace gravel beneath the alluvium. Composition of the gravel will depend over what rocks the rivers flow further upstream. In West Sussex the rivers flow mainly south over the Weald Clay, which contains some sandstones and limestones that could be incorporated into the river gravel. There are no known workings of river terrace gravels in West Sussex, however in neighbouring counties, they may be considered an economic resource and are used for concreting aggregate and for constructional fill.

Undifferentiated Head deposits are the result of movement of material downslope under gravity and depend on the rock from which they are derived. Where this rock contains a high proportion of hard material it may be economic for use as an aggregate (for example the Head Gravels described above). Little information exists about the content of these undifferentiated deposits.

5.1.2 Unconsolidated bedrock sand

The **Folkestone Formation** consists of largely uncemented sands which coarsen upwards and have a variable particle-size distribution. The sands become finer away from the centre of the county. They are also thickest in the centre (40 - 70 m) thinning to 10 - 20 m to the east and west. The Folkestone Formation is worked in a number of locations in West Sussex for a variety of uses. The variability of grain size and low clay content mean little or no processing is required to produce high quality building sands for mortar. In some places it can be used 'as dug'. Coarser sand is washed for use as concreting sand or to face bricks. Other products are coated for use in asphalt. In West Sussex the Folkestone Formation is not sufficiently pure to warrant processing to produce **silica sand** for glass and foundry applications, although it is in Surrey and Kent.

The **Sandgate Formation** is a well sorted fine grained sand 8 – 10 m thick which has been worked in the past for facing bricks, however it is considered too fine-grained for most construction applications, so it is not shown on the consultation map (Figure A5).

5.2 ECONOMIC GEOLOGY

Important factors in the economics of all aggregates include the amount of processing required to make a saleable product. Transport distances to the demand area and competition from alternative supplies are also important. In West Sussex, the high processing costs of the 'clayey' head gravels prove economic because there are no alternatives to supply, except material coming into to marine wharves. The two wharves in West Sussex, at Littlehampton and Shoreham, are affected by marine licence availability, wharf accessibility and transport distances from the wharf. Generally the land-won gravels are used in the area local to the deposits and further inland to the east, (the central part of West Sussex), which is further from the marine wharves.

The Folkestone Formation provides a sub-regionally-important source of good quality soft sand (mortar sand) in West Sussex and the South East region. There are no alternate economic supplies because marine dredged sand is generally unsuitable as soft sand (it is generally too coarse). It is the opinion of industry that the Folkestone Formation in West Sussex is likely to remain unsuitable for silica sand production unless a specific processing plant is established nearby.

5.3 MINERAL SAFEGUARDING AREAS: DECISIONS AND JUSTIFICATIONS

For this section, please refer to:

Figure A1: 1998 published county mineral resource map for West Sussex

Figure A2: Consultation map for unconsolidated sand in West Sussex

Figure A6: Mineral Safeguarding Areas for unconsolidated sand in West Sussex

The entire **Folkestone Formation** in West Sussex has been **included** in the Mineral Safeguarding Area (as shown in Figure A1, published resource map) as it is a sub-regionally important sand resource and potential future silica sand resource. Mineral Planning Guidance 15, paragraph 53 specifically refers to silica sand as a scarce national resource warranting safeguarding.

> *"Silica sand is a scarce resource and MPAs should, as far as possible and in cooperation with other planning authorities, safeguard deposits which are, or may become, of economic importance, against other types of development or other constraints which would be a serious hindrance to their extraction"* (Para 53).
>
> MPG 15: Provision of silica sand in England

The **Head and Fan gravels were included** within the MSA using the linework from the published County mineral resources map (Figure A1) which includes deposits concealed beneath overburden (elsewhere only the surface extent of deposits are shown) where these were revealed in more detailed studies (IMAU report). Because of their proximity to the town of Chichester and the nature of these deposits, it is suggested that these would be particularly suitable for **prior extraction**, should an opportunity arise.

The decision was made to **exclude the river terrace gravels, inferred sub-alluvial deposits** and also the **undifferentiated head** scattered around the county due to insufficient information warranting their inclusion (Figure A2 consultation map). It is thought unlikely that they would contain sufficient high quality hard cemented, or siliceous material to make a good concreting aggregate, although they may be suitable for bulk fill. Mapped surface extent and the nature of the deposits mean that volumes of material present are unlikely to be present in sufficient quantities to be economic, unless there was a specific demand in the locality.

