Staffordshire Geodiversity Action Plan

Laura Cox
Geodiversity Officer

Contributors

Staffordshire Geodiversity Action Plan Steering Group:

Paul Wilcox	- SGAP Chairman. Staffordshire County Planning
Alastair Fleming	- Education Dept, Keele University
Sue Lawley*	- Staffordshire Wildlife Trust
Laurence Crump	- Hanson Aggregates
Paul Brewer	- Tarmac Central Ltd
Jonathan Blowers	- English Nature
Vicki Shenton*	- Chairman, SRIGS
John Reynolds*	- ESTA / UKRIGS
Laura Cox*	- SWT Geodiversity Officer

**indicates members of Staffordshire RIGS group*

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Craig Slawson, Staffordshire Ecological Records
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Highshutt Quarry RIGS
(*L Cox*)

How This Action Plan Should Be Used

The Staffordshire Geodiversity Action Plan provides a framework within which various targets and actions are outlined to deliver a sustainable and local approach to the conservation and promotion of the geodiversity of the county.

The SGAP is structured around the following key elements:

1. **What geodiversity means in Staffordshire and whom it affects** – this is detailed in Chapter 1 and explains how the SGAP will focus on target areas to deliver the key aims such as promoting geodiversity, protecting and enhancing SSSI and RIGS sites and their educational and amenity value within the county.

2. **SGAP Objectives, Targets and Actions** – this represents an integrated approach to conserving and promoting geodiversity in Staffordshire. It provides a summary of the targets and actions that are detailed in the following Chapters. This can be found in Chapter 2

3. **The geodiversity of Staffordshire** – this is shown through a detailed stratigraphy of the geology of Staffordshire and the use of English Nature's Natural Areas. These help to set the geological and geomorphological 'scene' for the types of actions necessary to protect our geodiversity and provide the framework for measuring success. This is covered in Chapter 3(Staffordshire's stratigraphy) and Chapter 4 (Natural Areas).

4. **Action Plans for RIGS** – this details what will be done at a local level, and gives details of RIGS sites and provides a measure of the actions to enhance them. It also contains proposals for *geo-trails* around Staffordshire that pull together the education, amenity value and promotion of RIGS/SSSIs in a single activity. This is covered in Chapter 5. English Nature already works with landowners to conserve SSSIs.

Thus, the SGAP is designed as a reference and guidance document to promote activities and projects, and thus to increase awareness of geodiversity.

Prelude

The variety of geology and geomorphology provide the diversity for the wide range of life and landscapes in Staffordshire. This geodiversity underpins the biodiversity so important in the current thinking behind nature conservation. Geodiversity encompasses a range of exposures and sites from the commonplace to the rare. Many sites are 'at risk'.

The mosaic of landscapes and underlying rocks, fossils and minerals constitutes the foundation blocks for the very existence of life in general. It provides many of life's essentials; from minerals for agriculture, chemical and food production, raw materials and aggregates for construction and building projects, to sites for education in earth sciences and landscapes for leisure and relaxation. The value of geodiversity therefore extends beyond the educational and scientific benefits to be gained from exploring landscapes, to the economic potential of rocks and minerals.

In a local context, geodiversity has particular importance in giving a distinctive character to an area, be it the Carboniferous reef tops of the White Peak or the acidic lowland heaths of the Midlands Plateau. In towns and cities, geology makes important contributions to the local economy and the quality of life. The Potteries, literally and metaphorically, find their roots underpinned by the geological assemblage beneath them, made up of coal measures and various clays which contributed to the present day environment. Elsewhere in Staffordshire we find landscapes built on the fertile soils, such as in central Staffordshire where they are derived from the underlying mudstones and sandstones.

The geological resources, which constitute geodiversity, are in a state of constant flux as a result of both natural processes and human activity. There is therefore a compelling case for geological conservation since, if no action is taken, potentially there will be significant loss of educational, amenity and commercial opportunities. Although the UK has successfully utilised its geological wealth, especially during the last two centuries, much of this activity has left a legacy of geological sites and exposures that help to elucidate the very diversity which this plan now seeks to promote and conserve.

The primary aim of the Staffordshire Geodiversity Action Plan (SGAP) is to develop a countywide strategy for the conservation of geological diversity and the sustainable use of geological resources for amenity, education and research. The SGAP will achieve this aim through public consultation and contributions from national and local government, statutory conservation bodies, the extractive industries, academia, voluntary organisations and concerned individuals. Through SSSI and RIGS designations, landscapes and geological sites can be conserved for public awareness and understanding, education and science, and so contribute to geodiversity work in the national context.

In implementing the SGAP, contributors will have played a part in safeguarding Staffordshire's geodiversity.

Partnership Organisations and Individuals

The Staffordshire Geodiversity Action Plan follows a partnership approach in both its implementation and in delivering the actions for the future. The Steering Group formally acknowledges the important contribution of the following groups:

Apedale Country Park
British Geological Survey
Cannock Chase AONB
Cannock Chase District Council
Countryside Agency
Earth Science Teachers' Association
East Staffordshire District Council
English Nature
Hanson Aggregates
Keele University
Lafarge
Lichfield District Council
National Forest
National Trust
Newcastle-under-Lyme Borough Council
North Staffordshire Group of the Geologists' Association
Open University Geological Society
Peak District National Park Authority
Peak Park Caving Association
Potteries Museum and Art Gallery
Quarry Products Association
RIGS landowners
Royal Society for the Protection of Birds
South Staffordshire District Council
Stafford Borough Council
Staffordshire County Council
Staffordshire Ecological Records
Staffordshire Moorlands District Council
Staffordshire RIGS Group
Staffordshire University
Staffordshire Wildlife Trust
Stoke City Council
Tamworth District Council
Tarmac Central Ltd.
Trustees of Etching Hill
UKRIGS
WBB Minerals

Abbreviations

The following abbreviations are used in the SGAP:

BAP	Biodiversity Action Plan
EN	English Nature
ESTA	Earth Science Teachers Association
GIS	Geographic Information System
GCR	Geological Conservation Review
HAP	Habitat Action Plan (from SBAP)
LBAP	Local Biodiversity Action Plan
LGAP	Local Geodiversity Action Plan
NA	Natural Area
NSGGA	North Staffordshire Group of the Geologists Association
RIGS	Regionally Important Geological / Geomorphological Site
SAP	Species Action Plan (from SBAP)
SBAP	Staffordshire Biodiversity Action Plan
SER	Staffordshire Ecological Records
SGAP	Staffordshire Geodiversity Action Plan
SRIGS	Staffordshire RIGS (Group)
SSSI	Site of Special Scientific Interest
SWT	Staffordshire Wildlife Trust
UKRIGS	United Kingdom RIGS (national RIGS coordinating body)

Where specialist terminology is used it is explained in the text.

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Chapter 1 - Geodiversity in Staffordshire

1.1. What is geodiversity?

Geodiversity is a term that can be broadly defined as encompassing the variety of rocks, fossils and minerals and natural landscape forming processes on the earth. This is taken to include all geomorphological features and landscapes resulting from weathering and erosion and the transportation and deposition of soils and rocks. Familiar sights in the Staffordshire countryside such as The Roaches and the Trent Valley are prime examples of a 'resource' in the sense of their contribution to an environment with a degree of geodiversity.

1.2. Introducing Action Plans and the SGAP

The concept and value of *biodiversity* has been recognised for several years and good progress has been made in the development of Biodiversity Action Plans (BAPs). The Staffordshire Wildlife Trust has developed the Staffordshire BAP (SBAP) in line with national and international directives on biodiversity. It is important to remember that biodiversity can be more readily managed to achieve tangible benefits in terms of the range and numbers of species, but that you cannot grow rocks. Geodiversity is more finite in the sense that it works in geological time - millions of years, rather than the years or decades in which biodiversity can change.

There are several measures in place nationally to protect the most important geological and geomorphological sites – these include notification as a Site of Special Scientific Interest (SSSI), landform protection in the form of National Parks and Areas of Outstanding Natural Beauty (AONB). At the local level the protection and conservation of geodiversity is delivered through a network of Local Geodiversity Action Plans (LGAPs) to manage and safeguard an area's geodiversity into the future.

LGAPs bring together nationally designated sites (such as SSSIs) with regionally and locally important ones into a common framework across the county. The regionally/locally important sites are designated as Regionally Important Geological and Geomorphological Sites (RIGS). Such sites are protected locally through inclusion in relevant development plans, although no formal protection is afforded directly in law.

The concept of LGAPs was developed further in 2001 and into 2002 through an English Nature project. LGAPs, in a similar format to LBAPs, are currently being developed and include extensive community involvement. The first two pilot LGAPs – Cheshire and Warwickshire – were produced from this, together with the support of UKRIGS. The Staffordshire Geodiversity Action Plan is one of these, together with the Tees Valley (Cleveland) and the North Pennies AONB LGAPs.

Durham and Leicestershire LGAPs are being developed through the MIRO element of the ALSF, they are also being considered for the Isle of Wight and Dorset. A current project between English Nature, UKRIGS and The National Trust may also develop into regional-level LGAPs for The National Trust. LGAPs are also being considered in Wales.

The SGAP is the first of the initial projects to fully integrate with the biodiversity concept and the Habitat/Species focus used in the SBAP. This helps in the translation the SGAP into a practical and meaningful geological/geomorphological equivalent to the SBAP. In turn, the link helps to reinforce the holistic approach to nature conservation that is core to the protection of the natural world.

Once lost, a geological or geomorphological feature cannot be restored or re-introduced like some plants and animals, nor can the habitat it supported be recreated. An example of how geodiversity underpins biodiversity can be seen in the sense that habitats such as calcareous grassland exist because the underlying calcareous rocks control the nature of the soils.

1.2.1. The need for an SGAP

Non-statutory Local Sites are not as well known as SSSIs and lack their legal protection. The government document *Planning Policy Guidance Note 9 – Nature Conservation* makes it clear that Local Geological Sites, RIGS, and Local Wildlife Sites must be taken properly into consideration in local planning processes. RIGS are selected for their educational, scientific, aesthetic and historical values. Although some efforts have already been made to conserve RIGS sites, they remain at risk from certain activities and attitudes. The SGAP aims to redress the balance and specifically:

- Raise general awareness of geodiversity and its value
- Relate geodiversity to the community
- Provide a framework to coordinate the management and educational use of sites
- Provide a baseline for planning authorities for the protection of sites
- Communicate the potential threats to geodiversity and how to manage them

1.2.2. The SGAP and Staffordshire

The SGAP is a geodiversity action plan for Staffordshire – although it is recognised that geological and geomorphological features do not necessarily follow county boundaries. The SGAP targets and actions reflect this and whilst confined in their geographic scope, they work within the shared framework of LGAPs and RIGS across the United Kingdom.

The SGAP coverage includes the following district and borough councils:

- Cannock Chase District Council
- East Staffordshire District Council
- Lichfield District Council
- Newcastle-under-Lyme Borough Council
- Peak District National Park Authority
- South Staffordshire District Council
- Stafford Borough Council
- Staffordshire County Council
- Staffordshire Moorlands District Council
- Stoke City Council
- Tamworth District Council

The area covered by the SGAP is shown in Figure 1 overleaf.

Figure 1 Geographic coverage of the SGAP

1.3. How does the SGAP affect you?

The natural environment is built on geology and the earths resources. The SGAP can be seen as contributing to the promotion of sustainable development, in both individual and corporate terms, with respect to our geological diversity. The effect of the SGAP on an individual or a business is governed by the acceptance of the need to protect our geological diversity as the support mechanism for the natural world. It also acts as a valuable contributor to both the natural and man-made aspects of the environment in which we live.

1.3.1. Individuals and Groups

The SGAP provides a focus for attention to the geological content of the landscape and environment. Involvement may be through one of several avenues:

- sympathetic land management by farmers and other landowners to maintain local landscape features such as stone walls and buildings
- use and enjoyment of the amenity value of open access areas such as The Roaches and Cannock Chase, with an understanding of their presence and formation
- educational use of natural resources – learning through hands-on activities and developing an understanding and appreciation of the supply of raw materials

Active involvement in the management of RIGS locations through volunteering or participation in the SRIGS Group can also contribute through:

- involvement in practical, outdoor initiatives to protect and promote geological sites
- providing an opportunity to learn about the natural world - quite literally from the ground up

1.3.2. Businesses and Organisations

A considerable number of RIGS locations, and potential for future RIGS, are owned by the minerals industry and also by a number of larger landowners (e.g. the National Trust) in Staffordshire.

Those best placed to contribute to the SGAP and the protection and promotion of geodiversity are operators in the extractive industry, and to a lesser extent civil engineering. To a greater or lesser degree most businesses use natural resources and the suppliers of these materials have the chance to enhance the potential for learning and enjoyment through providing access to geological sites and through restoration work.

- responsibility as an employer in raising general awareness of geodiversity and its value
- develop a Corporate Geodiversity Action Plans that is complimentary to the SGAP
- to share information and access to geological resources

1.4. Staffordshire RIGS Group

The SGAP targets and objectives are in accordance with those established by the Staffordshire RIGS (SRIGS) Group, a key partner organisation of the SGAP. The objectives of the SRIGS Group, which are complementary to the SGAP, are:

- To identify and survey geological and geomorphological sites in Staffordshire
- To promote the establishment and protection of RIGS locations
- To co-ordinate the activities of all organisations involved in the conservation of RIGS sites in Staffordshire
- To maintain and enhance the geoconservation database, compatible with the UKRIGS GeoConservation, held by the Staffordshire Ecological Records Office.

The SGAP is primarily concerned with the activities involved in achieving these aims and gives details of the various activities and how their progress is to be both maintained and assessed. RIGS localities, whether geological or geomorphological, can be broadly categorised in to one of two types - a representative locality of the regional geology or a rare exposure or feature that may be of local or national importance.

The nature of RIGS localities is important in considering the RIGS group objectives - there is little difference in the evaluation of such sites but their management and conservation will differ by their very nature. Representative sites are such that they outline the local and regional geology and geomorphology, and link to a sense of place in the environment which provides continuity in the landscape. Sites designated for specific features or unique exposures can offer particular insight in to events and provide opportunities to help us interpret the past.

Chapter 2 - SGAP aims, objectives and targets

2.1. Primary aim and objectives

The key aim of the SGAP is the protection and promotion of the geodiversity of Staffordshire. The objectives relating to this focus on practical means of delivering the overall aim and allow for the setting of targets in key areas against which both progress and effectiveness can be measured. The fundamental objectives of the SGAP are:

- Partnership and Involvement
- Evaluation and Geo-audit
- Conservation and Management
- Education and Site Use

The primary co-ordinator of the activities is the Geodiversity Officer with the support of the SRIGS Group. This provides both a link between discreet areas and continuity to the SGAP.

2.1.1. Partnership and Involvement

The SGAP seeks to bring together a broad spectrum of parties with a common interest in the geodiversity of the county and the protection of it, to this end the SGAP delivers the establishment of an SGAP Steering Group with representatives from various parties, including:

  - Geological and wildlife conservation bodies
  - Staffordshire county planning
  - Extractive industry representatives
  - RIGS owners
  - Education
  - SRIGS
  - Geodiversity Officer

- Additional involvement of all local / national interest groups outside the main Steering Group for the SGAP where each body should have representation. The list may include:

  - Local community groups
  - Wildlife conservation groups
  - Geological conservation groups
  - Private landowners
  - Extractive industries
  - Local government and local/mineral planning authorities
  - Geological societies and trusts

- Local guidelines to complement planning policy and guidance for mineral workings (PPS9[i] and MPG14 [ii]) in liaison with Mineral Planning Authorities

[i] Planning Policy Statement Note 9 – Biodiversity and Geological Conservation

- Coordination through regular liaison between the Geodiversity Officer and UKRIGS placing SGAP in the national perspective with other LGAPs.

- Regular features / articles in local interest magazines and newsletters (e.g. *Staffordshire Wildlife* magazine of the SWT, Bulletin of the NSGGA) to promote the SGAP

- Resources – the Geodiversity Officer should coordinate resources in order to fulfil the planned activities required to meet the SGAP targets

- Funding – for implementation of the SGAP and site management and interpretation work

Coordination of the activities of various interested groups and working parties is the role of the Geodiversity Officer.

The SGAP should be carried forward through the proactive, participative use of RIGS as educational and community resources. This is inherent in the objectives for Natural Areas and the individual stratigraphic units found in the County. The following groups – or working parties – are key to the SGAP and its future. The titles (**blue**) contribute to the target areas with suggested activities and actions below:

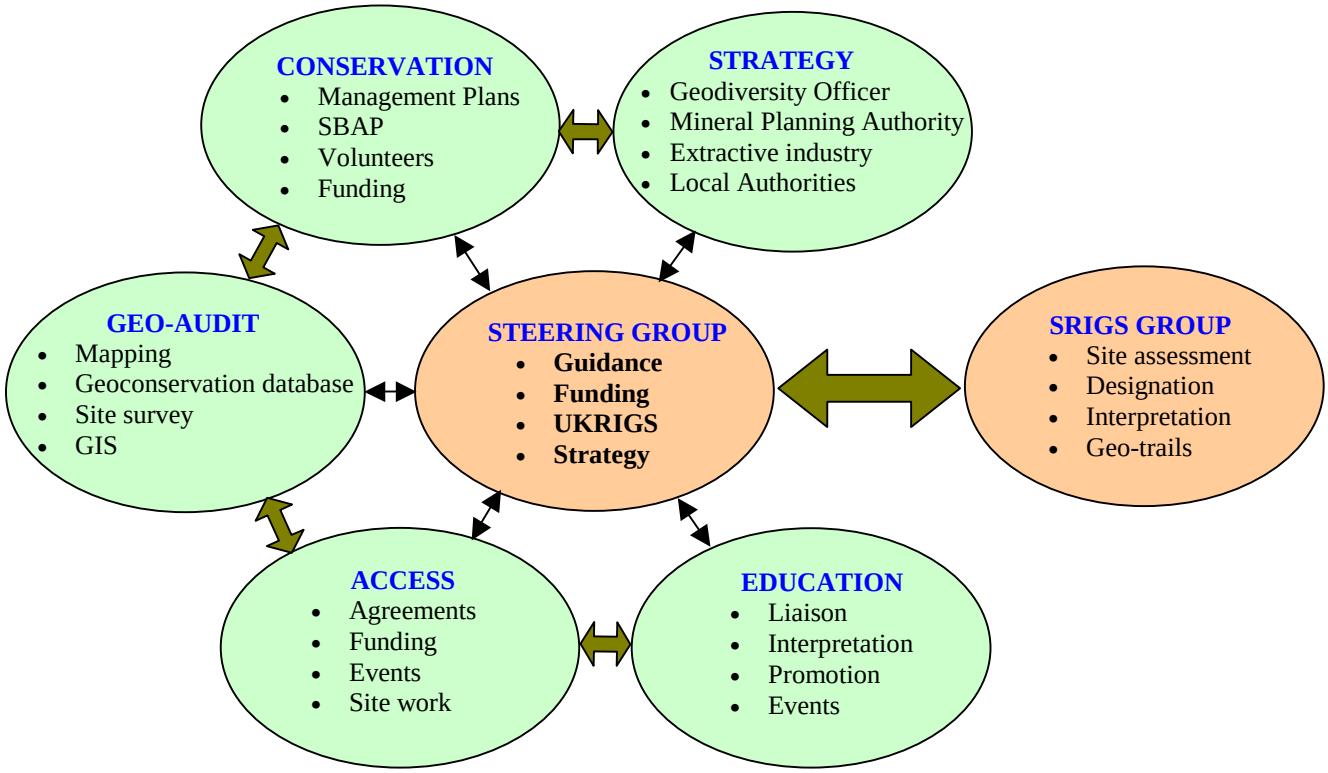


Figure 2 SGAP Working / Interested Parties

[ii] Mineral Policy Guidance note 14 - Revocation, Modification, Discontinuation, Prohibition and Suspension Orders Town and Country Planning (Compensation for Restriction on Mineral Working and Mineral Waste Depositing) Regulations 1997

The groups form an interrelated matrix of skills and knowledge to help achieve the SGAP objectives and target action in the most effective manner. Guidance for the working parties should come from the SGAP Steering Group, through the Geodiversity Officer's coordinating role. The application of the working parties is detailed in the individual Stratigraphic Objectives and Natural Area targets, together with RIGS locations themselves. The SRIGS group is complementary, but distinct, to the core of SGAP.

The Steering Group itself should contain a representative from all major interested parties – the Working Parties provide access to the governance of the SGAP for all groups. The Steering Group should provide guidance on the implementation and management of the SGAP, including representation of Working Party members.

Working Parties – targets and activities

Working parties are seen as a focus of skills, experience and resources – which can then be applied in a constructive manner to help deliver against SGAP targets. The structure of the targets involves lead partners/resources who coordinate and carry forward the activities associated with a particular target. A lead resource need not always be a working party group, as seen in the target tables (tables 1 to 4).

Working parties help to facilitate and provide the resources to achieve the target, under the guidance of a leader. The involvement in either a working party or as a target lead resource is not exclusive. It is envisaged that across the whole spectrum of targets and across the variety of working parties a balance between target lead and working party members will be achieved.

Working Party Constituents

The proposed Working Parties should be made up of a variety of individuals and organisations. The following breakdown shows potential membership of each Working Party:

SRIGS Group
- SRIGS members
- Site designation and interpretation

Geo-audit
- Members of the North Staffordshire Group of the Geologists' Association
- Geodiversity Officer
- Universities and colleges of further/higher education
- GeoConservation Database / Staffordshire Ecological Records
- SRIGS
- Interested individuals and landowners

Education
- Staffordshire Wildlife Trust
- Earth Science Teachers' Association / Educational establishments
- Rockwatch / Geowatch
- Aggregates companies
- Local museums

Access
- Landowners
- Wardens / Managers
- Aggregates companies
- SRIGS committee
- Local Authorities

Conservation
- Staffordshire Wildlife Trust
- SRIGS members
- Site owners/wardens/managers
- Aggregates companies
- Schools/Colleges/Universities
- Museums
- English Nature (SSSI coverage)

Strategy
- Geodiversity Officer
- Mineral Planning Authority
- Aggregates companies

2.1.2. Evaluation and Geo-audit

All RIGS locations identified in the initial evaluation work will be classified according to their position in the Staffordshire stratigraphic column and their geological classification as solid, drift or a geomorphological feature. The following criteria will be used in the assessment of individual sites for their suitability and/or eligibility as a RIGS locality:

- Reference to the Geological Conservation Review[iii] for site listings (complete coverage) and inclusion of all geological SSSIs in the county (13 sites)
- Listing and stratigraphic/geomorphological classification of all current RIGS localities (69 Staffordshire RIGS including 20 in the Peak Park)
- Representation of a full stratigraphic column for Staffordshire through RIGS and SSSIs locations
- Establish baseline conservation information for all RIGS locations
- Initial assessment and cross-reference with SBAP for all listed RIGS localities
- Identification and mitigation of any conflicting activities
- RIGS survey working party active in detailed survey work
- Educational value

An example of the RIGS assessment sheet is given in Appendix F. This shows the various categories that a site is assessed against, namely:

- Access and safety
- Education and science
- Culture, Heritage & Economic
- Geodiversity value

[iii] Geological Conservation Review – Joint Nature Conservation Committee initiative to identify and describe the most important earth science sites in Britain.

2.1.3. Conservation and Management

The current RIGS localities will be the main focus of the SGAP in terms of their conservation, balanced with the value that each locality offers. The management of geological and geomorphological SSSIs included in the SGAP is guided through English Nature.

To deliver a targeted approach, within resource constraints, conservation activities will be initially concentrated on key areas. The sustainability of the SGAP relies on the management of resources and agreements. This is to be undertaken by means of:

- Establishing and making contact with the owners of all RIGS sites, including any subsequent additions to the existing list
- Formulating detailed management plans for the targeted key sites including access arrangements, exposure visibility, site safety etc.
- Creation of initial management plans for all other sites
- On-going agreements in place to manage potential conflicts
- Promotion of a series of short 'Staffordshire Geological Trails' covering groups of sites placing local landscapes in the context of geological history

A significant element of the *conservation* activities such as site access and clearance, maintenance of exposures and prevention of damage are covered under the management of sites. The development of sites of local geological interest should, where feasible, be encouraged in consultation with mineral extraction companies in Staffordshire:

- Agree restoration and working practices, where possible, to preserve geological features in aggregate and mineral workings and promote RIGS
- Work with RIGS owners to maintain and enhance RIGS locations, together with managed access and use of the maximum number of appropriate sites

The core responsibilities of the Mineral Planning Authority (MPA) & Local Planning Authority (LPA) are also instrumental in the conservation and management of sites through:

- recognising the value of protecting such sites for their educational, research, historical and aesthetic importance in strategies and plans
- including policies/proposals to protect such sites in policy documents
- giving technical advice and guidance on conservation and management in codes of practice within policy documents
- taking into account the effects/impacts on the special interest/value of such sites in planning applications for development
- securing the conservation and management of such sites through the imposition of planning conditions and/or planning obligations on a grant of planning permission
- supporting bids for monies/ grant aid from bodies administering funds for conservation and management
- working in partnership with local Councils and consultation on planning applications to be determined by local planning authorities

In addition, the MPA also has key roles in:

- securing the conservation and management of such sites through determination of restoration and aftercare schemes submitted pursuant to a grant of permission
- securing the conservation and management of such sites as part of the review of old mining permissions under the Environment Act 1995

2.1.4. Education and site use

An important part of promoting RIGS and the SGAP is communicating ideas and developments with the communities in which RIGS localities are situated.

- Promotion of a small number of key sites for their educational value and use for fieldwork both for schools and colleges and for Higher Education
- Interpretative trails and information panels established at key locations that are of major educational importance, both for schools and for the public
- Agreeing access conditions for all sites, to an appropriate level of use
- Regular geological audits of key sites
- Resolution of any conflicting land use activities where possible
- Participation in public awareness and educational activities such as Quarry Open Days, Rockwatch events etc.

