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Managing Landscape Change:

A multi-disciplinary approach to future mineral extraction in North Yorkshire

Stage 4 Recommendations for Planning



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Appendix 1: Research, Investigation and Monitoring Techniques

1. Introduction

- 1.1 In January 2011, Capita Symonds was commissioned by North Yorkshire County Council to ‘develop an environmental evidence base and assess environmental sensitivities and capacity in North Yorkshire to inform a spatial planning strategy for the extraction of minerals’.

Background

- 1.2 Pressure on the environment from the extraction of surface minerals, particularly aggregates, in North Yorkshire has created an urgent need for a high quality, mapped environmental dataset to assess environmental sensitivities and capacity and to underpin informed decision-making and management of the environmental resource in areas of past, present and future mineral extraction. Such management will help ensure that key environmental issues are factored into minerals strategy development in a balanced way alongside a range of economic and social considerations. Output generated by the project will contribute to the production of a robust, credible yet proportionate evidence base to underpin spatial strategy development for minerals in North Yorkshire. Adequate evidencing of spatial strategies helps ensure that these strategies are rational, widely accepted by stakeholders and focused on delivery of meaningful outcomes.
- 1.3 Understanding of the capacity of an asset to accept change and the possibility of mitigation against negative aspects of change is an important tool for decision making, particularly where there are competing demands for the preservation or development of an asset. The results of this study will inform new policy and decision making and will also provide a case study of how such policies can be created and used in other areas where a multi-disciplinary approach can be used to address complex problem.

Aims and Objectives

- 1.4 The principal aim of this project is thus **“to develop an environmental evidence base and to assess environmental sensitivities and capacity to inform a spatial planning strategy for the extraction of minerals within North Yorkshire”**.
- 1.5 The more detailed objectives of the contract were to:
- i. define mineral specific Areas of Surface Mineral Resource Potential (ASMRPs) within the overall minerals resource area for North Yorkshire through the identification of the relevant geologies and their spatial extent;
 - ii. collate in GIS format available environmental data for the mineral resource areas to be studied, including historic environment, biodiversity and landscape data;

- iii. analyse the current state of knowledge about, and sensitivity of, the environment of each area of surface mineral resource potential;
- iv. undertake detailed environmental studies of indicative sample area(s) for each area of surface mineral resource potential, to include desk-based research, land-use study, landform classification and descriptions of environmental associations;
- v. assess the capacity for change within each ASMRP and provide a strategic assessment of the degree of impact that mineral extraction would have on each;
- vi. produce a short and focused research framework for each ASMRP to guide environmental evaluation and mitigation works associated with future minerals applications; and to
- vii. produce a report and prepare a digital archive resulting from the project results, suitable for web-access.

1.6 The Project is being delivered in five Stages:

Stage 1: Environmental mapping and characterisation

Stage 2: Detailed environmental evidence gathering and assessment of sample areas

Stage 3: Analysis and environmental overview of each ASMRP

Stage 4: Production of Guidance

Stage 5: Reporting, archive and dissemination of project results

The Scope of this Report

1.7 This report covers the output from Stage 4 of the project: production of guidance.

1.8 The Stage 4 work, overall, involved five individual tasks, as follows:

Task 4(i): Need/opportunities for mitigation and/or compensation;

Task 4(ii): Information requirements at pre-application stage;

Task 4(iii): Restoration / long-term management;

Task 4(iv): Mitigation strategies;

Task 4(v): Production of Stage 4 Highlight Report.

1.9 This report deals with Tasks 4(i) to 4(iv). Following discussion with the Project Steering Group, and in recognition of the overlap between these four elements, they are dealt with collectively rather than as individual chapters for each one. Task 4(v) is reported separately and the output files from the Geographic Information System (GIS) will form part of the project's digital archive.

2. Background: Minerals Planning Policy Context

- 2.1 Minerals planning seeks to provide for an adequate and steady supply of indigenous minerals that are needed to support sustainable economic growth. Planners therefore have to balance the need for mineral extraction with the need for environmental protection. The notion of 'Managing Landscape Change' lies at the heart of this process.
- 2.2 Understanding the extent and sensitivity of North Yorkshire's landscape, historic and natural assets, as informed by the evidence base developed in Stages 1 to 3 of this project, will help to ensure that key environmental issues are factored into minerals planning policies and strategy development in a balanced way, alongside economic and social considerations. This chapter outlines relevant aspects of the existing policy context, as a background to the planning guidance recommendations set out later in the report.

National Policy

- 2.3 National planning policy has traditionally dealt with individual planning topics, including the historic environment, biodiversity, geodiversity and a range of minerals planning issues, as well as the requirements which govern the operation of the planning system itself. Since 2006, the Government has been progressively streamlining National Policy, reducing this to a smaller number of more concise and overarching policies.
- 2.4 In March 2012, the culmination of this process was seen in the publication of the **National Planning Policy Framework** (NPPF), which deals with all planning topics in a single document. Previously, in December 2011, the Communities and Local Government Select Committee published its report on the earlier draft version of the NPPF¹, recommending that, *"once the NPPF is published, all guidance and advice documents be reviewed by DCLG—in consultation with local authorities—item by item, so that the content of the documents that local authorities find operationally and technically useful can be retained for reference in some form, lest councils spend valuable time reinventing numerous wheels"*.
- 2.5 For this reason, it is important to be aware of the previous national policies and guidance which were relevant to environmental protection, landscape and mineral development prior to the arrival of the NPPF, and which provided a context for existing and emerging local policies and approaches. Some of those key national documents are therefore briefly referenced below, before considering the NPPF itself.

¹ <http://www.publications.parliament.uk/pa/cm201012/cmselect/cmcomloc/1526/152602.htm> . Accessed on 14/02/2012

Planning Policy Statements

- 2.6 **PPS1:** *“Delivering Sustainable Development”*, published in November 2004, put sustainable development firmly at the core of land use planning. It recognised that the condition of our surroundings has a direct impact on our quality of life, and that the conservation and improvement of the natural and built environment brings social and economic benefits to local communities.
- 2.7 **PPS5:** *“Planning and the Historic Environment”*, was published in March 2010, updating and combining the former Planning Policy Guidance Notes PPG15 and PPG16. PPS5 recognised that planning has a central role to play in conserving our heritage assets and utilising the historic environment in creating sustainable places. It placed emphasis on intelligently-managed change to preserve what is of significance and is valued by local communities, whilst recognising that some degree of change may be necessary to ensure a viable and sustainable future. Implementation of PPS 5 was supported by the historic environment planning practice guide, produced by English Heritage² which, in turn, makes reference to the publication: *Mineral Extraction and Archaeology: a Practice Guide* (MHEF, 2008).
- 2.8 **PPS7:** *“Sustainable Development in Rural Areas”* emphasised the importance of sustainable development and noted that many country towns and villages are of considerable historic and architectural value, or make an important contribution to local countryside character. It required planning authorities to ensure that development respects and, where possible, enhances these particular qualities.
- 2.9 **PPS9:** *“Biodiversity and Geological Conservation”*, was published in August 2005. This required that development should have minimal impact on biodiversity, maximise opportunities for building-in beneficial biodiversity or geological features as part of good design, and enhance where possible UK Biodiversity Action Plan priority habitats.