The **raised beach deposits were also excluded** because of a lack of information on their properties as a resource and the likelihood that they are not of high enough quality to warrant safeguarding. It is generally thought that the sand is too fine-grained for most construction applications and the gravel although predominantly flint, also contains appreciable amounts of chalk and other deleterious material, making it unsuitable for aggregate.

5.3.1 Proximal development buffer

A **250 m** buffer around defined resources was applied to avoid future sterilisation by proximal development. It was not considered necessary extend the buffer around the Folkestone Formation to allow for down-dip extraction beneath overburden.

6 Brick clay and fuller's earth

This section describes in more detail the brick clay and fuller's earth mineral resources in West Sussex. It also outlines the reasoning behind inclusion or exclusion of certain areas of the mineral resource for mineral safeguarding.

6.1 GEOLOGICAL DESCRIPTION

Brick clay is the term used to describe common clay used in the manufacture of structural clay products, such as bricks, pavers, clay tiles, and clay pipes. Clay and shale can also be mixed with chalk in cement manufacture, used to line landfill, canals, lakes etc and as a source of lightweight aggregate for cement or constructional fill for roads. Usually different clay and sometimes non clay rocks are blended and mixed to produce a variety of desirable properties in the finished product. There are many clay bearing units in West Sussex and only the most important ones are described here in detail and shown on the consultation map (Figure7). The Weald Clay is the principal brick clay resource in West Sussex.

The **Wadhurst Clay Formation** is found in the north east of the county between East Grinstead and Horsted Keynes. It consists of a maximum of 70 m of banded mudstones and silty mudstones with sandstone, shelly limestone and clay-ironstones layers. The Wadhurst Clay is currently worked for the manufacture of bricks at two sites: West Hoathly and Freshfield Lane.

The **Weald Clay Formation** makes up an extensive deposit across south east England and it forms a broad band across the north and central part of West Sussex. It is up to 450 m thick and consists of mudstones and silty mudstones, with thin beds of sandstones, shelly limestones and clay-ironstone. Distribution of working and disused pits indicates that usable clays have been quarried from all levels within the Weald Clay, although horizons rich in pyrite and some other minerals are generally avoided for their detrimental effect on product properties. The Weald Clay is worked at several sites in West Sussex for the production of bricks and tiles.

The **Gault Formation** forms a 0.5 – 2 km wide E-W trending outcrop across the county. It comprises a 90 - 100 m thick sequence of mudstones and silty mudstones. Historically, the Gault Clay has been worked at several localities in the county both as a cement raw material and as a landfill sealant. However, only one working pit now remains, near Pitsham, where handmade bricks with aesthetic and restoration uses are manufactured. Poor forming properties caused by high shrinkage on drying renders this material unsuitable for most modern brick manufacturing processes.

The **Lambeth Group** (Reading Formation) contains mottled plastic clays interbedded with sandier units which are about 30 m thick near Chichester. Generally the deposit is overlain by superficial deposits, including head and brickearth. There are no current workings in the Lambeth Group in West Sussex.

The **London Clay Formation** is fairly uniform clay, generally of poor quality for brick making as it contains too high a proportion of swelling clays, although it has been used in cement manufacture. It is up to 100 m thick in West Sussex and overlies the Lambeth Group which, like it, is largely covered by superficial deposits.

Brickearth is a silty, reworked, but originally windblown superficial deposit. In West Sussex it is contaminated with gravel and most deposits are between a few centimetres and 5 metres thick, which make it unsuitable for modern brick manufacturing. However, in other counties, brickearth has accumulated in sufficient thicknesses and quality to be used for this purpose.

Fuller's earth is a highly plastic, swelling clay which has a variety of industrial uses of which cat litter is perhaps the most commonly known. Resources of fuller's earth are rare in the UK. In

West Sussex, occurrences have been found sporadically within the Lower Greensand Group, particularly at Tillington. However, deposits discovered to date have been too small and laterally discontinuous for it to be considered an economic resource.

6.2 ECONOMIC GEOLOGY

West Sussex contains regionally-important brick making raw materials. It supplies almost half the region's clay, mainly to London, a major consumer of brick clay. Figure 4 shows the outcrop distribution of the Weald Clay and Wadhurst Clay in the UK.