A series of *geo-trails* covering different aspects of the geology and geomorphology of Staffordshire are the primary means of providing on-going promotion of RIGS in the community. These should be relevant to a wide audience with aspects such as disabled access, animals, cycle-access all included to some extent. Proposals for each of the initial *geo-trails* are given in Appendix C.

Where a site is chosen for a visit / fieldtrip and it does not have open public access the land owner's permission should always be sought. In addition it is not reasonable to solely rely on the landowners' insurance in the unfortunate event of a serious incident arising. For this reason an example indemnity form is included in Appendix E. In all cases both the Geological Code and Countryside Code should always be followed, together with common sense.

2.2. Achieving SGAP Targets

The objectives of the SGAP will be delivered through a two-tier approach using Stratigraphy and Landscapes (Natural Areas).

Stratigraphy – geological and technical focus – Chapter 3

Natural Areas – geomorphological, regional and community focus – Chapter 4

A summary of the various activities to deliver against each of the key objectives of the SGAP are shown in the following sections.

2.3. Monitoring and Review

The setting of objectives within the SGAP must be quantifiable and realistic. All proposals should be assessed on the basis of either their landscape or stratigraphic value. The following factors are taken in to account in assessing the progress of the SGAP:

- Representation of the stratigraphic column
- Number/proportion of sites with open access / arranged access
- Educational use of sites - primary/secondary/tertiary
- Conservation activities
- External site funding - sponsorship/stewardship
- Promotion in the community - open access, interpretation
- Numbers of representative and rare/unique sites
- Levels of site management - vegetation clearance, face stability/grading
- Planning process - county, local and minerals

The planning process for future actions should follow an established route to ensure clarity of direction and understanding. If actions are not delivering the targets, the process must be reviewed and enhanced:

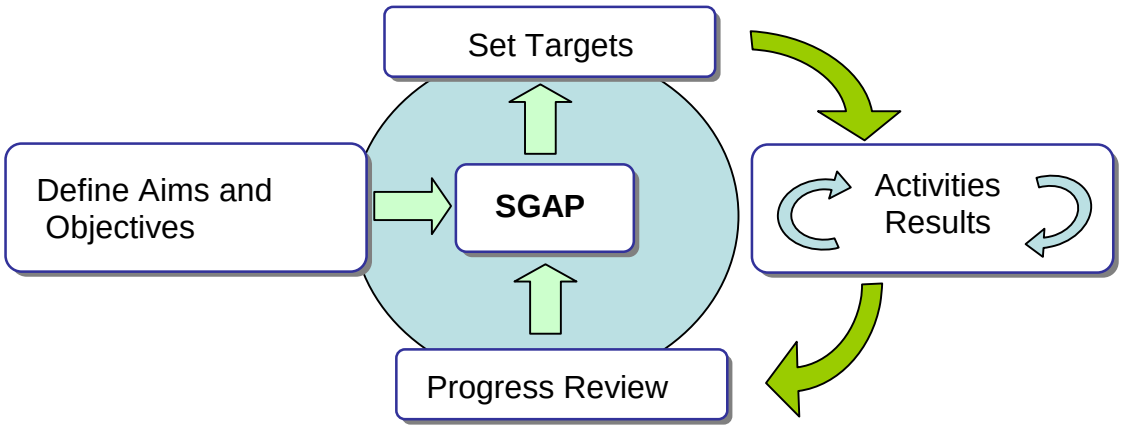


Figure 3 Planning and Progress Review process to deliver SGAP Targets

2.3.1. Targets

The primary aims outlined above will be delivered against through a series of targeted activities and actions which are listed in Figure 4. The following figures (Figure 5 to Figure 8) show how the activities discussed throughout the SGAP are to be used to deliver against the key targets in each area. These should be taken in the relevant stratigraphic or Natural Area context – or within individual site management plans. All of the targets outlined against the key objectives are also collated in a common format with proposed lead partners/resources identified against each. These are shown in Table 1 to Table 4 below and on the following pages.

Partnership and Involvement		
Activity	**Target**	**Lead Resource**
Set-up of parties as detailed in the SGAP	June 2004	LGAP Partners
Open website and publication of SGAP	February 2004	Geodiversity Officer
Regular meeting of SGAP Steering Group	Quarterly	Steering Group
Geodiversity Officer / SGAP representation	May 2004	SRIGS
SGAP website	Monthly review and update	Geodiversity Officer
SGAP publication	Monthly review and update	Geodiversity Officer
Creation of permanent display at Potteries Museum	April 2004	Stoke City Council
Regular updates and inclusion of all documents on website	Monthly	Geodiversity Officer
Link in SBAP HAPs	March 2005	SWT / SBAP
Provide SGAP to all RIGS landowners and review targets	March 2004	RIGS owners / Geodiversity Officer
Contact corporate GAP operators in Staffordshire	July 2004	Industry Partners

Table 1 Partnership and Involvement target summary (2004-2005)

Site Evaluation and Geo-audit		
Activity	**Target**	**Lead Resource**
Development of links with Natural Areas	September 2004	EN / Geodiversity Officer
Evaluation of Natural Area specific targets	June 2004	Geodiversity Officer / EN
Identify Natural Area Stratigraphic Resources	August 2004	Geodiversity Officer / BGS
Identify and meet with local interest groups	May 2004	Interest Groups
Information pack to local groups	June 2004	SWT Local Groups
Place all RIGS in local community with Parish Councils / Community Groups	July 2004	SWT Local Groups
On-going review of current sites	Continuous	SRIGS / Geodiversity Officer
Regular review of potential sites from Stratigraphic Plan	5 year rolling plan	SRIGS
Obtain baseline SBAP information	August 2004	SBAP / SGAP
Establish full Management plans for further key sites	January 2005	Site owners
Establish 5 stratigraphy based geo-trails	March 2005	SRIGS / Geodiversity Officer / SWT
Full RIGS details on Staffordshire Ecological Record (SER) database	Continuous	SER / SRIGS

Table 2 Site Evaluation and Geo-audit target summary (2004 –2005)

Conservation and Management		
Activity	**Target**	**Lead Resource**
Establish outline management plan for 20 RIGS	March 2005	Site owners / Geodiversity Officer
Liaise with all RIGS owners - management plans	February 2005	Geodiversity Officer / Site owners
Seek access agreements for privately owned sites	January 2005	Site owners / Geodiversity Officer
Promote inclusion of SGAP in all Local Plans	Continuous	SWT / Geodiversity Officer
Promote planning geo-guide to Local Authorities	March 2005	MPA / SWT / Geodiversity Officer
Raise geodiversity awareness generally - through distribution of the SGAP	February 2004	Geodiversity Officer
Inclusion of SGAP / Geodiversity in AONB plans	January 2004	AONB Unit - Cannock Chase
Inclusion of SGAP in Forest of Mercia plans	March 2004	Forest of Mercia
Action management plans for key sites	August 2004	Geodiversity Officer / SRIGS
Liaison with SWT Local Groups for working parties	Continuous	SWT / Local Groups
Management of geo-trail sites	Continuous	SWT / NSGGA / SRIGS
Creation of interpretive material for key sites	2 sites by June 2004 2 by September 2004	BGS / SRIGS
Ensure all reclamation/restoration schemes address the SGAP	Continuous	MPA / Geodiversity Officer / SWT / SRIGS
Align SGAP and Corporate GAPs	Continuous	Industry Partners
UKRIGS Conference representation	October 2004	Geodiversity Officer
Seek to increase the number of corporately owned sites involving promoting geodiversity	March 2005	Peak Park / National Forest / Central Rivers Project
Contact current operators in Staffordshire ensure that restoration plans address the SGAP	March 2005	Industry Partners / Geodiversity Officer / MPA

Table 3 Conservation and Management target summary (2004-2005)

Education and site use		
Activity	**Target**	**Lead Resource**
Seek and promote two new sites with access for school groups	March 2005	Geodiversity Officer / SWT
Run Staffordshire Rocks Quiz	>3 times per year	Geodiversity Officer / SWT
Geological themed guided walks	>3 times per year	Geodiversity Officer
Geodiversity article in SWT newsletter	Regular articles bi-monthly	Geodiversity Officer
NSGGA updates/newsletter	Regular feature	Geodiversity Officer
Regular site survey work in line with SBAP aims	*See SBAP*	SBAP
Establish Geodiversity exhibition at SWT headquarters	March 2005	SWT
Mobile display and site specific interpretation	January 2004	SWT
Update of website with brief interpretation for all sites	Initial data entered by March 2004 Monthly update	Geodiversity Officer / SER
Seek funding for the Creation and distribution of information leaflets at selected key sites	2 sites by June 2004 2 further sites by September 2004	SRIGS
Provide site specific activities for schools	September 2004	Rockwatch
Educational use of sites of >3 sites in accordance with management plans	July 2004	Universities

Table 4 Education and Site Use target summary (2004-2005)

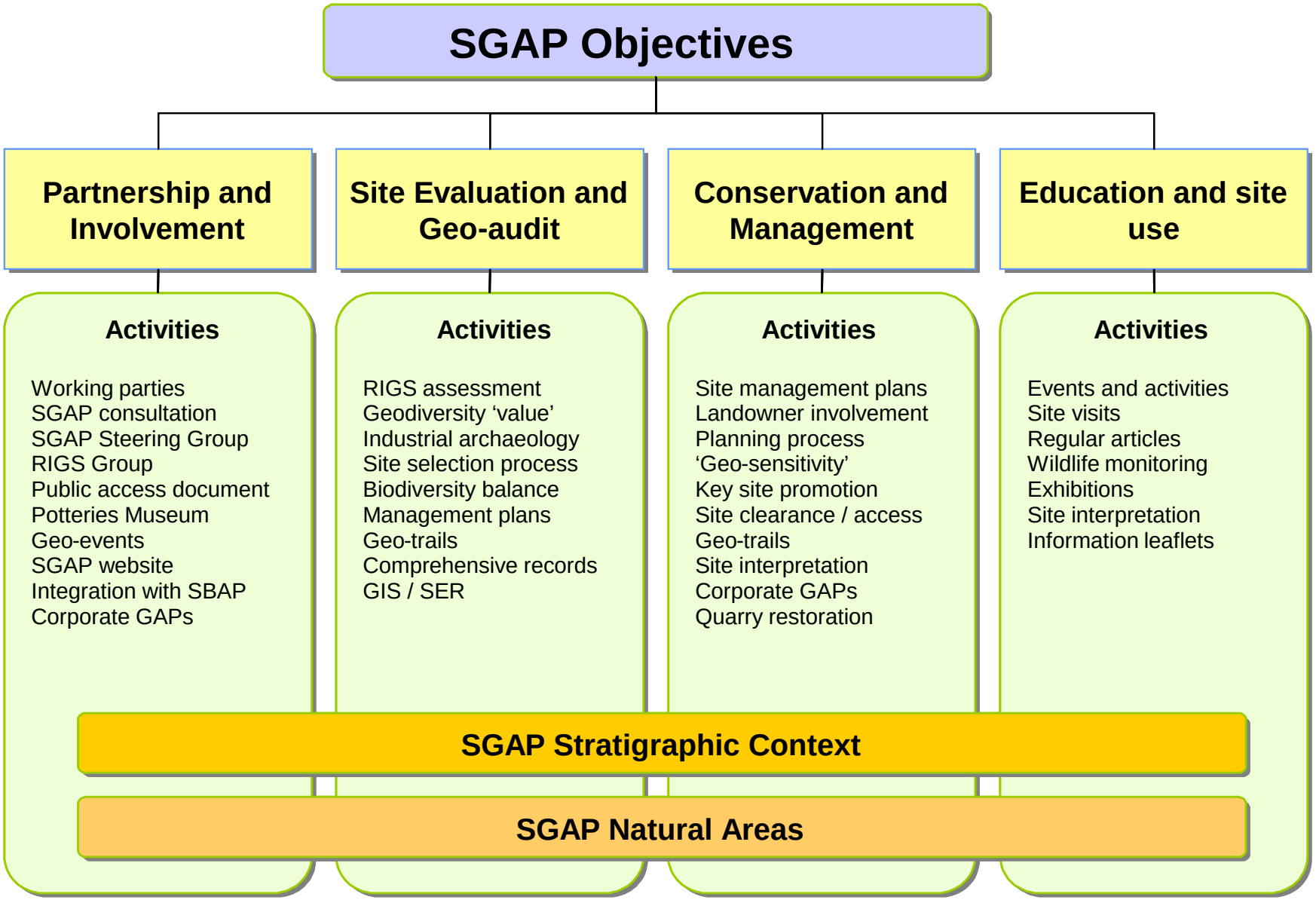


Figure 4 SGAP Objectives and related activities

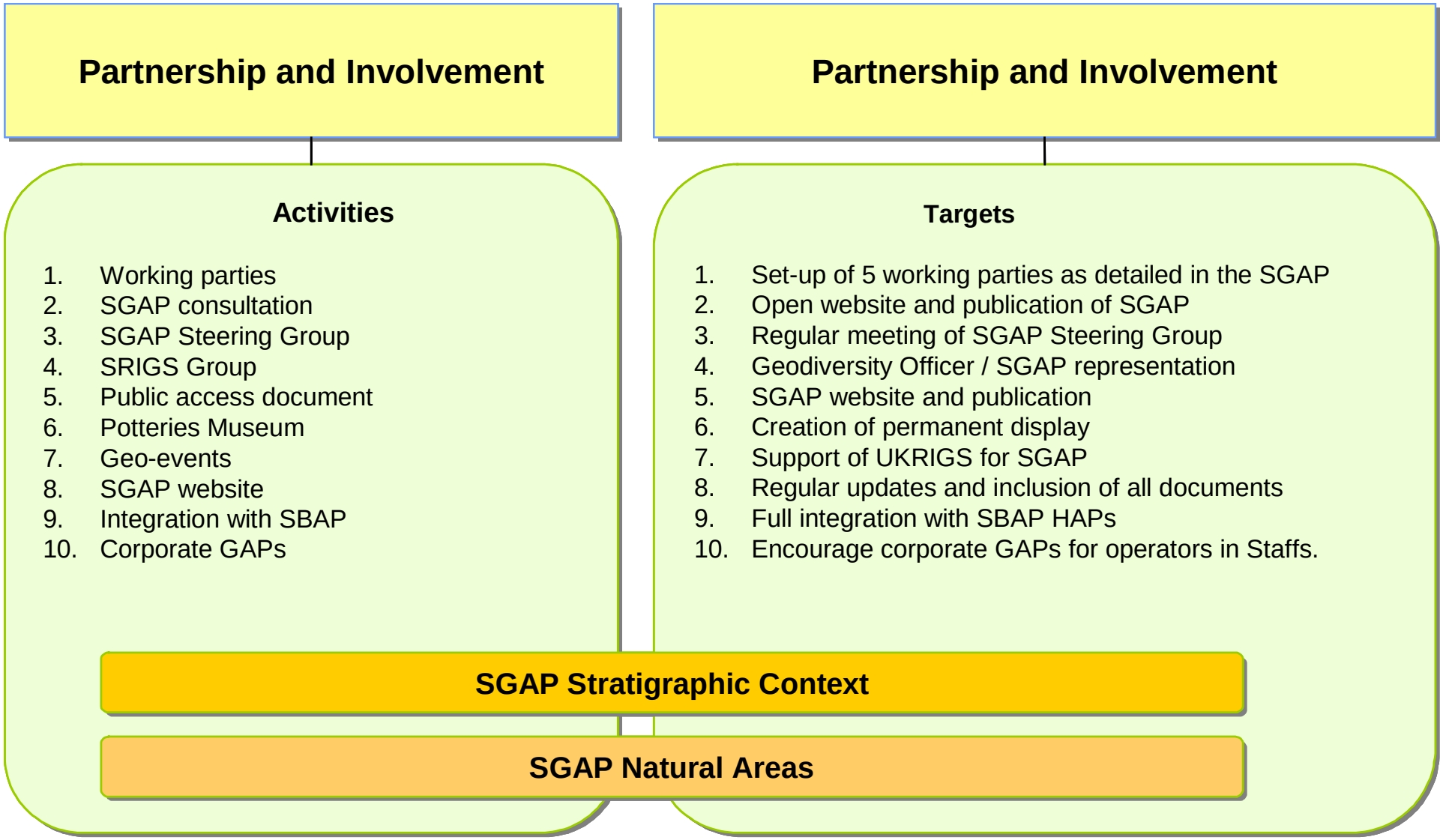


Figure 5 SGAP targets - Partnership and Involvement

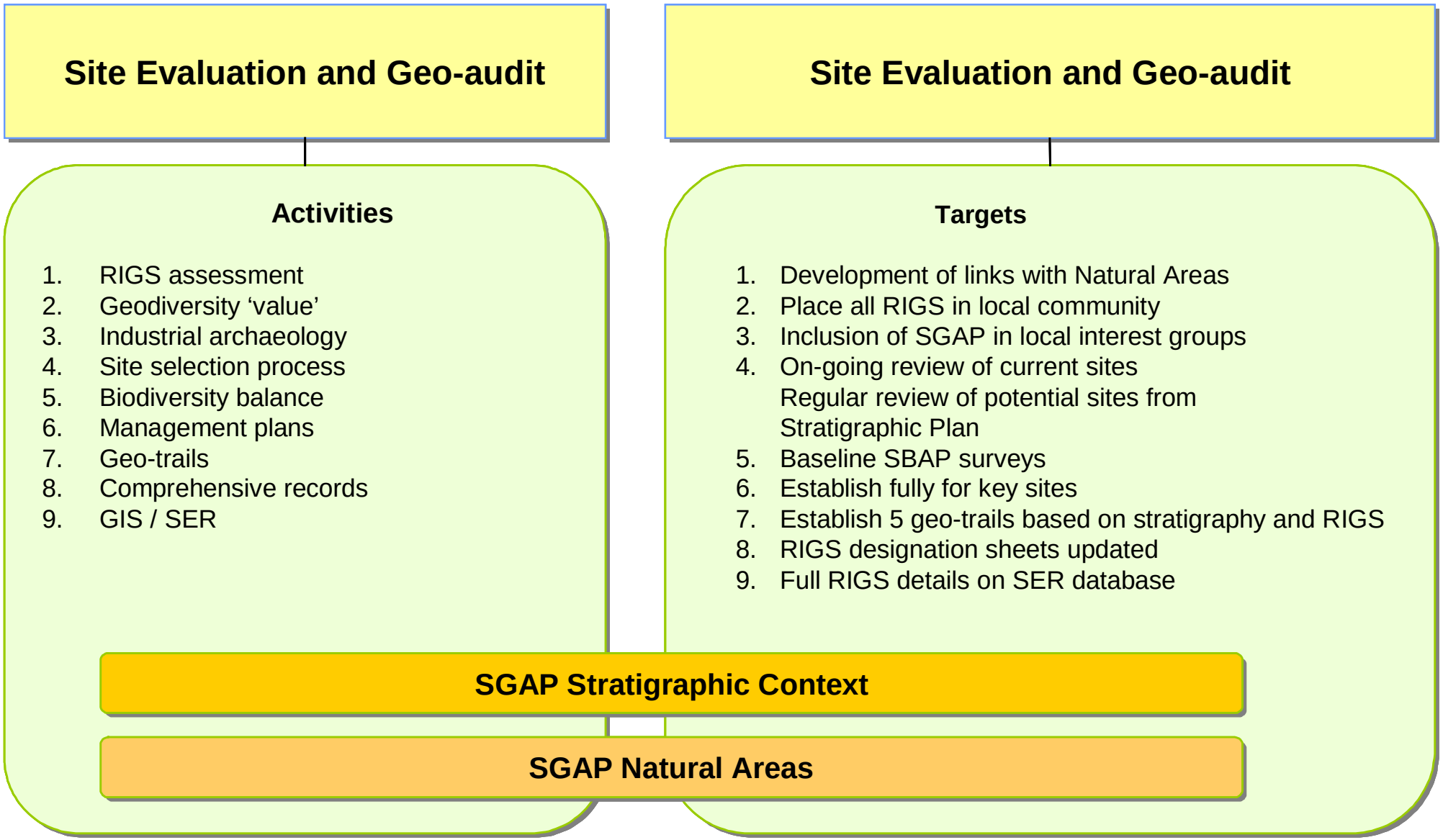


Figure 6 SGAP targets - Site evaluation and Geo-audit

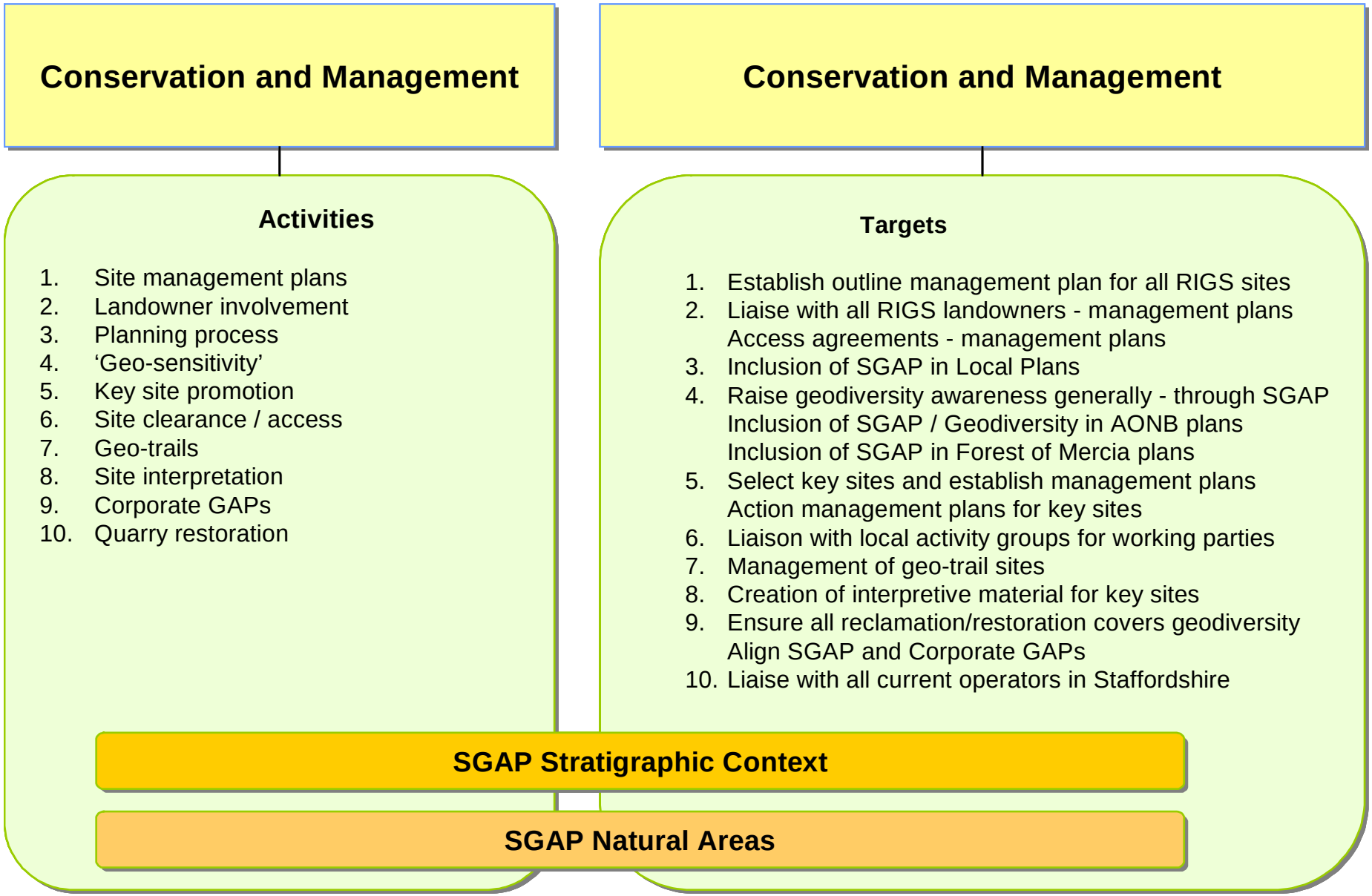


Figure 7 SGAP targets - Conservation and Management

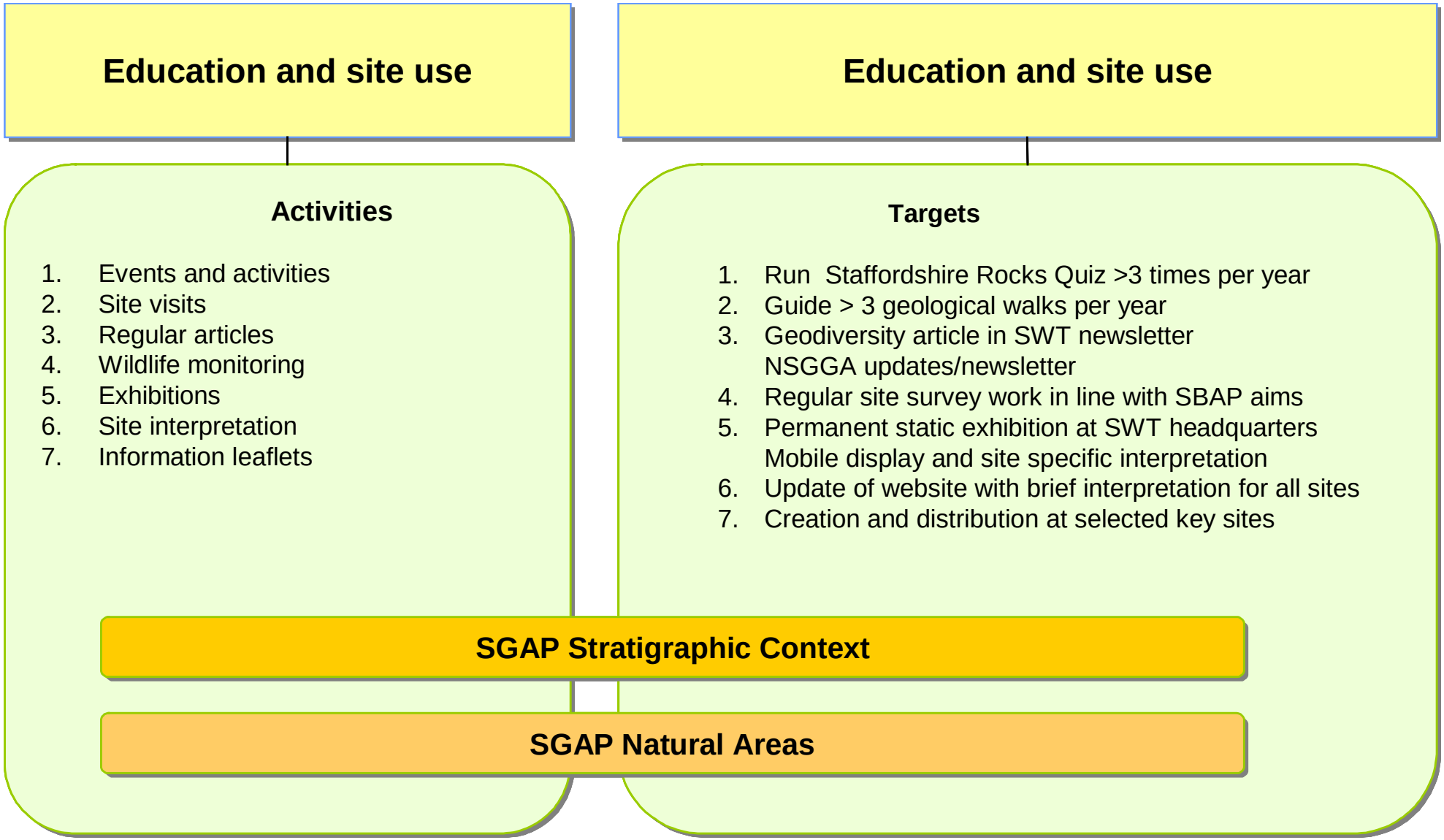


Figure 8 SGAP targets - Education and site use

2.3.2. Indicators and Feedback

Geological and geomorphological features are somewhat static when compared to the habitats and species of the SBAP. With this in mind, SGAP should be considered as a reference document providing a framework of objectives and targeted actions.

