TECHNICAL REPORT WA/96/1

A geological background for planning and development in the City of Bradford Metropolitan district

Volume 1: A guide to the use of earth science information in planning and development

Editors: C N Waters, K Northmore, G Prince and B R Marker

Authors: S Bunton, C N Waters, G Prince and K Northmore

BRITISH GEOLOGICAL SURVEY
In association with
ENTEC UK LIMITED

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Maps and diagrams used in this report are based on Ordnance Survey mapping.

Bibliographic reference

WATERS, C N, and others. 1996. A geological background for planning and development in the City of Bradford Metropolitan district. Vol. 1: A guide to the use of earth science information in planning and development. BUNTON, S, WATERS, C N, PRINCE, G, and NORTHMORE, K (editors). *British Geological Survey Technical Report,* No. WA/96/1.

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Printed in the United Kingdom for the British Geological Survey by Staples Colour Printers Ltd.

C3 6/96

Contents

FIGURES

TABLES

PLATES

EXECUTIVE SUMMARY

In 1993 the Department of the Environment commissioned the British Geological Survey in association with Entec UK Ltd to undertake a three year study to develop techniques for the synthesis and presentation of earth science information in a form which can be used readily and directly by planners and developers, and by those interested in conservation, and to provide a general introduction to the geological factors most relevant to planning and development in the City of Bradford Metropolitan District (CBMD).

The main objectives of the study were to:

- collect and collate earth science information of relevance to planners, developers, engineers and conservation interests;
- produce a set of thematic maps on applied geological topics which will assist planning of land use, development and conservation in the study area;
- produce a summary map showing the main earth science factors relevant to planning and development in the area;
- provide two reports, one for non-specialists and the other for those with specific technical knowledge in the fields of geology, hydrogeology, engineering geology and mineral resources.

The area of Bradford in West Yorkshire was selected for the study because it is the subject of extensive urban renewal and land reclamation initiatives to deal with the effects of past industrial use following the decline of a number of traditional industries. The City is now encouraging the development of tourism based on its history and nearby scenic areas. The study represents one of a series of research projects, commissioned by the Department of the Environment, for urban coalfield areas in the UK, including Morpeth-Bedlington, St.Helens, Castleford-Pontefract, Coventry, Nottingham, Wrexham, Black Country, South Leeds and Wigan.

The results of the study are presented in this report (Volume 1) which provides information for the non-specialists and is accompanied by a summary map of the key earth science factors affecting planning and development in CBMD (Map 1). The more detailed technical report (Volume 2) is accompanied by a set of seven thematic maps which cover a range of applied geological topics together with five computer databases containing site specific information.

Planning information presented in this report has been gained from two principal sources:

- published planning documents and other associated literature for the Bradford area;
- structured face to face interviews with representatives from both public and private organisations who have an interest in planning, development or conservation in CBMD.

Following the introduction to this report, Chapter 2 sets out the planning policy context including a brief outline of national, strategic and local planning policy. In Chapter 3 a number of the key planning and development issues in CBMD upon which earth science information may locally have a direct influence are identified. The key planning issues include:

- Land for housing and industrial development
- Improvement of transport network
- Protection and development of mineral resources
- Provision of waste disposal facilities
- Control of pollution
- Protection and development of water resources
- Protection of washland areas and flood prevention
- Landscape and nature conservation

Each issue is described in turn with the main earth science factors relevant to each issue identified.

Chapter 4 provides an insight into the earth science factors which should be taken into account by planners, developers and other interested parties involved in planning, development and conservation in CBMD. These factors include:

- Variable man-made ground conditions
- Known or potential shallow undermined ground
- Mineral resources
- Surface mineral workings
- Geological faults
- Landslip areas
- Water resources
- Washland areas liable to flooding

For each factor the following questions are addressed:

1) Why is this factor relevant to planning and development?
2) Where is this factor of importance?
3) What should be done about this factor?
4) What literature should be consulted?
5) Who should be contacted for further information?

By considering the nature and location of the above earth science factors at an early stage in the planning process appropriate action may be taken to ensure that the site and development are compatible and that appropriate mitigation measures are taken prior to development. The information may also be used to identify opportunities for development, particularly in respect of leisure, recreation and protection of sites of nature conservation interest. The information provided in this report should be used by planners, developers and those involved in conservation in the District at an early stage in the planning process. The information may be used to identify opportunities for development at the forward planning stage, or it may be used to identify potential problems and ensure that appropriate site investigations and due precautions are taken at the outset in order to minimise risks to both the developer and the wider community.

1 Introduction

1.1 AIMS AND OBJECTIVES

Urban and rural areas are of key importance to quality of life and conservation, and also as a focus of wealth creation. Such areas require sound planning in order to guide and protect investment and improve the quality of life. The consideration of earth science at an early stage in the planning process will help to secure environmentally sound development and to conserve the best features and resources of the natural and semi-natural environment. Earth science information may also be used to identify opportunities for development, particularly in relation to leisure and recreation and protection of sites of nature conservation interest.

In 1993 the Department of the Environment (DoE) commissioned the British Geological Survey (BGS) in association with Entec UK Ltd to undertake a three year study to provide earth science information on the ground characteristics of the area covered by the City of Bradford Metropolitan District (CBMD), and to present the information in a form which can be used readily and directly by planners and developers and by those interested in conservation.

The overall objective of the research was to improve approaches for collating and using earth science information in planning, using the City of Bradford Metropolitan District as an illustrative example. The research aimed to provide broad based advice on ground conditions for use in development planning and development control, and to provide a context for preliminary site investigations.

This study represents one of a series of research projects commissioned by the Department of the Environment in urban industrial areas which have, in part, been affected by mining. The City of Bradford Metropolitan District was selected for this study, as it is adjacent to other areas of West Yorkshire covered by the DoE programme, including Morley–Rothwell–Castleford, Garforth–Castleford–Pontefract and Leeds. Also, the diverse environments of urban areas and rural upland made the District suitable as an illustrative example of a wide range of planning and development issues.

The impact of earth sciences is only one factor in the development process and there are many other planning issues which need to be taken into account. However, planners and developers should be more aware of earth science factors and consider whether any factors are relevant to the particular planning or development issue which they are dealing with. The influence of earth science issues can range from minor considerations, which are not critical to planning decisions but of which developers should be aware, to being a major, if not the major consideration in determining appropriate land use.

It is important to note that Bradford is little different in terms of constraints than most other urban industrial areas in the UK. Adverse ground conditions may result in land allocated in development plans proving to be unsuitable for the purpose or expensive to develop. In other cases inadequate site investigations by developers may lead to abortive development or result in developments which may subsequently be affected by adverse ground conditions, or which may place surrounding development at risk, ultimately leading to expensive remedial measures. A greater appreciation of ground conditions at the forward planning, development control and preliminary site appraisal stages can identify potential problems and can help to ensure that due precautions are taken at the outset in order to minimise risks to the developer and the wider community.

This report (Volume 1) is accompanied by a summary map of the key earth science factors affecting planning and development (Map 1). A more detailed technical report (Volume 2) is accompanied by a set of seven thematic maps which cover a range of applied geological topics and five computer databases, compiled using dBase III+. Volume 2 contains a glossary of technical terms which may be referred to in both volumes of the report.

The complete set of maps produced during the study are:

Map 1 Earth Science Factors relevant to Planning and Development
Map 2 Bedrock Geology
Map 3 Superficial Deposits
Map 4 Mineral Resources and Surface Mineral Workings
Map 5 Mined Ground and Shafts
Map 6 Slope Steepness and Landslips
Map 7 Engineering Ground Conditions
Map 8 Water Resources and Flooding

The computer databases provide summary information on:

- borehole and trial pit data
- site investigation reports
- landslips
- landfill sites
- sandstone quarries

Copies of the reports and maps can be obtained from the British Geological Survey, Kingsley Dunham Centre, Keyworth, Nottingham NG12 5GG. Archival data are held at the same address. Copies of the computer databases are held at BGS, Keyworth, the Department of the Environment, and City of Bradford Metropolitan District Council.

Much of the information used in this study includes archival material collected from numerous sources. Most of this information was available to assist planning and development decisions before the instigation of this study. However, this research provides the first comprehensive compilation of these data into a single report for the District. In addition, the study produced new data on landslips and building stone properties and utilised new geological mapping of the entire District, funded and carried out by the BGS. These data were not previously available to planners and developers, but will assist in the process of making informed decisions.

1.2 GEOGRAPHICAL AND GEOLOGICAL BACKGROUND

The City of Bradford Metropolitan District in West Yorkshire, identified in Figure 1.1, lies to the West of the

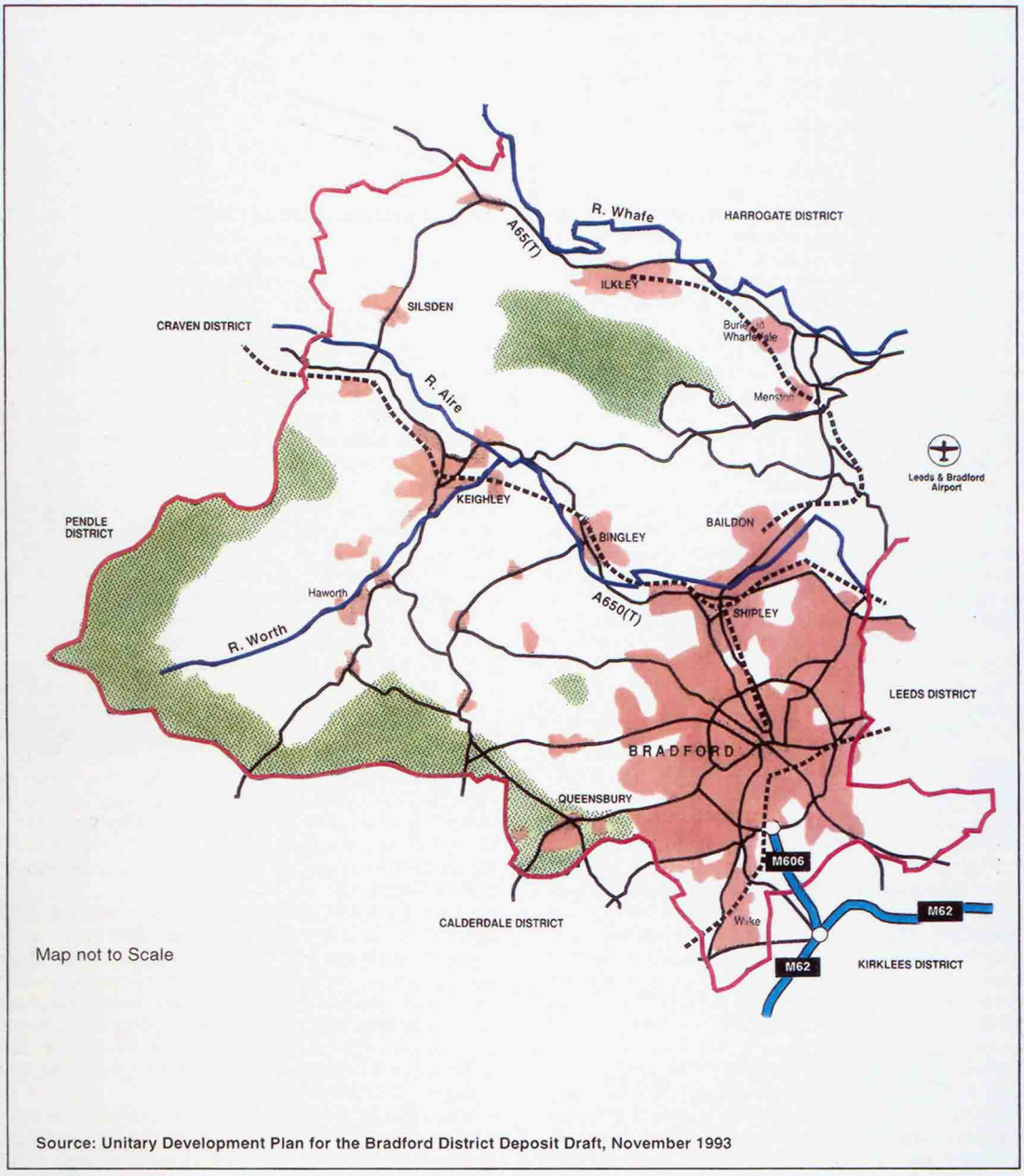

Figure 1.1 Summary map of the City of Bradford Metropolitan District, showing the main urban areas, transport routes and upland areas.

urban conurbation of Leeds, on the eastern flanks of the Pennines chain, the dominant topographical feature of Northern England. The total area of the District is approximately 400 square kilometres with a population in 1991 of about 475 000. Only around 30 per cent of the District has been urbanised, but this area contains about 86 per cent of the population. The majority of the population lives in the City of Bradford, with additional population centres in Airedale, including Shipley and Bingley, and Wharfedale, including Ilkley and Burley in Wharfedale. Keighley has developed at the confluence of the Rivers Aire and Worth and Haworth, with its connection with the Brontë sisters, is situated in the Worth Valley.