Minerals Policy Statements

- 2.10 **MPS1:** *“Planning and Minerals”*, published in November 2006, set out the Government’s overarching policies and principles for all mineral extraction in England. One its key aims, as stated in paragraph 1, was to *“provide a framework for meeting the nation’s need for minerals sustainably”* and, as part of this, *“securing avoidance or appropriate mitigation of environmental impacts where extraction takes place”*.
- 2.11 **MPS2:** *Controlling and Mitigating the Environmental Effects of Minerals Extraction in England*³, published in March 2005, set out the general policies and considerations in relation to the environmental effects of minerals extraction. It highlighted the need for pre-application discussions and advised that *“When preparing the application and in proposing any necessary*

² english-heritage.org.uk/publications/pps-practice-guide/pps5practiceguide.pdf

³ communities.gov.uk/documents/planningandbuilding/pdf/mps2.pdf

mitigation measures, the developer should demonstrate that any potential adverse effects have been properly and competently considered". It also noted that monitoring is an essential feature in controlling the effects of mineral extraction, and advocated the use of performance requirements which leave the developer free to make their own decisions on the most cost-effective way of meeting those criteria, while allowing outcomes to be monitored.

National Planning Policy Framework

- 2.12 The new NPPF replaces all previous, topic-specific national policy statements with a single, more streamlined document.
- 2.13 The NPPF clearly states, in paragraph 6, that the purpose of the planning system is to contribute to the achievement of sustainable development. It quotes Resolution 24/187 of the United Nations General Assembly which defined sustainable development as *'meeting the needs of the present without compromising the ability of future generations to meet their own needs'*.
- 2.14 Another key aspect of the NPPF is that, in accordance with the Localism agenda, it steers slightly away from the kind of 'top-down' spatial planning approach which has been central to the planning system in England for many decades, shifting the emphasis more towards engaging local communities directly in the decision-making process.

Minerals

- 2.15 In paragraph 163 of the NPPF, Mineral Planning Authorities are instructed to work with other relevant organisations to use the best available information to develop and maintain an understanding of the extent and location of mineral resource in their areas and to assess the projected demand for their use. Paragraphs 142 to 149 provide further details on 'Facilitating the Sustainable Use of Minerals'.
- 2.16 Paragraphs 145 to 149 set out the policy relating to the security of supply of aggregates and of industrial and energy minerals. With regard to aggregate minerals, emphasis is on the preparation of annual Local Aggregate Assessments by individual MPAs, or groups of MPAs. This theoretically allows greater scope for local minerals planning, but there is still a requirement for MPAs to participate in the operation of an Aggregate Working Party, and to take the advice of that Party into account when preparing their Local Aggregate Assessment. Moreover, there is also still a requirement for MPAs to take account of the National and Sub-National Guidelines for aggregates provision, issued periodically by the Department of Communities and Local Government (CLG). The 'top down' Managed Aggregate Supply System therefore still has a very important role to play in determining the requirements for aggregates provision at the local scale.

- 2.17 In paragraph 144, the NPPF requires that local authorities should ensure that *‘in granting planning permission for mineral development, that there are no unacceptable adverse impacts on the natural and historic environment, human health or aviation safety, and bear in mind the cumulative effect of multiple impacts from individual sites and/or from a number of sites in a locality’*.

Natural Environment

- 2.18 Paragraph 165 of the NPPF notes that planning policies and decisions should be based on up-to-date information about the natural environment and other characteristics of the area. A sustainability appraisal should be an integrated part of the plan preparation process, and should consider all the likely significant effects on the environment, economic and social factors.
- 2.19 Paragraphs 109 to 125 provide further details relating to the natural environment. This is taken to encompass the protection of valued landscapes, protecting and enhancing biodiversity and geodiversity, and preventing unacceptable risks to development from land, air, water or noise pollution and from land instability. Paragraph 113 notes that *‘Local planning authorities should set criteria based policies against which proposals for any development on or affecting protected wildlife sites or landscape areas will be judged. Distinctions should be made between the hierarchy of international, national and locally designated sites’*.
- 2.20 The draft policy on **landscape** places emphasis on national designations, but makes no mention of wider landscapes (except on the undeveloped coast) or of the European Landscape Convention. The policy on **biodiversity** is more enlightened, emphasising local ecological networks and areas identified by local partnerships for habitat restoration or creation, as well as designated sites. It requires local authorities to adopt a strategic approach, planning positively for the creation, protection, enhancement and management of networks of biodiversity and green infrastructure. It also highlights the need to plan for biodiversity at a landscape-scale across local authority boundaries.

Historic Environment

- 2.21 Paragraph 169 of the NPPF notes that local planning authorities should have up-to-date evidence about the historic environment in their area and use it to assess the significance of heritage assets and the contribution they make to their environment. They should also use it to predict the likelihood that currently unidentified heritage assets, particularly sites of historic and archaeological interest, will be discovered in the future. Local planning authorities should either maintain or have access to a historic environment record.
- 2.22 Paragraphs 126 to 141 provide further policy details relating to the historic environment, highlighting the Government’s objectives to conserve heritage assets in a manner appropriate to their significance (identified as a core planning principle in paragraph 17); and to contribute

to our knowledge and understanding of our past by capturing evidence from the historic environment and making this publicly available, particularly where a heritage asset is to be lost. Both of these objectives are highly relevant to minerals development. The policies emphasise the protection of designated sites, especially scheduled monuments, battlefields, grade I and II* listed buildings, grade I and II* registered parks and gardens, and World Heritage Sites. However, non-designated heritage assets that are demonstrably of equivalent significance to scheduled monuments are required to be treated in the same way (para 139). For these and other sites and features, the policies require a balanced judgement to be made, having regard to the scale of any harm or loss and the significance of the heritage assets involved. Para. 133 notes that *'Where a proposed development will lead to substantial harm to or total loss of significance of a designated heritage asset local planning authorities should refuse consent, unless it can be demonstrated that the substantial harm or loss is necessary to achieve substantial public benefits that outweigh that harm or loss'*. Developers are required to record and advance understanding of the significance of any heritage assets to be lost (wholly or in part) in a manner proportionate to their importance and the impact, and to make this evidence (and any archive generated) publicly accessible. However, as noted originally in the former PPS5, it emphasises that the ability to record evidence of our past should not be a factor in deciding whether or not such loss should be permitted.

North Yorkshire County Council Minerals Planning Policy

- 2.23 North Yorkshire County Council, in its role as the Mineral Planning Authority for that area (excluding the two National Parks and the City of York), is responsible for the production of a Minerals and Waste Development Framework (MWDF), setting out policies to guide and control the development of existing and future mineral operations and waste management operations within the county. The MWDF is currently in progress and, in the interim; certain policies within the existing minerals local plan continue to be relevant. Further details of both are therefore given below.

Existing Minerals Local Plan

- 2.24 The County Council's existing Mineral Local Plan contains policies were due to expire on the 27 September 2007, but the Secretary of State has allowed some policies to be 'saved' until new ones within the emerging MWDF supersede them. The saved policies cover only a few of the topics relevant to this project (including the identification of preferred areas and areas of search, and the determination of planning applications, but not landscape designations, major environmental designations or archaeology). The saved policies will continue to form part of the statutory 'development plan' and to provide the local policy framework for determining minerals planning applications until they are replaced by ones in the MWDF.