Actions and achievements should be reported and documented, and these should form part of the SGAP actions themselves – namely the maintenance of geological records and management plans for all RIGS locations. The dynamic element of the SGAP is to ensure the plan is self-perpetuating through a series of working parties under the guidance of the steering group.

2.3.3. Milestones

The SGAP objectives are focussed around the central aim of the conservation and promotion of educational and community use of geological sites where appropriate. Implementation of the targets actions requires considerable effort and planning – and should form the basis of the *actions* of the future.

Chapter 3 - SGAP in its stratigraphic context

The term *stratigraphy* refers to the study of layers of rock and their sequence in time. It is taken to cover both sedimentary and igneous rocks and may refer to various characteristics of rocks and the correlation of different beds within it. The *stratigraphic column* is a representation of the various geological *periods* listed in time order, generally with the oldest at the bottom. The full stratigraphic column is shown in Figure 9 with the strata that can be seen in Staffordshire highlighted.

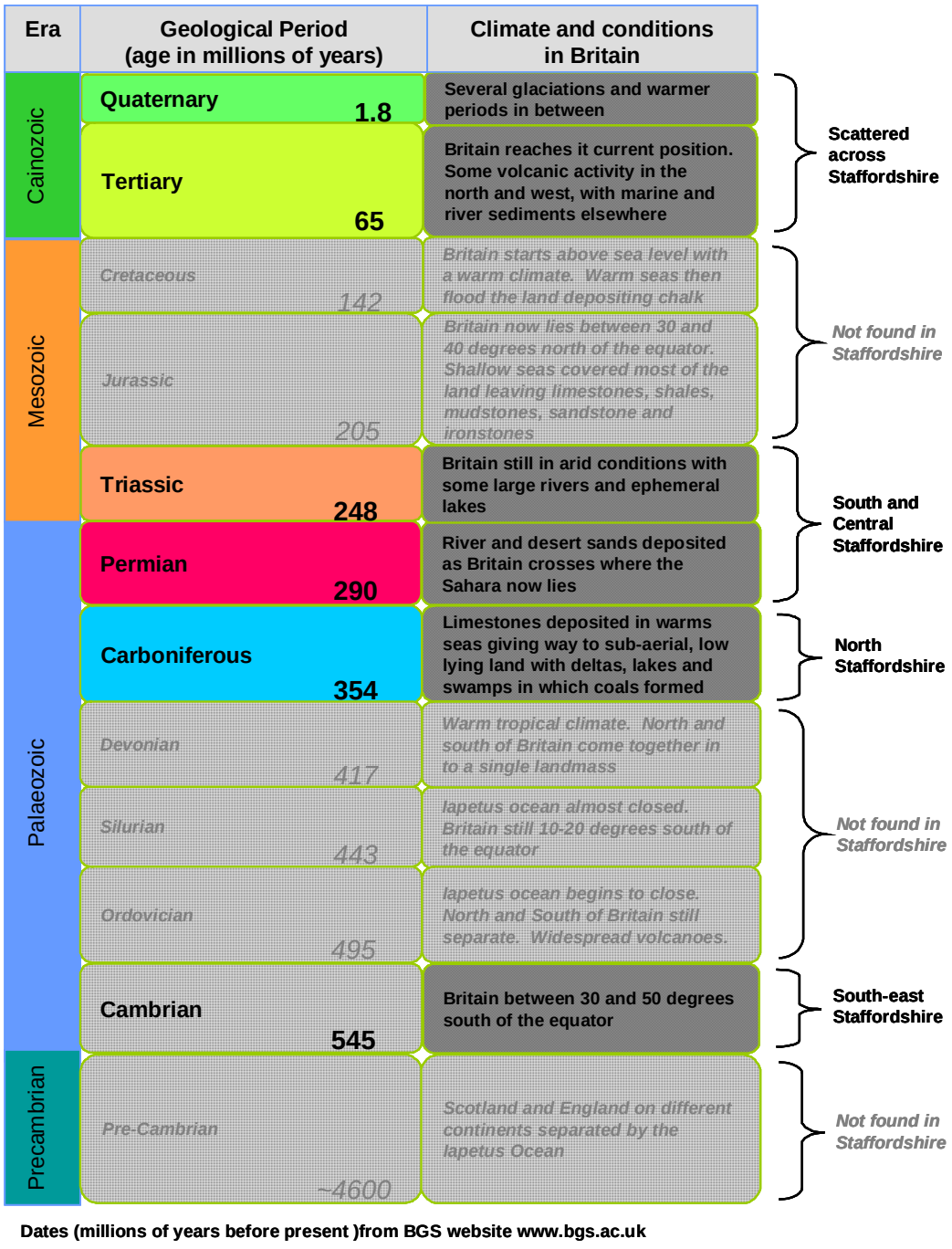


Figure 9 Staffordshire's stratigraphic column (*after L.Cox)*

3.1. Stratigraphic representation

The primary tier of the SGAP is the stratigraphic sequence of rocks that occurs in Staffordshire. This is a fixed reference from which the coverage of geological sites can be measured. The underlying rock-type (strata) of an area greatly influences the natural landform and frequently the land-use; to this end the stratigraphic objectives can be linked to Natural Areas.

The basis for the SGAP is geology and geomorphology, to emphasise this, the SGAP detail is based on the individual stratigraphic units that occur within the county. By using stratigraphy we have a means of classifying and understanding how well geological sites including RIGS and SSSIs are representing the county.

The elements of the geological sequence that are represented in Staffordshire are shown on the following pages, with links to where RIGS and SSSIs fall in terms of their stratigraphy. By the very nature of geology not all of the formations will be exposed in the county.

The targets related to Stratigraphic Representation are based upon the representation of the individual geological units found in Staffordshire and also a review of the *Geological Conservation Review* documentation. They must still be easily 'accessible' to the wider public, with themes built upon local features such as outcrops or local characteristics in building stone, farming landscape and the local economy (history of coal mining, sand and gravel extraction or quarrying).

The key attributes that will be measured against *stratigraphy* will be inherently more site specific, such as designation characteristics like geology, educational use, history, industry and aesthetics. Individual RIGS management plans will contain further details such as:

- Sediment transport/deposition
- Tectonic Setting
- Structures
- Features
- Source material
- Sediment provenence

The following pages detail geological stratigraphic columns for all of Staffordshire and also give some indication of the local variances and uses of rocks and minerals across the county.

3.2. SSSIs & RIGS in the Stratigraphic Column

The various formations that comprise the exposed stratigraphic column across Staffordshire are shown in the stratigraphic columns detailed by each geological period that is represented within the county. Superimposed on to these are the various geological SSSIs and RIGS in Staffordshire – there are however some notable exceptions (gaps) if RIGS coverage is to provide a full stratigraphical picture of the county. This important in delivering the key aims of the SGAP, especially in the realm of educational benefit.

Details of the coverage of SSSIs and RIGS are listed in the following sections – together with specific targets against each in order to complete the stratigraphic coverage of the county.

In viewing the diagrams it is important to note the overall picture across the Midlands and Northwest of England during each of the geological time periods. The two primary periods that are represented in Staffordshire, but whose geology differs across the county are the Carboniferous and Triassic. The differences in local and regional geology for these periods is shown on the diagrams where the same period is split in to several formations, each representing a geographic area of the county or adjacent counties.

3.2.1. Carboniferous environment

The Carboniferous period saw the deposition of limestones, mudstones and sandstones across much of the North of Staffordshire. During the Carboniferous there were important differences in the environment under which rocks were deposited. The Namurian deposits were more complex, with a series of inundations by the sea and local formations where large rivers have deposited grits in different ways.

The Dinantian limestones were deposited under varying depths of water with different formations and features being evident today. Typically the main difference is between shelf (shallow water) and off-shelf (deeper water).

3.2.2. Triassic environment

The Triassic saw generally arid conditions with some large rivers and ephemeral lakes and the landforms of the time have given rise to different ‘basins’ in which material was deposited. Tectonic activity gave rise to different basins in which sediment was deposited. Staffordshire includes three Triassic depositional basins, each with its own characteristics and rock formations. These are:

Stafford Basin – covers most of central Staffordshire
Needwood Basin – eastern central Staffordshire
Cheshire Basin – north and west fringes of Staffordshire

The different formations and geology of each basin can be seen in the figures on the following pages. The Sherwood Sandstone Group of the Triassic varies more widely between the basins than the Mercia Mudstone Group.

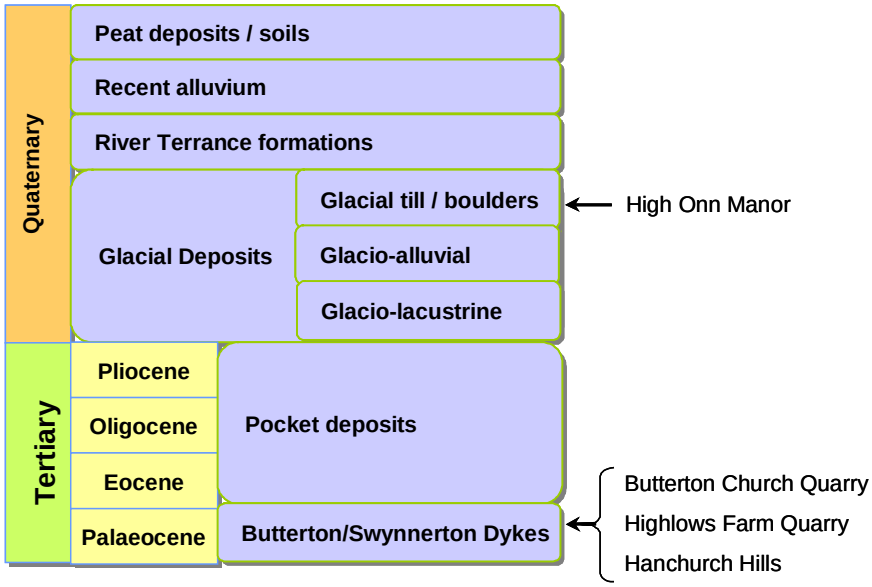
3.2.3. Tertiary and Quaternary Deposit

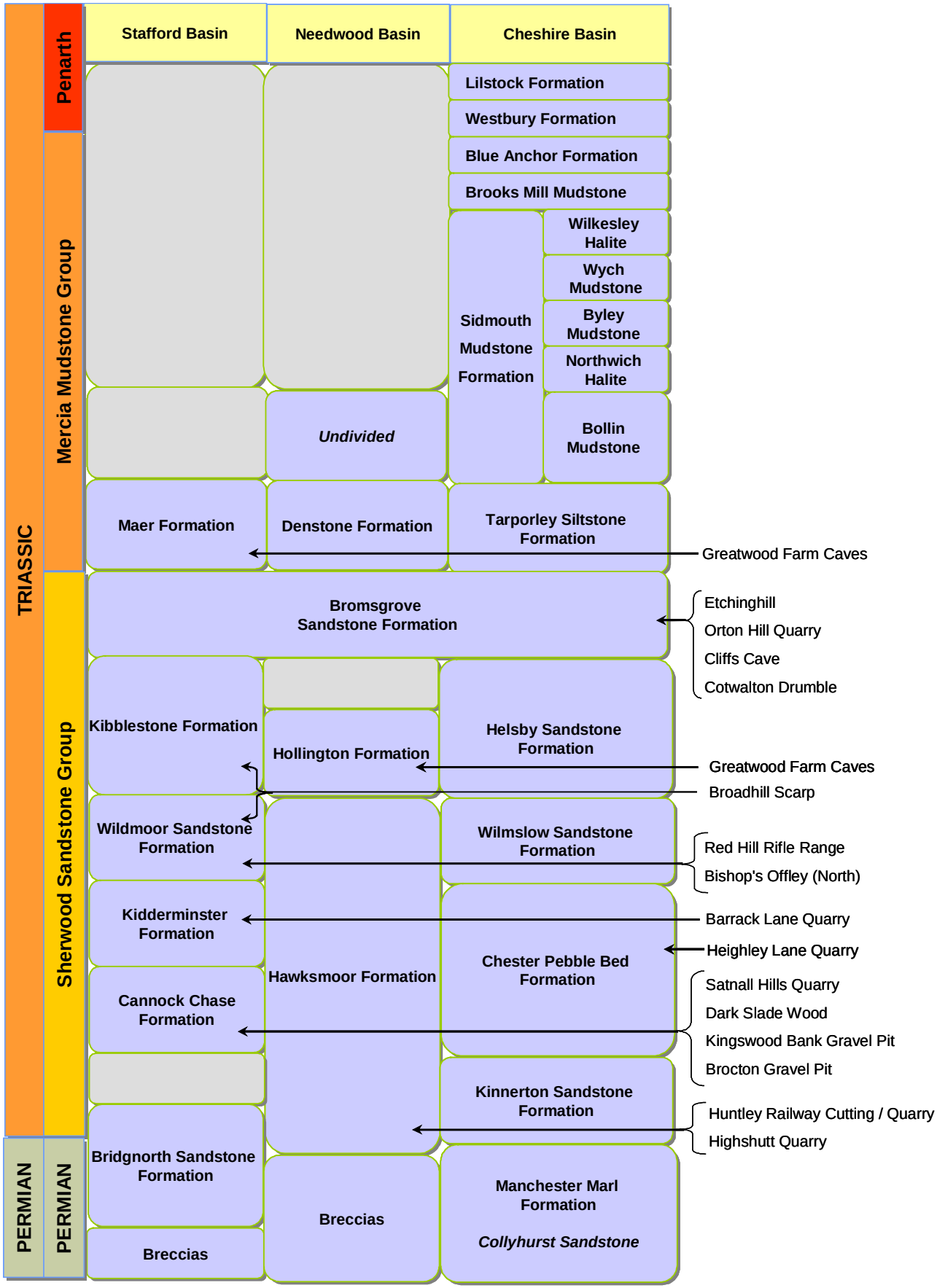
There are significant deposits of glacial tills and gravels across the county, together with alluvial gravels. These deposits are some of the most widely worked for sands and gravels. The solid geology includes minor Tertiary dykes across parts of county, contributing to several RIGS locations.

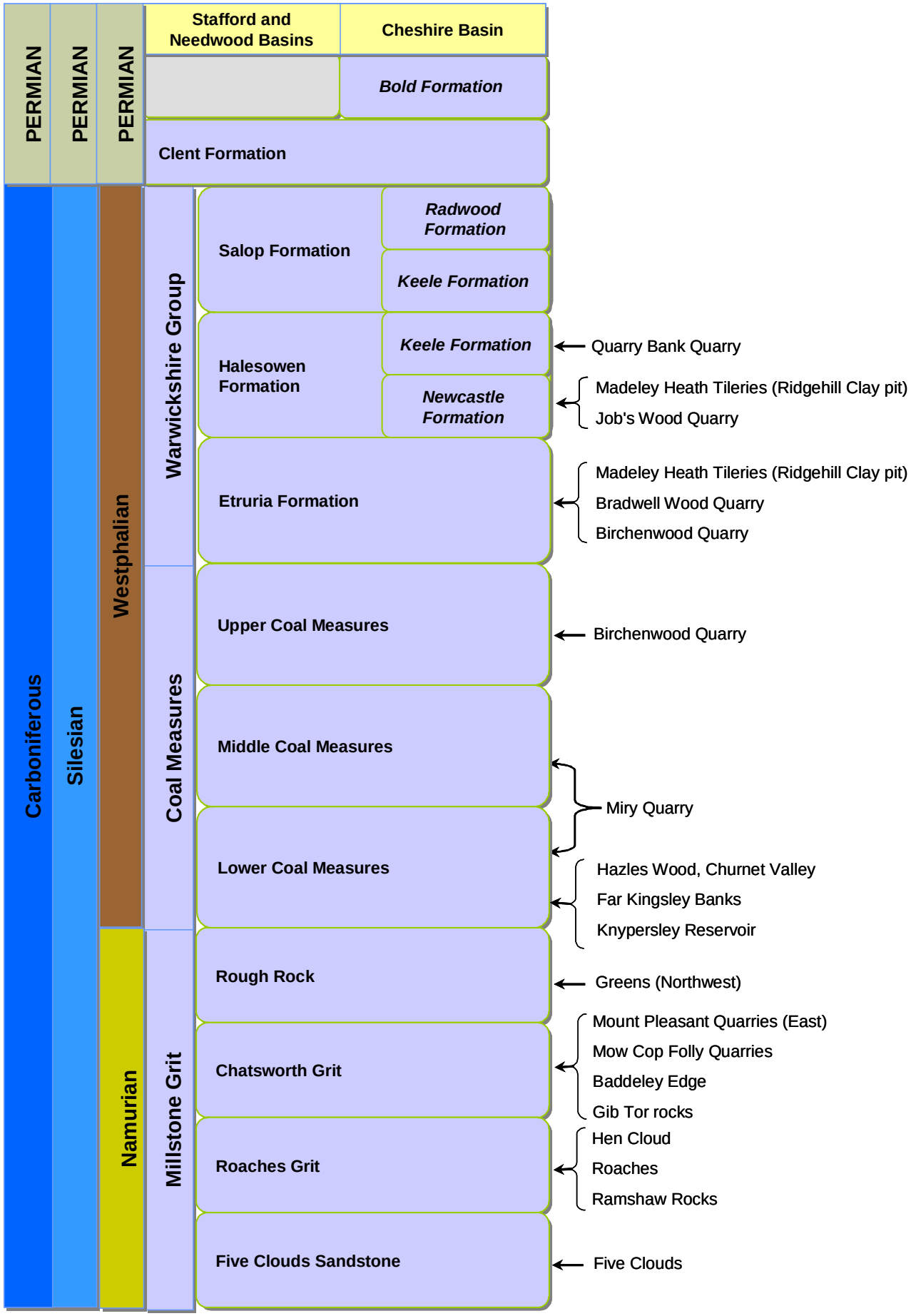
Geological Information

Throughout the SGAP the rock naming used is in accordance with the current guidelines from the British Geological Survey. Some of the more important changes to note are:

Old Name	New Name		
	Stafford Basin	Needwood Basin	Cheshire Basin
Rhaetic Beds	Penarth Group		
Keuper Marl	Mercia Mudstone Group		
Lower Keuper Sandstone	Kibblestone Formation	Hollington Formation	Helsby Sandstone Formation
Upper Mottled Sandstone	Wildmoor Sandstone Formation	-	Wilmslow Sandstone Formation
Bunter Sandstone	Bromsgrove Sandstone		
Bunter Pebble Bed	Kidderminster Formation/Cannock Chase Pebble Beds	Hawksmoor Formation	Chester Pebble Beds Formation
Lower Mottled Sandstone	Bridgnorth Sandstone Formation	Huntley Formation	Kinnerton Sandstone Formation




TRIASSIC
PERMIAN
Penarth
Mercia Mudstone Group
Sherwood Sandstone Group
PERMIAN
Stafford Basin
Needwood Basin
Cheshire Basin
Lilstock Formation
Westbury Formation
Blue Anchor Formation
Brooks Mill Mudstone
Sidmouth Mudstone Formation
Wilkesley Halite
Wych Mudstone
Byley Mudstone
Northwich Halite
Bollin Mudstone
Undivided
Maer Formation
Denstone Formation
Tarporley Siltstone Formation
Greatwood Farm Caves
Bromsgrove Sandstone Formation
Etchinghill
Orton Hill Quarry
Cliffs Cave
Cotwalton Drumble
Kibblestone Formation
Hollington Formation
Helsby Sandstone Formation
Greatwood Farm Caves
Broadhill Scarp
Wildmoor Sandstone Formation
Wilmslow Sandstone Formation
Red Hill Rifle Range
Bishop's Offley (North)
Kidderminster Formation
Barrack Lane Quarry
Heighley Lane Quarry
Chester Pebble Bed Formation
Cannock Chase Formation
Hawksmoor Formation
Satnall Hills Quarry
Dark Slade Wood
Kingswood Bank Gravel Pit
Brocton Gravel Pit
Kinnerton Sandstone Formation
Huntley Railway Cutting / Quarry
Highshutt Quarry
Bridgnorth Sandstone Formation
Breccias
Manchester Marl Formation
Collyhurst Sandstone
Breccias


PERMIAN
PERMIAN
PERMIAN
Stafford and Needwood Basins
Cheshire Basin
Bold Formation
Clent Formation
Carboniferous
Silesian
Westphalian
Namurian
Warwickshire Group
Coal Measures
Millstone Grit
Salop Formation
Radwood Formation
Keele Formation
Halesowen Formation
Keele Formation
Newcastle Formation
Etruria Formation
Upper Coal Measures
Middle Coal Measures
Lower Coal Measures
Rough Rock
Chatsworth Grit
Roaches Grit
Five Clouds Sandstone
Quarry Bank Quarry
Madeley Heath Tileries (Ridgehill Clay pit)
Job's Wood Quarry
Madeley Heath Tileries (Ridgehill Clay pit)
Bradwell Wood Quarry
Birchenwood Quarry
Birchenwood Quarry
Miry Quarry
Hazles Wood, Churnet Valley
Far Kingsley Banks
Knypersley Reservoir
Greens (Northwest)
Mount Pleasant Quarries (East)
Mow Cop Folly Quarries
Baddeley Edge
Gib Tor rocks
Hen Cloud
Roaches
Ramshaw Rocks
Five Clouds

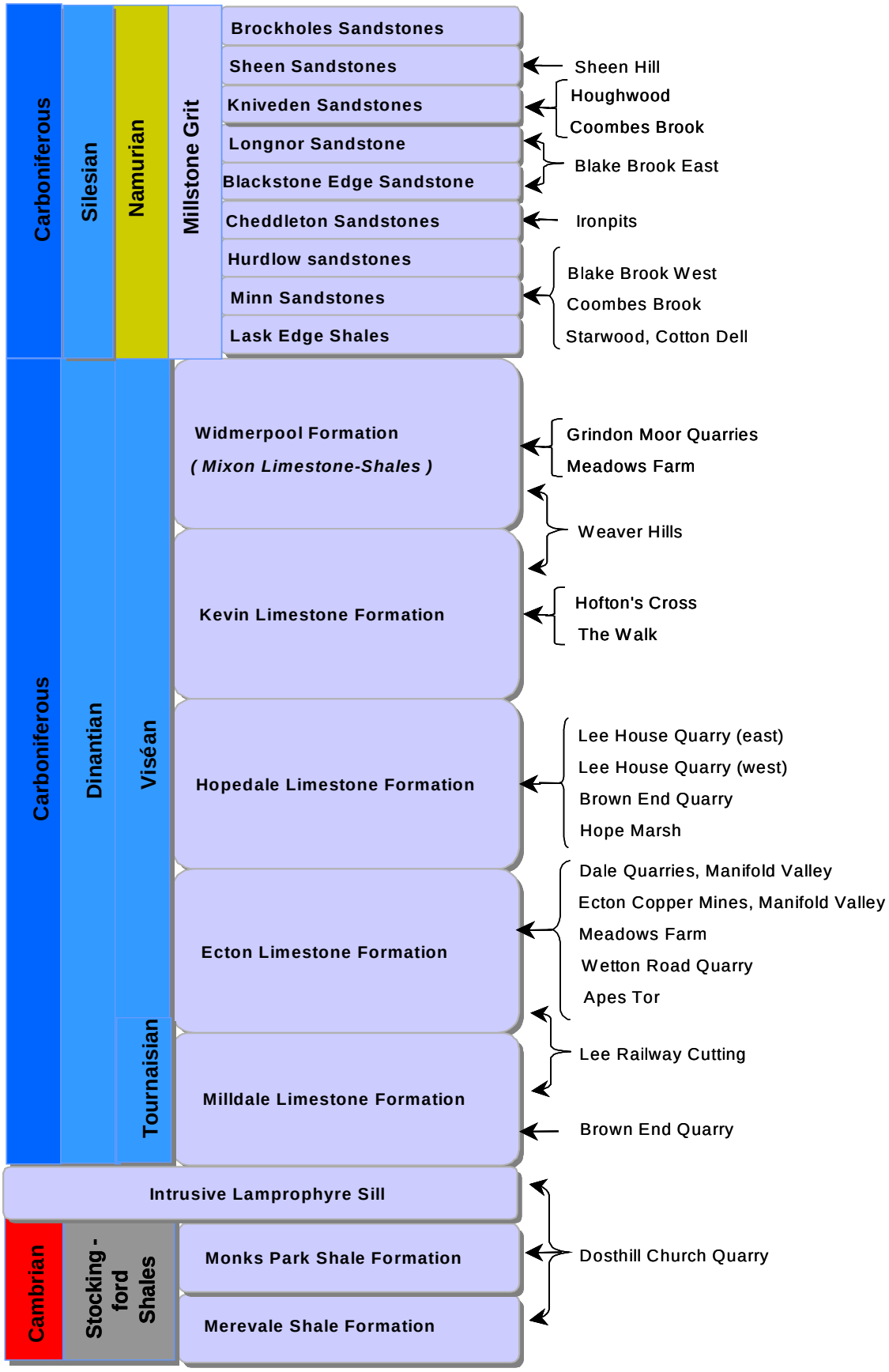


Figure 10 Staffordshire's Stratigraphic Column and RIGS/SSSI coverage (after Cox and Ambrose)

3.3. Economic geology of Staffordshire

The relationship between the Stratigraphic Objectives of the SGAP and Natural Areas is shown well when considering the economic geology of an area. The mineral wealth of Britain helped to place it at the forefront of the industrial revolution. This gave rise to the industrial, agricultural and domestic development that has made the landscape what it is today.