The bedrock geology of the District comprises Coal Measures, which underlies much of the south-east of the District, and Millstone Grit, which underlies the remainder of the District. Across much of the District, the bedrock is overlain by glacial and post-glacial superficial deposits. The bedrock and/or natural superficial deposits may locally be overlain by artificial, man-made deposits.

The District is characterised by areas of high relief, and deep, steep-sided valleys. Figure 1.1 shows that the parts of the District comprising land over 300 metres above sea level is largely restricted to the south-west and the area of Rombalds Moor in the north. These upland areas are of great nature conservation importance comprising extensive areas of moorland, grassland and heathland of value for their communities of native plants and animals. The Rivers Aire and Wharfe and a number of smaller rivers flow through the District. These river valleys form the lowest points in the District and provide the locations for the main urban centres and transport routes.

The abundance of water power provided by the Rivers Aire and Wharfe was one of the factors in the growth of the textile industry in the area. During the 1770s the construction of the Leeds–Liverpool Canal along the Aire Valley, connected to the town of Bradford by the Bradford Canal, further stimulated industrial growth in the early 19th Century. A rapid growth of the urban areas of Bradford during the mid 19th Century can largely be attributed to the exploitation of abundant and varied mineral resources including coal, ironstone, fireclay, brickclay and sandstone. The sandstones provided accessible supplies of building stone, with most local buildings being constructed from local stone until the early 20th Century. The result of this industrial activity was a legacy of areas of derelict and despoiled land.

Although Bradford remains renowned for its textile and engineering industries, and much is now being done to promote its heritage, the area is undergoing a process of revitalisation and change, including land reclamation initiatives resulting from past industrial dereliction and the decline of traditional industries. Such initiatives need to take account of the ground conditions that may arise as a result of previous human activities or of natural physical features.

1.3 METHODOLOGY AND SOURCES OF INFORMATION

Planning information presented in this report has been gained from two principal sources:

- published planning documents and other associated literature for the Bradford area;
- structured face to face interviews with representatives from both public and private organisations

A list of interviewees and sources of information are provided in Appendices 1 and 2 respectively.

1.4 STATEMENT OF LIMITATIONS

This volume, used in conjunction with Map 1, is intended to provide general information on the types and distribution of earth science factors which are of relevance to planning and development in the Bradford District. It also provides a brief introduction to the appropriate actions recommended where such factors exist and attention is also drawn to other sources of information and organisations which should be consulted for advice. Further information on the main earth science issues relevant to the District are provided in Volume 2 of the report, and the accompanying thematic maps, which are aimed for use by those with technical knowledge, such as geologists, engineering geologists, hydrogeologists, and those interested in conservation issues.

Each map has only a limited descriptive key and it is essential that the maps should be used in conjunction with the reports, which contain more detailed descriptions and indicate the limitations of the information portrayed. The report and associated databases may be used as a guide to more detailed sources of information such as the collection of non-confidential boreholes and other data which comprise the British Geological Survey, National Geological Records Centre data collection. These include 1:10 000/ 10 560 geological standards and technical reports from the geological survey of the area. Data used in the preparation of the reports and thematic maps are held by the National Geological Records Centre, BGS Keyworth, and, with the exception of confidential records, can be consulted by prior arrangement.

This report, and associated maps, provides only general indications of ground conditions and must not be relied upon as a source of detailed information about specific areas, or as a substitute for site investigations or ground surveys. Users are advised to seek appropriate professional advice and, if necessary, carry out site investigations and ground surveys, to ensure that ground conditions are suitable for any particular land use or development.

The report and associated thematic maps provide information which is interpretative, of variable quality and is distributed unevenly. Whilst efforts have been made to collect a representative range of relevant data, some information was not available for use in the study. In addition, new information is continually being acquired. Users of the report and maps are advised, therefore, to check carefully for additional relevant information, particularly when considering the characteristics and suitability of specific sites.

The report presents the views of the authors, which may not necessarily be those of the Department of the Environment or the City of Bradford Metropolitan Council.

2 Planning policy context

2.1 THE PLANNING SYSTEM

The town and country planning system was established in 1947 and remains unchanged in its essential requirements in that planning permission is required for most types of development to proceed. The legislation is now embodied in the Town and Country Planning Act 1990 and as amended by subsequent acts. The planning system is administered by the Department of the Environment but is operated by local planning authorities.

The planning process aims to regulate the development and use of land in the public interest. It is intended to facilitate much needed development whilst striking an appropriate balance with the need to conserve and protect the environment in order to enhance the quality of life. Any development requires a planning application to the local planning authority; the latter must take account of the development plan and other material considerations in reaching a decision and must grant planning permission unless the development will result in demonstrable harm to interests of acknowledged importance. The onus is on the applicant to provide any information with respect to material considerations, including those influenced by earth science factors.

Property developers are not always held liable for the clean-up of contaminated land. Responsibility in the first instance will fall on the original polluter, but then on the current owner of the land if the polluter cannot be found. Failure to obey an order to clean up a polluted site will be a criminal offence, with fines of up to £20 000, followed by daily penalties. In exceptional circumstances, the local authority may carry out the work and recover the costs from the land owner.

2.2 NATIONAL PLANNING POLICY

In order to facilitate the smooth operation of the planning system the Department of the Environment issues advice to local planning authorities and developers in the form of Planning Policy Guidance Notes (PPGs), Mineral Planning Guidance Notes (MPGs), Circulars and other Government policies and statements such as the 1990 White Paper on the environment "This Common Inheritance" and more recently "Sustainable Development, The UK Strategy", published in January 1994.

A list of current PPGs, MPGs and Circulars which describe the general features of the planning system, or relate to specific issues relevant to the Bradford area, are provided in Table 2.1.

2.3 REGIONAL PLANNING GUIDANCE FOR YORKSHIRE AND HUMBERSIDE

Regional Planning Guidance, resulting from joint consideration by the local planning authorities and the Department of the Environment is due to be published for Yorkshire and Humberside in 1996.

Regional Planning Guidance is provided by the Secretary of State for the Environment to assist local authorities in Yorkshire and Humberside in reviewing and preparing their development plans. It is a requirement of the planning acts that local planning authorities must have regard to such guidance when formulating strategic policies and proposals for their areas.

To date, local planning authorities in West Yorkshire have had regard to:

- the Secretary of State's Strategic Guidance for West Yorkshire, published in 1989 as RPG2; and
- the Secretary of State's consultation draft Regional Planning Guidance for Yorkshire and Humberside, published in January 1995.

The draft Guidance makes specific reference to the need to support continued efforts to regenerate and diversify the economic and industrial base of those areas affected by the rundown of employment in long established steel, engineering and woollen industries. The draft Guidance also stresses the need to protect areas of designated green belt from development, with new development concentrated as far as possible on re-cycled or derelict land within the urban fabric.

Throughout the region the key objectives are:

- to promote economic prosperity
- to conserve and where possible enhance the environment
- to facilitate the processes of industrial adjustment, economic diversification and urban regeneration; and
- to make best use of the available resources.

Specific information on dwelling requirements for the region over the period 1991–2006 is provided in the draft Guidance. For Bradford the figure is 2 100 new dwellings per annum, which represents a total of 31 000 new dwellings over the fifteen year period. It also provides details of schemes in the roads programme for the District. Furthermore the draft Guidance highlights the need to take precautions when considering development on unstable ground, in order to avoid development delays or subsequent damage to structures.

2.4 DEVELOPMENT PLANS

Development Plans are mandatory documents prepared by local authorities. These provide the context for deciding planning applications and identify sites needed to meet demands for various land uses and development. Preparation takes account of the views expressed in public consultation and plans are reviewed and updated as necessary, at appropriate intervals. The plans are based on extensive surveys of social, economic and physical characteristics together with trends which planning authorities compile for their areas.

The City of Bradford is the subject of a Unitary Development Plan (UDP) which consists of two parts. Part 1 sets out strategic policies for the area, whilst Part 2 contains detailed policies for planning and development. These

Table 2.1 Government guidance relevant to planning and development in City of Bradford MDC.

Planning Policy Guidance Notes (PPGs)		**Date Published**
PPG1	General Policy and Principles	March 1992
PPG2	Green Belts	January 1995
PPG3	Housing	March 1992
PPG4	Industrial and Commercial Development and Small Firms	November 1992
PPG6	Town Centres and Retail Development	July 1993
PPG7	The Countryside and the Rural Economy	January 1992
PPG9	Nature Conservation	October 1994
PPG12	Development Plans and Regional Planning Guidance	February 1992
PPG13	Transport	March 1994
PPG14	Development on Unstable Land	April 1990
PPG15	Planning and the Historic Environment	September 1994
PPG16	Archaeology and Planning	November 1990
PPG17	Sport and Recreation	September 1991
PPG21	Tourism	November 1992
PPG22	Renewable Energy	February 1993
PPG23	Planning and Pollution Control	July 1994
PPG24	Planning and Noise	September 1994
Minerals Planning Guidance Notes (MPGs)		
MPG1	General Considerations and the Development Plan system	January 1988
MPG2	Applications, Permissions and Conditions	January 1988
MPG3	Coal Mining and Colliery Spoil Disposal	July 1994
MPG4	The Review of Mineral Working Sites	Septembr 1988
MPG5	Minerals Planning and the GDO	December 1988
MPG6	Guidelines for Aggregates Provision in England	April 1994
MPG7	The Reclamation of Mineral Workings	September 1989
MPG12	Treatment of Disused Mine Opening and Availability of Information on Mined Ground	March 1994
Circulars		
22/80	Development Control Policy and Practice	November 1980
15/88	Environmental Assessment	July 1988
17/89	Landfill Sites : Development Control	July 1989
14/91	Planning and Compensation Act 1991	August 1991
17/91	Water Industry Investment : Planning Considerations	November 1991
30/92	Development and Flood Risk	December 1991
7/94	Environmental Assessment Amendment of Regulations	March 1994
11/94	Environmental Protection Act 1990 Part II : Waste Management Licensing, The Framework Directive on Waste	April 1994
3/95	Permitted Development and Environmental Assessment	March 1995
10/95	Planning Controls Over Demolition	May 1995

respectively mirror the function of structure plans, prepared by county authorities, and local plans prepared by districts, outside the Metropolitan area.

2.5 BRADFORD UNITARY DEVELOPMENT PLAN

The UDP for the District is currently being prepared by the Metropolitan District Council. The UDP provides advice to the public, landowners and developers on appropriate uses of land up to the year 2001. The Deposit Draft UDP for the Bradford District was the subject of a Public Inquiry in 1995.

The themes from the Principal Policies of the Deposit Draft UDP are similar to those set out in RPG2 and the draft Regional Planning Guidance for Yorkshire and Humberside and include:

- to promote the recycling of urban land;
- to minimise the loss of green fields;
- to revitalise urban areas;
- to respect, protect and where possible, enhance the natural environmental features on sites both within urban areas and on greenfield sites.

In identifying land for development, consideration has been given to making the best use of the District's land resources. For example, allocations in urban areas include Constrained Housing Sites. But inclusion of such sites has enabled more countryside to be protected from development; proposed plan allocations for housing and employment will only lead to the loss of about 70 hectares (0.3 %) of former Green Belt.

Since this study on ground characteristics in the Bradford area will not be finalised until April 1996, some of the information presented in this report may not be reflected fully in the current Deposit Draft UDP. However, this report will be available to be taken into consideration during the review of the UDP, which should commence in 1996 following the adoption of the existing Plan.

3 Planning and development issues

3.1 INTRODUCTION

The Deposit Draft of the UDP for the District and consultation with representatives of the Local Authority, public utility companies, consultancies and other interested parties (see Appendix 1 for list of interviewees) have highlighted a number of planning issues relevant to the District upon which earth science factors may locally have a direct influence.

- Land for Housing and Industrial Development
- Improvement of Transport Network
- Protection and Development of Mineral Resources
- Provision of Waste Disposal Facilities
- Control of pollution
- Protection and Development of Water Resources
- Protection of Washland Areas and Flood Prevention
- Landscape and Nature Conservation

Table 3.1 identifies the earth science factors which may locally have a direct influence on these planning and development issues. Each earth science factor identified in the table is discussed in more detail in Chapter 4. Table 3.2 indicates where in the District the earth science factors are important, indicates which thematic maps and chapters of Volume 2 of this report should be

Table 3.1 Summary of planning and development issues and relevant earth science factors in City of Bradford Metropolitan District.