The Weald Clay is particularly important, as almost all units within the Weald can be blended and used to make clay products. Modern brick making technology is highly capital intensive. This technology is increasingly dependent on clay raw materials with predictable and consistent forming and firing characteristics to achieve high yields of saleable products.

Resources of clay and mudstone suitable for cement manufacture are widespread and normally obtained from quarries adjacent to cement plants. The limiting factor regarding the use of shale in cement manufacture is transportation costs to deliver the shale to the cement plant.

MPS1 Annex 2 refers specifically to brick clay.

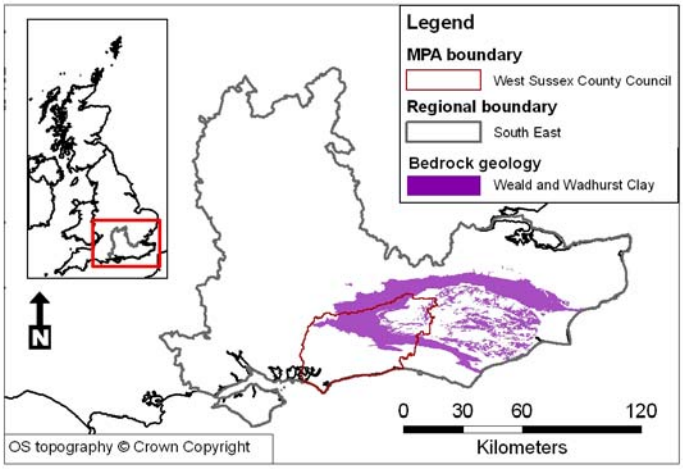

Figure 4 Weald and Wadhurst Clay in South East England (purple)

> *"MPAs should have regard to the need for clay supply for local use and repair of heritage buildings to meet the objectives of PPS1."* (Para. 3.3)
>
> "*Planning consideration…should take account of… the need for provision of brick clay from a number of different sources to enable appropriate blends to be made"* (Para. 3.4)
>
> Mineral Policy Statement 1 Annex 2: Brick clay (CLG, 2006)

6.3 MINERAL SAFEGUARDING AREAS: DECISIONS AND JUSTIFICATIONS

For this section, please refer to:

Figure A1: 1998 published West Sussex county resource map

Figure A3: Consultation map for brick clay in West Sussex

Figure A7: Mineral Safeguarding Area map for brick clay in West Sussex

The MSA **includes all the Weald and Wadhurst clays** as these have been identified as regionally and nationally recognised source of brick clay (DTLR, 2001). The current economics

of a brick clay deposit depend largely on its proximity to brick making facilities, to avoid large transportation costs. However, based on the geology of the Wadhurst and Weald Clays, it could all potentially be used economically in the future and so the entirety of both formations should be safeguarded. The exact linework for the boundary has been taken from the published 1998 map (Figure A1), which has not included some of the small outliers and parts where the deposit is less than 200 m thick. This is because those areas are too small to be considered an economic resource.

The **other clay units** shown on the consultation map (Figure A3) **have been excluded** because they have not been worked in the recent past and are unlikely to be worked in the future, due to their poor quality or location (e.g. beneath overburden):

The **London Clay** and **Lambeth Group have been excluded** from the MSAs because they are largely occur beneath mixed superficial deposits and so are likely to remain uneconomic in the foreseeable future. This is particularly true where they occur in close proximity to the much larger surface exposure and higher quality deposits of the Weald and Wadhurst clays.

The **Gault Formation has been excluded** from the brick clay MSA, as it is not considered economically significant on a county or regional scale. It is not suitable for large-scale brick making and although it has been used previously as a landfill sealant and as a clay for cement manufacture, it is considered that the safeguarded Weald Clay resources would be sufficient for these purposes should the need arise. The Pitsham brick works extract only a small amount of clay per year and while it is important to protect this specialised industry, it is not considered worth safeguarding the entire surface extent of the Gault Formation for this minor use.

To date deposits of **fuller's earth** that are sufficiently large to be economically exploited have not been identified in West Sussex. If any large developments occur on the Lower Greensand in the future, further deposits may be identified. However, based on current information, safeguarding the entire Lower Greensand (Hythe Formation) for fuller's earth is not considered appropriate.