The industrial and economic history of Staffordshire has involved extensive use of geological resources. Whilst not directly attributable to natural geological processes, the activity has left its mark, and continues to do so, in terms of the impact on the landscape and earth resources.

The Potteries are so named because of the juxtaposition of clays and marls with coal measures providing raw materials suitable for the manufacture of a range of pottery. The coal itself has been extensively worked both underground and in opencast pits. These activities, together with restored quarries and sand and gravel pits give rise to significant areas of made ground.

The economic and social history of Staffordshire has very tangible links to geology and geodiversity, which helps to cement the local nature of the SGAP.

The economic development of Staffordshire has been greatly influenced by its geological resources from coal mining in the Potteries to the extraction of sand and gravel from the Trent Valley. As a result of mining and quarrying activities, many of these man-made features have been subsequently designated as RIGS and are being promoted within the community and educational establishments. Coal mining has also historically contributed to the economy of Staffordshire.

3.3.4. Characteristic features of Staffordshire's Natural Areas

The following sections illustrate some of the practical applications of the geology of Staffordshire. Many of the formations outlined in the Stratigraphic Objectives are used for specific applications due to factors such as their locality or physical properties.

The figures on the following pages show some of the major uses to which the various geological formations found in Staffordshire are put to. Historically many formations have been used locally in the days before materials could be transported long distances with relative ease. This includes many of the clays and mudstones of the Triassic and Upper Carboniferous that are now overlooked for brick-making.

The influence of underlying geology on the landscape and landform is most marked in North Staffordshire. The Moorlands consist largely of hills of gritstone, with valleys of heavy clay soils. The gritstone exposures at The Roaches, Ramshaw Rocks, Biddulph Moor and Wetley Rocks are locally well-known, while Mow Cop still bears the evidence of workings for millstones.

The limestone plateau of the Peak is cut by steep-sided gorges, notably the Hamps and Manifold Valleys and Dovedale. These uplands tend to be colder and wetter and more difficult to farm than the lowlands. The climate, together with the thinner soils over limestone generally means that the land is almost entirely devoted to pastoral farming.

The geology towards the south and east of Staffordshire results in the landscape becoming much more rolling and dominated by arable farming on the fertile floodplain soils and weathered mudstones and marls. The areas of higher ground are much better drained than in the north of the county, the country around Cannock Chase being a good example of an elevated region of Triassic pebble-beds. The resulting ground being of poor agricultural value and it is now dominated by commercial forestry and managed heathland within the Cannock Chase AONB.

The east of the county sees a continuation of the Triassic sediments, together with a marked increase in the area of land covered with glacial moraines and tills. The mudstones and clays from the Triassic and later are locally worked, together with sand and gravel to yield bricks and construction aggregates. The occurrence of hard rocks for building stone is scarce, but better soils have given rise to hedges for field boundaries and an increase in the number of trees.

The influence of glacial till on the landscape is evident in the numerous local ponds and meres in the west of the county. Much of the peat deposits built up in these areas since the last glaciation have been drained for agricultural use or worked.

The following sections give a more detailed insight in to the uses of various elements of the stratigraphy of Staffordshire. The availability of materials are often limited to particular formations and hence particular Natural Areas as seen in the examples.

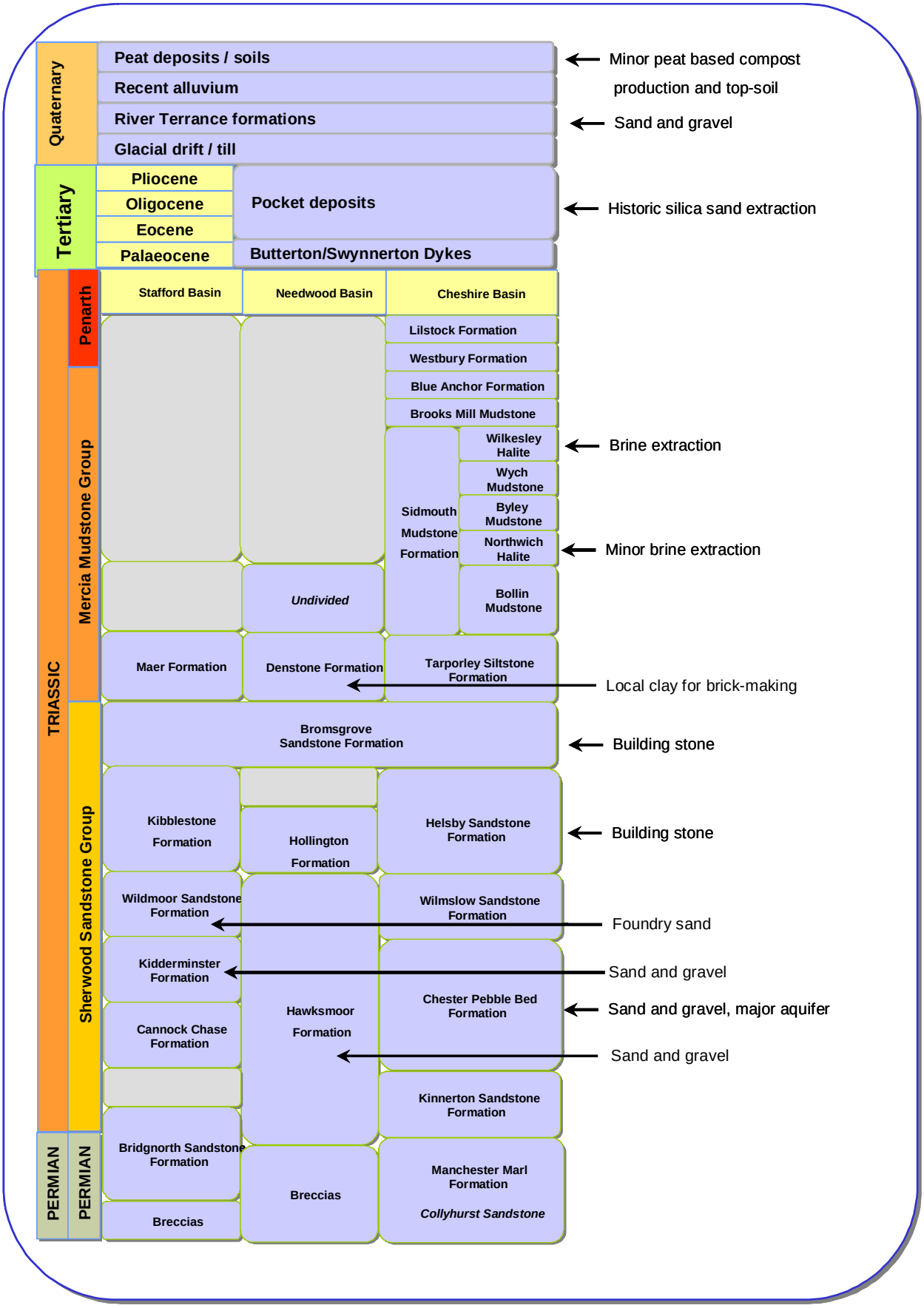


Figure 11 Uses of Staffordshire's rocks - Recent to Triassic (*after L.Cox)*

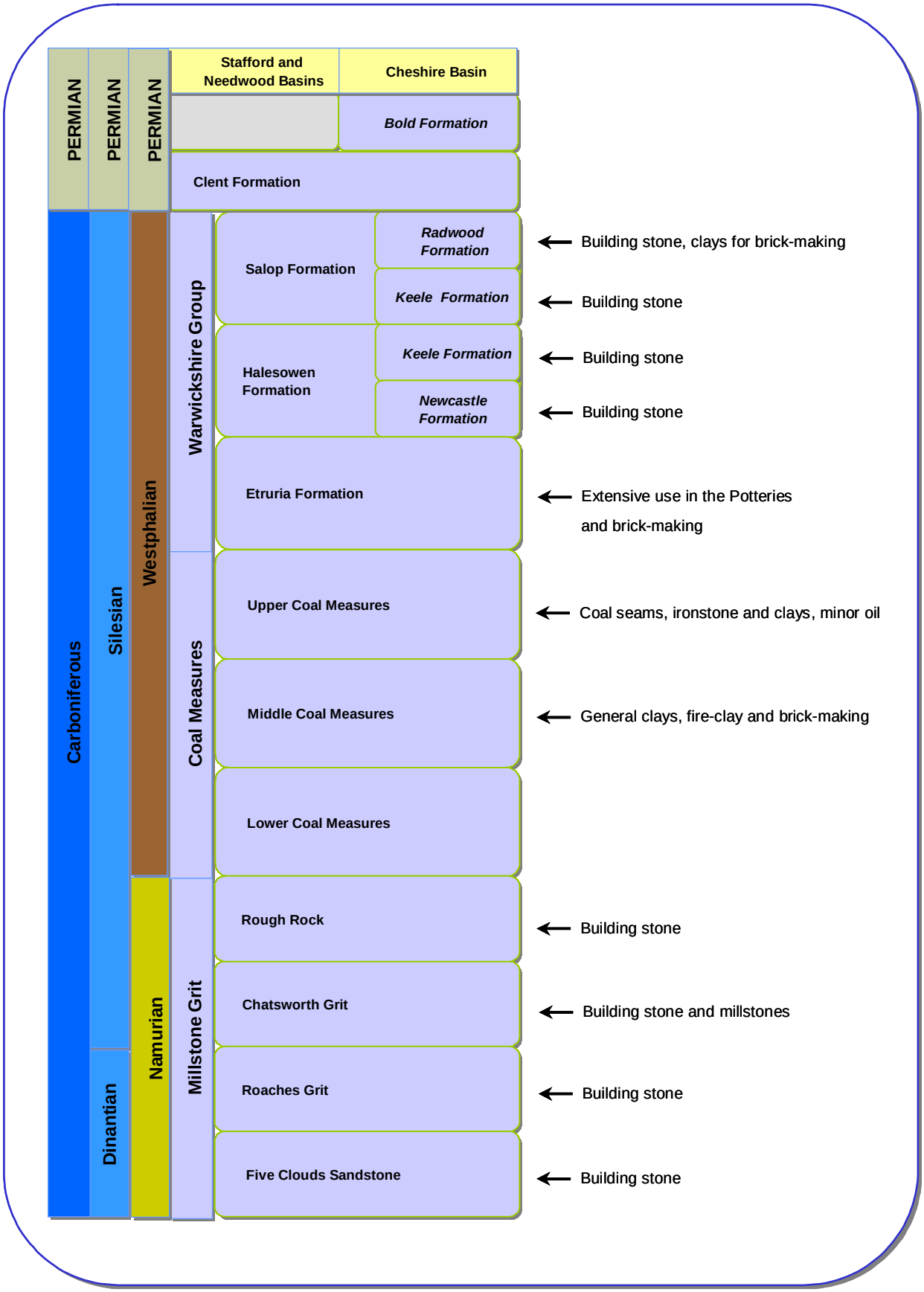


Figure 12 Uses of Staffordshire's rocks – Permian to Namurian (*after L.Cox)*

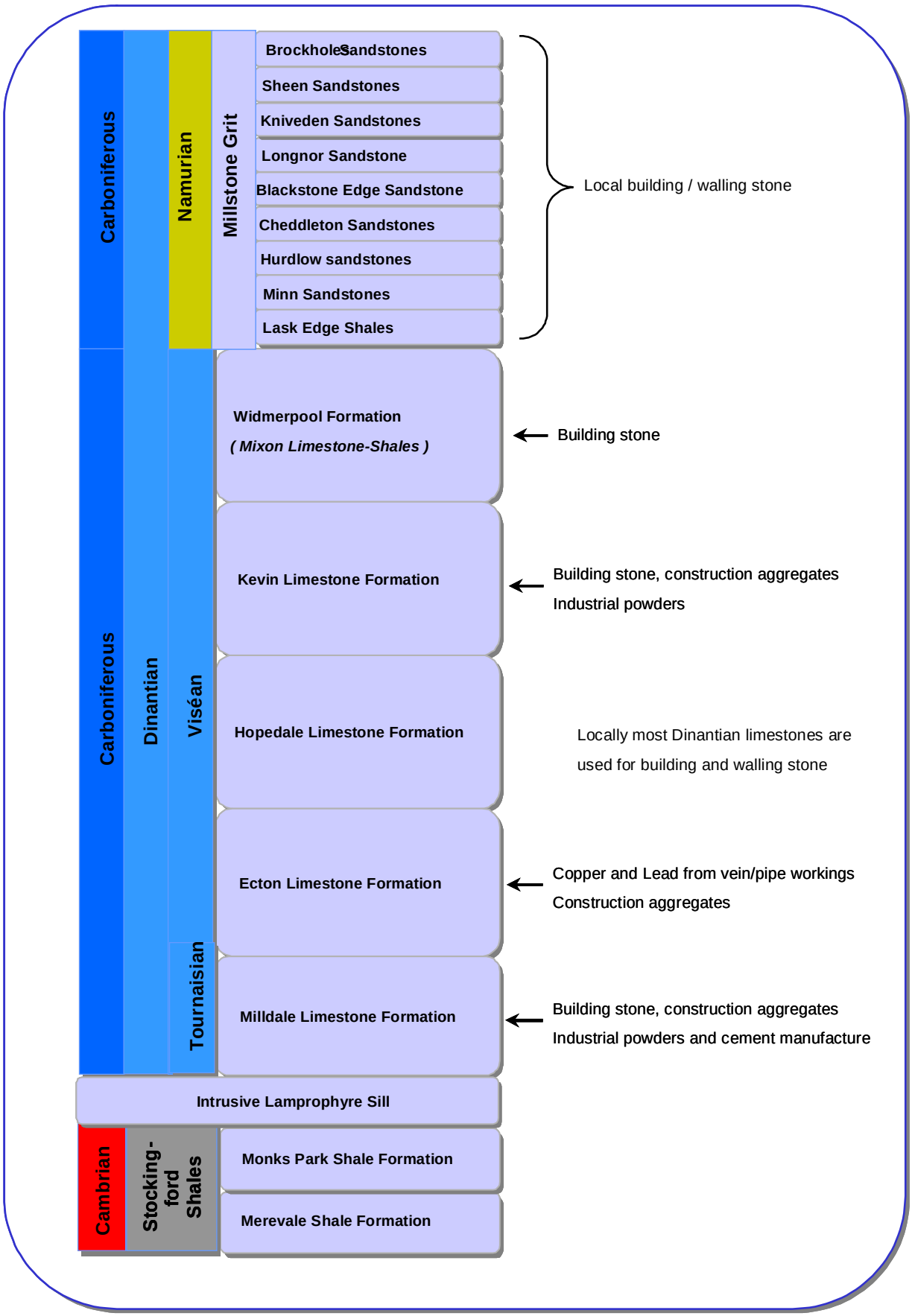


Figure 13 Uses of Staffordshire's rocks - Namurian to Carboniferous (*after L.Cox)*

3.3.5. Stone walls

A Characteristic feature of much of north Staffordshire is the stone walls which are used to form field boundaries. Much of the material to build the walls has been sourced locally due to its relatively low value and heavy weight – in many cases it has been quarried locally from small excavations that are now totally overgrown or may have been filled in.

Walling stone can provide an insight in to the underlying geology and also properties of the rock – some sandstone look durable when in-situ but in fact they may weather very quickly, the result being a collapsed wall.

The three most frequently used materials for drystone wall in Staffordshire are:

- **limestone** in the White Peak
- **gritstone** across the Southwest Peak and Roaches
- **sandstone** throughout the Churnet Valley and Stoke areas

Gritstone from the Roaches Grit, Chatsworth Grit and Rough Rock provides a durable walling material, but presents some problems as it slowly weathers to rounded stones. Figure 14 shows a typical random gritstone (Roaches Grit) wall with both rounded (weathered) and angular (fresh) pieces of stone. This type of wall is typical of the Staffordshire Moorlands area around the Roaches and Ramshaw Rocks RIGS sites.

Figure 14 Gritstone wall near the Roaches

Limestone walls are on the whole confined to the White Peak where the stone is readily available and now forms an integral part of the protected landscape. Figure 15 shows a random coursed limestone (Bee Low Limestone) wall made up of angular pieces of stone. This type of wall typifies the field boundaries in the White Peak, and often has a barbed wire stand at the top to deter sheep from jumping.

Figure 15 Carboniferous Limestone wall typical of the White Peak

The sandstones found in the Carboniferous coal measures of north Staffordshire are on the whole less durable than most. There are still many walls made from various sandstones within the Staffordshire Moorlands, such as that in Figure 16 made from Longnor Sandstone. Triassic sandstones are also used for walling and more commonly building stones where suitable formations occur.

Figure 16 Longnor Sandstone wall in North Staffordshire

3.3.6. Building / Dimension stone

Drystone walls are constructed from local materials with little or no preparation to the surface of the stone prior to construction. There are also significant local workings commonly in various sandstones in the Carboniferous Coal Measures and some workings in the Triassic Sherwood Sandstone Group.

Throughout north Staffordshire there are a great many stone houses and buildings – many built from the same materials as walling stone, dressed to a greater or lesser extent. Carboniferous sandstones within the Coal Measures are not generally worked, the overlying Barren Measures containing the Keele, Newcastle and Radwood formations have all been worked to provide building stone in the Stoke area.

3.3.7. Construction aggregates

There are significant workable deposits of sand and gravel across southern and central Staffordshire. These stem mainly from the Sherwood Sandstone Group and Quaternary deposits of fluvial and glacial gravels. The gravels may be crushed to provide a more favourable particle size, although the rounded nature of the gravels suits many applications, particularly when used in concrete.

Hard rock quarries also operate in the north of the county where Carboniferous limestone is worked to provide material for general construction and block making in addition to industrial uses. Limestone, together with shales, is also used in the manufacture of cement on the southern edge of the White Peak.

3.3.8. The Potteries

The *Potteries* derives it name from the profusion of ceramic and pottery manufacture in and around the towns and villages surrounding Stoke. Historically the juxtaposition between clay/marl and early industrial processes has meant that the area saw a dramatic increase in the production of fired clay and ceramic products. Until relatively recently the industry has continued in the area through the presence of a skilled workforce and the continued supply of coal.

3.3.9. Coal mining

There are several coal mining areas in the county, some of which can be traced back hundreds of years as the coal was exposed at the surface in several places. The coal fields found in Staffordshire can be divided in to those in the north around Stoke-on-Trent and those in the south around Cannock Chase.

The two coalfields differ quite markedly – those in the north tend to be shallower as the carboniferous coal measures outcrop at the surface, whereas those in the south are overlain by a considerable thickness of Triassic sediments from the Sherwood Sandstone Group.

3.3.10. Iron and Steel (after Reynolds, J)

Iron ores have been mined from the Coal Measures since C14 and gave rise to the iron and steel industries of the coalfield areas. Coke was first used in Apedale in about 1768 and furnaces were built throughout the coalfield ares. The Shelton Bar Iron Company was one of several enterprises which owned coal and iron mines providing the fuel and raw materials for iron and steel works. Many also owned brickworks using local clay and coal. Exhaustion of local iron ore and the cost of transporting ore from the East Midlands or abroad led to the eventual closure of all works by 2000. The many branches of engineering and metalworking used the finished iron and steel as raw materials for their products.

3.3.11. Metal mining

When compared to counties like Derbyshire, Durham and Cumbria, Staffordshire has seen relatively little metal mining. There are a few notable exceptions – the mines around Ecton and the Manifold valley in the White Peak have produced vast amounts of copper and lead, together with some secondary zinc and other minerals.

The majority of the mineralisation found in Staffordshire is contained within Carboniferous limestones. There is some minor mineralisation in the sandstones of the Triassic where they may be cemented with Barytes (Barium Sulphate). Some minor copper mineralisation also occurs – most noticeable as the green staining characteristic of copper formed from various minerals, most notably Malachite.

3.3.12. Hydrology

Staffordshire is not generally known as a dry county, with a fair share of moist upland areas feeding many stream and rivers. The counties drinking water and some water for industrial use are also taken from underground aquifers – the most important of these being the Chester Pebble Beds in the Sherwood Sandstone Group from the Triassic period.

Chapter 4 - SGAP in the context of Natural Areas

The variety of landscapes in England has been classified by English Nature into a series of *Natural Areas*. Each area exhibits different characteristics in terms of wildlife, natural features and land-use. Geology and geomorphology contribute greatly to the landscape, its natural features and quite frequently the land-use of an area. Natural Areas are bio-geographic zones that reflect the geological foundation, the natural systems and processes and the wildlife in different parts of England.

Natural Areas are used both to set distinct targets for delivery of the SGAP objectives and also to provide a link to the SBAP and its targets. There are seven NAs found in the county. These are shown below and in Figure 17, together with their reference number assigned by English Nature, there are 120 Natural Areas in total.

Mosses and Meres (27)
Potteries and Churnet Valley (28)
South West Peak (29)
White Peak (30)
Trent Valley and Rises (33)
Claylands (40)
Midlands Plateau (43)

These represent the 'local' element and underpin the geology and geomorphology of the regions of Staffordshire. The advantages of this are that a national approach can be applied at a local level and also links in with the structure of the SBAP.

Natural Area (NA)	% of Staffordshire area
Potteries and Churnet Valley	21.7%
Needwood and South Derbyshire Claylands	20%
Midlands Plateau	21%
Mosses and Meres	27.6%
Trent Valley and Rises	6.7%
South West Peak	2%
White Peak	1%

Table 5 Natural Area coverage in Staffordshire

Whilst the SBAP habitat action plans are at a lower level than a single Natural Area, the influences of geology and geomorphology on the landscape operate on a scale closer to that of a distinct Natural Area. For example, the areas of the Midlands Plateau that are in Staffordshire are primarily underlain by Triassic sandstones and mudstones, but contain a variety of different habitats (e.g. lowland heaths, meadows and acid grasslands).

Further detail on the other aspects of Natural Areas can be found on English Natures website or through contacting English Nature directly – details are in the Appendix.
www.englishnature.gov.uk/science/natural/role.htm

The details of the SGAP for each landscape differ somewhat from the SBAP in the level of information and listing of RIGS in each area. The division of the actions necessary to carry the SGAP forward is important in that it must be practical and achievable - on this basis the attributes that are proposed to be held and progressed as part of the Natural Area Objectives plans are:

- Community involvement and promotion of geodiversity
- Educational use and interpretation work
- Conservation - in conjunction with SBAP objectives

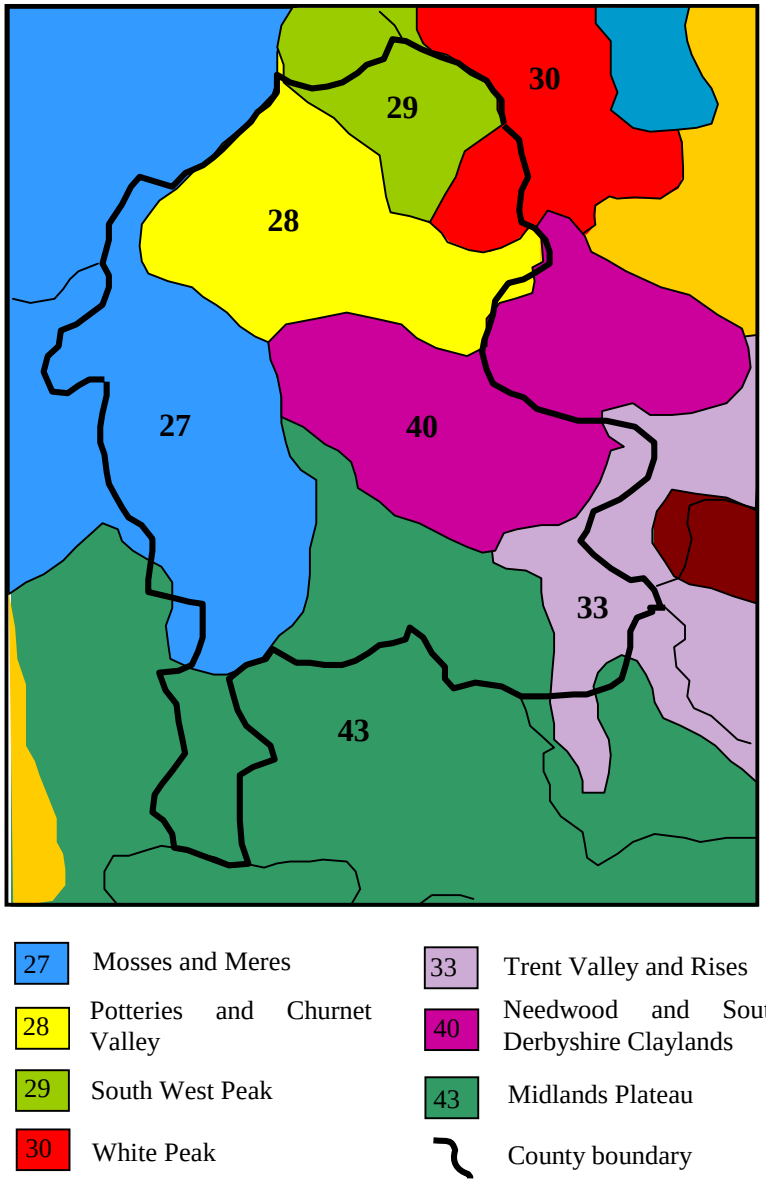


Figure 17 English Nature's Natural Areas across Staffordshire

(*adapted by L.Cox - boundaries courtesy of EN)*

4.1. SBAP – SGAP links within Natural Areas

The biodiversity of Staffordshire is supported and monitored through the Staffordshire Biodiversity Action Plan (SBAP). The SBAP is made up of Habitat Action Plans (HAPs) and Species Action Plans (SAPs) – both setting targets and outlining plans to achieve them. These relate to the Natural Area Objectives and Stratigraphic Objectives of the SGAP and together help to formulate a regional plan for the area for the protection and conservation of the natural world.