✓✓ Major Significance

✓ Minor Significance

Planning and Development Issues	Earth Science Factors								
	Variable Man Made Ground Conditions	Known or Potential Shallow Undermined Ground	Mineral Resources	Surface Mineral Workings	Geological Faults	Landslip Areas	Water Resources	Washland Areas Liable to Flooding
Housing and Industrial Development	✓✓	✓✓	✓	✓	✓	✓	✓	✓
Improvement of Transport Network	✓✓	✓✓	✓	✓	✓	✓✓		✓
Protection and Development of Mineral Resources	✓	✓	✓✓	✓	✓	✓	✓	✓
Provision of Waste Disposal Facilities	✓✓	✓✓	✓	✓✓	✓	✓	✓✓	✓
Control Of Pollution	✓	✓		✓✓	✓✓		✓✓	
Protection and Development of Water Resources	✓	✓	✓		✓		✓✓	
Protection of Washland Areas and Flood Prevention	✓	✓	✓	✓			✓	✓✓
Landscape and Nature Conservation	✓	✓	✓	✓				

Table 3.2 Summary of geographical areas in City of Bradford Metropolitan District affected by earth science factors.

✓✓ Major Significance

✓ Minor Significance

Earth Science Factor	Geographical Area				Further Information		
	South East Bradford City	South West Worth Valley	Central Aire Valley	North Wharfe Valley	Thematic Map	Technical Report Chapter	Organisations
Variable Man Made Ground Conditions	✓✓		✓✓	✓	3 & 7	6,10, 11,12	British Geological Survey/Bradford MDC Planning and Building Control/West Yorkshire Waste Regulatory Authority
Known or Potential Shallow Undermined Ground	✓✓				5	8,10, 11,12	British Geological Survey/Bradford MDC Minerals Division/ District Mineral Valuer/Coal Authority
Mineral Resources	✓	✓✓	✓✓	✓✓	4	7	Bradford MDC Minerals Division/ British Geological Survey/Coal Authority
Surface Mineral Workings	✓	✓	✓	✓	4	7	British Geological Survey/Bradford MDC Minerals Division/ District Mineral Valuer/Coal Authority
Geological Faults	✓	✓	✓✓	✓✓	2	6,9,10 11,12	British Geological Survey/Bradford MDC Building Control
Landslip Areas		✓✓	✓	✓✓	6	9	British Geological Survey Engineering Geology and Geophysics Unit/Bradford MDC Building Control
Water Resources	✓	✓✓	✓✓	✓✓	8	11	Yorkshire Water/NRA Yorkshire Region/British Geological Survey Wallingford
Washland Areas Liable to Flooding	✓✓	✓	✓✓	✓	8	11	NRA Flood Defence Unit

referred to, and which organisations should be contacted for further information.

3.2 LAND FOR HOUSING AND INDUSTRIAL DEVELOPMENT

The current rising demand for new housing development, a consequence of rising population and increased numbers of old housing stock in need of renewal, requires that the Deposit Draft UDP identifies land for house building. Such developments inevitably result in a requirement for provision of ancillary community facilities, such as schools, shops and health centres. The population growth in association with a general decline in the traditional heavy industrial base of the local economy presents a threat of rising unemployment in the District. The Deposit Draft UDP aims to overcome this by providing land to support the expansion or relocation of manufacturing and service industries. The Regional Planning Guidance requires the provision of an adequate supply of land for both housing and industry, with a wide range of sites in terms of location and size. The emphasis is on bringing vacant and derelict land in built up areas back into use (Plates 1 and 2).

3.3 IMPROVEMENT OF TRANSPORT NETWORK

A growth in volume of traffic in the District, with a resultant congestion of many of the main urban roads during peak periods, and continued loss of car parking facilities as sites are being developed in the urban centres, are important issues. The Regional Planning Guidance recognises the importance of improvement in the transport network to facilitate economic growth and urban regeneration. The Deposit Draft UDP transport strategy includes an aim to encourage promotion of public transport, but, with a realisation that a number of road improvement schemes are necessary to meet predicted road traffic growth (Plate 3). Local Authority policy is that "*planning consent will not normally be granted for other purposes for the development of land required for the construction of trunk roads included in the Department of Transport's national roads programme*". The following schemes are planned:

Department of Transport highway schemes

A650	Airedale Route Section III (Crossflatts to Cottingley Bar)
A629/A650	Hard Ing Roads, Keighley
A650/A6038	Shipley Eastern Bypass

Local Authority major schemes

M606/A6177 Staygate Roundabout improvement
Bradford City Ring Road (Stage IV)
Canal Road, Bradford (Stages 1 & 2)
Tong Street Improvements

3.4 PROTECTION AND DEVELOPMENT OF MINERAL RESOURCES

The Local Authority is the mineral planning authority and is responsible for planning control of mineral working, reclamation and restoration after extraction and safeguarding strategically important resources (Plate 4). Mineral Planning Guidance Notes and Regional Planning Guidance aim to ensure that demand for minerals is met, that environmental impacts are minimised during working and that land is rapidly returned to appropriate beneficial uses after working ends.

Policies set out in the Deposit Draft UDP, include:

i) *Proposals for new mineral working will normally be permitted provided it can be demonstrated that it is not reasonably practical to extend existing mineral workings.*

ii) *Proposals for extensions to existing mineral workings or new mineral workings (including the winning of minerals from railway embankments) will be permitted provided all of the following criteria are satisfied: There is evidence of a viable deposit of the mineral in terms of quality and quantity; there is a demonstrable need for the mineral except for hydrocarbons; there will not be an adverse impact on the local environment in terms of visual amenity, noise, dust, ground or water pollution or other nuisance during or after the operation; access arrangements are satisfactory and other traffic generated by the development will not have an adverse impact on existing traffic routes between the site and the principal road network or on residents living close to such traffic routes.*

iii) *Proposals for mineral workings which are acceptable in terms* (of the above) *will be permitted provided the following matters have been adequately addressed to ensure the development of the site is carried out in a satisfactory manner: A detailed timescale for all operations; the provision of screening in advance and whilst work is in progress; a detailed phased scheme of working, restoration and landscaping; the retention, maintenance or replacement of all boundary features; measures to maintain the stability of land surrounding the site; the preservation, replacement or diversion of existing site features and services including the safeguarding of conservation interests; the protection of groundwater, watercourses, lakes, ponds and other water bodies and the provision of any necessary drainage; satisfactory access, including measures to protect the environment from the effects of vehicles entering and leaving the site; location of ancillary facilities (offices, storage, etc.); protection, or diversion and reinstatement of all public rights of way; hours of working; measures to minimise the environmental impact of noise, dust and vibration; the making of satisfactory provision for the disposal of waste minerals arising from the mineral operations; the provision of a detailed scheme of aftercare and management.*

iv) *Applications for planning permission for surface development should safeguard mineral resources or make provision for ensuring that the mineral is extracted before surface development begins unless the applicant can demonstrate that it would not reasonably be practical to do so.*

v) *Proposals for the production of aggregates from recycled materials will normally be permitted.*

vi) *Proposals for the commercial extraction of peat will not be permitted where it would adversely affect the landscape character and ecology of the Pennine*

Uplands especially in areas designated for their nature conservation importance.

3.5 PROVISION OF WASTE DISPOSAL FACILITIES

The Environmental Protection Act 1990 resulted in the establishment of Waste Regulation Authorities, responsible for issuing licences and preparing Waste Disposal Plans, and Waste Disposal Authorities, responsible for making arrangements for the disposal of waste. Under the Planning and Compensation Act 1991, the UDP has to take account of these Waste Disposal Plans.

The West Yorkshire Waste Management Joint Committee Waste Disposal Plan, published in June 1990, established the following planning policies:

i) *The principal means for the final disposal of waste will be by landfill until such time as better or more appropriate waste disposal options become available.*

ii) *Proposals for the disposal of waste will only be approved where it can be shown that the effects of the proposals on the environment, on existing and proposed land uses in the locality and on the local communities are acceptable taking account of the extent to which the area has been subject to the effects of past disposal activity, mining or mineral operations.*

iii) *Proposals acceptable under the above will be subject to conditions and legal agreements which provide for: Adequate screening of the site; minimising other environmental problems; appropriate modes of transport; satisfactory access arrangements; safeguarding of conservation interests; appropriate phased restoration, linked to a permitted period of operation; the design, maintenance and arrangements for the control of leachate and/or landfill gas arising from waste disposal sites during tipping operations and after completion of tipping.*

A revised draft Waste Disposal Plan for West Yorkshire is at consultation stage, but will become obsolete by April 1996, when the Environmental Agency is set up.

Although the Deposit Draft UDP emphasises the Local Authority commitment to recycling wastes, and to incineration of wastes, it is anticipated that there will be a growing need for additional landfill sites in the future and that there is a growing shortage of suitable sites (Plate 5).

Policies set out in the Deposit Draft UDP, include:

i) *Proposals for landfill or landraising will normally be permitted provided all of the following criteria are satisfied: There will not be an adverse impact on the local environment in terms of visual amenity, noise, dust, smell, air, ground or water pollution or other nuisance during or after the operation; there will be no loss of important landscape, ecological or geological features; access arrangements are satisfactory and any traffic generated will not have an adverse impact on routes or the amenity of residents living close to these routes) between the site and the principal road network; land will not be lost that is currently in recreational use with public access unless the site, or part of it is in a degraded or derelict state and the proposal would improve the site for future use by the public.*

ii) *Proposals for landfill or landraising which are acceptable in terms (of the above) will be permitted provided the following matters have been adequately addressed to ensure the development of the site is carried out in a satisfactory manner: A detailed timescale for all operations; the provision of screening in advance and whilst work is in progress; a detailed scheme of operation and landscaping to minimise environmental impact; a restoration scheme which must take account of the proposed after use and provide for the protection of ground water, watercourses, water bodies and drainage; satisfactory provision for leachate and landfill gas control, monitoring and dispersal during and after operations; satisfactory access, including measures to protect the environment from the effects of vehicles entering and leaving the site; location of ancillary facilities (offices, storage, etc.); hours of working; measures to minimise the environmental impact of noise, dust and wind-blown material; a detailed scheme of aftercare and management.*

3.6 CONTROL OF POLLUTION

Under the Environment Act 1995, every local authority has a duty to identify areas of contaminated land. The Deposit Draft UDP emphasises the Local Authority's policy stating the importance of recognising areas of land used for industrial purposes where hazardous substances may be found. PPG23 *Planning and Pollution Control* gives guidance to local authorities on the relevance of pollution controls to planning policy.

Although the Local Authority encourage a full and effective use of land in urban areas, it is important that public health and safety are not endangered by such developments. Policies set out in the Deposit Draft UDP, include:

i) *Planning permission for development on land known or strongly suspected by the Council to be contaminated will be granted provided that: A full site investigation has been carried out by the developer to determine whether contaminants are present or not, and if any contaminants are found the developer carries out any measures required to adequately overcome the problem prior to the commencement of development.*

ii) *Development proposals within 250 metres of former landfill sites should make satisfactory arrangements to overcome the dangers of migrating gas.*

iii) *The reworking or disturbance of landfill sites restored or reclaimed to a satisfactory environmental standard will not normally be permitted except where it can be demonstrated that there would be no risk of creating pollution or hazards to public safety.*

3.7 PROTECTION AND DEVELOPMENT OF WATER RESOURCES

The main bodies involved in water resource planning are the National Rivers Authority (NRA), the rôle of which is to be replaced by the Environment Agency after April 1996, the Local Authority and Yorkshire Water plc. The

NRA are responsible for producing policy on catchment management planning concerning surface water quality for the River Wharfe, Aire and Calder catchment areas. NRA Policy and Practice for the Protection of Groundwater (1992) provides a framework for the protection for individual groundwater sources and the protection of the resource as a whole. The NRA are also responsible for providing discharge consents and abstraction licences. They also liaise with, and prepares guidance for local authorities. Yorkshire Water are responsible for producing a water supply policy and responding to NRA recommendations. The local authority is responsible for the preparation of planning policies and development plans, control of development and taking action on environmental health issues.

The Deposit Draft UDP does not make specific recommendations concerning water resources. However, it emphasises that water quality issues are a major concern of the Council and that within the planning powers available, it will seek to protect and where possible improve the quality of water bodies present in the District (Plate 6). In particular, the Deposit Draft UDP recognises that:

- Adequate provision of surface water drainage, sewerage and sewage treatment are required for new surface developments;
- Mineral exploitation and waste disposal do not pollute surface water or groundwater bodies;
- The nature conservation value of water bodies are recognised and safeguarded;

3.8 PROTECTION OF WASHLAND AREAS AND FLOOD PREVENTION

The National Rivers Authority (NRA) catchment management plans designate areas of 'washland' for the main rivers. These are mostly areas of natural river floodplain which provide essential storage of floodwaters (Plate 7). A development in an area of washland which raises the level of land or acts as a barrier to floodwater can lead to more serious flooding problems elsewhere. The Deposit Draft UDP recognises the significance of, and aims to protect, washland areas. The policy set out in the Deposit Draft UDP, is that:

> *development will not be permitted on washlands defined on the proposals maps except where the proposed development would not significantly affect the function of washlands, and there would be no serious risk to the development from flood debris or pollution.*

Any development proposal on washland areas requires consultation between the Local Authority and the NRA.