6.3.1 Proximal development buffers

A **250 m buffer** has been applied to the previously published Weald Clay and Wadhurst Clay resource linework, in order to safeguard them from proximal development. The clays are extracted by scrapping and no blasting is necessary, therefore a 250 m buffer is considered sufficient to protect the resource from potential sterilisation.

7 Chalk

This section describes in more detail the chalk mineral resources in West Sussex. It also outlines the reasoning behind inclusion or exclusion of certain areas of the mineral resource for mineral safeguarding.

7.1 GEOLOGICAL DESCRIPTION

The Chalk is a relatively soft, fine-grained, white limestone, mostly consisting of the debris from planktonic algae. It was deposited during the Upper Cretaceous in a shallow sea across eastern and southern England. In West Sussex, the Chalk is up to 400 m thick and forms the prominent natural feature of the South Downs which run east – west across the county in a 6 – 10 km wide band.

Although the Chalk has a fairly uniform appearance, it can be subdivided into units based primarily on its purity (clay content): traditionally these are the Lower, Middle and Upper Chalk, however the 'Upper Chalk' and 'Middle Chalk' are now referred to as the White Chalk Subgroup and the 'Lower Chalk' is now called the Grey Chalk Subgroup. The Grey Chalk Subgroup generally contains the most clay and therefore has the lowest chemical purity (< 93.5 percent $CaCO_3$) increasing non-uniformly to the very high purity of the White Chalk Subgroup (97.0 to > 98.5 percent $CaCO_3$). Flint nodules, which occur along bedding planes, are often present in the younger chalks.

7.2 ECONOMIC GEOLOGY

Chalk is an important source of limestone raw materials. In West Sussex, chalk is currently extracted from only two quarries; a further three are inactive at present. The formations extracted include the Holywell Nodular Chalk, New Pit Chalk and Lewes Nodular Chalk formations of the White Chalk Subgroup. It is mainly used for agricultural lime; minor local uses include constructional fill, although it is generally too soft and hydroscopic to be used more widely. There has been no extraction of chalk for cement production in West Sussex since the closure of the Shoreham cement works in 1991, and chalk production in West Sussex has declined dramatically since then. In 2005, at least 23 000 tonnes of chalk were produced in West Sussex and large reserves still exist in the county. Chalk is a microporous limestone and is an important aquifer in south-east England. It is the principal source of water supply in West Sussex.

Pits lie predominantly along the northern (scarp) edge of the Grey Chalk Subgroup outcrop, and cut back southwards back into the White Chalk Subgroup. This positioning is probably due to historic factors, such as for the ease of transporting the agricultural lime down the scarp slope for use in the fields to the north. Today, the agricultural lime produced is also used extensively on the fields of the coastal plain to the south of the chalk outcrop. Pits are also positioned along the north-south transport routes through West Sussex and supply within a local, 20 – 25 mile radius. Haulage costs generally preclude transporting the relatively low value commodity much further, however an added value product such as chalk in powdered form for cement could be potentially be transported further.

Although current production in West Sussex is focussed on the Holywell Nodular Chalk, New Pit Chalk and Lewes Nodular Chalk formations, in the neighbouring county of Hampshire, the Newhaven Chalk and Seaford Chalk formations are extracted for agricultural lime because it is softer. Generally the Grey Chalk Subgroup is more difficult to extract, because it is harder, although it has been used in the past for cement making because it has a higher clay content. However, it is likely that any future cement works would utilise a purer chalk in order to be able

to add more controlled amounts of clay. Also the purer chalk tends to be softer and easier to crush, reducing processing costs.

In West Sussex, chalk for agricultural lime is generally extracted using a ripper and is then crushed where necessary. Flints are removed during processing and are sometimes sold as a separate commodity for ornamental or rockery stone. Flints have also been used as a building material. Blocks of lump chalk are cut to supply a small but consistent demand for carved restorative building stone (for example for the crypt of Chichester Cathedral). Other occasional specialised restoration and conservation uses include the use of chalk as a fill in rampart walls.