Emerging Minerals Core Strategy

- 2.25 In April 2010, the County Council commenced work on the preparation of its Minerals Core Strategy (MCS) - one of the essential Development Plan Documents within the new MWDF, which will cover the period to 2030. Submission of a draft strategy for examination in public is scheduled for December 2012, with adoption scheduled for December 2013.
- 2.26 Between July and September 2011 NYCC consulted on an Issues Paper relating to the Minerals Core Strategy (North Yorkshire Minerals and Waste Development Framework Minerals Core Strategy Issues Paper, July 2011). The County Council had already carried out extensive consultations with stakeholders, and has built up an initial evidence base of current minerals extraction and likely future requirements based on a number of factors including mineral operator and landowner proposals and industry predictions. The Council's intention is that the Minerals Core Strategy will use the consultations and considerations of sustainability and capacity to identify broad areas of possible minerals activity, and *may* identify strategic sites in. The Minerals Spatial Map within the issues paper identifies six particular spatial areas based on a range of environmental, demographic and minerals resource factors, and the accompanying table sets out briefly the broad characteristics and constraints of each one.
- 2.27 NYCC's responses to issues raised during this consultation exercise are published on the Council's website. The consultation was sent to 2,318 consultees including local authorities and parish councils, as well as statutory consultees and a range of interested parties. Chapter 6.3 of the issues paper looked specifically at environmental assets and constraints and referenced this current Managing Landscape Change study as an important future source for more detailed understanding of the relationship between minerals and landscape, heritage assets and bio diversity considerations. Specific issues such as managing potential conflicts within the plan area, and further consideration of the cumulative impacts of minerals working on landscape character are raised, as is the potential for impacts from development to be felt outside a designated area. Consideration of eco systems services and green infrastructure and the negative and positive impacts on environment and quality of life will be considered during the preparation of the Minerals Core Strategy. A number of consultees responded to a specific question about parts of the plan area that would be sensitive in terms of environmental constraints and impacts on local amenity. NYCC noted (page 21) the range of comments about the Swale and Ure Valleys, the impacts of mineral movement and potential for site reclamation, which would be considered as the Minerals Core Strategy progresses to full draft. One issue raised and which was commented on by NYCC was the loss of agricultural land and opportunities for reclamation schemes to restore land to agricultural and not leisure use or a nature site. The next stage will be the undertaking of consultation on possible policy options.
- 2.28 Few policies saved from the Minerals Local Plan in 2007 have direct application to the consideration of natural and historic environment assets other than within the overarching policy 4.1 Determination of Planning Applications. The National Planning Policy Framework

thus provides the main steer for mineral applications and decision making within the minerals study area at present.

Information Requirements

- 2.29 Of particular importance to the concept of managing landscape change associated with new development (including minerals) is the need for proposals to be informed by a good, holistic understanding of the existing landscape, natural environment and historic environment within the area surrounding the proposed development, not just the site itself. In this way, potential impacts can be assessed more comprehensively, within a wider landscape context, and thereby avoided or adequately mitigated; and opportunities for enhancement can be identified and optimised through good design. Detailed recommendations relating to pre-application information requirements are set out in Chapter 4 of this report.
- 2.30 In order to understand the requirements in more detail, there are clear benefits to mineral operators engaging with the authority in pre-application discussions. These allow the Council to explain their approach, to set out the information that will be needed to assess prospective applications, and to highlight the benefits to applicants of using an integrated, holistic approach in gathering this information. The discussions help to guide the pre-application research and investigations that need to be carried out by the developer in order to be able to provide adequate supporting information. They also allow applicants to consider any modifications which may be needed to their proposals in the light of this information and/or Development Plan policies.
- 2.31 Through its consideration of environmental sensitivities associated with individual mineral resources in North Yorkshire, and with the geographical areas involved, the present study has enabled more detailed observations to be made regarding this overall approach and to suggest both key principles and key environmental research questions which lead to recommendations for planning in North Yorkshire. These are detailed in the following chapters.

3. Key Principles for Managing Landscape Change

Introduction

- 3.1 This chapter identifies the key principles relating to the process of managing landscape change associated with future mineral development within North Yorkshire. This, together with the background material presented in the previous chapter, provides the basis for the planning recommendations set out in Chapters 4 to 11, below.

Key Principles

- 3.2 Through the work carried out in Stages 1 to 3 of this project, including the detailed appreciation that has been gained of the complex inter-relationships between all aspects of the landscape, the natural environment and the historic environment, the varying degree and nature of the environmental sensitivities involved, and the wide range of potential impacts and corresponding mitigation and monitoring techniques which may need to be applied, a number of key principles have been identified as being important components of a successful strategy for managing landscape change. These comprise:
- **Integrated Understanding** (the development of a comprehensive awareness of the wider landscape surrounding the site of a development proposal or in the general area of potential future site allocations, including the historic environment and natural environment components, and their interactions over time. At the detailed level of specific proposals this can be expressed in the form of a conceptual '***predictive landscape model***⁴ which is then used to focus pre-application research to inform the location and design of the proposal);
 - **Spatial Planning** (the need to integrate the spatial requirements for current and future minerals development with those of other relevant factors, including the distribution of mineral resources, the occurrence and significance of environmental and other planning constraints (including existing and planned development); the geographical distribution of likely future demand; and alternative sources of supply. These are issues which need to be considered in the formulation of policies, strategies and plans, but also in relation to the consideration of alternatives for individual proposals);
 - **Long-term Vision** (relating to the development proposal, the landscape and environment involved and to the successive involvement of relevant personnel. This includes the need to consider mineral development as part of a continuum of landscape change, not only within the timescale of an individual Development Plan or planning application, but over a

⁴**Predictive landscape modelling** involves building up an understanding of the evolution of a particular part of the landscape over time, so that associations between landscape, landform, ecology, historical land use and climate change can be adequately reflected in the design of any new proposals for development. In both cases the essence is to develop a sound and comprehensive understanding of the processes, interactions and features involved, so that any impacts on these processes and features can properly be anticipated, assessed and mitigated as an integral part of the proposal.

much longer period of time, in order to recognise and fit in with other environmental, climatic and land use changes that are likely to occur. To include the concept of '**dynamic baseline monitoring**⁵);

- **Environmental Impact Assessment** (a normal requirement of most minerals planning applications, this should form an integral part of the design process, informed by a sound, integrated understanding of the environment and of the ecosystem services provided by the various components of the landscape - both now and on completion of quarrying and reclamation).
- **Imaginative Design and the Creation of Environmental Benefits** (designing to ensure that adverse impacts are avoided or mitigated, that the proposal fits in with and (where possible) enhances the surrounding landscape, and that opportunities for creating environmental benefits during final reclamation are optimised through the imaginative design of the excavation itself. This process can benefit from the use of an **ecosystems approach**⁶ and the balanced consideration of individual **ecosystem services**);
- **Monitoring** (planned strategies to ensure that progress and potential impacts are adequately and efficiently monitored, and that monitoring results are properly assessed so that, where necessary, they can trigger mitigation measures or changes in implementation, aftercare and management, and also the design of further extraction);
- **Mitigation Measures** (designed on the basis of a good, integrated understanding of the wider landscape (see above) and using demonstrably effective mitigation methods. Where uncertainty exists, staged or tiered mitigation strategies, linked to ongoing monitoring which provides early warning of impending impacts, allow the **precautionary principle**⁷ to be used); and
- **Compensatory Measures** (used where there is an over-riding need for mineral extraction and where certain impacts cannot be avoided and adequate mitigation cannot be achieved).

⁵ The concept of **dynamic baseline monitoring**, in which the long-term impacts of mineral development are monitored against the observed, changing background of other, ongoing and independent aspects of environmental change, rather than just in relation to pre-operational baseline data, has been proposed within guidance relating to the control of impacts of surface mineral workings on the water environment (Thompson *et al.*, 2007, 2008). In principle, it also has much wider applicability to other aspects of the natural environment and land use change, and allows for sensible adaptation of long-term reclamation plans.

⁶ See paragraphs 8.14 *et seq.* for an explanation of the **Ecosystems Approach** and **Ecosystem Services**.