3.9 LANDSCAPE AND NATURE CONSERVATION

One of the striking features of the District is the quality and character of its landscape, ranging from rugged open moorland to rolling farmland and from open river valleys to wooded hillsides.

Much of the District's countryside is designated in the Deposit Draft UDP as Green Belt (approximately 62 percent of the total area of the District). Policies in the Deposit Draft UDP set down basic principles to strictly control development in the Green Belt, within the guidelines set down by Government policy in PPG2 Green Belts. In particular, except in very special circumstances, planning permission will not be given within the Green Belt for the construction of new buildings or for the change of use of existing buildings for purposes other than agriculture and forestry, outdoor sports, cemeteries, institutions standing in extensive grounds or other uses appropriate to a rural area. Changes to the extent of the Green Belt will only take place when exceptional circumstances exist which necessitate such revisions.

Within the Green Belt and other rural areas there are areas of high quality landscape defined as Special Landscape Areas. Among the types of landscape regarded as special and worthy of protection are open moorland areas (and their settings), mature parkland and well wooded steep valley sides. The policy set out in the Deposit Draft UDP for Special Landscape Areas, is that:

> *Within or adjacent to the Special Landscape Areas shown on the proposals maps, development will not be permitted if it adversely affects the visual character of the Special Landscape Area. The scale, siting, design and materials of development in such areas should be sympathetic to such character.*

The District also possesses a great diversity of areas of nature conservation interest. The District has three Sites of Special Scientific Interest (SSSIs) and 21 sites designated as Sites of Ecological/Geological Importance (SEGIs). There are also a number of Local Nature Reserves. The location of these sites are identified in the Deposit Draft UDP and a list is provided in the section on Conservation Sites in Volume 2, Tables 8 and 9.

A total area of over 2000 hectares of SSSIs and SEGIs are identified. The majority of sites are located in the north of the District, in the countryside near Keighley, Ilkley and Shipley. They range from large areas such as Ilkley Moor to small but significant ponds such as Beechcliffe Ings at Keighley. Also included is the 24 kilometre length of the Leeds-Liverpool Canal where it passes through the District.

Regionally Important Geological/Geomorphological Sites (RIGS) represent areas of specifically geological interest, which are of county significance in terms of education, scientific, aesthetic and historic value. A programme of identification of RIGS is currently being carried out in the District. Many of the sites proposed are disused quarries.

SSSIs have a statutory designation notified by English Nature, and as such are subject to statutory consultations. If a development is proposed that will have a significant effect on a SSSI the Secretary of State for the Environment may call in the planning application to make the decision himself. Local Nature Reserves, SEGIs and RIGS are non-statutory designations. However, in the Deposit Draft UDP there is a commitment to safeguard all such notified sites from adverse development. The policy set out in the Deposit Draft UDP is that:

> *Development will not be permitted if it would directly or indirectly adversely affect either physically or through air, noise or water pollution the character of Sites of Special Scientific Interest, Sites of Ecological or Geological Importance, or local nature reserves shown on the proposals maps or which are subsequently designated.*

Plate 1 A 20 hectare area of rubble and debris strewn waste land with remains of a former mill building and railway siding and land vulnerable to flooding, prior to development of the Grattan site. Reproduced with permission from City of Bradford Metropolitan Council, Design and Construction Services.

Plate 2 The Grattan warehouse site after development. Pictured by Joan Russell, Guzelian.

Plate 3
Construction of the Burley in Wharfedale Bypass; one of a number of schemes to improve the transport network of the District. The scheme, now complete, involved re-routing the River Wharfe, supporting the river bank and stockpiling soil and alluvial gravels.

Plate 4 Hand-parting of sandstone flags at Deep Lane Quarry: Yorkshire Stone Quarries (Bradford) Ltd; one of 12 working quarries at the time of the project. Sandstone, the main resource in the District, is worked for building stone, ornamental stone or crushed for aggregate or sand.

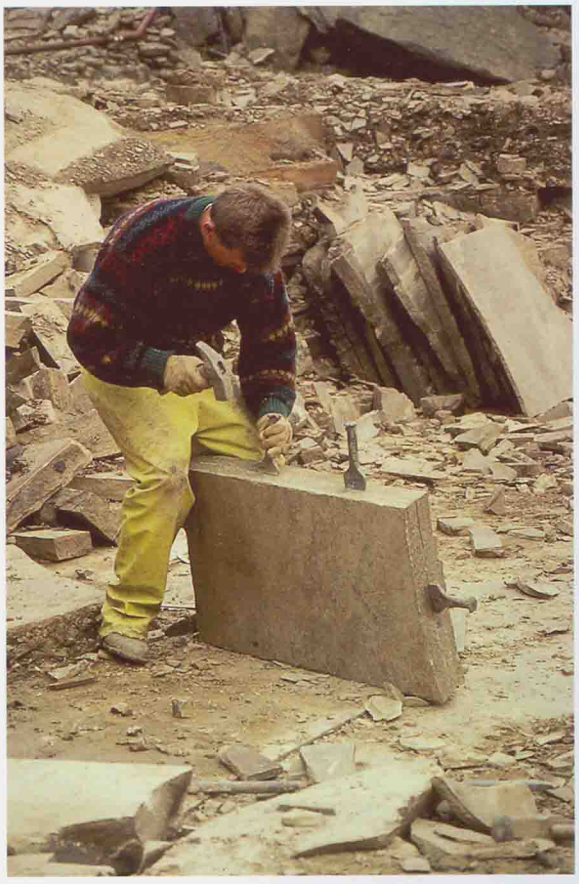

Plate 5 Sugden End landfill site, near Haworth. Many of the landfill sties in the District occupy disused quarries or railway cuttings, though Sugden End is infilling a glacial meltwater channel.

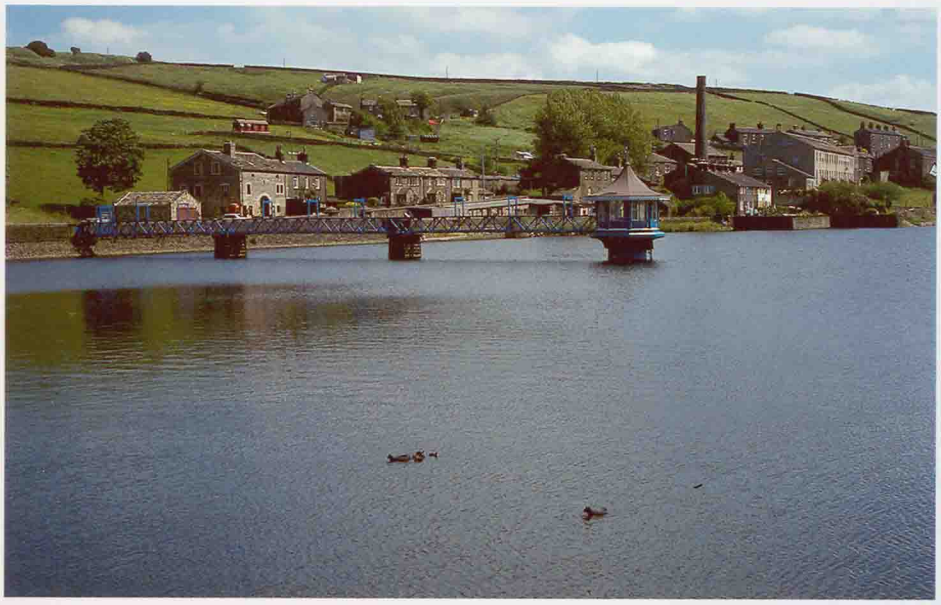

Plate 6 Leeming Reservoir, near Oxenhope; one of a series of reservoirs located mainly in the upland areas in the west of the District, or outside the District in North Yorkshire, which supply water to the area.

Plate 7 A view of Airedale, with Steeton in the distance, showing flooding of washland areas.

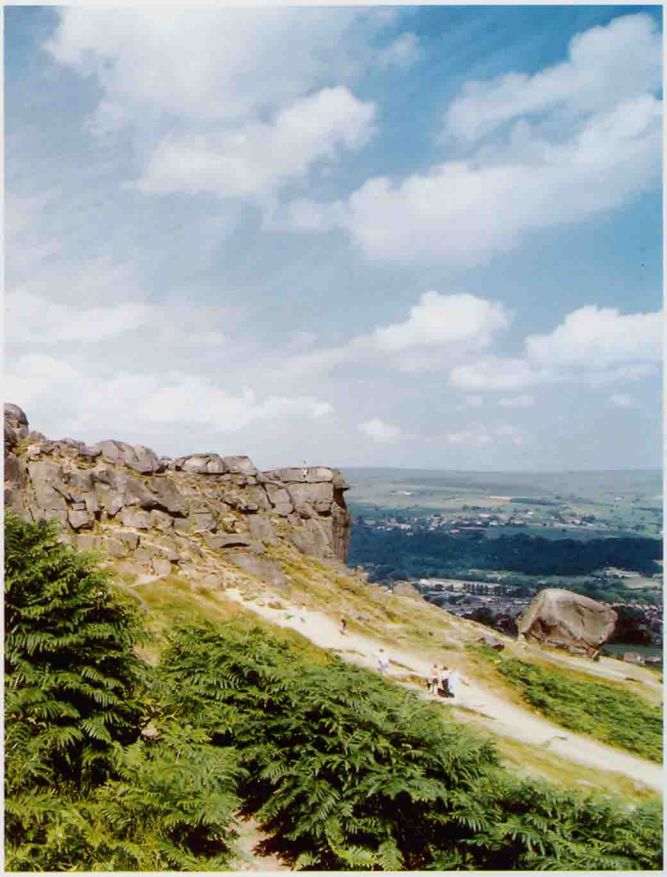

Plate 8 The Cow and Calf Rocks, Ilkley, provide a popular recreational amenity for walkers and climbers. The crag, in Millstone Grit sandstone, was formerly quarried in part and is of earth science interest, particularly as an example of a large topple fall (the 'Calf'). Reproduced with permission from City of Bradford Metropolitan Council, Economics Initiatives Division: Marketing Unit.

Sites of nature conservation interest provide a valuable resource for recreation as well as an important asset for research and education (Plate 8). It is important, therefore, to encourage the establishment of new sites and ensure the retention and maintenance of existing sites. Once any land is built on, the restoration of natural or semi-natural habitats and landscape features is rarely possible and usually expensive.

English Nature can provide advice and may contribute towards the cost of setting up and managing nature conservation projects in local communities. Information may be obtained from the Humber to Pennines Local Area Team of English Nature, as well as the Countryside Commission.

The Ecological Advisory Service for West Yorkshire has recently compiled a comprehensive survey of the ecology of Bradford. The information is available to both professionals and the public and is held by The Ecological Advisory Service and City of Bradford MDC Planning Department.

Chapter 6 *Conservation sites* of Volume 2 of this report should be consulted for further information.

4 Relevance of earth science

4.1 INTRODUCTION

This chapter provides a brief insight into the earth science factors which should be taken into account by planners, developers and other interested parties involved in the planning and development process in City of Bradford Metropolitan District. More detailed information is provided on the thematic maps and in Volume 2 of the Technical Report. In addition, the Local Authority and British Geological Survey hold databases which contain site specific information.

Consultation with representatives of the Local Authority, public utility companies, consultancies and other interested parties (see Appendix 1 for list of interviewees) have identified the main earth science factors which may locally have a direct influence on a number of planning issues relevant to the District. These factors are:

Variable man-made ground conditions
Known or potential shallow undermined ground
Mineral resources
Surface mineral workings
Geological faults
Landslip areas
Water resources
Washland areas liable to flooding

For each factor the following questions are addressed:

Why is this factor relevant to planning and development?
Where is this factor of importance?
What should be done about this factor
What literature should be consulted?
Who should be contacted for further information?

Planners and developers should use the information provided in this report when carrying out a development appraisal of the District. During the initial stage Map1 should be examined to determine areas where important earth science factors may have a relevance to planning and development. During this initial appraisal process the available literature and contacts highlighted for each factor should also be consulted.