7.3 MINERAL SAFEGUARDING AREAS: DECISIONS AND JUSTIFICATIONS

For this section, please refer to:

Figure A1: 1998 published county mineral resource map West Sussex

Figure A4: Consultation map for chalk in West Sussex

Figure A8: Mineral Safeguarding Area map for chalk in West Sussex

The MSA **includes the 6-10km band of Chalk shown on the published BGS county mineral resource map** (Figure A1). This is where the Chalk outcrops at the surface (the South Downs) and so it is economic, because it is relatively easy to extract. All of the chalk formations within this outcrop have been included in the MSA because the general homogeneity of the Chalk makes any part of it suitable for its many uses. Current trends of extraction from the northern scarp edge are based on historic reasons, rather than any preferential geological suitability of the rock produced.

The **Chalk deposits south west of Chichester and along the coast east of Bognor Regis** (shown on the consultation map, Figure A4) **have been excluded** from the MSAs because they are beneath overburden and so are likely to remain uneconomic into the foreseeable future.

7.3.1 Proximal development buffer

A **250 m buffer** has been applied to the previously published chalk resource linework, in order to safeguard chalk from proximal development. Current methods of chalk extraction do not include blasting, therefore a 250 m buffer is considered sufficient to protect the resource from potential sterilisation.

8 Consolidated bedrock deposits (crushed rock aggregate and building stone)

This section describes in more detail the consolidated bedrock mineral resources in West Sussex used for crushed rock aggregate and building stone. It also outlines the reasoning behind inclusion or exclusion of certain areas of the mineral resource for mineral safeguarding.

8.1 GEOLOGICAL DESCRIPTION

West Sussex has some consolidated bedrock units, mainly of Lower Cretaceous age in the northern part of the county. They are not high-quality sources of crushed-rock aggregate, although the Hythe Formation is used locally as crushed aggregate for low grade uses such as constructional fill. A number of formations have historically been worked as building stone in West Sussex. A continuing supply of building stone for new building and for restoration is necessary to maintain local vernacular architecture.

The **Hythe Formation** outcrops in the north east of the county. Present workings are at Bognor Common quarry near Fittleworth where it is crushed on site and used as aggregate for local paths, hardcore and constructional fill and also rockery and ornamental stone. In the past certain beds within the Hythe Formation were also used for building stone, although lateral variation in the deposits means that this has not been mapped as a separate unit.

'**Clunch**' is the local name for part of the Upper Greensand Formation in the West of the county, along the boundary with the Lower Chalk. Also known as Malmstone or Bluestone, it is a soft, very fine grained calcareous sandstone, which weathers to white. Historically it has been used as a local building stone, although its specific distribution is not mapped.

The **Ardingly Sandstone** is the upper 15 to 18 m of the '**Lower Tunbridge Wells Sand'** part of the **Tunbridge Wells Sand Formation**, which is part of the Wealden Group (formerly known as the 'Hastings Group'). It comprises a massive, fine and medium-grained quartzose sandstone. The Ardingly Sandstone is currently quarried from three localities in the High Weald. These are generally where unweathered stone occurs beneath a cover of Grinstead Clay Member.

Cuckfield Stone is a calcite-cemented sandstone, found between the 'Upper' and 'Lower' parts of the Tunbridge Wells Sand Formation. It was used historically for road stone, flooring slabs and in some cases for roofing, which was worked where it was unweathered beneath a clay capping.

Beds of fine-grained micaceous sandstone in the upper part of the '**Upper Tunbridge Wells Sand'** have been exploited in the past as building stone. Well-bedded material produced even-thickness slabs of fine-grained durable sandstone from this unit, which crops out between Horsham and Haywards Heath. Some material is produced at the Freshfield Lane brickworks to blend with the clay to make bricks.

A number of the sandstone and limestone units within the Weald Clay have been extensively worked for building stone, the most important of which is the **Horsham Stone**. The stone is a hard, fine-grained calcareous sandstone and is found in layers between 0.1 and 0.6 m thick. It is used for roofing and flagstones. It has been valued traditionally as a source of building stone and high-quality paving and roofing stone. One remaining quarry is still active at Theale, west of Horsham. Higher within the Weald Clay, thin beds of ***Paludina*** **limestones** have been used historically as an ornamental building stone, particularly for internal dressings in churches.

8.2 ECONOMIC GEOLOGY

Generally the consolidated bedrock units in West Sussex are of limited value as an aggregate resource, however due to the scarcity of other equivalent resources in the local area and the south east, the Hythe Formation is still economic when used locally for low grade aggregate. For high grade aggregate applications, alternatives must be shipped in from elsewhere.