⁷ The **Precautionary Principle** is a basis for adopting a cautious approach to regulating development which may otherwise cause damage to the natural environment. The concept was first defined as Principle 15 of the Rio Declaration, 1992, which states: "*Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*". This can be reflected in a number of different approaches. Planning permissions may be subject to incremental stages (e.g. one bench at a time for deep hard rock quarries), whereby each stage is subject to the satisfactory performance of mitigation measures in the previous stage and to the review of operational monitoring data. Alternatively, or in addition, where the likelihood of the risk is low but cannot be ruled out, this could be reflected in a staged mitigation strategy which requires certain measures to become mandatory in the event that the assessed likelihood of serious impact is increased through the results of routine operational monitoring. In such cases, the relevant thresholds or trigger levels need to be agreed prior to the grant of planning permission or other development consent and need to provide an adequate early warning of any serious or irreversible risk. The details will usually need to be reflected in legally binding Section 106 planning obligations.

- 3.3 These suggestions have arisen in part from this study and in part from existing good practice within North Yorkshire and elsewhere. They are compatible with the overarching principles of sustainable development, as set out within the National Planning Policy Framework.

Benefits of Adopting these Key Principles

- 3.4 There are numerous benefits to be gained by following the key principles outlined above and by adopting pro-active, front-loaded requirements for information to enable more informed decision making based on understanding and valuing landscape as a whole. This helps both mineral operators and the planning authority to manage landscape change in a positive way. The potential benefits to operators include:
- Opportunity to identify potential problems and resolve issues prior to submission of a planning application;
 - Identification at an early stage what and where specialist advice is necessary (e.g. landscape, ecology or archaeology);
 - Early consultation and archaeological evaluation can minimise the risk of non-designated heritage assets coming to light later on;
 - The local planning authority will give advice that can help the applicant prepare a better planning application, so that it may be processed more quickly; and
 - Greater confidence in planning the long-term development of available reserves in the less sensitive parts of a given resource outcrop. .
- 3.5 Being able to ‘tell the story’ of how a particular landscape has evolved is extremely important in terms of the overall benefit to the public, and the consideration of ‘**public value**’ is a vital aspect in determining what might be the best approach in any given situation. Demanding the *in-situ* preservation of all aspects of the historic environment, natural environment and landscape would stifle the production of essential minerals. A balance therefore has to be reached in each case in order to obtain the ‘optimum’ overall benefits. However, the ability to record evidence of our past should not be a factor in deciding whether such loss should be permitted (NPPF, para 141).
- 3.6 It is important to recognise, however, that there is no ‘one size fits all’ solution: different approaches and different outcomes are needed for different situations, to reflect variations in the types of mineral working and the types of environmental and landscape sensitivities involved.

4. Recommendations for Planning: Introduction

- 4.1 The following chapters set out a number of recommendations for planning at each stage of quarry development, from pre-application research and information gathering, to quarry design, (including monitoring and mitigation design), and to the implementation of these designs during the operational, reclamation and after-use stages.

Overview

- 4.2 An overview of this logical sequence of stages is set out below:

- **Spatial Planning** (noting the importance of this in focusing plans, strategies and individual proposals for future mineral development on areas which contain suitable mineral resources but which also avoid the more sensitive landscapes and environmental features, as far as possible);
- **Pre-Application Information Requirements** (highlighting the importance of developing a good, holistic understanding of the wider landscape and environment surrounding the proposed application site through a sequential, iterative⁸ process of investigation. This includes an indicative series of key **Environmental Research Questions** which should assist applicants in fulfilling these requirements);
- **Pre-Application Research and Baseline Monitoring** (noting the methods likely to be required in obtaining the necessary pre-application information, supported by more detailed guidance within Appendix 1);
- **Environmental Impact Assessment** (noting the need for this to be an integral and iterative part of the design process, and therefore carried out in parallel with the stages outlined below, making use of the comprehensive information and integrated understanding built-up throughout the pre-application stage);
- **Quarry Design** (noting the generic aspects of design philosophy which should help to achieve more sustainable mineral extraction, to enhance the potential for creating environmental benefits, and to optimise the overall benefits in terms of ecosystem services. This includes recommendations relating to the development of a **Long-term Vision** - focusing on the benefits to all parties of long-term planning - both for minerals and for the landscape itself, including adaptation to more general environmental and climate change);

⁸ Throughout this document there are references to the need for an '*iterative*' process of gathering and utilising information. This is considered to be a vital aspect of the process of managing landscape change. In the broadest sense it refers to the need to understand what has gone before, and to reflect this understanding in what happens next. More specifically, it applies to the gathering of information, both during the pre-application stage and throughout the lifetime of the operational and post-operational stages. Such information will sometimes necessitate changes to previously-conceived ideas, whether this be the design of further information gathering, the location and design of the proposed excavation, or the design and implementation of the reclamation and long-term management phases.

- **Design of Operational Monitoring, Mitigation and Compensation Strategies** (detailed guidance, highlighting the importance of these being designed in advance and used as effectively as possible to monitor and control impacts throughout the operational and post-operational stages of mineral development);
- **The Operational Phase of mineral extraction and processing** (highlighting the need for design concepts and strategies to be implemented, or adapted where necessary, with the continued advice of relevant specialists, and with ongoing dialogue with North Yorkshire County Council, including the monitoring, enforcement and periodic review of agreed planning conditions and obligations)
- **The Reclamation and Long-term Management Phases of mineral development** (again, highlighting the importance of implementing or adapting the agreed design concepts with the continued advice of relevant specialists and ongoing dialogue with the planning authority)

4.3 In each chapter, the recommendations are set out in bold text, highlighting the main aspects of good practice which are needed to achieve the sustainable management of landscape change associated with future mineral extraction in North Yorkshire. In each case the recommendations are preceded by explanatory text which links back to the evidence base developed in Stages 1 to 3 of the project.

4.4 The recommendations are based on the findings of this project and on the implementation of the key principles identified in Chapter 3. In each chapter, generic recommendations which apply to all areas and all types of mineral extraction are presented first, followed by additional or more specific recommendations relating to specific minerals and/or geographic areas within North Yorkshire.

Spatial Planning

4.5 Notwithstanding the requirements of the Localism Act 2011, which places greater emphasis on local planning and community involvement, strategic spatial planning still has a vital role to play - not least in terms of both mineral development and landscape-scale environmental protection.

4.6 Paragraph 152 of the NPPF confirms the general requirement to avoid impacts, as far as possible, as a first priority, before consideration is given to mitigation or compensatory measures. This can be achieved most effectively through spatial planning - i.e. by locating new development away from sensitive 'receptors'. This requires action at two levels: firstly by NYCC as the Mineral Planning Authority, in terms of guiding development proposals towards areas which have the greatest capacity to accommodate such development; and secondly by mineral operators in refining their proposals on the basis of more detailed investigation and understanding within their particular areas of interest.