A key target of the SGAP is the incorporation of geodiversity in the SBAP and all wildlife conservation projects in Staffordshire where appropriate. Details of the relevant SBAP HAPs and SAPs pertinent to each RIGS location are contained in the RIGS Plans. This will also be reflected in the SBAP in due course.

Geodiversity – SGAP		**Biodiversity - SBAP**	
Natural Area	**Stratigraphy/Geology**	**Habitat**	**Species**
South West Peak	Carboniferous ~ Namurian Millstone Grit	Upland Acidic Grasslands	Brown Hare
Trent valley & Rises	Pleistocene ~ glacial clays, sands & gravels Triassic ~ Mercia Mudstone Group	Unimproved Neutral Grasslands	Skylark Lapwing Dyer's Greenweed Pink Meadow Cap
White Peak	Carboniferous ~ Limestone	Lowland Calcareous Grassland	Brown Hare Skylark Lapwing
Meres and Mosses	Pleistocene ~ glacial clays, sands & gravels	Mosses	Snipe White-faced Darter
Midlands Plateau	Triassic ~ Sherwood Sandstones	Lowland Heathland	Solitary Bees & Wasps Nightjar Woodlark

There are fundamental links between the SGAP and SBAP in several areas. The variety of habitats found in Staffordshire is substantial, from upland moors to lowland meadows, with wetlands, woods and rivers in between. To the north-east of Staffordshire, the limestone area falls within the White Peak and is covered by the Lowland Calcareous Grassland HAP. Further to the North of the county are sandstones and gritstones, which cover part of the South West Peak and are covered by the Upland Acidic Grasslands HAP. Sandstones from the Triassic dominate the Midlands Plateau and are covered by the Lowland Heathland HAP.

4.2. Natural Area Targets

The general targets for each of the seven Natural Areas which the SGAP covers are grouped in to four categories for each Area.

- Promotion of geodiversity
- Sustainable use of Resources
- Planning and development
- Geo-audit / GCR coverage

The *Geo-audit* pertaining to Natural Area targets is based on known sites identified as part of the national Geological Conservation Review (GCR). The SGAP should ensure that all GCR sites in Staffordshire's Natural Areas are designated as RIGS, if not already part of an SSSI.

4.2.1. Summary of Natural Area Actions

Each of the Natural Areas that occur in Staffordshire has their own set of earth resources and characteristics. These are detailed for each area and also how the objectives and actions of the SGAP are applied to each. A summary of the priority issues follows:

3.3.12.1. Promotion of Geodiversity

- Existing geodiversity
- Geological context
- Landscape context
- Educational value

3.3.12.2. Sustainable use of Resources

- Existing operations – quarries, sand and gravel, clay and industrial minerals
- Management of resources
- Industrial and economic heritage
- Landscape and community usage

3.3.12.3. Planning and development

- Existing Local and Minerals plans
- Conservation and preservation
- Fluvial processes and flood defence

3.3.12.4. Geo-audit / GCR coverage

- RIGS / SSSI audit and recording
- GCR coverage
- Education and interpretation

4.2.2. Mosses and Meres (Natural Area 27)

The underlying sediments are mainly sandstones, but the current landforms are dominated by the results of the ice sheets and climate of the Pleistocene. There are important glacial and peri-glacial landforms such as those at Aqualate Mere SSSI.

Promotion of geodiversity

- Triassic stratigraphy and palaeoenvironments
- Pleistocene stratigraphy and palaeoenvironments
- Triassic mineralization
- Current fluvial geomorphology
- Peat deposits

Sustainable use of Resources

- Geomorphology of peat mosses
- Maintenance of the water table

Planning and development

- Road construction
- Drainage and flood defences

Geo-audit / GCR coverage

- Glacial geomorphology
- RIGS coverage of geomorphological sites
- Aqualate Mere SSSI

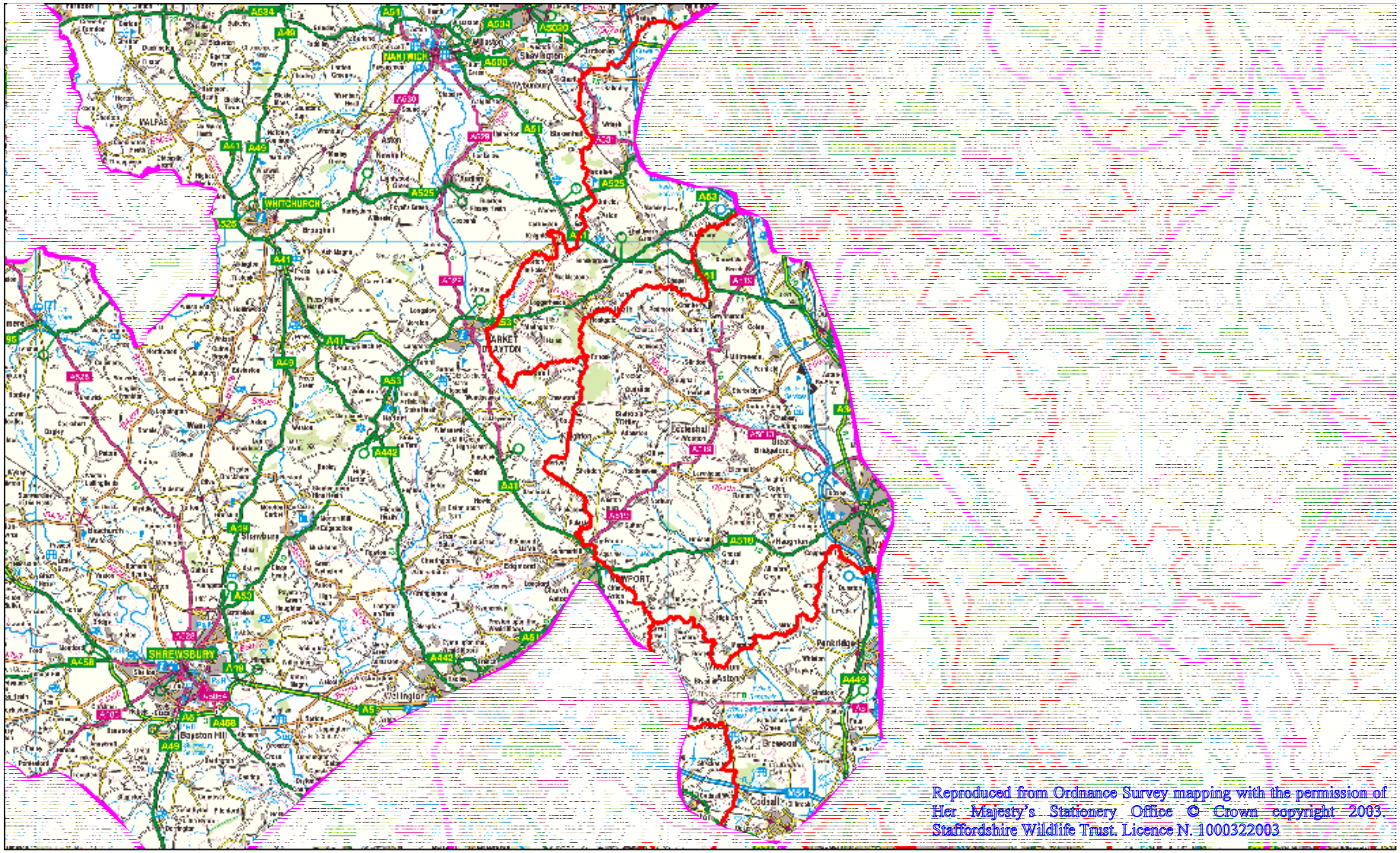


Figure 18 Mosses and Meres – Natural Area 27

4.2.3. Potteries and Churnet Valley (Natural Area 28)

The geology of the area is relatively diverse, including Triassic marls and siltstones, and Carboniferous coal measures and gritstones. The landscape is equally wide ranging in its appearance, although it is dominated by deeply incised and over steepened valleys due to glacial meltwaters running through them at the end of the last ice-age. This has given rise to some of the best wildlife habitats in the county.

Promotion of geodiversity

- Carboniferous coal measures
- Carboniferous stratigraphy
- Ironstone workings
- Landscape / geomorphology
- Etruria formation
- Palaeoenvironments

Sustainable use of Resources

- Stone walls and buildings
- Wildlife habitats
- Sand and gravel extraction – Sherwood sandstone
- Lack of Coal Measures and Triassic exposures

Planning and development

- Urban encroachment
- Industrial land-use
- Landfill

Geo-audit / GCR coverage

- Westphalian
- Triassic
- Geomorphology
- Significant number of RIGS
- Hulme Quarry SSSI
- Metallic Tilleries SSSI

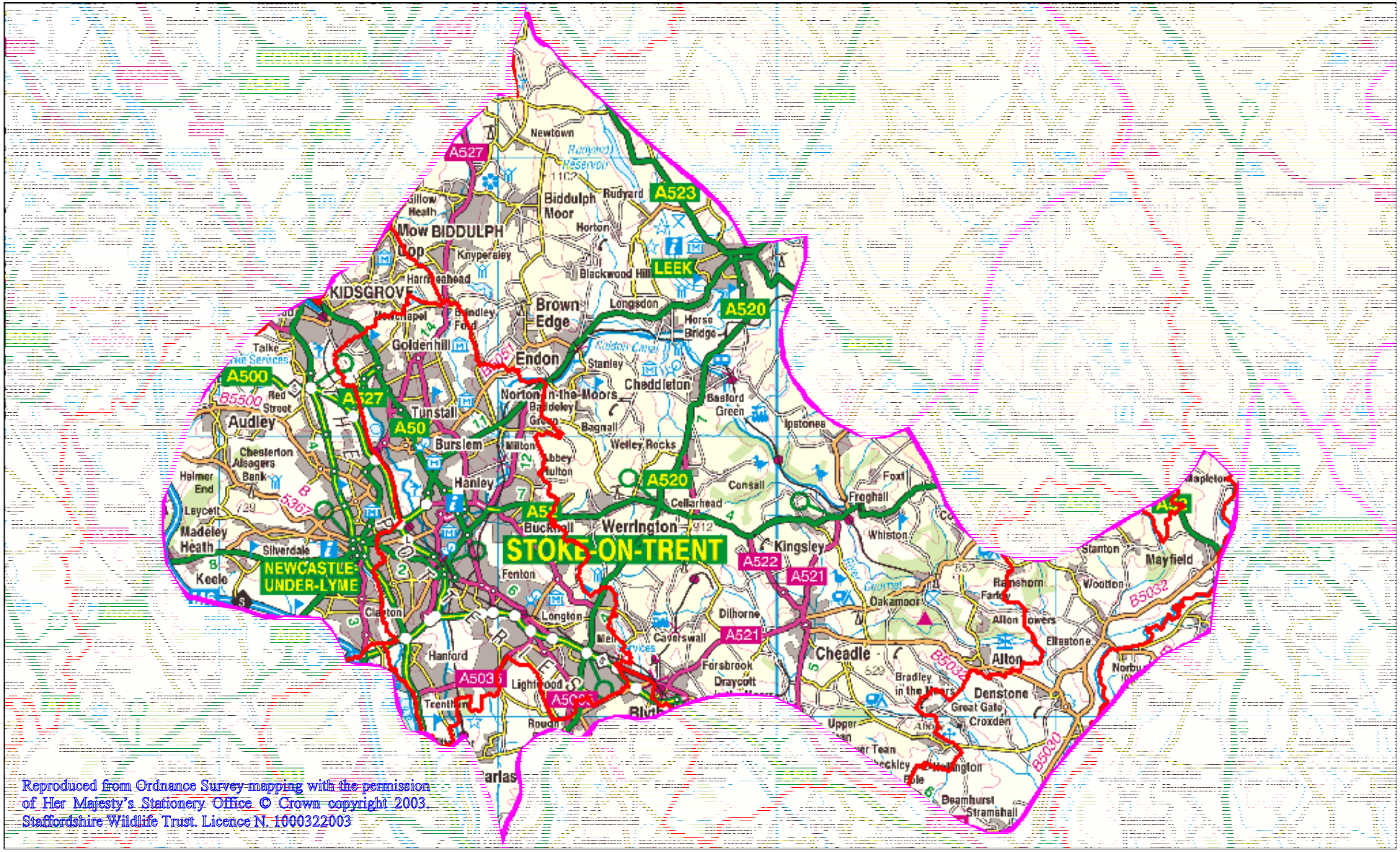


Figure 19 Potteries and Churnet Valley - Natural Area 28

4.2.4. South West Peak (Natural Area 29)

The South West Peak is dominated by Carboniferous gritstone series consisting of shales, siltstone and cross-bedded sands and grits of Namurian age. The weathering of the gritstone has produced some very dramatic landforms such as the Roaches and Ramshaw Rocks. Less well known gritstone crags and tors are equally important for their geological interest and importance, such a Gibb Tor.

Promotion of geodiversity

- Carboniferous coal measures
- Landforms and escarpments
- Internationally important Namurian gritstone exposures
- Landscape development during the Pleistocene
- Evidence of Palaeoenvironments of the Namurian
- Luds Church/Cave biological SSSI – evidence of major landslip

Sustainable use of Resources

- Stone walls and buildings
- Gritstone crags and escarpments
- Vegetation encroachment
- Peat deposits over the moorlands

Planning and development

- Recreational use of gritstone escarpments
- Walking / erosion
- Stone walls and buildings built from local materials

Geo-audit / GCR coverage

- Westphalian
- Namurian
- RIGS coverage
- Leek Moors SSSI

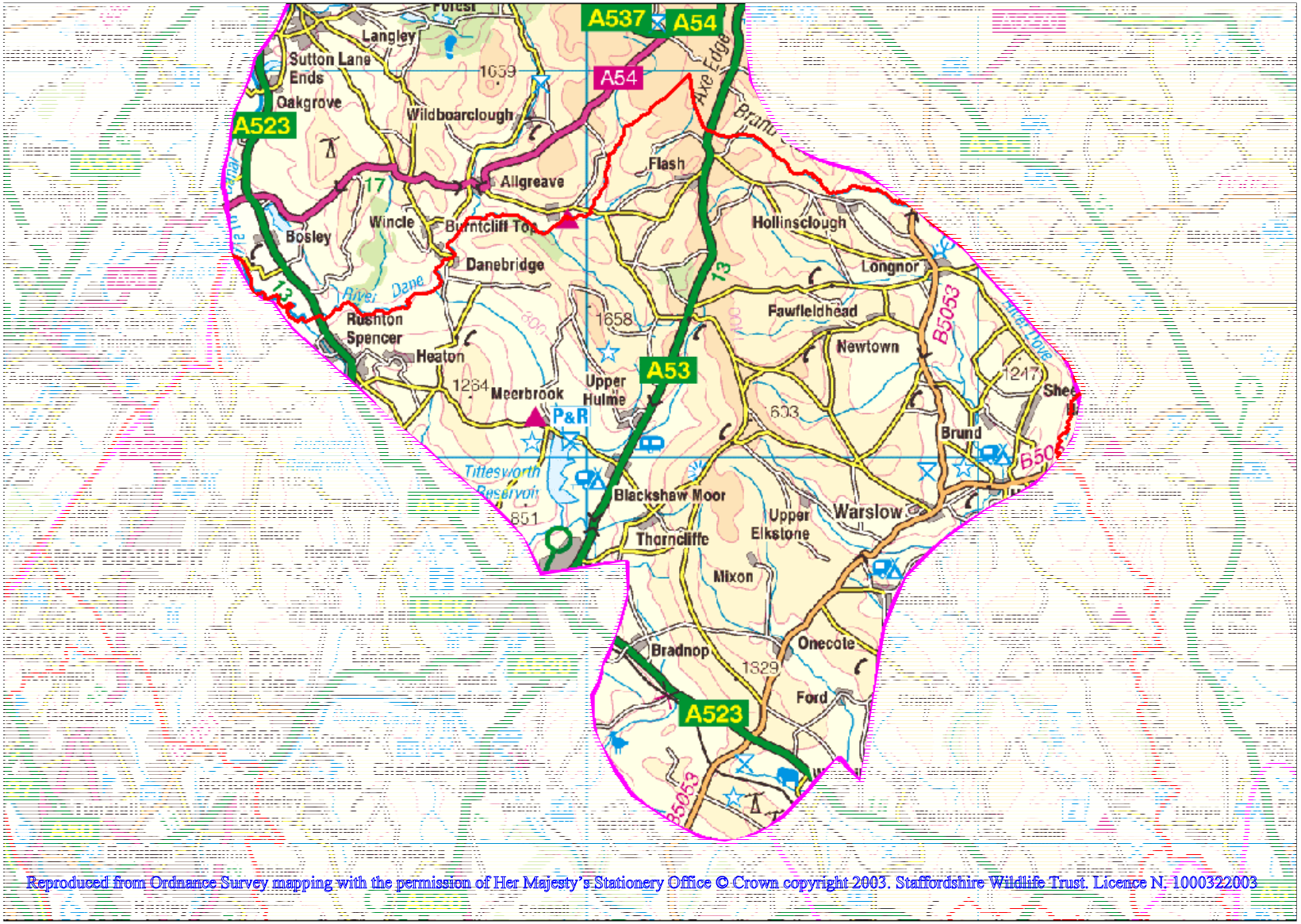


Figure 20 South West Peak - Natural Area 29

4.2.5. White Peak (Natural Area 30)

The areas of the White Peak found in Staffordshire are more subdued than the limestone reef structures found in the central area. There are good examples of dry valleys created by glacial meltwater during the last ice age where streams no longer flow. There are also good examples of Karst scenery and cave systems – both as a result of the chemical weathering of limestone by naturally acidic rainwater.

Promotion of geodiversity

- Exposed Carboniferous stratigraphy
- Karst features
- Mineralisation of Carboniferous limestone
- Landscape

Sustainable use of Resources

- Quarrying of limestone
- Stone walls and buildings
- Fossil and mineral collecting

Planning and development

- Quarries
- Peak Park Planning Authority

Geo-audit / GCR coverage

- Dinantian limestone
- Brown End SSSI
- Ecton Copper Mine SSSI
- Hamps and Manifold valley SSSI

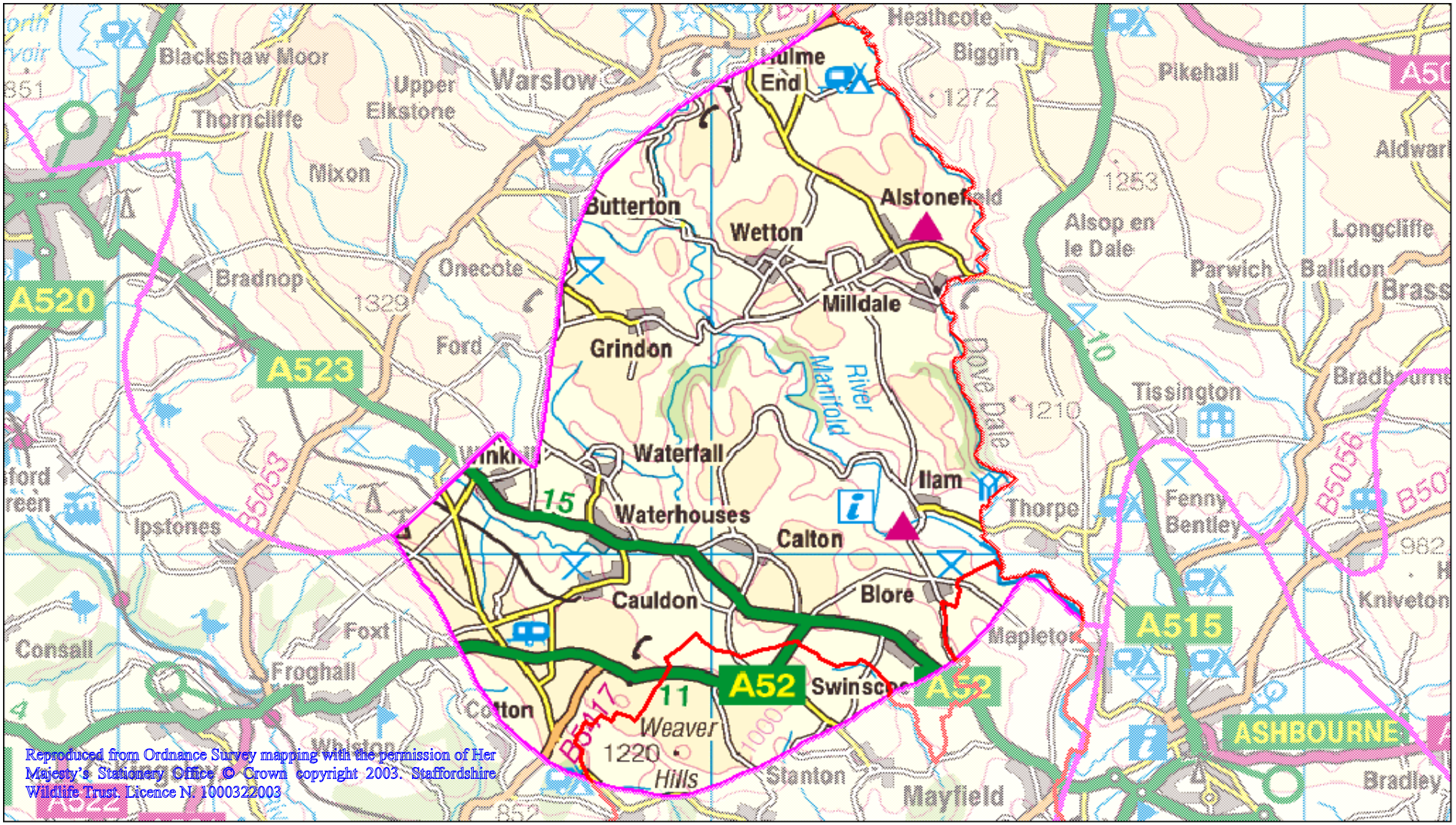


Figure 21 White Peak (Natural Area 30)

4.2.6. Trent Valley and Rises (Natural Area 33)

The solid geology of the area is dominated by rocks from the Triassic - Mercia mudstones and Sherwood sandstones both give rise to a gently undulating landscape which has formed fertile agricultural soils. There are numerous river systems cutting the area, primarily the Trent, Penk and Sow. In Staffordshire these are associated with economically important sand and gravel deposits from both geological recent river action and glacial deposition. The area is also extensively covered by glacial tills which complicate the surface landforms and habitats.