In terms of building stone, there are four existing small scale building stone quarries which supply stone for new buildings as well as for conservation of old ones. These are economic only on a small scale and very locally, however following MPS1, it is increasingly important to safeguard these local building stones for restoration purposes (MPS1, annex 3: Natural building and roofing stone).

> *"English Heritage and the industry are encouraged to make MPAs aware of important sources of building stone that they consider should be safeguarded from other forms of development through policies in their LDDs."* (Para. 3.2)
>
> *"important historic quarries should be safeguarded as far as is practical."* (Para. 3.3)
>
> MPS1, Annex 3: Natural building and roofing stone

8.3 MINERAL SAFEGUARDING AREAS: DECISIONS AND JUSTIFICATIONS

For this section, please refer to:

Figure A1: 1998 published West Sussex county resource map.

Figure A5: Consultation map for consolidated bedrock deposits in West Sussex.

Figure A9: Mineral Safeguarding Area map for consolidated bedrock deposits in West Sussex.

Units selected for **inclusion** in the bedrock MSA are the **Hythe Formation, Horsham Stone, Ardingly Sandstone** and **Cuckfield Stone.** This is because stone matching for restoration work in the area may become more important should the area become a designated National Park in the future. According to MPS1, ordinarily it should be the responsibility of English Heritage to inform the MPAs of important building stone resources, however sufficient information is as yet unavailable for West Sussex. On this basis, these resources have been selected for safeguarding.

'Clunch' has been excluded from the MSA until more detailed information becomes available on the historic extent of the resource. Historically only the western-most part of the Upper Greensand was used for building, because of lateral variations in quality and suitability. This higher quality stone area has not been mapped as a separate unit, although it may be feasible to define the area based on a detailed study into the location of the historic quarries. The timescales involved in such a task was beyond the scope of this project.

The '**Lower Tunbridge Wells Sand' has been excluded**, except for the upper part of it which is the Ardingly Sandstone, because there is no recent or important quarrying of building stone known in the rest the formation.

The '**Upper Tunbridge Wells Sand' has also been excluded** although there are many thin sandstone units within it, as it is not known in enough detail which units have been quarried for building stone in the past. Current extraction at the Freshfield Lane brickworks is not for building stone purposes and so is considered minimal.

8.3.1 Proximal development buffer

All units included in the MSA were buffered using the standard project buffer of 250m, to avoid sterilisation of resources by proximal development. The building stone in West Sussex is not hard enough to be extracted using blasting and it is generally cut or bulldozed out and cut into blocks.

9 Conclusions

This study has provided West Sussex County Council with a clearly defined and delineated set of Mineral Safeguarding Areas and Mineral Consultation Areas. The project has followed recommendations and guidance, where possible, from ‘A guide to mineral safeguarding in England’ (McEvoy et al., 2007) in support of MPS1.

A summary of each geological units considered for inclusion in the Mineral Safeguarding Areas and Mineral Consultation Areas can be found in Appendix 3.

Paper maps and Adobe PDF documents were provided to West Sussex County Council showing the mineral resources, Mineral Safeguarding Areas and Mineral Consultation Areas within the Mineral Planning Authority. The digital data was supplied in the form of ESRI shapefiles for use in a Geographical Information Systems. West Sussex County Council licensed the BGS mineral resource linework for the county for this project.

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Appendix 1 Consultation letter to stakeholders

West Sussex County Council

Mineral Safeguarding Areas and Mineral Consultation Areas

Dear

West Sussex County Council have asked the British Geological Survey (BGS) to assist them in delineating Mineral Safeguarding Areas (MSAs) and Mineral Consultation Areas (MCAs). The purpose of this correspondence is to inform you that this is taking place and that the BGS would like to consult you during this process. Industry often has the local knowledge that is essential to this process.

MSAs will be delineated for each mineral resource in the county. These are clay, chalk, sand and gravel and sandstone. Once the MSAs have been identified MCAs will be delineated using a set of criteria established by West Sussex County Council and through the consultation process. A definition of MSAs and MCAs is provided in the Appendix to this letter along with a list of some related documents.

Consultation process and timescales

Consultation with industry (either directly with operators and/ or trade bodies as appropriate) and other stakeholders will be by letter, email, telephone and, where agreeable, onsite meetings. This will take place mainly in August 2007 and early September 2007. The BGS is planning a visit to the West Sussex area between 13th and 15th August and it may be possible at this time to meet individuals if requested. Specifically, the consultation aims to discuss:

- mineral resources and safeguarding
- local geological and operational considerations
- possible criteria for the delineation of MSAs
- possible criteria for the delineation of MCAs.