- 4.7 Led by NYCC, but with input from mineral operators and other interested parties, a spatial planning strategy for future mineral extraction within North Yorkshire should take account of the availability and distribution of economically viable mineral resources, and of spatial variations in sensitivity and capacity, in order to provide an overall framework and policy context in which mineral operators can bring forward proposals for development. In accordance with paragraphs 143 and 145 of the NPPF, this should include the identification of **Mineral Safeguarding Areas (MSAs)**, **Areas of Search**, **Preferred Areas** and, if possible, **Specific Sites** for future mineral development. Whilst the first of these should be defined primarily by the distribution of mineral resources, the others need to take increasingly detailed account of constraints and opportunities relating to the landscape, the natural environment and the historic environment, as well as other relevant constraints and opportunities. However, in accordance with the principles outlined in the previous chapter, this should entail more than a simple analysis of designated sites and areas; it should be based upon an integrated understanding of all three types of interest (landscape, natural environment and heritage), and the sensitivities involved. The work on sensitivity and capacity described in Stage 3 of this research should help to inform this process, but additional information is also likely to be required.
- 4.8 Consideration should also be given to strategic opportunities for mineral workings (including long-term reclamation plans) to contribute to wider initiatives relating to biodiversity enhancement, historic environment research and the maintenance or improvement of landscape character (including, for example, the use of locally-sourced natural building and roofing materials).
- 4.9 It is important that spatial analysis, at this scale, should also incorporate a wider appreciation of the sustainability implications relating to the transportation of minerals to known markets. This may dictate, for example, that areas of resource which may be free of designations but located far away from relevant markets are less important than more constrained areas in closer proximity to those markets. The economic factors, traffic impacts and carbon emissions associated with transportation will need to be factored in to the overall analysis through the use of comprehensive sustainability appraisals.
- 4.10 A County-wide spatial strategy, once created, would provide a starting point from which mineral operators could then develop individual proposals in the light of more detailed spatial analysis of potential alternative sites within their area(s) of interest. Such proposals would need to demonstrate how the preferred location for a particular proposal has been selected in such a way as to avoid potential impacts to features of special sensitivity within that general area. The analysis required here would be facilitated by the information gathered by the operator at the pre-application stage, and their development of an integrated, holistic understanding of the landscape, natural environment and historic environment within the area concerned (as explained in more detail within the next chapter).

RECOMMENDATIONS: Spatial Planning

- 4.11 **NYCC should develop a spatial strategy for future minerals development within the County. This should take account of the availability and distribution of mineral resources (informed by the latest available information from the British Geological Survey); environmental sensitivities and capacity (informed in part by Stage 3 of this project); wider sustainability issues relating to mineral transportation; and the prospects for mineral extraction and reclamation to contribute to other initiatives for maintaining and enhancing the existing landscape and natural/historic environment.**
- 4.12 **Mineral operators should be expected to develop their proposals in the light of a more detailed analysis of potential alternative sites within their area(s) of interest, demonstrating in each case how their preferred location has been selected in such a way as to avoid potential impacts to features of particular sensitivity within that general area.**

Variations relating to specific minerals or geographical areas

- 4.13 Unlike the recommendations detailed within chapters 6 to 11 of this report, those listed above are applicable to all minerals and all geographical areas. Spatial differentiation will emerge from these recommendations in terms of more detailed requirements, but the basic need to undertake spatial analysis and to reflect this in Plans, policies and proposals applies to all areas.

5. Pre-Application Information Requirements

Introduction

- 5.1 Prospective applicants need to provide sufficient information to enable the MPA and its consultees to understand the proposal, the reasons/justification for it, the likely significant environmental effects, the proposed mitigation measures and the likely residual effects or risks, after mitigation. Ultimately, that information will be used, in conjunction with the Development Plan and other material considerations, as the basis for determining the application.
- 5.2 Detailed advice regarding information requirements can be obtained by mineral operators through pre-application discussions relating to the site in question. The requirements will vary from one location to another, depending on the types of mineral working and the types of environmental and landscape sensitivities involved. There are however some generic requirements which relate to all applications, and others which are focused on particular geographical areas which share similar sensitivities to the potential impacts of mineral extraction. These are set out below.
- 5.3 The level of information that can reasonably be expected to inform planning decisions needs to be proportionate, reflecting the sensitivities and significance of the receptors and assets which are potentially at risk. It is therefore important to adopt an iterative, sequential procedure which brings in additional, more detailed requirements for information, research and baseline monitoring where deemed to be necessary.

Developing an Integrated Understanding of the Environment

- 5.4 As noted in Chapter 3, the need for proposals to be informed by a good, holistic understanding of the wider landscape, natural environment and historic environment within the area all around the proposed development is one of the key principles relating to the concept of managing landscape change. This is in accordance with the former PPS5 which took a holistic view of the historic environment in its widest sense. By developing a fully integrated understanding of the landscape and the assets within it, including its origins, characteristics and ongoing processes (both natural and anthropogenic), key characteristics, significances and sensitivities can be more readily identified, potential impacts are more able to be understood (and thereby more likely to be avoided or adequately mitigated). Opportunities for appropriate reclamation and environmental enhancement can also be identified and optimised through good design, based on a more complete understanding of the wider context of a site (see below).

- 5.5 The frequently-cited phrase '*working with nature rather than against it*' encapsulates at least part of this, with respect to the natural environment, but the same basic concept can be applied more widely in terms of respecting the historic environment and the overall landscape - in each case seeking ways to work '*with the grain of the land*' so as to avoid unnecessary discordance in terms of landscape change.

Predictive Landscape Modelling

- 5.6 The other essential aspect of this is to understand how the particular features and sensitivities of a given area are often inter-dependent, both in terms of their origin over thousands of years of landscape evolution, and in terms of their vulnerability to further change. Biodiversity and archaeological features, for example, are often strongly dependent upon the landforms, geology and soils with which they are associated; and with the characteristics of both the local hydrology (surface water) and hydrogeology (groundwater) regimes. As demonstrated in the Stage 2 'Predictive Landscape Modelling' report, all of these relationships, as well those between climate, natural vegetation, geomorphological processes and human cultural development and land use have combined in a very complex way to create the present-day landscape. Moreover, all have been influenced by human intervention in the past, and all can be affected by future development, including the effects of mineral extraction. These various effects can be detrimental (unless adequately mitigated), but some of them can also be beneficial if properly understood and 'harnessed' as part of a well-founded, integrated design concept.
- 5.7 Effective evaluation of loss or of potentially damaging effects can only be achieved, however, by first having a thorough understanding of the site and the wider landscape around it, by developing a sound appreciation of the environmental conditions and processes involved, and (where appropriate) by developing a conceptual '***predictive landscape model***' which demonstrates and explains the inter-relationships⁹. Conceptual modelling is a vital step in relation to the most dynamic of these linkages - particularly those relating to the water environment (Thompson *et al.*, 2007, 2008) - but the same basic principle can usefully be extended to other relationships and is central to the notion of achieving balanced, sustainable development.
- 5.8 The development of any conceptual model needs to comprise a number of iterative, sequential stages. It should begin with a desk-based assessment over a wide area, in order to identify target areas for more detailed investigation - for example by eliminating areas which are unlikely to contain commercially viable resources and those which are likely to have the highest environmental or landscape sensitivities. Successive stages of investigation can then gather more detailed evidence, building up an improved understanding of the characteristics

⁹ See footnote on page 16

and evolution of the remaining areas, and eventually focusing on the areas which would be likely to experience significant environmental effects from the proposed development.

- 5.9 The landscape itself frequently provides a complex, multi-layered tapestry of information which gives vital clues to the historical evolution of present-day field patterns, settlements and land uses, and to the setting of important historic buildings and monuments. Capturing and, wherever possible, retaining and enhancing the ‘narrative’ that is expressed through landscape features is another vital component of managing future landscape change. General information on this has been compiled within the Stage 2 Predictive Landscape Modelling and Stage 3 Sensitivity and Capacity assessments, drawing on North Yorkshire’s county-scale Landscape Character Assessment by Chris Blandford Associates (2011) and on NYCC’s Historic Landscape Characterisation (HLC) data. More detailed information should be obtained by the applicant, relating more specifically to the area around the proposed development, so that a detailed understanding of the wider landscape and environmental context within that area can be reflected in the submitted proposals and supporting information.