Following this initial "broad brush" appraisal and the identification of a specific area of search the more detailed thematic maps, technical report (Volume 2) and databases should be examined. These will provide more information about the potential ground conditions of a particular area. From this, it is possible to predict the types and level of detail of investigations and some general features of preventative and remedial measures which may be necessary prior to development. The approximate costs of these measures may then be entered into the equation during the individual site analysis stage.

It should be noted, however, that the information contained within this report and the technical report and shown on the thematic maps does not, in any way, replace the need for a detailed site survey, carried out by suitably qualified professionals.

Planners involved in strategic planning should use the information presented in this report and the more detailed technical report, together with the thematic maps, when considering allocating sites for certain types of development. The information should be taken into consideration along with other social, economic and environmental factors. This should ensure that sites allocated for a particular land use are capable of being effectively and economically developed for that particular use. However, there may be some circumstances where promotion of development which may not be the most economic may still be valid.

Planners working in development control should take the information in this report into consideration when determining planning applications. If it is an outline application, the information can help towards determining whether it is an appropriate land use for the site. It can also be used to highlight any factors which need to be considered when formulating planning conditions. If a detailed application is being determined the information should be examined to determine whether any potential earth science constraints or possible opportunities effecting the site have been taken into account in the application, and once again planning conditions should relate to specific factors identified.

The information should be used by planners when developing a view on whether information presented with a planning application addresses all of the necessary issues or is detailed enough and, thus, whether there is a need to request additional information. Planners may also use the information to decide whether there is a need to refer planning applications to the building control section. **Professionals working in Building Control** may also find the information useful when determining applications for building regulations. For example, ensuring that appropriate foundations are used if the site is affected by unstable ground.

By considering earth science factors at an early stage in the planning process appropriate action may be taken to ensure sites proposed for development or other changes to the use of the land are suitable, or that appropriate mitigation measures are taken prior to development. This should help to minimise the vast cost, disturbance and inconvenience that arises when remedial measures have to be carried out during or after a site has been developed.

4.2 VARIABLE MAN-MADE GROUND CONDITIONS

The industrial development of the district has left much of the urban and industrial areas now comprising areas of man-made deposits. These deposits may be deposited on natural ground and can include civil engineering works, spoil from mineral extraction industries, building and demolition rubble, waste from heavy industries, such as slag from ironworks and cinders from textile mill boilers, and domestic waste. The deposits can also occur in areas where the natural ground surface has been removed through mineral excavations or railway cuttings and later wholly or partly backfilled using a variety of material. Common types of fill include excavation waste, construction and demolition waste, domestic refuse and industrial waste.

Why is this factor relevant to planning and development?

Historically in the UK, areas of man-made deposits have either been developed with little consideration of the potential environmental effects, or, have been avoided in favour of greenfield sites. However, there is growing pressure to protect greenfield sites from development together with a driving force by central and local government to regenerate former industrial areas.

The main hazards associated with man-made deposits are:

- The often uncompacted or poorly compacted nature of man-made deposits can give rise to unstable foundation conditions. Cavities and boundaries between man-made deposits and bedrock present problems of differential settlement.

- Potentially harmful substances may be present as a primary component of the man-made deposit or generated as a consequence of chemical or biological reactions. These contaminants may migrate both within the deposit and into adjacent permeable strata. Contaminants may exist in soils where they may be a particular hazard to gardeners and children. They may migrate in low concentrations into water supplies. In some cases, contaminants in the ground may affect construction materials.

- Toxic or explosive gases, particularly methane and carbon dioxide, may be generated in man-made deposits which contain a high proportion of biodegradeable material. Such gases can migrate through adjacent permeable strata and accumulate within buildings some distance from the source. An associated problem is the presence of offensive odours.

Where is this factor of importance?

The areas of variable man-made ground conditions, shown on the accompanying map (Map 1), are in the main urban centres of Bradford, Shipley, Bingley, Keighley and along the River Aire. The map does not distinguish between the different types of man-made deposit. The nature of these deposits often relates to a former industrial land use, which is shown on Map 3. However, this provides only a guide to the possible composition of the deposit, which can only be ascertained through suitable site investigations. The following are types of former land use which may be associated with potentially hazardous deposits:

Landfill Sites

Prior to The Control of Pollution Act 1974 there was little control applied to landfill operations in terms of siting, nature of fill and restoration. Pre 1970s sites often contain unknown waste, there is no monitoring of landfill gas or leachate and nothing is known about the current state of the wastes. Contaminants may include a wide range of heavy metals, sulphates, sulphides, acids, alkalis, hydrocarbons, phenols, dioxins and PCBs. Biodegradation of organic material in landfill generates gases such as methane and carbon dioxide, which in extreme circumstances may lead to the risk of fire or explosion, and the formation of leachates, which can lead to the pollution of surrounding soil and groundwater. The main locations for landill sites in the District include:

Former quarries and pits — both in urban and rural areas
Disused railway cuttings — particularly within urban Bradford
Topographical depressions — particularly dry valleys in rural areas

Colliery Spoil

The coal mining industry was largely restricted to the south and east of the District, in the area where Coal Measures outcrop, though small scale mining activity occurred elsewhere in the vicinity of Keighley and Haworth. However, it is in urban Bradford that significant volumes of colliery spoil are found at the surface. This spoil may contain high coal and carbonaceous shale contents, which can be subject to spontaneous, accidental or deliberate ignition. The deposits may be associated with high sulphate contents which can be harmful to concrete present in foundations or buried services.

Quarry Spoil

Large volumes of quarry spoil are common in both rural and urban parts of the District. This material is generally inert and is not associated with the generation of harmful gases or presence of contaminants. However, such spoil may present poor foundation conditions if it contains large cavities and/or was deposited on steep slopes.

Railway land

This includes depots, carriage works and other engineering and storage activities where ashes, cinder and other fill materials have been used to raise or level the ground. Disused railway lines are a feature of the south of the District, and in particular of urban Bradford. Such ground may be polluted with heavy metals, oils, solvents, paints, asbestos and PCBs and may be susceptible to combustion due to the presence of timbers and coal.

Gasworks

This includes land used for coal carbonisation, purification, tar and coke storage, and also areas of tar refining and asphalt production. Former gasworks tend to be located in the urban parts of the District. Contamination of soils and groundwater may be severe, and include sulphates, sulphides, phenols, coal tars, aromatic hydrocarbons, oils, cyanides, asbestos, benzene, toluene and heavy metals.

Sewage Works

This includes land used for sewage treatment and storage. Although modern treatment sites are located in the Aire Valley, old disused storage sites were often located anywhere adjacent to urban areas. The solid wastes may contain high concentrations of heavy metals and organic matter which may decompose to produce nitrogen-rich leachate and toxic or explosive gases such as methane, carbon-dioxide and hydrogen sulphide.

Textile Industry

Bradford is a particularly important centre for the textile industry, though the number of mills has decreased in recent years. Former mill sites may be located in the main urban centres of the District, or in the outlying villages. Much of the associated man-made deposits are cinders and ashes from the coal boilers. These deposits may contain concentrations of toxic heavy metals. In addition residues from bleaches and dyes may persist in the soil and groundwater.

Chemical Industry

The main chemical works produced dyes, bleaches and solvents for the textile industry, plus acids, herbicides and

chemicals for the paper and armaments industries. Most of the chemical works have been and still are located in the south Bradford area. A wide range of contaminants may be associated with such works.

Ironworks/Foundries
Wastes from the iron industry include slag, foundry sand, spent refractories, which may contain high levels of heavy metals, sulphates, sulphides, acids and alkalis and asbestos. The main areas of such waste are in urban Bradford.

What should be done about this factor?

There are three main stages in dealing with potential hazards associated with man-made deposits.

- Identification of the possible presence of a hazard. This should involve checking archival sources including maps, geological maps, trade directories and site investigation reports. If, from this check, it is strongly suspected that a site may contain a hazard, then further information will normally be required from the developer by the local planning authority.

- Assessment of the degree of hazard through site investigation. This should determine the depth, extent, type and condition of the man-made deposits and the chemistry of groundwaters prior to any development taking place. Such investigations should identify the measures needed to make the land safe to develop.

- Remedy of the problem. The solution will depend on the nature of the hazard, whether it is ground stability, contamination or hazardous gases. Options can include removing the man-made deposit, treating the deposit or protecting the development. Sufficient flexibility should be retained to cope with any unforeseen conditions found at a site during the implementation of planning permission. Remedial measures are discussed fully in Volume 2 of this report, Chapters 10 and 12.

Many of the problems associated with current landfill sites have been dealt with through the implementation of environmental protection legislation, the latest of which is the Environmental Protection Act 1990. This has resulted in improved landfill design, operation, monitoring and the retrospective fitting of control measures to existing sites. The aim of operators of present day sites is to minimise the environmental impact and allow the ultimate reclamation of the land.

Although Government is promoting the regeneration of derelict land it is also introducing tighter environmental legislation relating, in particular, to the development of contaminated land. The Environment Act 1995 integrates the control of pollution. Under the Act, local authorities will have to carry out inspections designed to identify polluted land.

According to Government advice in PPG23 *Planning and Pollution Control*, a developer applying for planning permission should supply information detailing whether the land is contaminated and when determining a planning application, the local planning authority should consider whether the proposal takes proper account of contamination (PPG23 paragraph 4.10). Furthermore, in certain circumstances, it may be appropriate for the local authority to make detailed investigation or specific remedial measures a condition of the planning permission (PPG23 paragraph 4.11).

In 1993 the Government established the Urban Regeneration Agency, known as English Partnerships, to promote the reclamation and development of vacant and derelict land and buildings throughout England, particularly in urban areas. Working in partnership with the private sector, local authorities and other bodies with a role in regeneration, its aim is to make land available for housing, employment and recreation. English Partnerships receives a grant allocation each year from the Single Regeneration Budget (SRB) which was introduced in April 1994.

The SRB combines 20 previously separate programmes, including City Challenge which was launched in 1991 to help regenerate disadvantaged urban areas in England. Bradford City Challenge, one of 11 first round winners which piloted the programme, concentrated on the post-war housing estate of Holmewood and the surrounding area of south-east Bradford.

What literature should be consulted?

- *A Geological Background for Planning and Development in the City of Bradford Metropolitan District*, Volume 2, British Geological Survey Technical Report WA/96/1; Chapters 6, 10, 12 and Maps 3 and 7.
- *Unitary Development Plan*, prepared and published by the City of Bradford Metropolitan Council
- *Waste Management Paper No. 27: The Control of Landfill Gas, DoE, January 1989.* This is a technical memorandum on the monitoring and control of landfill gas. It is a key document when considering development adjacent to operational or restored landfill sites.
- *Planning and Pollution Control, PPG23*, July 1994, DoE.
- *Derelict Land Grant*, 1991
- *Contaminated Land*, DoE/Welsh Office, consultation paper, March 1994.
- *Site Investigation in Construction*, 1993. Published by Thomas Telford.
- *Building Regulations* 1991, HMSO. This addresses the need to properly consider potential hazards caused by substances on or in the ground.
- *Interdepartmental Committee of the Redevelopment of Contaminated Land (ICRCL) guidance notes.* These cover aspects of problem sites, including landfills, gas-works, and sewage works.
- *Environmental Protection Act*, 1990.
- *Methane: Its Occurrence and Hazards in Construction.* Hooker and Bannon, CIRIA Report 130, 1993.
- *Construction of new buildings on gas-contaminated land*, BRE, 1991.

Who should be contacted for further information?

Further information about development of brownfield sites may be obtained from:

- City of Bradford Metropolitan Council Transportation and Planning Division
- English Partnerships

Information about ground conditions may be obtained from:

- British Geological Survey
- West Yorkshire Waste Regulation Authority (relating to landfill sites)

4.3 KNOWN OR POTENTIAL SHALLOW UNDERMINED GROUND

The underground mining of coal, and related minerals such as fireclay and ironstone, and of sandstone are no longer carried out in the District. However, mining was formally an important industry and contributed in no small measure to the industrial growth of Bradford.

Why is this factor relevant to planning and development?

In areas of former coal and sandstone mining the principal concerns relate to:

- ground instability caused by the collapse of unsupported shallow workings. This may be evident as general ground subsidence or as the development of crown-holes. Collapse of shaft fill, linings or cappings may also result in surface subsidence. Ground instability problems may result from coal or sandstone workings;

- the migration of mine gases, such as methane or carbon dioxide, which may be potentially combustible, act as an asphyxiant or are toxic. Gases may become a hazard when they accumulate in poorly ventilated enclosed spaces such as basements or foundations. The generation of these gases applies to coal or colliery-based workings only, but the gases may collect in any underground void provided there is a migration path. Fissures, broken ground due to subsidence and mine workings may act as pathways for gas migration;

- the migration of ferruginous and acidic mine waters. This applies to coal or colliery-based workings only.