I will shortly forward some draft maps for your comment. If you are not the most appropriate contact I would be grateful if you could forward this correspondence or let me know who I need to contact.

Yours sincerely

Ellie Steadman, Project Leader

Appendix 2 Consultation letter with maps (Figures A2-A5)

West Sussex County Council

Mineral Safeguarding Areas and Mineral Consultation Areas

Dear

Further to my letter last week please find enclosed five maps showing the mineral resources of West Sussex as follows:

- Published map of the Mineral Resources of West Sussex (1998)
- Clay mineral resources
- Unconsolidated sand and gravel
- Bedrock sand and gravel
- Chalk

I appreciate not all of these maps will be off interest to you, please disregard those that are not.

You will note that the individual mineral maps differ to those of the published map. The reason for this is that we taken the decision to include additional formations in their entirety at this stage of the process. Based on your local knowledge you may consider all or part of these formations to be classed as mineral resources. We would appreciate your views on what should or should not be safeguarded and therefore could be excluded from the final map.

Please feel free to annotate the maps and return to me at the address below, or highlight areas of concern that you may wish to discuss further with me. The BGS is planning a visit to the West Sussex area between 13th and 15th August and it may be possible at this time to meet individuals if requested. The deadline for comments is 7th September 2007.

Please do not hesitate to contact me should you require any further information or would like to discuss anything in more detail.

Yours sincerely

Ellie Steadman

Project Leader

Appendix 3 Geological units included in MSAs and MCAs in West Sussex.

Category / geological unit	Units included or excluded from the **maps used during the consultation phase** of the project (Figures A2-A5) (Figure numbers refer to the maps in Appendix 4)	Units included or excluded from the **MSA & MCA maps**. (Figures A6-A9) (Figure numbers refer to the maps in Appendix 4)
Unconsolidated sand and gravel	**A2**	**A6**
Head Gravel deposit	included	included
Fan Gravel deposit	included	included
River terrace deposit	included	excluded
Sub-alluvial deposit	included	excluded
Raised Beach deposit	excluded	excluded
Raised Storm Beach deposit	excluded	excluded
Folkestone Formation	included	included
Brick Clay	**A3**	**A7**
Brickearth deposit	excluded	excluded
London Clay Formation	included	excluded
Lambeth Group (Reading Formation)	included	excluded
Gault Formation	included	excluded
Fuller's earth	excluded	excluded
Weald Clay Formation	included	included
Wadhurst Clay Formation	included	included
Chalk	**A4**	**A8**
Culver Chalk Formation	included	included
Newhaven Chalk Formation	included	included
Seaford Chalk Formation	included	included
Lewes Nodular Chalk Formation	included	included
Undifferentiated 'Upper Chalk'	included	excluded
New Pit Chalk Formation	included	included
Hollywell Nodular Chalk Formation	included	included
Zig Zag Chalk Formation	included	included
West Melbury Marly Chalk Formation	included	included
Glauconitic Marl Member	included	included
Consolidated bedrock	**A5**	**A9**
Upper Greensand Formation ('Clunch', 'Malmstone')	included	excluded
Sandgate Formation	excluded	excluded
Hythe Formation	included	included
Ardingly Sandstone	included	included
Paludina Limestones	excluded	excluded
Horsham Stone	included	included
Upper Tunbridge Wells Sand'	included	excluded
Cuckfield Stone	included	included
Lower Tunbridge Wells Sand'	included	excluded

Appendix 4 Maps

Figure A1 West Sussex Mineral Resources map (published 1998)

Figure A2 West Sussex - Unconsolidated sand and gravel

Figure A3 West Sussex - Brick clay

Figure A4 West Sussex - Chalk

Figure A5 West Sussex - Consolidated bedrock

Figure A6 MSA and MCA - Unconsolidated sand and gravel

Figure A7 MSA and MCA - Brick clay

Figure A8 MSA and MCA – Chalk

Figure A9 MSA and MCA - Consolidated bedrock

Figure A10 West Sussex Mineral Safeguarding Areas

Figure A11 West Sussex Mineral Consultation Areas