Promotion of geodiversity

- Quaternary sediments – river gravels
- Glacial deposits
- Pleistocene fauna remains

Sustainable use of Resources

- River terrace gravels
- Triassic sand and gravel deposits
- Wooded areas where glacial tills cover more fertile sand/mudstones

Planning and development

- Minerals planning
- Restoration and after use planning
- Flood works / fluvial processes

Geo-audit / GCR coverage

- Triassic
- Recent fluvial processes
- Pleistocene

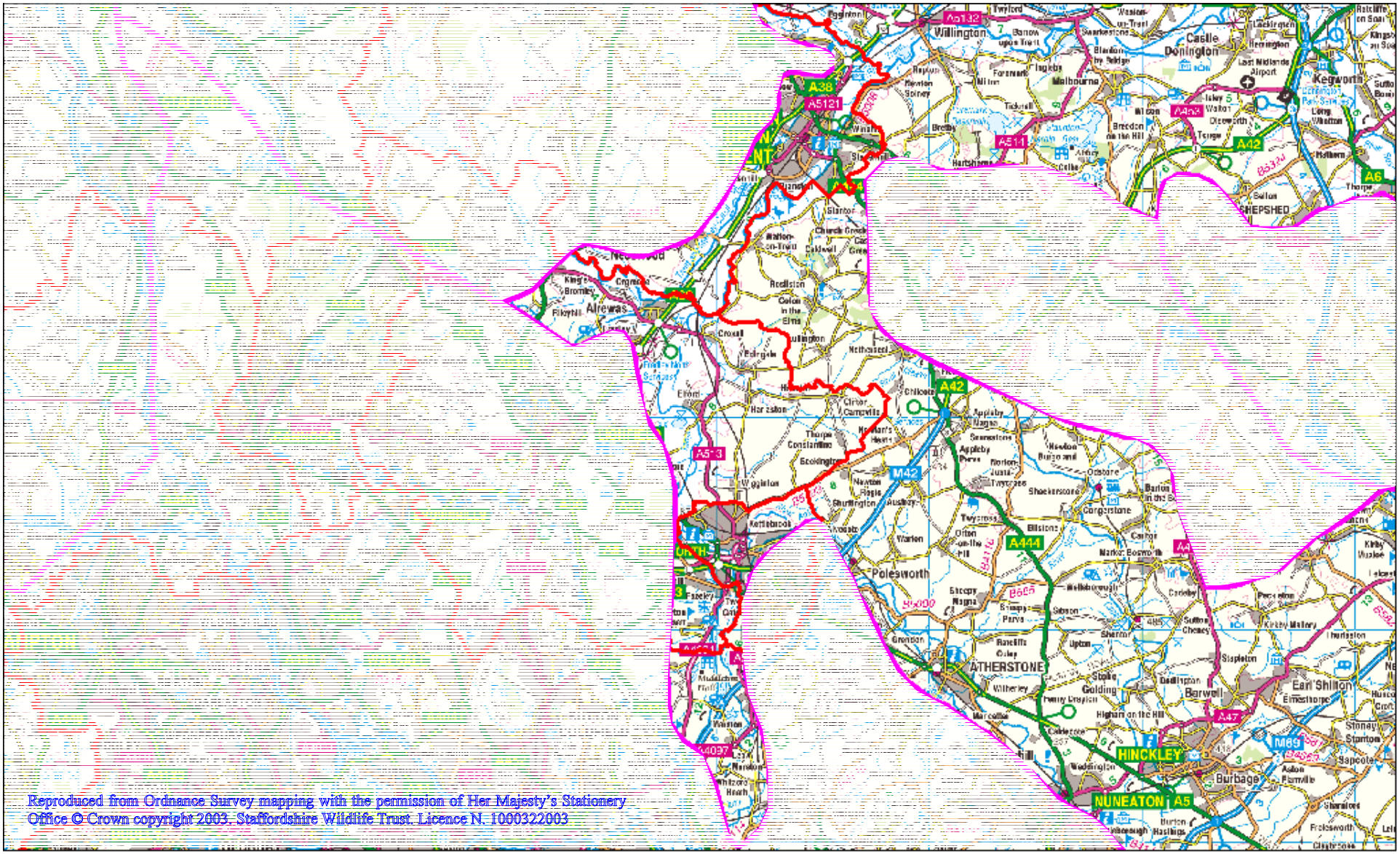


Figure 22 Trent Valley and Rises - Natural Area 33

4.2.7. Claylands (Natural Area 40)

The landscape of the whole of the south and east of Staffordshire is generally low-lying – the Claylands are no exception. The underlying Mercia mudstones and Sherwood sandstones of the Triassic are well weathered giving rise to few exposures. The dominating geological resources are rivers gravels deposited during the Quaternary period, many of which have been extensively worked.

Promotion of geodiversity

- Triassic stratigraphy
- Glacial clay deposits
- Evidence of periglacial activity during the last ice advance
- Lack of appropriate RIGS for Triassic sediments

Sustainable use of Resources

- Site restoration
- Sand and Gravel extraction
- Need for survey work

Planning and development

- Urban development
- Restoration
- Landfill

Geo-audit / GCR coverage

- Triassic
- Glacial moraines and sediments
- Periglacial landforms

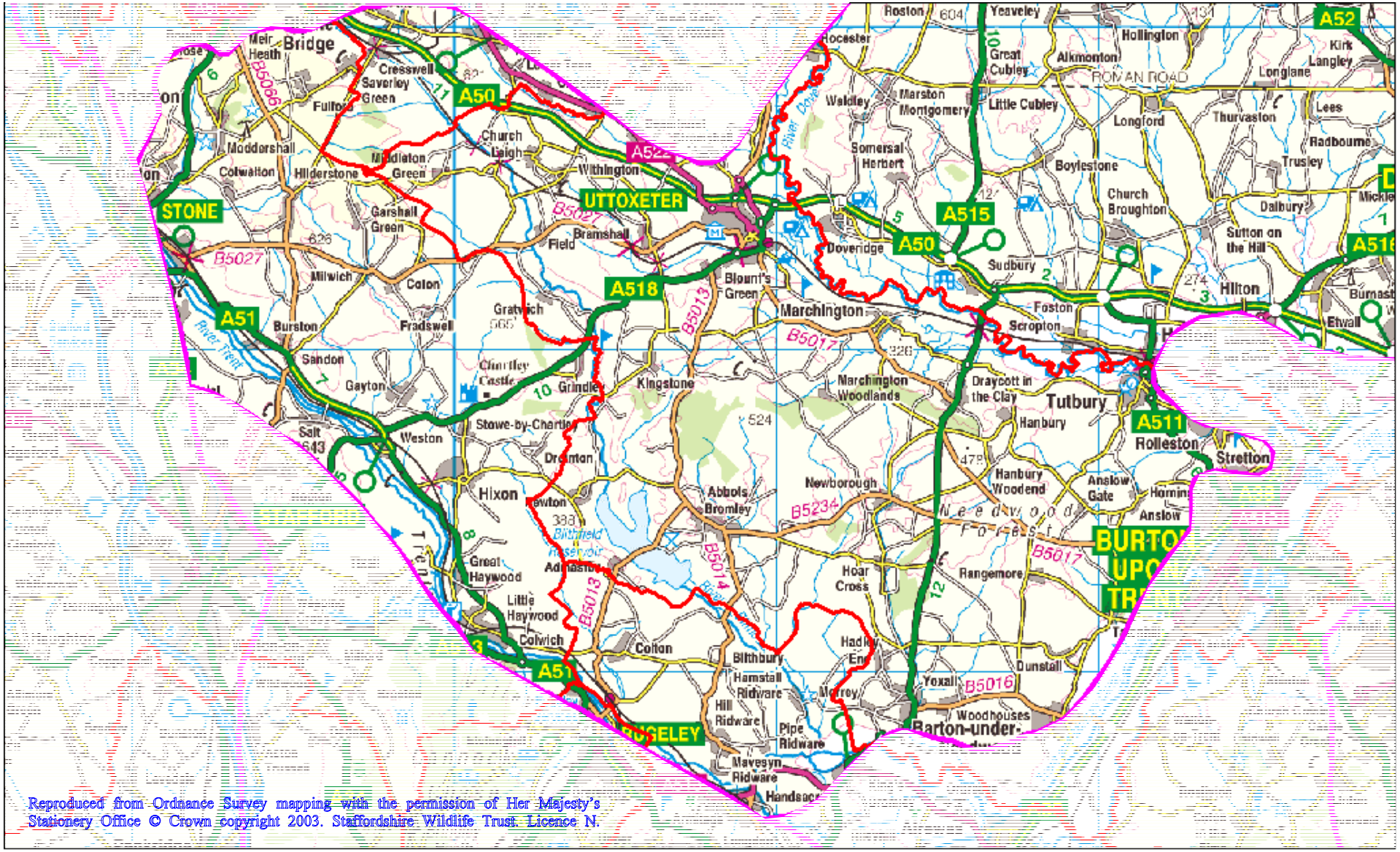


Figure 23 Claylands - Natural Area 40

4.2.8. Midlands Plateau (Natural Area 43)

The areas of the Midlands Plateau which cover Staffordshire are representative of the Triassic rocks from the Sherwood Sandstone and Mercia Mudstone groups. This gives rise to a relative uniformity in the landscape without the same level of diversity as in adjacent areas. The area contains numerous small aggregate operations. The co-operation of the operators of such sites is important in the preservation of exposures after operations cease. The economic value for landfill of excavations near urban areas often means that geological conservation is overlooked.

Promotion of geodiversity

- Triassic stratigraphy and features
- Pleistocene stratigraphy and features
- Present day fluvial processes (river valleys)
- AONB landscape

Sustainable use of Resources

- Sand and gravel extraction
- Pleistocene clays
- Dimension stone (sandstone)
- Scrub invasion at some RIGS

Planning and development

- Urban development
- Road building
- River engineering and flood defences
- Landfill

Geo-audit / GCR coverage

- Triassic – Wollaston Ridge Quarry (Bridgnorth Sandstone / Kidderminster Formation)
- Triassic – Brocton Quarry (Cannock Chase Formation)
- Permian – Kinver Edge GCR (Bridgnorth Sandstone)
- Glacial / Fluvial geomorphology
- Four Ashes SSSI
- Pleistocene

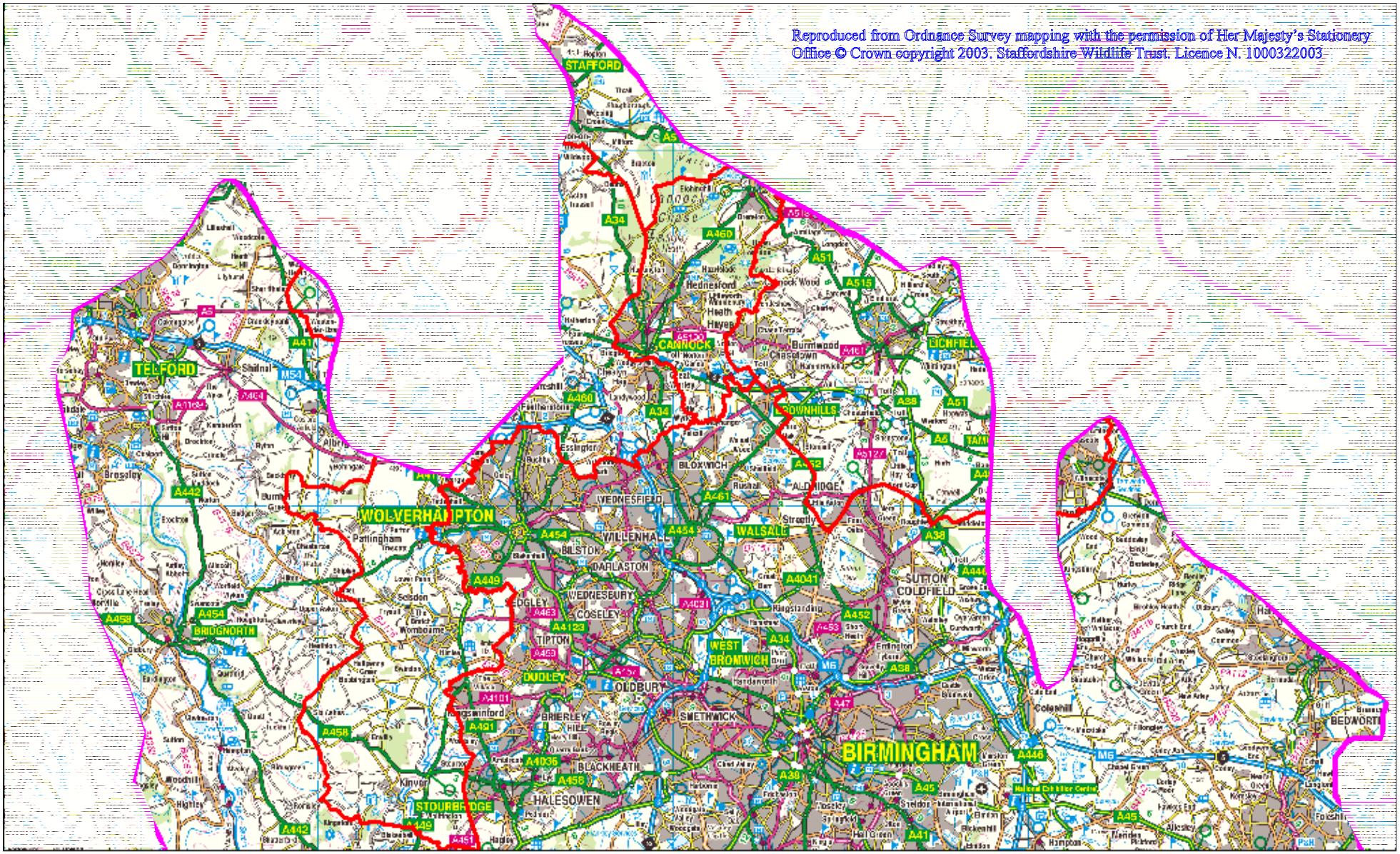


Figure 24 Midlands Plateau - Natural Area 43

4.3. Geomorphology

There are many geomorphological features to be found across all the Natural Areas covering Staffordshire and as such they are considered separately in the SGAP. Staffordshire itself was at the edge of the ice sheet during the last glacial advance (the Devensian) giving rise to interesting landforms, with glacial meltwater and the deposition of till and moraine having a significant effect on the landscape.

Promotion of geodiversity

- Glacial landforms and features
- Periglacial landforms and features
- Fluvial processes
- Weathering features – gritstone tors
- Awareness of landscapes

Sustainable use of Resources

- Sand and gravel deposits
- Flood works and groundwater
- Earthworks
- Erratics

Planning and development

- Mineral planning
- Urbane development
- Civil engineering earthworks
- Road construction and civil engineering works

Geo-audit / GCR coverage

- Glaciation
- Fluvial processes
- RIGS coverage

Chapter 5 - Staffordshire RIGS Action Plans

The SGAP is primarily about providing a framework to act as a focal point for a series of targeted actions in relation to the promotion and conservation of the geodiversity of Staffordshire. A key aspect of this is the use of targeted action plans for RIGS in the county.

5.1. Achieving RIGS Targets

5.1.1. Reference database

All RIGS designation details are held with the Staffordshire Ecological Records office at the SWT. This database should form the basis for building a geo-archive of information on all RIGS and includes details of other locations of geological interest, such as temporary exposures, borehole logs and destroyed sites.

5.1.2. Interpretation materials

Management plans are to be drawn up for all RIGS locations. A key target of the SGAP in this area is the educational and interpretative use of RIGS – the initial implementation of this is the completion of interpretive material for the key sites, during 2003 and 2004. The selection of these sites is based on both the RIGS assessment and their characteristics when compared against the four key objectives of the SGAP, namely:

- Partnership/involvement – actual/potential involvement
- Evaluation – RIGS assessment
- Conservation and Management – partner organisations and agreements
- Education and site use – primarily public access

These sites might include:

1. Satnall Hills Quarry, Berkswich, Cannock Chase – Cannock Chase Formation
2. Lydiates Hill, Baggeridge Country Park, Himley – Enville Formation (conglomerate)
3. Apedale Furnace Cannel Row, Stoke-on-Trent - Carboniferous
4. Apes Tor, Ecton, near Wetton – structural folding in Carboniferous limestone

Interpretive material will also form part of the geological trails to be set up covering various aspects of the geodiversity of Staffordshire. A further promotional aspect for educational use of RIGS could be '*Adopt a RIGS'* for nearby schools.

5.2. Management Plans

The partnership approach adopted throughout the SGAP comes in to its own in the management plans for each location. The owners of the RIGS generally have ultimate responsibility for the site. A key deliverable of the SGAP is the creation of Management Plans for all RIGS sites in liaison with the site owners and managers.

The primary areas covered in each management plan are:

- Geo-audit / resource log
- Monitoring (deterioration)
- Site maintenance and conservation
- Conservation sections
- Amenity use and events
- Access agreements
- Site interpretation
- Geo-trails coverage

A draft management plan is included in Appendix G – this is based on a real RIGS location in north Staffordshire.

Appendices

Appendix A Staffordshire RIGS and SSSI Directory

RIGS Locations

The primary tool for delivering the detailed, site based actions of the SGAP are the individual management plans for each RIGS location. These correspond to the SAPs within the SBAP. A summary of the current RIGS locations in Staffordshire is shown below. Please be aware that these sites do not indicate public access – landowners' permission must always be sought.

Cannock Chase District		
Etching Hill Rugeley	SK 027 187	Designated as a RIGS as a topographical feature produced by a local variation in the hardness of the sandstone.

Table 6 RIGS in the Cannock Chase District

East Staffordshire Borough		
The Walk Weaver Hills, Wootton	SK 094 464	Designated as a RIGS as an example of an observable change in limestone lithology which reflects depositional conditions.
Buttermilk Hill Marchington	SK 109 284	Designated as a RIGS as the best exposures of rocks of Rhaetian age in Staffordshire.
Fauld Crater Hanbury	SK 183 277	Designated as a RIGS as an historical reminder of the use of geological excavations beyond their original purpose.

Table 7 RIGS in the East Staffordshire Borough

Lichfield District		
Barrack Lane Quarry Hammerwich	SK 062 058	Designated a RIGS as an example of Triassic sandstone in the southern part of Staffordshire.

Table 8 RIGS in the Lichfield District

Stoke-on-Trent		
Baddeley Edge Baddeley Green	SJ 915 513	Designated as a RIGS as a prominent ridge feature formed from the Namurian Chatsworth Grits.

Table 9 RIGS in the Stoke-on-Trent area

Tamworth District		
Dosthill Church Quarry (Dosthill Granite Quarry) Tamworth	SP 211 998	Designated as a RIGS as it is the best exposure of Millstone Grit rocks in south east Staffs and within the former boundary of Warwickshire. Much older Cambrian mudstones are also exposed, along with an intrusion of igneous rock.

Table 10 RIGS in the Tamworth District

Stafford Borough		
High Onn Manor Church Eaton	SJ 825 162	Designated as a RIGS as a site which shows evidence of the direction of flow of glaciers in the last Ice Age.
Bishop's Offley (north) Adbaston	SJ 782 298	Designated as a RIGS as a road cutting showing a good length of examples of Triassic sandstone features.
Greatwood Farm Caves Eccleshall	SJ 775 312	Designated as a RIGS as examples of structures produced from the extraction basal 'marl' horizon.
Broadhill Scarp Gnosall	SJ 801 196	Designated as a RIGS as an extensive outcrop of mottled Triassic sandstone.
Cowley canal cutting Shropshire Union Canal, Gnosall	SJ 823 196	Designated as a RIGS as a site where structures in the mudstones can be found.
Highlows Farm Quarry Coldmeece, Eccleshall	SJ 858 334	Designated as a RIGS as the historically important site where the first magnetic geophysical equipment was tested.
Beech Caves Swynnerton	SJ 855 382	Designated as a RIGS as an uncommon example of pillar-and-stall workings in a sandstone quarry.
Hanchurch Hills Swynnerton	SJ 841 400	Designated as a RIGS as an historically important site associated with Charles Darwin and the recognition of an igneous dyke.
Kingswood Bank Gravel Pit Trentham Park, Swynnerton	SJ 854 403	Designated as a RIGS as an excellent example of typical Triassic sandstone and conglomerate interbedding.
Brocton Gravel Pit (west) Brocton	SJ 974 191	Designated as a RIGS as a well exposed example of Triassic pebble beds.
Satnall Hills Quarry Berkswich	SJ 983 208	Designated as a RIGS a well exposed example of the Cannock Chase Formation pebble beds.
Cotwalton Drumble Stone	SJ 917 349	Designated as a RIGS as a Triassic sandstone showing typical water-produced sedimentary structures.
Cliffs Caves Great Haywood, Colwich	SK 000 218	Designated as a RIGS as a fine exposure of Triassic building sandstone which also shows copper mineralisation in places.

Table 11 RIGS in Stafford Borough

South Staffordshire District		
Orton Hill Quarry Wombourne	SO 872 949 SO 877 946	Designated as a RIGS as an excellent example of Triassic sandstone and conglomerate beds in southern Staffordshire.
Lydiates Hill Baggeridge Country Park, Himley	SO 898 926	Designated as a RIGS as an open access site for good exposures of calcareous conglomerate beds of the Salop Formation (Enville Member).
Dark Slade Wood Teddesley Hay	SJ 973 163	Designated as a RIGS as an example of irregularly bedded sandstones and pebble beds with manganese deposits in cavities.

Table 12 RIGS in South Staffordshire District

Staffordshire Moorlands District		
Knypersley Reservoir Greenway Bank Country Park, Biddulph	SJ 894 555	Designated as a RIGS as an example of sandstone from the lower Coal Measures.
Far Kingsley Banks Consall Nature Park, Kingsley	SJ 995 481	Designated as a RIGS as it is one of the few exposures of a coal seam in the area.
Houghwood Bagnall	SJ 919 514	Designated as a RIGS as a ridge feature made from Namurian Kinderscoutian sandstone.
Huntley Railway Cutting and Quarry Cheadle	SK 004 415	Designated as a RIGS for the exposure of Triassic Hawksmoor Formation sandstones and the close proximity of exposures of the older Coal Measure rocks.
Hazles Wood Churnet Valley, Kingsley	SK 005 483	Designated as a RIGS for the exposure of a geologically important time boundary; that between the Namurian and Westphalian rock series.
Highshutt Quarry Hawksmoor, Cheadle	SK 032 439	Designated as a RIGS as an easily accessible and impressive exposure of Triassic conglomerate which contains a variety of derived pebble material.
Peakstone Rock Alton Common, Alton	SK 051 421	Designated as a RIGS as an outstanding example of a pillar structure formed by differential erosion.
Starwood Cotton Dell, Cotton	SK 061 460	Designated as a RIGS because of the unusual occurrence of a richly fossiliferous goniatite bed.
Hofton's Cross Caldonlow, Cotton	SK 074 481	Designated as a RIGS as a good exposure of a fossiliferous 'reef' limestone.
Combes Brook Combes Valley Nature Reserve, Cheddleton	SK 004 524	Designated as a RIGS as an accessible exposure of fossiliferous Kinderscoutian shales.

Table 13 RIGS in the Staffordshire Moorlands

Newcastle-under-Lyme Borough		
Red Hill Rifle Range Maer	SJ 786 397	Designated a RIGS for the examples of Triassic braided river plain and aeolian dunefield sedimentary structures.
Heighley Lane Quarry Madeley	SJ 773 469	Designated a RIGS as an example of typical Lower Triassic rock facies.
Madeley Heath Tileries (**Ridgehill Clay Pit**) Madeley	SJ 788 452	Designated a RIGS as an example of a large quarry exposing Etruria Formation mudstones topped by siltstones of the Newcastle Formation.
Kent Hill Quarry Audley Rural	SJ 789 509	Designated as a RIGS as it represents a very rare example of an adit-worked conglomerate quarry.
Quarry Bank Quarry Keele	SJ 807 461	Designated as a RIGS as being the prime exposure of the red Keele Sandstone.
Miry Quarry Apedale	SJ 812 494	Designated as a RIGS because of the rare exposure of the significant time-boundary indicator bed - the Vanderbeckei Marine Band.
Apedale Furnace Quarry Apedale	SJ 822485	Designated as a RIGS as a good exposure of the Cannel Row Coal with fossils to be found in the mudstones above the coal seam.
Job's Wood Quarry Silverdale	SJ 823 460	Designated as a RIGS as the best local exposure of Hanchurch Sandstone in the Newcastle Formation.
Butterton Church Quarry Whitmore	SJ 833 419	Designated as a RIGS as being a prime example of the effects of an igneous dyke (Darwin's Dyke) intruding into sandstone.
Bradwell Wood Quarry Newcastle-under-Lyme	SJ 843 504	Designated as a RIGS for the exposure of the Etruria Formation mudstones used in the local brick and tile industry.
Birchenwood Quarry Birchenwood Country Park, Kidsgrove	SJ 855 542	Designated as a RIGS as one of the few large exposures of typical Coal Measure rock sequences.
Mount Pleasant Quarries (East) Kidsgrove	SJ 851 565	Designated as a RIGS as an example of Millstone Grit showing large fault structures with bartye mineral veins.
Mow Cop Folly Quarries Kidsgrove	SJ 857 573	Designated as a RIGS as an impressive ridge outcrop of Millstone Grit.

Table 14 RIGS in the Newcastle-under-Lyme Borough

Peak District (Staffs. Moorland District)		
Meadow Farm (south) Hamps Valley, Onecote	SK 046 579	Designated as a RIGS as an example of moderately fossiliferous Ecton (Mixon) Limestones.
Ironpits Hamps Valley, Waterhouses	SK 066 520	Designated as a RIGS as an exposure of Arnsbergian aged fossiliferous shale.
Grindon Moor Quarries Grindon	SK 060 559	Designated as a RIGS as an example of the fossiliferous Onecote Sandstone.
Lee House Quarry (west) Waterhouses	SK 086 503	Designated as a RIGS as it is the Type Locality for the brachiopod *Gigantoproductus crassiventa.*
Lee House Quarry (east) Waterhouses	SK 087 503	Designated as a RIGS as an unusually fossiliferous example of the Hopedale Limestones.
Wetton Road Quarry Grindon	SK 094 541	Designated as a RIGS as an example of easily recognised large scale folding in the Ecton Limestone rocks.
The Lee railway cutting (north) Manifold Valley, Warslow and Elkstones	SK 093 581	Designated as a RIGS as it is the stratigraphical boundary between the Milldale and Ecton Limestones.
Dale Quarries Manifold Valley, Warslow and Elkstones	SK 093 587	Designated as a RIGS for the good exposures of the higher (younger) levels of the Ecton Limestones.
Ecton Copper Mines Manifold Valley, Wetton	SK 099 580	Designated as a RIGS because of the historically important copper ore extraction and the visible remains of this industry.
Hen Cloud, Leekfrith	SK 008 616	Designated as a RIGS as an impressive topographical feature of Roaches Grit.
Five Clouds Leekfrith	SK 001 627	Designated as a RIGS as a well exposed site of Five Clouds Sandstone.
Roaches Leekfrith	SK 002 633	Designated as a RIGS as a prominant landscape crag feature of Roaches Grit.
Greens (north-west) River Dane, Quarnford	SK 005 670	Designated as a RIGS because of the folding and sedimentary structures exhibited in the Rough Rock Group sandstone.
Ramshaw Rocks Heathylee	SK 019 623	Designated as a RIGS as an outstanding landscape feature produced from Roaches Grit.
Gib Torr Rocks Quarnford	SK 018 648	Designated as a RIGS as an impressive exposure of the Chatsworth Grits.
Blake Brook (west) **Blake Brook (east)** Fawfieldhead	SK 061 612 SK 065 612	Designated as a RIGS as a section through several marine bands around the horizon of the Minn Sandstones to the west, and an almost complete Kinderscoutian sequence to the east.
Apes Tor Wetton	SK 099 586	Designated as a RIGS as an impressive example of structural folding in Carboniferous limestone
Hope Marsh Alstonefield	SK119 555	Designated as a RIGS as a rare fossiliferous exposure of inter-reef beds in the Hopedale Limestones.
Wiggenstall Stream (south) Fawfieldhead	SK 091 606	Designated as a RIGS because of the exposure of bentonite (altered ash) bands within the Namurian shales.
Sheen Hill Sheen	SK 111 625	Designated as a RIGS as the most prominent example of the Sheen Sandstones.