Where is this factor of importance?

Coal and sandstone mining is largely restricted to the area of outcrop of the Coal Measures in the south and east of the District, including much of urban Bradford. However, small centres of coal mining are recorded in Millstone Grit coals present near to Stanbury and Keighley. Map 1 presents the extent of known and potential coal workings at a depth of less than 30 m below the ground surface. This outline is generalised and approximate at 1:50 000 scale and should not be relied upon for site investigation purposes. In areas of thin drift cover, which includes much of the coalfield area, 30 m is considered to be the critical depth of seams at which there is a potential for the development of localised "crown-holes" at the surface due to the collapse of unsupported workings. It should be noted that in areas of thick drift cover, crown-holes may develop from workings present to depths of up to 30 m below rockhead (i.e. base of superficial deposits). Furthermore, problems associated with mine gases and mine drainage can result from coal workings at depths in excess of 30 m. The map presents:

- the extent of known areas of coal mining recorded on abandonment mine plans at depths known or estimated to be at less than 30 m depth below ground surface;

- areas in which the main workable coal seams are known or estimated to be present at less than 30 m depth below ground surface, but for which there are no abandonment mine plans.

Sandstone mining occurred in parts of the south and east of the District, though as there are few abandonment plans for such workings their extent is poorly known. The known areas of sandstone mining and the locations of the abandoned shafts and adits are not shown on the accompanying map but details are provided on Map 5 Mined Ground and Shafts which accompanies Volume 2 of the Technical Report.

What should be done about this factor?

It is important to realise that the existence of unaffected developments on or near a site, does not indicate that the area is free from mine workings which might affect subsequent development. Where shallow mine workings are known or suspected beneath a site it is important to carry out site investigations prior to any development to determine whether the area has been undermined and, if so, at what depths and what methods of mining were employed. The identification of disused mine workings does not preclude development at a site, or necessarily result in a requirement for expensive remedial measures. However, the information from the site investigations does facilitate an assessment of the risk to surface land uses and development and the design of appropriate remedial measures for a particular development. Where problems with mine gases are identified it is important that expert advice should be sought to identify the scale, volume, emission rates and risks. Treatment of sites prior to development is generally less expensive than resolving a problem after development is complete.

The recommended procedure for a proposed development is:

- identification of the possible presence of a hazard. This should involve checking archival sources including maps and geological maps for the location of shafts, abandonment mine plans and site investigation reports. If as a consequence of this check, a possible hazard is identified or is strongly suspected to exist on a site which is proposed for development, the local planning authority will normally require the developer to proceed to the next stage be carried out;

- assessment of the degree of hazard through site investigation. This should determine the depth, extent, type and condition of the disused workings or mine entries prior to any development taking place. Such investigations should identify the measures needed to make the land safe to develop;

- remedy of the problem. The solution will depend on the nature of the hazard, whether it is ground stability, hazardous gases or mine drainage. Options can include excavating and removing shallow workings, especially if remaining coal can be extracted as part of the redevelopment, treating the workings or mine entries or protecting the development. Sufficient flexibility should be retained to cope with unforeseen conditions found at a site. Remedial measures are discussed fully in Volume 2 of this report, Chapters 8 and 12.

What literature should be consulted?

- *A Geological Background for Planning and Development in the City of Bradford Metropolitan District*, Volume 2, British Geological Survey Technical Report WA/96/1; Chapters 8, 10, 12 and Map 5.
- *Review of Mining Instability in Great Britain*, Arup Geotechnics 1990. Volume 1 provides the regional reports for the Planning Regions of England, Volume 2 includes reports on the effects of mines, investigation

methods, preventative, remedial and monitoring techniques in areas of mining subsidence and procedures for locating disused mine entries. Volume 3 includes a series of case studies, including part viii on sandstone mines in West Yorkshire.

- *Mining in the Elland Flags: a forgotten Yorkshire industry.* Godwin, C.G., 1984. British Geological Survey Report 16 (4), HMSO. Includes details on the location of known workings in the District.
- *Methane: Its Occurrence and Hazards in Construction.* Hooker and Bannon, CIRIA Report 130, 1993.
- *Treatment of Disused Mine Openings and Availability of Information on Mined Ground.* MPG 12, March 1994, DoE/Welsh Office.
- *Development on Unstable Ground,* PPG 14, April 1990; Annex 1, 1996, DoE.
- *Islwyn shallow mining.* Report No. 94/2426 Ove Arup and Partners (Cardiff) 1994.
- *Methane and other gases from disused coal mines: the planning response.* Wardell Armstrong Ltd. (in preparation).
- *Radon, methane, carbon dioxide, oil and potentially harmful elements from natural sources and mining: relevance to planning and development.* Appleton, J.D., 1995. British Geological Survey Technical Report WP/95/4, BGS (Keyworth).

Who should be contacted for further information?

Further information about the location and nature of undermined ground may be obtained from:

- British Geological Survey, Keyworth
- Coal Authority
- City of Bradford Metropolitan Council Transportation and Planning Division

4.4 MINERAL RESOURCES

Why is this factor relevant to Planning and Development?

Mineral resources present in the District may be considered to include those minerals which can be won at or near to the surface, as the economics of underground mining are unlikely to be favourable in the future.

Mineral resources are finite, therefore care must be taken to safeguard those deposits which are of economic importance against other types of development which would sterilise deposits or be a serious hindrance to their extraction.

Sandstone is the principal mineral currently extracted in the Bradford District and demand for this resource is likely to continue in the future. Many of the existing sandstone quarries make a significant contribution to the regional output of building stone and crushed rock aggregate. Despite the current economic climate there is a continuing demand for the sandstone for use locally, regionally and nationally. Small volumes of fireclay are currently worked at a single site and is is considered that this small-scale demand will continue for the specialist production of glasshouse pots. There are also deposits of sand and gravel and coal, which though not currently worked may become viable in the future.

Where is this factor of importance?

The main mineral resources in the District are considered to be sandstone and sand and gravel. The extent of these resources are presented on the accompanying map (Map 1), with more detailed information on these and additional resources of fireclay, coal and brickclay shown on the Mineral Resources and Surface Mineral Workings Map (Map 4) and in Chapter 7 of Volume 2 of this report.

The main sandstone resources have been identified as those sandstones which have been historically, and are still being worked in the District; namely the Elland Flags, Rough Rock/Rough Rock Flags, Woodhouse Grit/Woodhouse Grit Flags. These sandstones occur at outcrop across most of the District, with the exception of Wharfedale and the extreme south-east, in the vicinity of Tong to Wyke. The future viability of the resource is in part dependent on the thickness of overburden, including natural drift deposits and man-made deposits, neither of which are shown on the map. The deposits are, however, shown on the Superficial Deposits Map (Map 3), which accompanies Volume 2 of this report. This map also shows the thickness of natural drift deposits.

The main sand and gravel resources have been identified as those areas in which significant volumes of the resource are present; namely the Alluvium and River Terrace deposits and buried Glaciofluvial deposits of the Wharfe and Aire valleys.

It is unlikely that the extraction of coal by underground mining will become a viable option in the future. However, there is a limited potential for future opencast mining. A number of sites have been investigated as potential coal opencast sites though, as yet, none have come into operation. The resource is almost entirely confined to the outcrop of the Coal Measures, which underlie the south and east of the District. Over much of this area the resource has been sterilised by urban development. It is possible that the economics of coal extraction may be improved by the combined working of coal and fireclay in an opencast site. However, at present the only fireclay workings, in the vicinity of Denholme, are for a specialist clay beneath the Hard Bed Coal, which itself is not being worked. This fireclay is present near to ground surface in a strip extending from Denholme to Shipley.

Peat is not considered to be a significant resource in the area, partly as it is unsuitable for horticultural purposes, but also as the deposits, which are located on the uplands of the west of the District, are generally too thin.

What should be done about this factor?

The Deposit Draft UDP states that "*applications for planning permission for surface development should safeguard mineral resources or make provision for ensuring that the mineral is extracted before surface development begins unless the applicant can demonstrate that it would not reasonably be practical to do so*".

Government policy set out in Mineral Planning Guidance notes (MPGs) and advice in Regional Planning Guidance aim to ensure that, in general, demand for minerals is met and the environmental impact of workings and associated activities is minimised. Policies in the Deposit Draft UDP reiterate this advice by seeking to meet the need for minerals at minimum cost to the environment. This will be achieved by releasing reserves gradually through an agreed scheme of working. A possible method, is for land required for future mineral extraction to be leased for other short-term purposes, with the agreement that the land is made available for mineral extraction at an agreed future date. It may also be preferable that new extraction sites should, as far as possible,

redevelop former, disused workings rather than despoil undeveloped land.

What literature should be consulted?

- *A Geological Background for Planning and Development in the City of Bradford Metropolitan District*, Volume 2, British Geological Survey Technical Report WA/96/1; Chapters 7 and Map 4.
- *Unitary Development Plan*, prepared and published by the City of Bradford Metropolitan Council
- *Mineral Industry Guidance Notes* IPR 3/1 to 3/6, HMIP/HMSO, 1992.
- *Mineral Planning Guidance Notes*, DoE.
  MPG1: General considerations and the development plan system, January 1993.
  MPG2: Applications permissions and conditions, January 1988.
  MPG4: The review of mineral working sites, September 1988.
  MPG5: Minerals planning and the general development order, December 1988.
  MPG6: Guidelines for aggregate provision in England and Wales, April 1994.
  MPG7: The reclamation of mineral workings, August 1989.

Who should be contacted for further information?

Bradford MDC is the mineral planning authority for the district and, as such, it is responsible for planning control over mineral workings and reclamation after extraction, as well as the safeguarding of strategically important resources.

Further information may be obtained from:

- British Geological Survey
- Coal Authority

4.5 SURFACE MINERAL WORKINGS

Why is this factor relevant to Planning and Development?

Former quarries or pits which have not been backfilled represent an important resource, for the following reasons:

- they may provide a suitable void for the disposal of waste to landfill,
- they may be reopened as a source of minerals,
- their steep exposed rock faces may provide a recreational facility for climbers,
- they may be flooded to provide a facility for water sports,
- they may provide a valuable haven for wildlife, as well as containing interesting geological features. The site may, therefore, provide an opportunity to develop a local nature reserve which would be of educational, recreational and wildlife value.

Former quarries or pits which have not been backfilled may also represent a constraint to development, for the following reason:

- steep rock faces may be unstable and may represent a hazard to development both within and adjacent to the site.

Landfill is currently the cheapest and most common form of waste disposal in Britain, accounting for about 90% of domestic wastes and over 80% of hazardous wastes. In the District most options for landfill sites have already been utilised, adding pressure to use remaining disused sandstone quarries, many of which are present in rural areas.

Where is this factor of importance?

The location of former or active quarries or pits which have not been backfilled are identified on the accompanying map (Map 1); these are generally distributed throughout the District. Five minerals have previously been extracted in the District, including sandstone, fireclay, sand and gravel, coal and brickclay, though the majority of open excavations are in sandstone. The sandstone quarry database, which accompanies Volume 2 of this report, identifies 91 sites which have a maximum horizontal dimension in excess of 100 metres. Only these quarries are shown on the accompanying map. In addition to these, there are many more smaller excavations, not shown on the map, the location of which can be determined from British Geological Survey 1:10 000-scale geological maps.

What should be done about this factor?

The decision as to the proposed useage of surface mineral workings is dependent upon a number of social, economic and environmental factors.

i) *Use as landfill site*

The regulations for the development of landfill sites for the disposal of special waste falls under Schedule 1 of the Town and Country Planning (Assessment of Environmental Effects) Regulations, 1988 and will require an environmental assessment. Schedule 2 of the Regulations applies if the development relates to the disposal of controlled waste, with a requirement that an environmental assessment is necessary if it is likely to have a significant effect on the environment by virtue of factors such as nature, size or location.

During the assessment detailed geological or hydrological investigations should be carried out to determine:

- the permeability of the containing medium
- the presence of faults, bedding planes or joints and old workings
- the level and flow directions and rates of groundwater.

These factors relate specifically to landfill gas and leachate migration, which can cause problems such as explosions, asphyxiation and pollution of groundwater if not properly controlled (as discussed in Chapter 12 of Volume 2). Landfill sites may be either:

- **Uncontained sites**: designed for inert wastes which will not generate potentially hazardous gases or leachate.
- **Containment sites**: designed for active waste materials, to isolate the waste from the environment until they are no longer polluting. Such sites may require management of leachates and landfill gas for some considerable period after completion of tipping.