Nosterfield: an example of the benefits of a landscape modelling approach to characterising archaeology

- 5.10 Between 1995 and 2011, various applications to extend the area of mineral extraction have been made in the area close to Thornborough Henges: a Scheduled Ancient Monument (SAM) set within a wider archaeological landscape on the Magnesian Limestone ridge, adjacent to the Vale of York. Mineral workings in the area originally began in 1995 and, over the years, 6.5 million tonnes of sand and gravel have been extracted. Pre-application discussions regarding archaeological characterisation of the wider landscape between the County Council, English Heritage and the developer have become increasingly important.
- 5.11 The archaeological significance of the area around Thornborough Henges is such that it has been difficult to determine whether or not any part of this landscape would be suitable for further mineral extraction. English Heritage and NYCC therefore encouraged the applicant to develop a model to assist with the understanding of the detailed character and significance of this archaeological landscape (Archaeoscope, 2008).
- 5.12 The process gathers existing archaeological knowledge and information about a place then looks at what elements contribute to archaeological characterisation in order to develop a hypothesis. This information is mapped within a GIS using various non-intrusive investigatory techniques, including desk-based assessments, aerial photography, LiDAR imagery and localised geophysical surveys, and areas of archaeological potential are identified. The hypothesis can then be tested by carrying out more detailed site surveys, including trenching and coring, in areas which the model shows are more likely to yield archaeological evidence of past activity, as well as also testing the lower potential areas in order to verify the model. Consequently, the model can help to guide extraction operations to areas where the least or no damage to archaeology can occur, subject to appropriate mitigation measures.

- 5.13 Archaeological characterisation is carried out not only on the application site but on the wider landscape. This ensures that future applications for any quarry operations can be planned to take into account archaeological considerations.
- 5.14 The work carried out at Nosterfield has demonstrated an integrated approach to determining the history of the environment and landscape change. This process has led to an improved, integrated understanding of the landscape (how it was formed; how it was and is currently used; what the landscape supports and what it holds within it to provide evidence of former use). The model is therefore a useful tool in guiding site location and developing future plans for after-use strategies. It successfully characterised the archaeological resource which greatly assisted assessment of the impacts of future quarrying proposals. This is an approach endorsed by *Mineral Extraction and Archaeology: A Practice Guide* (MHEF, 2008).

RECOMMENDATIONS: Pre-application information

- 5.15 In all cases, the information required from prospective applicants should demonstrate a good, holistic understanding of all aspects of the landscape and environment within and surrounding their proposed application site. This should include an appreciation of how the various elements of the landscape, historic environment and natural environment relate to each other, and how these have interacted to create the present-day landscape since pre-historic times. This will provide a basis for understanding and for the evaluation of distinctiveness, significance, sensitivity and capacity. It could also lead to more informed and appropriate mitigation strategies. It could also provide a context for understanding both future interactions and opportunities for environmental enhancement.
- 5.16 This information should cover a wide area, defined in each case through pre-application discussions, to take account of local environmental characteristics and sensitivities. It should demonstrate how the proposed site was selected, based on a rigorous analysis of the need for extraction, the availability and distribution of commercially exploitable resources, and the sensitivity and significance of all landscape and environmental assets within that area. It should show how the proposal can play a positive role within this wider natural and historic landscape, with a minimum of adverse consequences.
- 5.17 The information should cover all aspects of the proposal, so that it is able to inform each stage of development from initial preparatory works through to mineral extraction, reclamation and long-term management.
- 5.18 The information should be based on a clear sequential and iterative procedure, beginning with a desk-based assessment of the wider area and progressively focusing down to more detailed assessments and investigations which are sufficient to address the issues identified for the site in question, including the identification of effective mitigation strategies.

- 5.19 **In order to identify the key issues pertaining to a particular site, a number of key environmental research questions need to be asked as part of the iterative process. Examples are given below.**

Key Environmental Research Questions

- 5.20 A series of primary research questions are set out below, each with a number of secondary questions that should help to address the main issue. Primary questions 1 to 3 form the first part of an iterative sequence leading to the identification of a preferred location within a wider potential resource area. The subsequent questions should then enable more detailed information to be gathered in the areas of greatest relevance to the proposal, as the application develops. In most cases, those additional questions will lead to a refinement of the proposal before it is submitted, and in some cases may lead to a changed location.
- 5.21 **It must be emphasised that the questions are not intended to be a definitive checklist or to impose unnecessary burdens, but are suggested as a guide to achieving optimum environmental benefits. They should be drawn upon as relevant to any specific development proposal.**
- 5.22 Primary Question 1: what is the wider context for the proposed development site? (NB. Pre-application discussions will clarify the extent of the area to be included within this preliminary phase of research. The following subsidiary questions are intended to be indicative rather than exhaustive).
- Does any part of this area fall within or close to nationally or internationally-designated sites or to heritage assets of national significance, whether designated or not?
 - Is the area covered by any relevant previous or ongoing studies or surveys (e.g. on landscape character, biodiversity, geodiversity, water environment, archaeology or other aspects of the historic environment?)
 - What planning policies, relevant to the proposed development, are applicable to the area?
 - What other strategies, initiatives or masterplans are applicable to the area (e.g. biodiversity opportunity areas, 'green' or 'blue' infrastructure corridors; Biodiversity Action Plans (BAPs), Geodiversity Action Plans (GAPs)?
 - What defines the existing landscape character within this wider area at national and local level, and how has this evolved over the centuries?
 - What important features of the natural environment exist within this area (including habitats, species and wildlife corridors, features of geodiversity interest and all aspects of the water environment such as lakes, ponds, surface watercourses, floodplains, wetlands, aquifers and water resources)?
 - What is the significance of the heritage assets within this area, including known heritage

assets (designated and non-designated) and archaeological potential?

- What is the broad relationship between the geology, topography, hydrology, hydrogeology, natural vegetation, land use and present day landscape character of the area?
- How sensitive is the area to physical change (in terms of intrinsic vulnerability, irrespective of the precise nature of any proposed development) and what is the nature of the main sensitivities involved (including landscape, historic environment and natural environment)?
- To what extent are these sensitivities likely to be able to be addressed by careful location of the proposal within this wider area, or by appropriate mitigation, and what are the implications of this for the area being able to accommodate change?

5.23 **Primary Question 2: Are there important local interests to be considered?**

- How is the area currently used?
- How is the area valued by local people and how important is it to them (e.g. in terms of landscape character or quality, cultural interest, nature conservation or as a recreational resource)?
- Are there any local designations, such as Sites of Importance for Nature Conservation, Local Geological Sites, locally listed buildings or conservation areas or Areas of Great Landscape Value within the area?
- Would the local community like to be involved in the development of the proposal and/or in future management of the site following reclamation?

5.24 **Primary Question 3: Has other development taken place in this wider area in the past or is any such development being planned?**

- If so, what is the potential for generating further cumulative effects on habitats, heritage assets, landscape character or visual impact?
- What is the scope for such effects to be avoided or mitigated through the production of a contextual landscape plan, area action plan or other long-term masterplan to enhance the area?
- Is there potential for generating positive effects through extension of habitat restorations or restoration to agricultural land for example?
- Taking account of this, what are the implications in terms of capacity for further minerals development?

5.25 **Primary Question 4: Taking account of the information gained from Questions 1 to 3, and after discussion with the MPA and other specialist consultees, what would seem to be the preferred location for the proposed mineral development within the wider area?**

5.26 The following questions, intended to inform the more detailed evidence base relating to the proposal, are applicable to the operator's preferred location and to the area surrounding this which might be affected by one or more potential impacts. This 'zone of potential influence' is likely to be different for each type of impact, and will be informed by the preliminary investigations outlined above.