Table 15 RIGS in Staffordshire's Peak District's National Park

SSSI Locations

Geological SSSIs in Staffordshire		
Aqualate Mere	SJ 770 205	Notified as a rare example in the Midlands of an esker system formed by glacial meltwaters during the late Devensian glaciation.
Brown End Quarry	SK 090 503	Notified for its important exposures of a sequence of limestones formed during the Carboniferous Period.
Cauldon Low	SK 077 492	Notified for its outstanding Carboniferous Limestone section of considerable palaeogeographic and stratigraphic significance.
Ecton Copper Mines	SK 099 581	Notified for its array of veins developed predominantly within the Ecton Limestones of Lower Carboniferous age.
Four Ashes Pit	SJ 914 083	Notified as the type site for the Devensian Stage of the Quaternary Period ca. 50,000 years ago.
Gospel End Road Cutting	SO 904 936	Notified as the best available exposure of the so-called 'breccias' belonging to the Etruria Formation.
Hamps and Manifold Valleys	SK 100 540	Notified for its range of features of geological interest, which cover almost the whole area.
Hulme Quarry	SJ 929 446	Notified for its magnificent exposures of the Cannock Chase Formation of the Sherwood Sandstone Group.
Kinver Edge	SO 831 829	Notified for its 3-D exposures of the Bridgnorth Sandstone of the Lower Permian Period.
Leek Moors	SK 020 650	Notified for its features of the Millstone Grits and Coal Measures of the Carboniferous Period.
Metallic Tilleries	SJ 840497	Notified as the only known site in the North Staffordshire Coalfield showing the unconformable contact between the Etruria Formation red-beds and the black shales and sandstones of the Newcastle Formation (Middle Carboniferous).
Milford Quarry	SJ 977 191	Notified for its excellent 3-D exposures of the Cannock Chase Formation.
Wollaston Ridge Quarry	SO 883 848	Notified as an exposure of the Kidderminster Formation (Triassic Period) lying unconformably on the Bridgnorth Sandstone (lower Permian).

Table 16 Geological SSSIs in Staffordshire (after English Nature).

Appendix B Geological History of Staffordshire

The following is directly from the geology section in a currently unpublished volume on the flora of Staffordshire written by J.Reynolds and D.Steward.

The diversity of the landscape, soils and natural vegetation of Staffordshire is largely a result of the variety of underlying rocks exposed by weathering and erosion over several million years. The rocks themselves are even older, being originally the sediments of ancient environments including seas, deltas, swamps, deserts and glaciers. Staffordshire has a wide variety of such sedimentary rocks. These include sandstones and gritstones, formed from sands; mudstones, clays and shales from muds; limestones from shelly muds; coal from plant debris; and rock salt and gypsum from evaporating seas. Igneous rocks, cooled from hot molten magma, occur in a series of narrow linear intrusions called dykes between Keele and Norton Bridge - Charles Darwin studied them when he lived at Maer and was the first to realise their origin. Around Wednesfield and Pouk Hill (Staffs vice-county) a sill of magma has been intruded as a sheet layer between the existing beds of rock. Rocks of igneous origin are too limited in outcrop to affect the flora. Metamorphic rocks, formed by the alteration of earlier rocks by heat and pressure, and various other igneous rocks are only found in the county as large hard boulders carried by glaciers. These glacial erratics originated from North Wales, the Lake District and Scotland. The sands and clays which accompanied them are more important in soil formation. There has also been a long history of rock and mineral exploitation, in the county, creating botanical habitats such as the derelict and post-industrial landscapes of the Potteries and the Black Country.

In the north of the county, the history of the rocks seen today started about 330 million years ago. During the Lower Carboniferous, the area of Staffordshire was submerged by a warm, shallow sea with land to the north and south. In this tropical environment algae, corals, brachiopods and other organisms flourished, producing thick layers of shelly sediment and some reef-like mud mounds composed mostly of the mineral calcite. These produced the limestones that can be seen in the White Peak District, Caldon Low, Manifold Valley and Dovedale, with excellent exposures at the Brown End Quarry nature reserve, Waterhouses. The area is fairly clearly defined by the occurrence of the grey-white rock in drystone walling. Limestone forms high ground because it is relatively resistant to weathering and erosion. As well as the usual abraision processes of river erosion, chemical solution is at work. River water, made slightly acid by rotting vegetation and by dissolved carbon dioxide in rain (‘acid’ rain), dissolves the basic limestone (calcium carbonate). This produces a topography known as *karst*, where sink holes, cave systems and gorges are typical features.

Older limestones are found in the south of the Staffordshire vice-county to the south and east of Walsall and at the famous Wrens Nest Hill in Dudley. These limestones are of Silurian age and were formed in shallow seas around 420 million years ago.

Use: The economic value of the limestone is great and it has many industrial uses including: aggregates for roadstone, railway ballast; and concrete; cement; lime for agricultural and chemical industry use; flux for smelting iron and steel; and as a building and walling stone. Working and abandoned quarries, large and small, are a feature of the area.

Soil: The soils developed over limestone bedrock are brown earths in which any native lime has been leached out of the upper layers. They are silty, freely drained and easily worked, but are rather shallow and although their topsoils are naturally acid, the calcareous nature of the bedrock, which normally occurs well within rooting depth, means that plants preferring alkaline conditions usually flourish here. The mine tips around Ecton have soils contaminated by waste from copper and lead mining.

By about 315 million years ago, earth movements had caused the land to the north and south of present day Staffordshire to rise. The rate of erosion was increased and rivers flowing into the tropical sea formed large deltas (similar to the Mississippi) which covered the shallow seabed with alternating layers of sand and mud. Through time, these compacted to produce the grits and shale bands typical of the Staffordshire Moorlands and of the Dark Peak District. The coarse sandstones, known as Millstone Grits, are the most conspicuous rocks. They outcrop from Mow Cop northwards along Congleton Edge and form ridges of high ground from Biddulph Moor to Werrington and Wetley Rocks. However the most dramatic landscapes are those north of Leek where the Roaches and surrounding moorlands are dominated by crags produced by a combination of resistant gritstone interbedded with easily eroded dark grey shales. The geology of the area is readily apparent as gritstone walls mark the field boundaries.

Use: As well as being used as a general roadstone, building and walling stone, a few of the gritstones consist almost entirely of quartz and are pure enough to be worked as silica stone which is used in the manufacture of scouring powders, glass, foundry moulds and grindstones - from which the name derives. The shales have a greater economic importance as they are used in the production of cement.

In the vales the Carboniferous shales with thinner sandstones have weathered to produce heavy impermeable wet clayey soils with peaty surface layers. Where the Millstone Grits outcrop forming ridges, lighter but very acid podzols, often with peaty tops, are developed and carry a moorland type of vegetation dominated by great tracts of heather.

About 300 million years ago, sediment from the earlier deltas had pushed back the coastline and heavily forested coastal swamps had become established. The tropical weather and the abundance of freshwater provided ideal ground conditions for early plants such as clubmosses, horsetails and ferns. Relatives of the modern genus *Equisetum* were able to grow up to 30 metres in height, with insects and primitive amphibians to be found living amongst them. As the trees died, vast thicknesses of organic material accumulated which, after compaction, became coal. Layers of sand and mud, deposited when the sea temporarily drowned the swamps, interspersed the decaying vegetation to produce the repeated sequences of sandstone, mudstone, ironstone and coal as found today. The coal seams and grey mudstones erode easily but the sandstones are more resistant. The resultant topography is one of gentle ridges as found in the Potteries and, to a lesser extent, from Cannock to the Black Country.

Towards the end of the Carboniferous Period the swamps decreased as drier conditions predominated. Muddy red sediments were deposited intermittently along river floodplains and later sands, eroded from rising land to the south, built up in shallow, evaporating lakes. Over time these have given rise to the commercial ‘Etruria’ clays and the sandstones of the higher ground in Newcastle-under-Lyme and Wombourne. This was all a precursor to the desert conditions of the following Permian and Triassic periods.

Use: Coal has a great history as a valuable commodity and at one time the ironstone seams were very important sources of iron ore whilst the fireclays and refractory clays were used in the potteries before being replaced by china and ball clays. Etruria clays are still used in brick and tile manufacture.

The dominance of underlying mudstone means that any natural soils are poorly drained and heavy to work. The ground in the built-up areas is rarely left in peace and organisms living in or on it must be able to cope with the changes. Mining has disturbed large areas and, on tips where scrub has regenerated, two very immature soil types are developing: one is a very shallow, acid raw soil on slopes with a high run-off of rainwater; and the other is a slightly deeper, highly impermeable wet acid clayey soil in the hollows.

There is a gap in the geological time sequence at this stage. During most of the time when it would be expected to find rocks of Permian age (c.290 - 240 million years ago) there were major earth movements involving the uplift, folding and faulting of what is now central England. At the same time this area was also on a piece of the Earth's crust that was beginning to move northwards from the tropics into the Trade Wind belts. These factors resulted in desert conditions and caused extensive weathering and erosion of the existing local rocks throughout the Permian and into the Triassic Period.

At the start of the Triassic Period (c.230 million years ago) the area of Staffordshire was still mainly above sea level and in desert conditions, where wind-blown sands formed dunes. Subsequently major downpours in mountains to the south resulted in flash floods transporting large volumes of coarse, and later fine, sediments. As each flood subsided the gravels and sands settled out on the valley floors, eventually burying the ancient landscape beneath great thicknesses of sediment. Conditions were poor for living plants and animals and even poorer for preserving their remains. Today these sediments occur as conglomerates (pebble beds) and sandstones of the Sherwood Sandstone Group, their red colouration is due to iron oxide (hematite) found especially in the fine clays which stick to sand grains. Some of the wind-blown sands have survived to be exposed today and the Kinver Edge escarpment is an example of the more resistant sandstone they produced. Remains of the deltas can now be seen in the Trentham and Parkhall areas of Stoke-on-Trent, and in the Cannock Chase area where rounded pebbles are commonly found under foot. The later finer sediments now outcrop as clayey sandstone, again in the south of the county. Where not quarried, the landscape is one of rolling countryside such as Maer Hills, Hanchurch Hills, Downs Bank and Penkridge Bank.

Later in the Triassic a semi-arid climate prevailed and the landscape was one of low relief with a wide plain covering Staffordshire. Temporary lakes flooded this plain, initially depositing materials in deltaic fans and later a brief incursion of seawater deposited some shales. Lake conditions returned leaving thick layers of clay and evaporation of water left deposits of halite (salt) and gypsum. The sandstones that resulted from the compaction of the deltaic lake deposits together with the mudstones and clays derived from the later finer sediments collectively form the Mercia Mudstone Group. The red clay / mudstones, which still retain the salt and gypsum deposits, erode easily and have produced the low relief landscape typical of the central Staffordshire plain.

Rocks of the Penarth Group, found in small areas of Bagot's Park and Needwood, represent the final chapter of the Triassic Period (which ended c.200 million years ago). They consist of dark grey to black shales with thin fine grained sandstones and calcareous nodules often containing marine fossils and represent the first stages of the marine invasion from the west which turned the Triassic desert environments into the seas which dominated the Jurassic and later times.

Use: Pebbles are used as a local source of aggregate for the construction industry and the clayey sandstone, although now mainly replaced by synthetic material, was once important as a moulding sand. Certain sandstones are much used as building stones, particularly those from around Hollington. The clays have been used to make bricks although the presence of gypsum is detrimental. The gypsum deposits themselves are extensively worked near Tutbury for use in cement, paper, plaster, plasterboard and ornamental alabaster industries and salt, as brine, was extracted near Stafford.

Soil: Heathland in Staffordshire is found almost exclusively on the pebble beds or glacial sands and gravels, both of which weather to produce light, pebbly acid brown sands or podzol soils. As they are well drained they are often poor in nutrients. The clays form reddish clayey soils, often with poor drainage, that are best suited to grassland and cereals. The presence of salt in the Stafford – Salt area does affect the soil and unexpected plants can grow there.

Sedimentary rocks from about 200 million years ago to 2 million years ago are not found in Staffordshire. The widespread deposition of Jurassic rocks was followed by erosion and later deposition of rocks of Cretaceous Age. However, these too have been removed from this area by long periods of erosion later in the Cretaceous and in the Tertiary Period. Tertiary times came to an end as global cooling reached a critical stage, leading to onset of the cycles of the Quaternary Ice Ages.

Staffordshire was covered several times by the advance and melting of the ice sheets over the past 1.5 million years. The constantly moving ice ground the bedrock into a fine clay forming a veneer, called a till. Larger pieces of rock were plucked up and transported by the ice and, when the ice melted, where mixed with the till to formed a surface deposit commonly known as boulder clay. The large boulders are termed glacial erratics. Some areas of high ground stuck out above the general ice mass and caves provided natural shelter for many animals.

The scouring effect of the ice has produced much of the modern landscape. Relatively hard rocks, like the Millstone Grit, resisted erosion better than the soft mudstones which were easily planed off leaving the flat land of central Staffordshire. The last glaciation, the Devensian, extended as far south as Wolverhampton. Four Ashes is an important site and here peat deposits from 36,000 years to as young as 30,000 years ago are found beneath the till. The eastern extent of the ice was restricted by the Moorlands, reaching as far as Bradnop. Ice pushed down the valley of the Churnet as far as Consall, the Blithe to beyond Cresswell and the Trent to Cannock Chase, extending into the Blithe at Abbot's Bromley.

Drift is the general term for the superficial deposits formed as a result of glacial and post-glacial deposition and weathering. Upon the melting away of the glaciers, tills would have covered most of the county, but these and coarser glacial debris have been reworked to form alluvium and river terrace deposits associated with the present river systems. Typical glacial retreat features such as moraines and drumlins are difficult to distinguish in the county, although meltwater terraces are more common. At Aqualate Mere there is an esker, a sand and gravel ridge laid down by a meltwater stream under the ice as it melted.

The final melting of ice was accompanied by deposits of sands, gravels and a thin till, together with the establishment of the present drainage pattern. Flooded hollows, known as kettle holes, filled with mud and organic material including peat formed the meres and mosses landscape extending from north Shropshire and south Cheshire. A radiocarbon date of 13,500 years ago from muds beneath peat at Stafford puts these events into their time frame.

As the climate of the British Isles became warmer after the Ice Age a lack of vegetation under glacial conditions gave way to herbs and grasses typical of the Tundra. Soon Scots pine followed closely behind the taller birches in colonising the land; both are hardy pioneer species with windborne seeds well suited to form a first tree cover and both are liable to be supplanted, in time, by other trees that live longer or cast a denser shade. Under its present climatic conditions, temperate forest should be the natural vegetation over most of Britain. At one time 70% of the British Isles was covered in woodland but today the figure stands at around 8%. Deciduous woodland consists largely of broad-leaved trees (hardwoods) which shed their leaves annually, usually in the autumn as a protection against winter conditions.

Use: Glacial material provides much of the sand and gravel for the construction industry with large workings of river terrace deposits in the Trent Valley.

Soil: Immature soils of variable texture are the initial product of glacial drift deposits, these however can be modified by weathering, erosion and redeposition. The alluvial soils, which cover the lowest ground immediately next to the water courses, are frequently wet and subject to flooding when ground water levels rise. Terrace soils form at slightly higher levels though they may be seasonally waterlogged at depth; they are normally light, easily worked and excellent agricultural soils where the pebble content is not too high.

Appendix C Staffordshire RIGS Trails Proposals

Organised events and educational use of RIGS requires set times and visits but in order to increase the accessibility of RIGS to a wider audience a series of themed trails are proposed by the SRIGS Group. These use sites that are targeted within the RIGS Management Plans and ensure full coverage of the Stratigraphic objectives.

The trails are based around recommended routes with interpretative material and are to be available centrally from the headquarters of the Staffordshire Wildlife Trust and selected partners throughout the county

1. Geomorphology
    - Glacial landforms
    - Fluvial landforms and processes
    - Soil formation
    - Working landscapes

2. Triassic
    - Exposures of Triassic formations covering:
    - Hawksmoor formation and Freehay member
    - Mercia Mudstone group
    - Palaeoenvironments

3. Westphalian
    - Cyclotherms
    - Economic importance
    - Impact on landscape

4. Namurian
    - Gritstone landscapes
    - Palaeoenvironments

5. Dinantian
    - Depositional environment
    - Fossil evidence / examples
    - Influence on current landform

Appendix D Educational event details

SGAP Timeline

Many activities of the sort associated with SGAP targets have already been undertaken during the development of the SGAP. These are outlined below:

Activity	Location	Target	Date
Launch of SGAP project	-	SGAP Project	November 2002
SGAP Consultation	-	Partnership	December 2002 on
RIGS surveys - Staffordshire	Staffordshire	Evaluation	Jan - June 2003
RIGS surveys - Peak Park	Staffordshire	Evaluation	April - June 2003
SGAP website launched	-	Involvement	March 2003
Rocks Quiz / SGAP	Cellarhead Centre	Education	April 2003
Croxden Quarry Open Day	Croxden Quarry	Education	June 2003
Rocks Quiz / SGAP	Loynton Moss	Education	July 2003
Lecture to OUGS	Birmingham	Education	July 2003
Guided walk - OUGS	Hen Cloud / Roaches	Education	July 2003
Rocks Quiz / SGAP	Wolseley Centre	Education	August 2003
Rocks Quiz / Fossil casting	Shugborough Farm (AONB)	Education	August 2003
SGAP education day	Apedale Country Park	Education	August 2003
Rocks Quiz / SGAP	Potteries Museum, Hanley	Education	August 2003
Guided walk	Cannock Chase AONB	Education	August 2003
SGAP Draft	-	SGAP Project	October 2003
UKRIGS conference	Edinburgh	Partnership	October 2003
JNCC LGAPs conference	Peterborough	Partnership	December 2003
SGAP Publication	-	SGAP Project	February 2004
Site interpretation	Satnall Hills	Site-use	March 2004
Geo-trail (Limestone)	Manifold Valley	Site-use	March 2004

Staffordshire Rocks Quiz

The Staffordshire Rocks Quiz has been used throughout the year as an educational tool and introduction to the rocks commonly found in the county. It also provides an introduction to geodiversity and discussion to accompany a static display on the geodiversity of the county and the SGAP.

The quiz can be tailored to fit the region of the county and the rocks found locally, an example of a quiz suited to the Carboniferous and Triassic sediments of North Staffordshire is given overleaf. The rocks include:

Coal
Sandstone
Clay
Limestone
Conglomerate
Mudstone

Staffordshire Rocks Quiz

I can be found in Staffordshire but what rock am I?

- I am made of bits of fossil plants and I feel quite light in weight
- They have become CARBON and I am black in colour
- I am often shiny, but sometimes have dull layers

Rock name:

- I am made of fine grains of sand that can be easily seen
- They are made of a glassy mineral called QUARTZ
- My grains of sand have been rounded and are stuck together by a rusty iron cement which is not very strong

Rock name:

- I'm usually red/brown in colour, although I can be grey too.
- I am made of tiny minerals which are too small to see
- I'm soft when wet and hard when dry

Rock name:

- I am made of fossil shells stuck together
- Crystals of CALCITE have grown in spaces
- I am grey, white or cream in colour and I fizz when acid is put on me

Rock name:

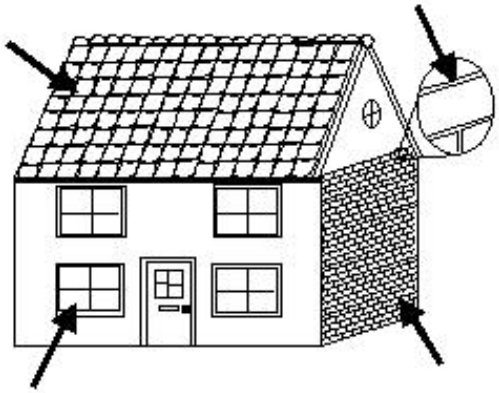
- I am made of bits of older rocks and pebbles stuck together
- Many of the pebbles have round edges and corners
- Sand and mud helps to cement them all together
- Some say I look like concrete

Rock name:

- I am made of clay minerals which are too small to see
- I feel smooth, I break easily and I am usually grey in colour
- I may contain fossils and if I split into layers, I would be called shale

Rock name:

Where in our homes, do we use the rocks you identified? Can you think of other rocks types that can also be found in our homes? The arrows show some of the more common uses:



Tie Breaker: I like rocks, minerals and fossils because _____

All details below are optional, but if we don't know who you are, we won't be able
to give you the prize if you win!

Name:

Contact details: (Address or telephone or e-mail)

The winners will be announced at 3.30pm. If you can, come along and see if you've won!

The SGAP project is funded [illegible] Aggregates Levy Sustainability Fund.

ENGLISH NATURE

Appendix E A typical Indemnity Form (after RIGS Handbook, 1999)

THE BEDROCK STONE COMPANY
QUARRY LANE
LUTON
BEDFORDSHIRE

FORM OF INDEMNITY

To: THE BEDROCK STONE COMPANY

Visit to: CBEDROOCK QUARRY **Site:** QUARRY LANE, LUTON BEDFORDSHIRE

On: SATURDAY **Date:** 22 MAY 1999

I/We hereby agree that permission to visit the above site has been given to me/us on condition that:

1) I/We accept full responsibility for any damage done to your property by me/us or by any member of my/our party.

2) You shall not be liable for any injury, loss or damage sustained by me/us during the visit howsoever caused.

3) I/We shall indemnify you against claims by third parties (including members of my/our party) in respect of injury, loss or damage sustained by them during the visit and caused by negligence of me/us or by any member of my/our party.

4) Provided in the case of (1), (2) and (3) that such injury, loss or damage is not due to the negligence of yourselves or of your employees.

Signed:

Dated:

Ivor Lotterick
Wealden Geological Society
20 Haynes Way
Beckenham
Kent BR3 6RL

Appendix F RIGS Assessment Forms

UKRIGS Field Record and Site Assessment

Staffordshire RIGS Group

UKRIGS guidelines for RIGS selection:

- The value of a site for educational purposes in life-long learning
- The value of a site for study by both professional and amateur Earth scientists
- The historical value of the site in terms of important advances in Earth science knowledge, events or human exploitation
- The aesthetic value of a site in the landscape, particularly in relation to promoting public awareness and appreciation of Earth sciences

Site name: Satnall Hills Quarrysite number: 91/79/41

parish: Berkswich district: Stafford Borough

special area: *(e.g. National Park, AONB, etc)* Within Cannock Chase AONB

OS sheet no.: 127 grid ref. (centre for large site): SJ 983 208 BGS sheet no.: 140 (1:50 000)
surveyed by (privileged information): Laura Cox date of survey: 25/03/03

present site status: RIGS date designated: 26th Jan 1995

site ownership and/or tenancy details: (private ownership may be privileged information) Staffordshire County Council
contact details for permission to visit: Judith Moor or Helen Kennedy, Cannock Chase AONB Unit, Dairy Cottage, Shugborough Park Farm, Main Road, Milford, Near Stafford, ST17 0SB. Stafford, ST16 3TJ. Tel: 01785 223121. Alternatively: Roger Hill, County Ecologist, Staffordshire County Council, Riverway, roger.hill@staffordshire.gov.uk Tel: 01889 882613.