Depending on the results of the environmental study, it may be necessary to control the types of waste deposited at a site. This, and possible measures for effectively sealing the site to prevent the migration of gas and leachate should be discussed between the waste regulatory authority and

waste disposal company and implemented prior to the site receiving any waste.

ii) *Use as site of future mineral exploitation*
The importance of safeguarding mineral resources is discussed in the previous section (section 4.3). If a site is considered to contain significant mineral resources which may be extracted in the future, it may be necessary to prevent other development or to permit only short-term development or use of the site, perhaps for recreactional purposes.

iii) *Use as recreational or conservation site*
The use of quarries for this purpose may be planned as a permanent development, as a short-term measure prior to planned mineral exploitation, or landfill scheme in which faces of the quarry may be preserved. Before any development of a site goes ahead it is essential that developers check with the Local Authority that a site is not already protected as a Site of Special Scientific Interest (SSSI) or Site of Ecological or Geological Importance (SEGI). SSSIs have statutory protection, whereas SEGIs have no statutory protection but are taken into consideration by local authority planners when considering the impact of development. Where a site is intended to be developed for recreational or conservation purposes, such a use should be developed in discussion with the Local Authority and English Nature, and other interested parties such as Regionally Important Geological Sites (RIGS) groups, the British Mountaineering Council, to discuss suitability, safety, access, provision of facilities and information boards and parking arrangements.

What literature should be consulted?

- *A Geological Background for Planning and Development in the City of Bradford Metropolitan District*, Volume 2, British Geological Survey Technical Report WA/96/1; Chapters 6, 7, 12 and Maps 4.
- *Unitary Development Plan*, prepared and published by the City of Bradford Metropolitan Council.
- *Environmental Protection Act 1990.* (Commencement No15) Order 1994, SI No1096, HMSO. This brought into force the waste management licensing provisions.
  (part 2). In particular, S50 places a duty on waste regulation authorities to draw up waste disposal plans.
- *Circular 11/94, Waste Management Licensing: The Framework Directive on Waste*, ISBN 0 11 752975 3, HMSO.
- *Waste Management Paper No. 4: Licensing of Waste Management Facilities*, ISBN 0 11 752525 0, HMSO.
- *Waste Management Paper No. 26A: Landfill Completion,*. ISBN 0 11 752807 2, HMSO.
- *Planning and Pollution Control, PPG23*, July 1994, DoE.
- *Contaminated Land*, DoE/Welsh Office, consultation paper, March 1994.
- *Earth Science Conservation for Landfill Managers*, English Nature, 1991.

Who should be contacted for further information?

Further information on the location and nature of disused surface mineral workings may be obtained from:

- City of Bradford Metropolitan Council Transportation and Planning Division.
- British Geological Survey, Keyworth, Nottingham.
- Coal Authority.

Information relating to the development of a landfill site may be obtained from:

- West Yorkshire Waste Regulation Authority.

Information on providing a facility for climbers or a water sports facility should initially be discussed with:

- City of Bradford Metropolitan Council Transportation and Planning Division.

For advice on nature conservation and geology the following should be consulted.

- English Nature
- West Yorkshire Ecological Advisory Service
- Geology Museum at Cliffe Castle
- The local Regionally Important Geological Sites (RIGS) Group

4.6 GEOLOGICAL FAULTS

Why is this factor relevant to Planning and Development?

As far as the needs of the planner and developer are concerned the details of the structural history are not directly relevant. What is important, is the recognition that a site will be affected by the nature of the geological structure.

Geological faults may have the following influences on developments:

- structures straddling a fault are susceptible to uneven settlement in areas prone to mining subsidence (see Volume 2, Chapter 8)

- if a fault occurs across a site it may introduce broken rock conditions where sound rock would otherwise be expected. Faults may form a structural contact between different rock types and may also have a physical character which could affect the nature of the geotechnical conditions within a locality (see Volume 2, Chapter 10)

- faults may provide possible pathways for hazardous gases, including landfill gas, mine gas and naturally occurring radon gas (see Volume 2, Chapter 12)

- faults may provide possible pathways for leachate migration, which is particularly significant when considering the location and design of a landfill site (see Volume 2, Chapter 12)

- faults may act as a conduit for groundwater flow, potentially increasing yields from water boreholes, however, faults with large displacements may reduce the interconnectivity of aquifer sandstones, thus limiting groundwater flow (Volume 2, Chapter 11)

- faults may influence the location of areas of slope instability or landslips, (see Volume 2, Chapter 9).

Where is this factor of importance?

There is extensive faulting throughout the District, with a number of major NW/SE to W/E trending faults, together with a complex network of lesser faults of NE/SW and

NNW/SSE trend. The accompanying map (Map 1) only shows the main faults considered to be present within the District, with throws (vertical displacement along fault plane) in excess of 10 metres. These, and smaller faults are shown on the Bedrock Geology Map (Map 2) and discussed in Chapter 6 of Volume 2 of this report. The portrayal of faults on the map as a single line may be a generalisation as they may occur as a zone of faults several tens of metres wide.

What should be done about this factor?

It is important to note that the location of faults is very rarely observed in the District, and their position is usually inferred from other geological information. Consequently, the position of fault lines shown on geological maps may be imprecise. Where a fault is shown to be located near to a proposed development, it is prudent to design a site investigation to assess the possible presence, extent and nature of the faulted ground. This information can then be taken into account during the foundation design stage of a project.

What literature should be consulted?

- *A Geological Background for Planning and Development in the City of Bradford Metropolitan District*, Volume 2, British Geological Survey Technical Report WA/96/1; Chapters 6, 10, 11 and 12 and Map 2.

Who should be contacted for further information?

Information relating to the position, nature and implications of geological faults may be obtained from:

- British Geological Survey, Keyworth, Nottingham.
- City of Bradford Metropolitan Council Transportation and Planning Division.

4.7 LANDSLIP AREAS

Why is this factor relevant to Planning and Development?

The prime sites for development in the District have been historically, and still are, within the flat lowland areas of the main valleys. Consequently, during the rapid growth of urban Bradford last century, the prime sites were soon occupied and development was forced to extend onto the steep valley sides. Development, particular for housing, continues to utilise steep slopes. Such slopes may provide climatic advantages when associated with a southerly aspect and the views that they provide may be valued. However, steep slopes may be associated with stability problems, as well as access problems.

In terms of slope stability most rock types have a threshold of steepness beyond which they become unstable. In the short term the threshold may change with the saturated moisture state of the soils on the slope. On a longer time scale the threshold will reduce in value as weathering of the slope material takes place.

In many cases, the landslips present in the District developed in response to oversteepening of slopes during the last phases of glaciation, and the landslips may be considered to be inactive or may be regarded as comparatively stable. However, the slopes may become unstable if disturbed by the following:

- undercutting of the slope, for example during road construction or cutting a bench for housing;
- top-loading of the slope, either through locating a development, or storage of large volumes of spoil, waste or topsoil, on a steep slope;
- introduction of large volumes of water, such as may occur due to alteration of drainage patterns during development.

Where is this factor of importance?

The landslip database which accompanies Volume 2 of this report identifies 201 landslips in the District. These include areas of former slope instability for which there is no evidence of recent activity as well as currently active sites.

The accompanying map shows the distribution of landslips, many of which are located on the steep, north-facing slopes of the Aire and Wharfe valleys, particularly between Keighley and Bingley and in the vicinity of Ilkley. Landslips are also common in a number of small tributary valleys, including the Worth Valley, Newsholme Dean, around Silsden Reservoir and adjacent to Bradup Beck.

Factors associated with the location of landslips include the association of slopes usually in excess of 10° with one or more of the following:

- areas of glacial Till
- the presence of a permeable, water-bearing, sandstone capping dipping into the valley overlying an impermeable mudstone
- the presence of a fault associated with extensive fracturing of mudstone
- areas of deeply weathered mudstone
- the presence of springs or seeps

What should be done about this factor?

The presence of landslips does not preclude development at a site. However, where construction activities are proposed in an area of current or past slope instability, or where a potential problem is suspected, a site investigation and stability analysis should be carried out to assess the effect of the construction work on the stability of the slope. It is important to note that the area of problems and potential hazard are not restricted to the area of landslip alone and it is essential to consider ground upslope, downslope and adjacent to the area of identified landslip. The investigations may need to be extended beyond the limits of a specific development site.

Site investigations should look for slip planes as well as determine the nature of bedrock and/or superficial deposits, including the degree of weathering and the presence of fracturing. Stability analysis should take into account slope information along with site geology and groundwater conditions, for it is often the combination of such factors that may give rise to prospective ground difficulties.

For a proposed development, care should be taken not to load the top of, or undercut the slipped area or to adversely redirect drainage into the slip area, as this may reactivate an existing slip or trigger a new one, unless remedial measures are undertaken prior to construction work. Buildings should be constructed with foundations and structures designed to limit the potential effects of internal deformation and downslope displacement.

Where a development already exists upon a known landslip, it is recommended that the stability of the slope be assessed and if appropriate monitored. Where there is evidence of current slope instability an assessment of the ground conditions, through a site investigation, is essential. From this, the choice of most appropriate remedial measures can be made. These may include redirecting drainage, anchoring foundations, providing internal and external supports. In the most severe cases demolition and reconstruction may be the only option.

What literature should be consulted?

- *A Geological Background for Planning and Development in the City of Bradford Metropolitan District*, Volume 2, British Geological Survey Technical Report WA/96/1; Chapters 9 and Map 6.
- *Unitary Development Plan*, prepared and published by the City of Bradford Metropolitan Council.
- *PPG14 Development on Unstable Land,* April 1990, DoE, and Annex 1: Landslides and Planning (draft consultation document), DoE.
- *Assessment of landslip potential: South Wales* 1986, Sir William Halcrow & Partners for DoE/Welsh Office, 3 Vols.

Who should be contacted for further information?

Further information about landslips and unstable ground may be obtained from:

- City of Bradford Metropolitan Council Transportation and Planning Division.
- BGS Engineering Geology and Geophysics Unit

4.8 WATER RESOURCES

Why is this factor relevant to Planning and Development?

The water resources of the District comprise surface water features, such as reservoirs, rivers, canals and springs, and sub-surface aquifers, or groundwater. Water resources are important to the District for the following reasons:

- reservoirs present both within and outside of the District provide the majority of its water supply
- groundwater supplies provide water supply to isolated farms in the upland areas and licenced water abstraction for industrial purposes throughout the District
- surface water features may be utilised for leisure and recreation activities
- surface water features may be associated with areas of nature conservation.

All of the above can be seriously affected by surface or groundwater pollution. New developments, particularly associated with landfill sites (discussed in Chapter 4.1), buried fuel, sewage or chemical tanks or pipework and sewage treatment works may release contaminated liquids into the ground. Pollution may also arise from drainage of water from abandoned mine workings. Where mine drainage waters reach the surface, their high pH, in addition to iron precipitation, can result in worst cases in the complete extermination of flora and fauna.

Protection of surface water supplies for domestic consumption is of paramount importance. However, particular attention should be paid to the protection of groundwater, as pollution of this resource is more difficult to monitor and once polluted it is very difficult, if not impossible, to rehabilitate.

The issue of water supply came to the fore in 1995, with Yorkshire Water, the company responsible for the provision of water and sewage services, imposing Drought Orders in the District to protect a dwindling supply of water in the reservoirs. Although Yorkshire Water have no proposals for the development of additional reservoir sites, they are considering the possible future extraction of groundwater supplies to top-up reservoirs during emergency periods.

Where is this factor of importance?

The principal source of water for domestic supplies is from reservoirs, the majority of which are situated in the upland areas in the west of the District (see accompanying map). Very little groundwater is used for public use due to the good network of links with reservoirs in the area. However, there are a number of licensed groundwater sources, principally for industrial useage, distributed across the District (see accompanying map). The extent of the main sandstone aquifers are presented on Map 8 Water Resources and Flooding. The Millstone Grit sandstones are considered to provide higher quality groundwater supplies than Coal Measures sandstones, which tend to have high concentrations of sulphates, iron and trace metals. This suggests that future supplies of good quality, potable groundwater may be abstracted from the north and west of the District.

The main rivers in the District include the Rivers Aire, Wharfe and Worth and Bradford Beck and the Leeds-Liverpool Canal follows the length of the Aire Valley. The River Aire and Bradford Beck have long suffered problems with pollution and are still associated with poor water quality. The River Aire is the outlet for treated sewage from the two main Sewage Treatment Works at Esholt and Marley. Bradford Beck is particularly affected by industrial effluent discharges. In contrast the water quality of the Rivers Wharfe and Worth are generally good.

Despite pollution problems, the River Aire provides much river based recreation, canoeing and angling. Many of the reservoirs are used for leisure and recreational pursuits. The recreational use of the River Wharfe is restricted by large landowners.

The Rivers Worth and Wharfe may provide areas suitable for nature conservation sites. In contrast, the River Aire has limited conservation value. From Skipton to Bingley, the river has undergone significant modification, with straightening and deepening of the river channel for flood defence purposes. However, many of the other rivers and tributaries provide important wildlife corridors.