5.27 **Primary Question 5: What would be the basic form of the proposed development**, including the intended size and shape of the void, the method of excavation, whether or not dewatering would be required, and the intended reclamation plan? *(NB these and other more detailed aspects of the design will need to be revisited as an iterative process, as the following questions are addressed, so as to minimise impacts, incorporate mitigation and optimise the potential for environmental enhancement. In some cases, this iterative process might lead to a change of preferred location).*

5.28 **Primary Question 6: What aspects of the water environment could be affected by the proposal?**

- What is the likely zone of influence of the proposal on all aspects of the water environment?
- What sensitive features of the water environment are present within this area (including watercourses, lakes, ponds, floodplains, wetlands, aquifers and water resources), and what is the nature of their sensitivity?
- What are the baseline conditions of each of these receptors, including the typical range of seasonal variations and any evident longer-term trends?
- What potential impacts might the proposed development have on each of these receptors?
- How can each of these impacts be avoided or mitigated?

5.29 **Primary Question 7: What habitats, vegetation communities and species are present within the area, how are they inter-connected, and how could they be affected by the proposal?**

- What is the ecological zone of influence of the proposal, including foraging areas for BAP and other protected species, and including water-dependent ecosystems which could be affected by impacts on the water environment
- What ecological surveys are required? (See appendix A for further details of statutory and other requirements following this preliminary scoping stage).
- What are the baseline conditions for each of these habitats and species, including the

typical range of seasonal variations and any evident longer-term trends?

- What potential impacts might the proposed development have on each of these receptors?
- How can each of these impacts be avoided or mitigated?
- How can the proposed development ultimately enhance these and/or other sustainable priority habitats through reclamation, including re-establishing connections between previously fragmented habitats and wildlife corridors?

5.30 **Primary Question 8: What topographic and geodiversity features are present within the area, and how could they be affected by the proposal?**

- What are the characteristic landforms within the area and how do these relate to the wider landscape character?
- What active geomorphological processes are operating within the area?
- What geological exposures are present within the area and what is their significance?
- What potential adverse impacts might the proposed development have on each of these features?
- How can each of these impacts be avoided or mitigated?
- How can the proposed development enhance or add to the geodiversity interest of the area, including links with wider landscape and biodiversity features?

5.31 **Primary Question 9: what is the Historic Landscape Character of the proposed development site and its wider landscape setting?**

- What is its historic landscape character and is it sensitive to changes as a result of development?
- How has the historic landscape character changed over the centuries and are there opportunities for restoration or enhancement?

5.32 **Primary Question 10: Does the site sit within, adjacent to, or within the landscape setting of a designed landscape or registered Park and Garden?**

- How will the development impact on the site and its setting?
- Does the development affect the significance of the designed landscape?
- Can the landscape be protected through screening or other mitigation?
- Is there scope for restoration or enhancement?

5.33 **Primary Question 11: Is there a designated heritage asset or the setting of a heritage asset (such as a listed building or other structure) that could be affected by the development?**

- What is the significance of the asset and its setting?
- Will impacts be temporary or long-term?
- Is there a possibility of mitigation, including the wider landscape setting?
- Is there scope for restoration or enhancement of the setting?

5.34 **Primary question 12: How sensitive is the archaeological resource at the site or environs?**

- Are there waterlogged deposits within the development site or environs that could be affected by impacts on the water environment (particularly, but not only the effects of dewatering)?
- To what extent have the archaeological remains at the site and environs been impacted by earlier disturbance, such as ploughing or dewatering?
- To what extent could the identified heritage resource be affected by the proposed development, and can these impacts be mitigated by an adjustment of the proposed excavation or reclamation design or by recording?
- How will the proposed development affect the visual setting of the archaeological landscape, and any designated monuments within the wider landscape?
- What would be the cumulative effect of the proposal upon the wider archaeological landscape?

5.35 **Primary question 13: What archaeological remains will be directly or indirectly impacted by the mineral extraction?**

- What is the documented archaeological resource within the proposed development area and within the wider environs?
- How visible are archaeological remains within the environs of the proposed development and how is site visibility affected by the local soils and underlying geology. To what extent is the documented resource likely to correspond with the actual resource?
- How does the anthropogenic activity within the development relate to the wider man-made landscape, and how does the identified resource relate to the surrounding topography and geology? In particular, are there early archaeological deposits preserved beneath layers of fluvial sediment.
- How was the landscape formed over time and to what extent is the present day landscape a product of anthropogenic activity. What was the historic landscape at the time that the principal archaeological activity established?
- What is the actual archaeological resource within the proposed development area and within the wider environs?
- What is the condition of the archaeological remains?

- How might the above questions be answered? What is the appropriate archaeological evaluation strategy to use in the particular location? Would the production of a landscape model be a useful tool to aid understanding?

5.36 Primary question 14: What is the significance of the archaeological remains?

- How rare and significant are the identified remains within the development site and wider environs?
- How significant is that part of the archaeological landscape within the development footprint, by comparison with that of the wider landscape?
- Does the landscape at the site and wider environs reflect a palimpsest of different episodes of activity, and does the significance of the site reflect that the archaeology has developed over an extended period?

Variations relating to specific minerals or geographical areas

- 5.37 Unlike the recommendations detailed within chapters 6 to 11 of this report, those listed above, including the generic research questions, are applicable to all minerals and all geographical areas. As with the recommendations relating to spatial planning, differentiation will emerge from the answers to these questions, but the basic requirements are applicable to all areas.

6. Baseline Research and Monitoring

Introduction

- 6.1 In order to address the questions outlined in the previous chapter, and thereby provide adequate information to support the application and inform the Environmental Statement, there is a need for prospective applicants to carry out or commission a range of investigation and research, including baseline monitoring. General guidance on this is given below, followed by more detailed variations applicable to specific minerals and/or geographical areas.

General, Desk-based Preliminary Research

- 6.2 Pre-application research should draw initially on desk-based sources of information including (where relevant):
- published literature (the consolidated bibliography from this project provides a useful starting point),
 - mineral resource maps and supporting detailed geological maps from the British Geological Survey (BGS);
 - mineral resource assessment reports from the BGS and/or other sources, including in-house surveys by mineral operators;
 - landscape designations (including proximity to National Parks adjacent to North Yorkshire, and proximity to or location within Areas of Outstanding Natural Beauty or local landscape designations);
 - landscape character assessments at County or larger scales (where available), including in-house or commissioned local assessments;
 - Historic Landscape Characterisation (HLC) data;
 - Historic Environment Records (HER);
 - Historic Environment designations (Scheduled Ancient Monuments, Listed Buildings, Registered Parks and Gardens, Registered Battlefields, World Heritage Sites);
 - Natural Environment designations (Special Areas of Conservation, Special Protection Areas, Ramsar sites, Sites and Areas of Special Scientific Interest, National Nature Reserves, Ancient Woodlands, Local Nature Reserves, Sites of Importance for Nature Conservation, Local Geological Sites);
 - Phase I habitat survey and other ecological data held by the North and East Yorkshire Ecological Data Centre;

- The UK Biodiversity Action Plan and the Biodiversity Action Reporting System (BARS);
- Local biodiversity action plans (LBAPs) and company biodiversity action plans;
- Local geodiversity action plans (LGAPs) and company geodiversity action plans (cGAPs);

- 6.3 The foregoing list is intended as a guide rather than a prescriptive requirement, and is not exhaustive. Professional standards and guidance should be followed, for example that produced by the Institute for Archaeologists (<http://www.archaeologists.net/codes/ifa>) and English Heritage (<http://www.helm.org.uk/server/show/nav.19702>).
- 6.4 The integrated data compiled and created in the course of this Managing Landscape Change project, including the final report, individual Stage reports and the supporting digital archive, is also likely to be helpful in the initial stages of investigation.
- 6.5 As the assessment is narrowed down towards the selected application site, more detailed research methods will need to be deployed in order to obtain a sufficiently comprehensive understanding of the various aspects of the environment within and surrounding the application site, and the interactions between them. An iterative approach is therefore vital. Basic requirements are outlined below under each of the three main headings but emphasis needs to be placed, once again, on developing an integrated, holistic understanding, guided by pre-application discussions with NYCC and other relevant consultees.