SITE DESCRIPTION

brief history and present status (including SSSI, wildlife site, etc)
Disused quarry, now owned by Staffordshire County Council, managed by Cannock Chase AONB unit, currently used as a car park.

general description of geology/geomorphology [field sketch / location map on separate sheets]
Lies within the Midlands Plateau natural area. Triassic period, Sherwood Sandstone Group
Cannock Chase Formation

likely conservation measures required (first impression)
None

LITERATURE REFERENCES AND OTHER EXISTING RECORDS
N/A

Enquiries to: The Geodiversity Officer, Staffordshire Wildlife Trust, The Wolseley Centre, Wolseley Bridge, Stafford, ST17 0WT

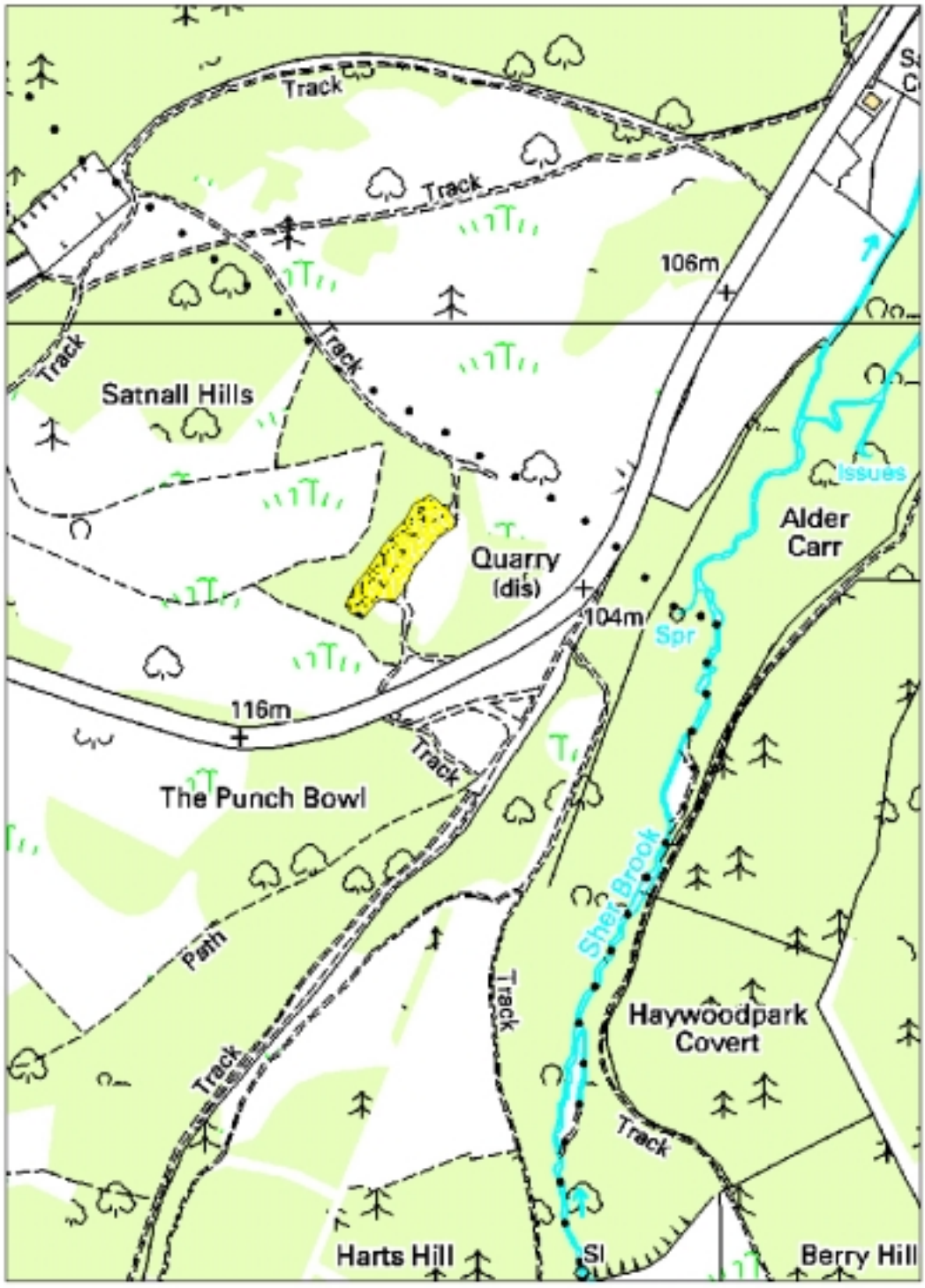
Copyright Notice: submitting this data constitutes a licence for UKRIGS and its agents to use the information in any enquiry or to pass the information on to third parties. Copyright remains with the original recorder.

Personal information will not be released without prior consent unless agreement is made below:
I agree*/do not agree* to allow the release of personal information without the need to obtain further consent.

Signed: **Date:** ***delete as appropriate**

Map of site.
A Geographical Information System (GIS) map would be ideal

Please label: position(s) of key geological/geomorphological features, access points, parking spaces, hazardous features, facilities, etc.



Scale: 1cm = 50m

Geological section/log

Thickness	Lithology	Clay & Silt	Sand F M C	Gravel

Sketches and/or photographs of site (with scale)
(include a cross-section of the site if appropriate & description: colour, grain size, texture, fabric, structure, weathering, rock type)

The exposure consists of coarse-grained, red-brown, current-bedded sandstones with conglomerate beds.

Conglomeratic beds:

Consist of well-rounded pebbles composed mainly of vein quartz, quartzite and occasionally chert, limestone and pebbles of igneous origin in a poorly cemented and sorted matrix. Conglomeratic beds are predominantly clast-supported, polymodal. Maximum clast size 15cmx10cm. Modal (within 0.5x0.5 square) = 12cmx7cm. Bed thickness varies from 3.80m and 1.10m. General reverse size-grading of pebbles through beds. Preferred orientation of pebbles NE-SW. Some pebbles have pressure solution points.

Sandstone bed:

Dark red- brown (fresh surface) to grey(weathered surface) medium to coarse (500um – 1mm) grained, moderately sorted sandstone with dark red, fine grained micaceous sandstones occurring in thin beds (up to 10cm). Quartz grains predominantly angular to subangular.

Interpretation:

The large sizes of the pebbles indicate a good competency of the flow of water (high velocity). The pebble-matrix relationship, which is predominately clast-supported polymodal is typical of fluvial gravels.
The clear pressure solution marks on certain pebbles within the pebble-bed layer are as a result of close contact, compressive forces and of a silica reaction acting between adjacent pebbles.
The sandstones and pebble beds were deposited by wide fast flowing rivers carrying large amounts of sand and water worn pebbles and cobbles from mountains far to the south, around what is the present day south coast and across the channel to Brittany.
As these rivers wandered across the then barren landscape, they left behind channels and areas of less turbulent waters, which can be seen as the sandstone bands and lenses like those in the face at Satnall Hills. The increase in the general size of the pebbles up the face is probably due to changes in the climate and rainfall in the region at the time where the rocks were being eroded away in the south, to be carried to Cannock Chase and deposited at sites such as Satnall Hills.

Assessment of value of site

ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; NA not applicable; DK don't know

Access and safety	***comments / details***	***assessed rating*** *(circle one)*
1 road access & parking	Suitable parking for cars, minibus and coaches	0 1 2 3 4 5 6 7 8 9 (10)
2 safety of access	Exposure adjacent to parking. Possible to park right up to exposure – even coaches!	0 1 2 3 4 5 6 7 8 9 (10)
3 safety of exposure	No climbing required. Suitable for wheel-chair users.	0 1 2 3 4 5 6 7 8 9 (10) NA
4 permission to visit	Public Access	0 1 2 3 4 5 6 7 8 9 (10) DK
5 current condition	Very good.	0 1 2 3 4 5 6 7 8 (9) 10 NA
6 current conflicting activities	None	
7 restricting conditions	None	
8 nature of exposure	Disused quarry	
9 multiple exposure / prospect for trail	Several good geological outcrops within walking distance, even though they are not RIGS. Possible trail (car trail?) with Brocton Pit RIGS and Dark Slade Wood RIGS.	
notes		

Education and science	***comments***	***assessed rating*** *(circle one)*
1 surface processes	Clear examples of chemical weathering of orthoclase feldspar within the igneous pebbles into clay.	0 1 2 3 4 5 6 7 (8) 9 10
2 geomorphology	N/A	0 1 2 3 4 5 6 7 8 9 10
3 sedimentary	An excellent and typical example of Cannock Chase Formation (Sandstones with conglomeratic layers).	0 1 2 3 4 5 6 7 8 9 (10)
4 fossils	N/A	0 1 2 3 4 5 6 7 8 9 10
5 igneous	As pebbles	0 1 2 3 4 (5) 6 7 8 9 10
6 metamorphic	As pebbles	0 1 2 3 4 (5) 6 7 8 9 10
7 tectonic (structural)	Current- bedding in sandstones. Pressure solutions marks on pebbles within pebble beds.	0 1 2 3 4 5 (6) 7 8 9 10
8 minerals	Within pebbles, mainly quartz.	0 (1) 2 3 4 5 6 7 8 9 10
9 historical geology (stratigraphy)	N/A	0 1 2 3 4 5 6 7 8 9 10
notes		

Culture, Heritage & Economic	***comments***	***assessed rating*** *(circle one)*
1 historic, archaeological & literary associations	N/A	0 1 2 3 4 5 6 7 8 9 10
2 aesthetic landscape	Within Cannock Chase AONB	0 1 2 3 4 5 6 (7) 8 9 10
3 history of Earth Sciences	N/A	0 1 2 3 4 5 6 7 8 9 10
4 economic geology	Ex-quarry	0 1 2 3 (4) 5 6 7 8 9 10
notes		

Geodiversity value	***brief details***	***assessed rating*** *(circle one)*
brief note on key specific scientific interest (fuller details recorded separately)	Excellent example of coarse-grained, red-brown, current-bedded sandstones with conglomeratic lenses and layers. Well-rounded pebbles are mainly quartzite with quartz veins on occasions with pressure solution marks	0 1 2 3 4 5 6 7 (8) 9 10

UKRIGS Field Record and Site Assessment

Staffordshire RIGS Group

UKRIGS guidelines for RIGS selection:

- The value of a site for educational purposes in life-long learning
- The value of a site for study by both professional and amateur Earth scientists
- The historical value of the site in terms of important advances in Earth science knowledge, events or human exploitation
- The aesthetic value of a site in the landscape, particularly in relation to promoting public awareness and appreciation of Earth sciences

Site name: **site number:**

parish: district:

special area: *(e.g. National Park, AONB, etc)*

OS sheet no.: grid ref. (centre for large site): BGS sheet no.: (1:50 000)

surveyed by (privileged information): date of survey:

present site status: date designated:

site ownership and/or tenancy details: (private ownership may be privileged information)

contact details for permission to visit:

Site Description

brief history and present status (including SSSI, wildlife site, etc)

general description of geology/geomorphology [field sketch / location map on separate sheets]

likely conservation measures required (first impression)

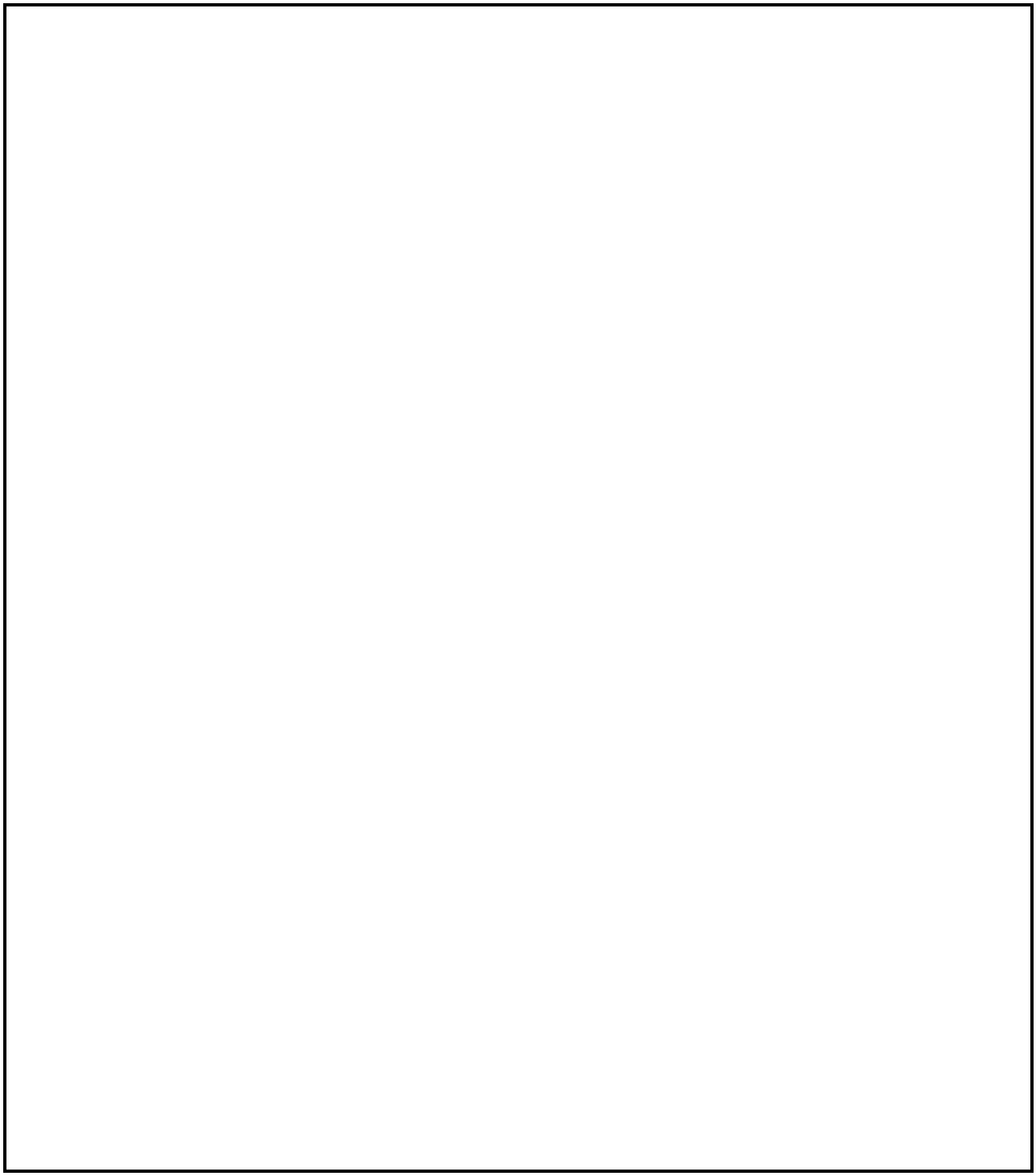
Literature references and other existing records

Enquiries to: Ms Laura Cox, Geodiversity Officer, Staffordshire Wildlife Trust, The Wolseley Centre, Stafford, ST17 0WT. Tel:01889 880100

Map of site.

A Geographical Information System (GIS) map would be ideal

Please label: position(s) of key geological/geomorphological features, access points, parking spaces, hazardous features, facilities, etc.



Scale: _____

Geological section/log

Thickness	Lithology	Clay & Silt	Sand F M C	Gravel

Sketches and/or photographs of site (with scale)
(include a cross-section of the site if appropriate & description: colour, grain size, texture, fabric, structure, weathering, rock type)

Assessment of value of site

ratings: 1-2 very poor; 3-4 poor; 5-6 acceptable/useful; 7-8 quite good; 9-10 very good/excellent; NA not applicable; DK don't know

Access and safety	***comments / details***	***assessed rating*** *(circle one)*
1 road access & parking		0 1 2 3 4 5 6 7 8 9 10
2 safety of access		0 1 2 3 4 5 6 7 8 9 10
3 safety of exposure		0 1 2 3 4 5 6 7 8 9 10 NA
4 permission to visit		0 1 2 3 4 5 6 7 8 9 10 DK
5 current condition		0 1 2 3 4 5 6 7 8 9 10 NA
6 current conflicting activities		
7 restricting conditions		
8 nature of exposure		
9 multiple exposure / prospect for trail		
notes		

Education and science	***comments***	***assessed rating*** *(circle one)*
1 surface processes		0 1 2 3 4 5 6 7 8 9 10
2 geomorphology		0 1 2 3 4 5 6 7 8 9 10
3 sedimentary		0 1 2 3 4 5 6 7 8 9 10
4 fossils		0 1 2 3 4 5 6 7 8 9 10
5 igneous		0 1 2 3 4 5 6 7 8 9 10
6 metamorphic		0 1 2 3 4 5 6 7 8 9 10
7 tectonic (structural)		0 1 2 3 4 5 6 7 8 9 10
8 minerals		0 1 2 3 4 5 6 7 8 9 10
9 historical geology (stratigraphy)		0 1 2 3 4 5 6 7 8 9 10
notes		

Culture, Heritage & Economic	***comments***	***assessed rating*** *(circle one)*
1 historic, archaeological & literary associations		0 1 2 3 4 5 6 7 8 9 10
2 aesthetic landscape		0 1 2 3 4 5 6 7 8 9 10
3 history of Earth Sciences		0 1 2 3 4 5 6 7 8 9 10
4 economic geology		0 1 2 3 4 5 6 7 8 9 10
notes		

Geodiversity value	***brief details***	***assessed rating*** *(circle one)*
brief note on key specific scientific interest (fuller details recorded separately)		0 1 2 3 4 5 6 7 8 9 10

Staffordshire RIGS Group, Member of UKRIGS

Site Evaluation and Designation

single exposure / multiple exposure	**site number:**

site name:

proposed RIGS site name if different:

grid reference (centre for large site):

if applicable, part of multiple exposures forming proposed RIGS site.

Case for site designation

Please make a clear summary evaluation against each criterion, based on Field Record and Assessment of value, indicating if not applicable. The decision on RIGS status will be guided by these comments. The descriptors in the notes relating to the Assessment Criteria may be useful in formulating your comments.

Access and safety

Value of site for educational purposes in life-long learning

Value of site for study by both professional and amateur Earth scientists

Historical value of the site in terms of important advances in Earth science knowledge, events or human exploitation

The aesthetic value of the site in the landscape, particularly in relation to promoting public awareness and appreciation of Earth sciences

Geodiversity value, and any other comments

Site evaluated by:	**date:**

RIGS Committee Status Recommendation

Decision ***Comment (if any)***

signature of committee chairman ***date of committee meeting***

Staffordshire RIGS Group

(Member of Association of UKRIGS groups)

Notification of Regionally Important Geological/Geomorphological Site

To: *(name of planning authority, with contact name and address)*

Regionally Important Geological/Geomorphological Site

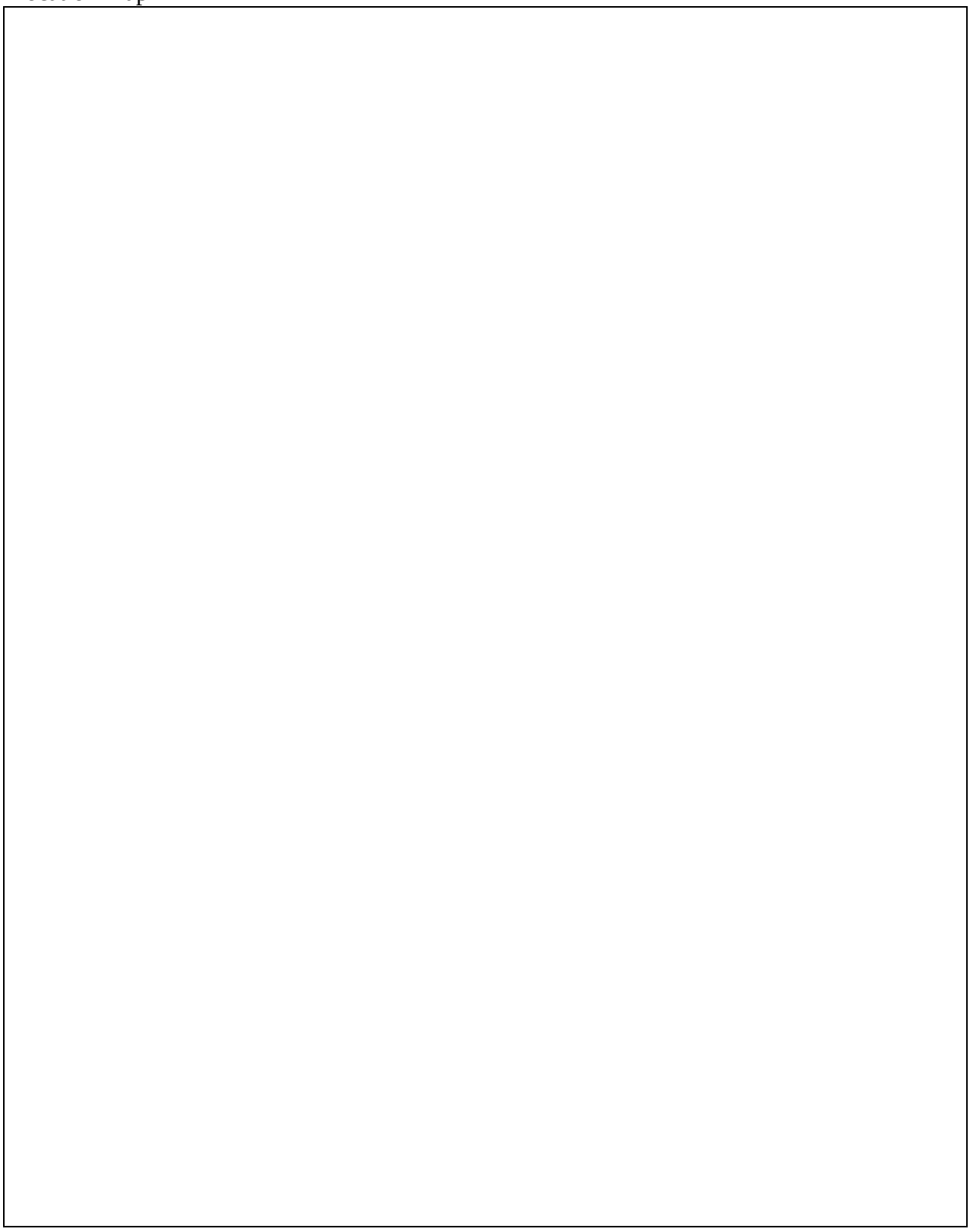
site name:
grid reference:
parish:
district:
county:
date of approval by RIGS committee:

Brief site description

Summary evaluation of site value and importance

Overleaf is a location/boundary map of the site

Location Map



In the event of a consultation which relates to this site or its immediate surrounds please contact: .

The Geodiversity Officer, Staffordshire RIGS Group

C/O Staffordshire Wildlife Trust, The Wolseley Centre, Stafford, ST17 0WT

Appendix G Template Management Plan

Site details:

Location of site including site map
Ownership and access details
Safety assessment requirements
Background – history
SBAP link – habitat/species importance?

Geological Designation

Designation details (from RIGS sheets or SSSI/GCR info)
Geological sketch map if appropriate, noting features/areas of particular interest

MAP OF SITE

Principle of Conservation

Based on geological (RIGS/SSSI) importance and aims of SGAP – statement for this site as to what it is for, why it's important etc. Set against the four key areas of:

- *Partnership/involvement – who is it for?*
- *Evaluation – why do it?*
- *Conservation – what is required?*
- *Management – how to do it?*

Site Status

Rolling record of site visits and status based on the RIGS points system – not required at every visit, but necessary on a material change or say every 2-3 years if possible?

Management Objectives

Establish a list of agreed objectives that have definite targets – these will come from the SGAP guidance and be applied to each site as appropriate. This is to ensure consistency and transparency in setting targets for individual sites against the main SGAP objectives

- *vegetation encroachment*
- *wildlife/habitats – rabbit/badger damage etc.*
- *land use – leisure, agriculture, extractive industry etc.*
- *face/exposure stability*
- *degradation/weathering*
- *scree/slumping – exposure of features*
- *legal access and insurance details*
- *site layout – ease of access, disabled access, parking etc.*
- *damage – fly tipping, vandalism, destruction*
- *construction activity, track clearance, fencing etc.*
- *hydrology – alteration of drainage, flooding etc.*
- *planning and development threats and controls*
- *site's potential – education, geological self-guided tour etc.*
- *interpretative material – potential for panels, leaflets etc.*
- *resource requirements – owner, financial, professional, volunteer etc.*
- *partnership potential – quarries, recreational users, local groups etc.*
- *relevance of good practice guides – fossils, minerals etc*

Action Plan

Specific points required to implement the targets specific to the site – these will depend on the site and the objectives that are relevant to it

Recommendations

Specific points required to implement the targets specific to the site

Appendices

Supporting information, maps, site visits, geology, bibliography etc.

Photo-archive – important to maintain a photographic record of the site and before/after pictures.

Appendix H Sources of Information

The following books/CDs can provide further information on the geology and geodiversity of Staffordshire:

Aitkenhead, N, 1985 Buxton, Leek and Bakewell. Memoir for sheet E111. BGS. ISBN: 0118843893

BGS, Ashbourne, 1983 1:50000 Geological Map of England and Wales Sheet 124, Solid and Drift Geology, ISBN: 075180519

BGS, Burton Upon Trent, 1982 1:50000 Geological Map of England and Wales Sheet 140, Solid and Drift Geology, ISBN: 0751805416

BGS, Buxton, 1978 1:50000 Geological Map of England and Wales Sheet 111, Solid and Drift Geology, ISBN: 0751805114

BGS, Dudley, 1975 1:50000 Geological Map of England and Wales Sheet 167, Solid and Drift Geology, ISBN: 0751805688

BGS, Lichfield, 1926 1: 63360 Geological Map of England and Wales Sheet 154, Solid and Drift Geology, ISBN: 0751801097

BGS, Macclesfield, 1968 1:63360 Geological Map of England and Wales Sheet 110, Solid and Drift Geology, ISBN: 0751800732

BGS, Stafford, 1974 1:50000 Geological Map of England and Wales Sheet 139, Solid and Drift Geology, ISBN: 0751805386

BGS, Stoke-on-Trent, 1994 1:50000 Geological Map of England and Wales Sheet 123, Solid and Drift Geology, ISBN: 0751828548

BGS, Wolverhampton, 2002 1:50000 Geological Map of England and Wales Sheet 153, Solid and Drift Geology, ISBN: 0751833282

Chisholm, J.I. 1988, Ashbourne and Cheadle. Memoir for sheet E124. BGS. ISBN : 0118844121

English Nature 1998. The Midlands Plateau Natural Area Profile.

English Nature 1997. Trent Valley and Rises Natural Area Profile.

English Nature 1997. The Potteries and Churnet Valley Natural Area Profile.

English Nature 1998. White Peak Natural Area Profile.

English Nature 1997. Needwood and South Derbyshire Claylands Natural Area Profile.

English Nature 1998. South West Peak Natural Area Profile.

PORTER, L. and ROBEY, J., 2000. *The Copper and Lead Mines around the Manifold Valley*, Landmark Collector's Library, Landmark Publishing Ltd., Ashbourne, Derbyshire. ISBN 1 901 522 77 6

Rees, J.G.A, 1998 Stoke-on-Trent. Memoir for sheet E123. BGS. ISBN: 0118845373

Reynolds, J and Steward, D. 2004. Chapter on Geology in Flora of Staffordshire. Draft – unpublished.

Whitehead, T.H., 1947. Dudley and Bridgnorth. Memoir for sheet E167. BGS. ISBN : 0118842412

The following publications can provide further information on Geodiversity Action Plans and RIGS.

POTTER, J. and BUREK, C. LGAPs. Setting the Context for Geological Conservation. 2002 (download from www.lgaps.org.uk)

RSNC,1999.RIGS Handbook. (downloaded from www.ukrigs.org.uk/promo/promotion.html#rigshandbook)