What should be done about this factor?

Under the Water Resources Act 1991, the National Rivers Authority (NRA) Yorkshire Region are responsible for improving the water environment and safeguarding it from pollution. It is also a statutory consultee for some types of development under planning legislation. In addition, the NRA has its own powers under the Water Resources Act 1991 and byelaws to control development within eight metres of the Rivers Aire and Worth in the District. It also has powers under the Land Drainage Act 1991 to control any works which could affect the flow in an ordinary watercourse.

Because of the difficulty in treating contaminated surface and groundwater, the prevention of pollution is paramount. With respect to surface water, developers are required to provide facilities to minimise pollution risk and any new discharges require the specific consent of the NRA, with conditions imposed to ensure that river quality objectives are achieved. It is particularly important to protect reservoir gathering grounds from polluting activities. However, in the District this is a relatively minor problem at present, as the majority of reservoirs are located in upland areas, away from population centres.

The NRAs groundwater protection policy has two main objectives:

- to prevent excessive exploitation and long-term reduction in the availability of groundwater resources
- to prevent deterioration in groundwater quality by contamination.

A suitable strategy may be to subdivide the land surface into zones based upon vulnerability of the aquifer to pollution, with certain activities controlled or prohibited in at-risk zones. In order to protect water supplies to licenced abstraction points, it may be necessary to define wellhead protection zones within which potentially contaminative activities are prohibited.

To prevent the pollution of groundwater, activities such as the disposal of effluent in soakaways, landfilling of unsealed sites over permeable bedrock or inappropriate storage of chemicals should all be carefully controlled, particularly when the activities are sited over aquifers or close to surface waters.

An important aspect of the control of water resources in the District is the establishment of monitoring sites. The NRA is responsible for monitoring:

- surface water discharge and water quality, both chemical and bacteriological
- groundwater quality, both chemical and bacteriological, flow directions and velocities and physical and chemical characteristics of the aquifer.

Within the District, little information is currently available on groundwater characteristic. It is only through monitoring of the sub-surface aqueous environment that a greater understanding of the effects of surface developments and pollution on the groundwater can be achieved.

Development in locations where water resources are already scarce may result in less reliable supplies for the existing population and industry. Thus, development should be limited to where adequate water resources exist.

Development, or more often redevelopment, can result in the enhancement of the environment of rivers and their tributaries. For instance, by increasing public access, improving water-related habitats, landscape or water quality or by securing the restoration of natural features. The improvement of water-related habitats and water quality is likely to have a beneficial effect on the fish population.

What literature should be consulted?

- *A Geological Background for Planning and Development in the City of Bradford Metropolitan District*, Volume 2, British Geological Survey Technical Report WA/96/1; Chapter 11 and Map 8
- *PPG23: Planning and Pollution Control*, July 1994, DoE.
- *Water Industry Investment: Planning Considerations*, DoE Circular 17/91, November 1991.
- *River Catchment Plans: for the Wharfe, Aire and Calder*, NRA.
- *Policy and Practice for the Protection of Groundwater*, NRA 1992.
- *Environmental Protection Act 1990*, HMSO.
- *Water Resources Act 1991*, especially section 85.

Who should be contacted for further information?

- National Rivers Authority- Yorkshire region
- Yorkshire Water
- City of Bradford Metropolitan Council Transportation and Planning Division.
- British Geological Survey, Hydrogeology Unit, Wallingford

4.9 WASHLAND AREAS LIABLE TO FLOODING

Why is this factor relevant to Planning and Development?

Washlands are areas of land along rivers which provide essential space for the storage of floodwater. Such areas are designated by the National Rivers Authority (NRA) and are identified in River Catchment Management Plans and Deposit Draft UDP. Extreme heavy rainfall or prolonged periods of lesser rainfall can increase the volume of water present in the rivers to cause flooding of the washlands adjacent to the river. If a river is deprived of washlands, for example, by development which raises the height of the land or creates a barrier to floodwater this can lead to more serious problems of flooding downstream. Impermeable surfaces such as paved areas and roofs reduce the ground area capable of absorbing rainfall. Hence, new development may increase the rate at which run-off reaches watercourses. These effects may cause the capacity of a watercourse to be exceeded at times of flood risk, especially where there are culverts, bridges or other artificial or natural restrictions.

Washlands can also provide important nature conservation sites, comprising areas of marshland environment, in addition to their capability to store floodwaters.

Where is this factor of importance?

In the District, the main areas of washland, defined by the NRA, are parts of the natural floodplains of the Rivers Aire and Wharfe (see accompanying map). It is these flat, lowland areas close to the main transport routes which are under greatest pressure to be developed for industrial or housing purposes.

To improve the standard of flood protection, channel improvements and flood defences have been constructed at Keighley on the Rivers Aire and Worth. Further works are proposed at Bingley, Shipley and upstream of Keighley. In addition, a flood alleviation channel has recently been completed under the City of Bradford itself in order to relieve the city from future problems of flooding of Bradford Beck.

What should be done about this factor?

The Deposit Draft UDP proposes that development will not be permitted on areas of washland unless the proposed development would not significantly affect the function of the washland and there would be no serious risk to the development from flood debris or pollution.

Where it is decided that development on washlands should be permitted for social or economic reasons, then appropriate flood protection and mitigation measures, including measures to restore washlands or provide adequate storage of water, flood barriers and channel improvements may be required to compensate for the impact of development.

Disposal of waste within the washland should be restricted to inert waste only, in order to limit the potential of pollution of watercourses. Waste disposal sites which involves the raising of ground level should also be restricted as this can reduce the capacity of the washland to store water and may impede the flow of floodwater.

Under the Water Resources Act 1991 the NRA has a general duty to provide effective defence for people and property against flooding. The aim of the NRA is to ensure that:

- new developments are not at risk from flooding which could damage property and even endanger life
- land and existing developments are not subjected to an increased risk of flooding as a result of new developments
- any work which is required to mitigate the effects of new development on flooding is paid for by the developer and not the public.

In order for the NRA to carry out its flood prevention role successfully they must receive details of any proposed works affecting watercourses and grant permission for the work to proceed, requesting any modifications which may be necessary. Consequently landowners or developers must obtain a Land Drainage Consent from the NRA **before** the work commences. Development which would interfere in the ability of the NRA and other bodies to carry out flood control works and maintenance will not usually be allowed.

As part of the NRAs assessment of the risk from flooding it is important to maintain a long-term monitoring of river discharge levels, which can be used in conjunction with historical data to provide an indication of flooding patterns.

The NRA recommend that washlands are used for the following:

- recreational activities
- short stay car and lorry parks at existing ground levels
- agriculture
- sites designated for conservation or environmental purposes

What literature should be consulted?

- *A Geological Background for Planning and Development in the City of Bradford Metropolitan District*, Volume 2, British Geological Survey Technical Report WA/96/1; Chapter 11 and Map 8.
- *Unitary Development Plan*, prepared and published by the City of Bradford Metropolitan Council.
- *Development and Flood Risk: DoE Circular 30/92*, December 1991.

Who should be contacted for further information?

- NRA Yorkshire Region Flood Defence Unit
- Yorkshire Water Flood Defence Unit.
- City of Bradford Metropolitan Council Transportation and Planning Division.

5 Summary

During the study we have identified a number of earth science factors which may locally have a direct influence on planning and development issues in the District. The earth science factors include both natural and man-made factors. The natural ones in the main relate to water and mineral resources, which may require protection to prevent pollution or sterilization, respectively, and also the risk of flooding and the nature of geological faults and landslips. The man-made ones in the main relate to quarrying, mining or waste disposal. The location and extent of each of the earth science factors identified are shown on the accompanying map (Map 1). The map should be used in conjunction with this report.

The information provided in this report should be used by planners, developers and those involved in conservation in the District at an early stage in the planning process. The information may be used to identify opportunities for development, particularly in respect of leisure and recreation, or to identify resources, such as mineral resources or sites of nature conservation interest, or it may be used to identify potential problems and ensure that appropriate site investigations and due precautions are taken at the outset in order to minimise risks and costs to both the developer and the wider community.

The information provided in this report should be used only as a guide to more detailed sources of information and must not be used as a substitute for site investigations or ground surveys. Planners, developers and other users of this report must always seek appropriate professional advice to ensure that ground conditions are suitable for any particular land use or development.

Appendix 1 Interviewees

The interviews were held between 20 October and 19 November 1993.

Bradford MDC (Principal Building Control Surveyor)	Mr P Stefanuti
Bradford MDC (City Engineer)	Mr J Knight
Bradford MDC (Minerals Planning Officer)	Mr P Hatherley
Bradford Reference Library	Miss S Wilmott
British Coal Corporation	Mr M Allen
British Coal Opencast Executive	Mr G Wilson
Bullen and Partners, Consulting Engineers	Mr E Spivey & J Dennis
District Mineral Valuer	Mr M D Evans
Ecological Advisory Service	Mr J Lavin
Geological Curator	Miss A Armstrong
Hammond Suddards	Mr S Bell
Local Authority Waste Disposal Company	Mr S Rayner
National Rivers Authority	Dr J Aldrick
National House-Building Council	Mr R M Milner
Waste Regulation Authority	Mr M West
Weatherall Green and Smith	Jan Toulson
West Yorkshire Archaeology Service	Dr R Yarwood
Yorkshire Water	Mr P Beaumont & Mr D Smith

Appendix 2 Contacts for further information

British Geological Survey
Keyworth
Nottingham
NG12 5GG

Telephone: (0115) 9363100
Fax: (0115) 9363100

British Geological Survey
Maclean Building
Crowmarsh Gifford
Wallingford
Oxfordshire
OX10 8BB

Telephone: (01491) 838800
Fax: (01491) 692345

City of Bradford Metropolitan Council
Transportation and Planning Division
Jacobs Well
Manchester Road
Bradford
West Yorkshire
BD1 5RW

Fax: (01274) 722840
Telephone:
- General Enquiries (01274) 754605
- Strategy and Implementation for the Deposit Draft Unitary Development Plan (01274) 754050
- Development Control for the:
  Bradford Area Team (01274) 753942
  Keighley Area Team (01535) 618071
  Shipley Area Team (01274) 757029
  Minerals Section (01274) 753770
- Building Control (01274) 753777

Geological Curator (West Yorkshire)
Cliffe Castle
Keighley
West Yorkshire
BD20 6LH

Telephone: (01535) 618238

Ecological Advisory Service (West Yorkshire)
Cliffe Castle
Keighley
West Yorkshire
BD20 6LH

Telephone: (01535) 618240
Fax: (01535) 610536

The Coal Authority
Bretby Business Park
Ashby Road
Burton on Trent
Staffordshire
DE15 0QD

- Mines Records Office for abandonment plans and geological records
  Telephone: (01283) 553462
  Fax: (01283) 553464
- Law Society-type mining enquiries
  Telephone: (01283) 550606
  Fax: (01283) 551233

Contracts Department — dealing with reportable hazards

The Coal Authority
200 Lichfield Lane
Berry Hill
Mansfield
Nottinghamshire
NG18 4RG

Telephone: (01623) 427162
Fax: (01623) 427316

Countryside Commission
John Dower House
Crescent Place
Cheltenham
GL50 3RA

Telephone: (01242) 521381

Department of the Environment
Minerals and Waste Planning Division
2 Marsham Street
London
SW1P 3EB

Telephone: (0171) 2763961
Fax: (0171) 2763936

Government Office
Yorkshire and Humberside
City House
New Station Street
Leeds
LS1 4JD

Telephone: (0113) 2836349
Fax: (0113) 2836557

English Nature
Humber to Pennines Local Area Team
Bullring House
Northgate
Wakefield
West Yorkshire
WF1 3BJ

Telephone: (01924) 387010
Fax: (01924) 201507

West Yorkshire RIGS Group
English Nature
44 Bond Street
Wakefield
WF1 2QP

English Partnerships
Yorkshire and Humberside Regional Office
Hall Cross House
1 South Parade
Doncaster
South Yorkshire

Telephone: (01302) 366865
Fax: (01302) 366880

National Rivers Authority Yorkshire Region
Olympia House
Gelderd Road
Leeds
LS12 6DD

Telephone: (0113) 2440191

West Yorkshire Archaeology Service
14 St Johns North
Wakefield

Telephone: (01924) 296797
Fax: (01924) 296810

West Yorkshire Waste Regulation Authority
Western Division
69 Bradford Road
Brighouse
HD6 1RS

Telephone: (01484) 716717

Yorkshire Water plc
Strategy Development
PO Box 500
Western House
Halifax Road
Bradford
BD6 2LZ

Telephone: (01274) 692430