Landscape Research

- 6.6 Information to support planning applications in relation to landscape character and visual context of a site is gathered using 3 methods: desk-based research; site assessment and consultation. With regard to pre-application information relating to landscape it is useful for a developer to understand what the term 'landscape' means. The first European Landscape Convention (ELC) brought representatives from Europe together to specifically discuss and promote landscape protection, management and planning, and European co-operation on landscape issues. Members at the ELC fostered the Council of Europe 2000 definition of landscape was as:

"An area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors."

- 6.7 This definition suggests that landscape character is based on present day appreciation and perceptions of the landscape. However, it is also important to understand how the landscape has been formed and used to reach its present day character as well being informed by present day uses and perceptions. Carrying out detailed landscape and visual assessments of the site and its environs will provide an understanding of what elements contribute to and create its character. This process of assessment and evaluation enables Chartered Landscape

Architects to make judgements about the quality of a landscape and its setting in order to inform landscape aspects of the planning process and the landscape design and management of the application site and its context.

- 6.8 Existing landscape character assessments are a useful starting point in understanding, but further research may be still be required - especially where no local and recent character assessment exists. The process of carrying out landscape and visual impact assessment is an iterative one; starting with information gathering (desk based research) to gain an initial understanding of how the landscape is perceived, it then moves into site assessment and consultation.

Desk-Based Research

- 6.9 This would typically include research into other existing landscape character studies of the area, namely the National Character Areas (NCA), The Countryside Agency and English Heritage 2005; North Yorkshire and York Landscape Characterisation Project, CBA 2011 and any other more localised assessments which cover the area of proposed operations. It would also involve research of all the landscape and environmental designations which cover the landscape.
- 6.10 At this stage of the project a map of the site and its context should be created in order to identify potential viewpoints from both within and outside the site boundary. The production of a Visual Envelope Map (VEM) or Zone of Visual Influence (ZVI) will aid site assessment work and can be refined on site. Aerial photographs of the area and a land ownership plan together with necessary permissions to access private land are also very useful for the site assessment.

Site Assessment

- 6.11 In order to identify landscape characteristics of the site in relation to the wider landscape, a landscape and visual assessment would be carried out by two Chartered Landscape Architects. It is always advisable to carry out assessments in pairs, not only because it is far more practical but also to ensure judgements are as objective as possible. The methodology for these assessments is set out in Landscape Character Assessment Guidance for England and Scotland, (Swanwick and Land Use Consultants, 2002). Landscape Character Assessments carried out as part of this study can be referenced in the Stage 2 report, Appendices.

Consultation

- 6.12 Consultation with the local community is now an important activity in the planning process. Early and continued consultation can identify and resolve issues which would not otherwise be identified through the desk top research and site assessment stages. The process of community engagement can lead to fewer or no objections once the planning application has been submitted.

Historic Environment Research

- 6.13 A number of investigative tools can be utilised in order to address the key historic environment research questions involved at the pre-application stage of the planning process. These are listed in Table 6.1 at the end of this chapter and described in greater detail in the appendix 1.
- 6.14 The various procedures need to be applied and combined in an iterative evaluation strategy to accord with the specific circumstances associated with individual proposed mineral extraction sites. They are intended to provide information that will help to inform the development and eventual determination of mineral planning applications. Further guidance on these pre-determination techniques, as well as on other techniques which are applicable during the post-determination (operational) and post operational phases of mineral extraction, is provided in the practice guide on Mineral Extraction and Archaeology (MHEF 2008).
- 6.15 The process of investigation is iterative, which develops from stage to stage. The procedures are initially desk-based and are intended to establish the existing data available for the application site. It is recognised, however, that further data will be necessary in order to gain a sufficient understanding of the potential and significance of the site and environs, and that this will require site investigations. The second stage of survey work is therefore intended to develop on from the desk-based information, but this stage is not intended to be intrusive and will not have a direct impact on any archaeological remains or the landscape. Subject to the results of the survey phase there is likely to be a requirement for intrusive investigations of the site, which typically will be an archaeological evaluation and would entail trial trenching to identify anthropogenic activity within the area of the development. The way in which the various techniques are applied depends upon the characteristics of the individual site, and recognises that certain techniques are more applicable than others in certain geological and topographic contexts (Hey & Lacey 2005). The choice of technique(s) will reflect issues raised by the Research Questions and earlier stages of investigation. Understanding the potential of any given site requires both informed interpretation, as well as the exercise of professional judgement. Two key themes of minerals planning are a coherent and consistent approach that engages stakeholders through all stages of the process, and a question-led targeted approach to archaeological work, with clearly defined research goals. The latter should prevent a 'one size fits all' approach to evaluation and provide a clear focus to ensure the correct techniques are applied to evaluate the potential of an area, rather than to sample it (Brightman & Waddington 2010).
- 6.16 All evaluation strategies should be carried out in accordance with a written scheme of investigation agreed with the local planning authority, in consultation with the NYCC Development Management Archaeologist and Regional Science Advisor at English Heritage, following professional standards and guidance (IFA 2008a and 2008b; English Heritage 2006, 2007 and 2008a; MHEF, 2008).

- 6.17 The starting point for historic environment research in relation to a proposed development is the Historic Environment Record (HER) for North Yorkshire. The HER is maintained by NYCC and is a record of heritage assets, including archaeological sites and excavations, historic landscapes, parks and gardens, buildings and other structures. There is a large amount of information and part of the HER information is available digitally. The remainder is held as maps, books, articles and reports.
- 6.18 The research carried out for this Managing Landscape Change project has used the HER data base to inform the conclusions on the sample study areas and this gives an indication of the range of material available. The Stage 2 and 3 reports from this project (including the Predictive Landscape Modelling report) have made reference to *archaeological potential*. Previous 'events', finds and excavations can identify the increased likelihood of similar or more extensive sites within that landscape or adjacent to it. In such an instance a range of investigation methods can be used. Where there are historic buildings and settlements on or close to the proposed site, additional building surveys may be required. Designed historic landscapes, parks and gardens and settings and vistas may require further assessment with regard to impacts, using a combination of landscape and archaeological techniques.
- 6.19 In some areas of the county the archaeological resource is well documented, because the soils and underlying geology are conducive to revealing cropmarks, which are visible from aerial photographs, and provide a valuable insight into the underlying remains. In other areas, particularly where poorly-drained soils are developed on glacial tills or glacio-lacustrine clays, crop marks are not so evident and techniques, such as magnetometry (geophysics) can also have limited success. This leaves an apparent gap within the documentary records (poor site visibility), but does not necessarily reflect an absence of early activity or remains. Where there is a potential for poor site visibility, as indicated by a paucity of known remains and/or the presence of poorly-drained clay soils, a more intensive staged exploratory strategy may be necessary in order to determine if the absence of documented heritage reflects an absence of archaeological remains or merely an absence of evidence for them. Different geophysical techniques, such as Ground Probing Radar (GPR) or resistivity, may be useful in some areas, but often there may be a need to undertake borehole surveys and/or intrusive evaluation trenching.
- 6.20 The aim of the overall investigative process is to minimise the impact of mineral extraction upon the archaeological resource, but when the proposed extraction areas are in the environs of a significant resource there can be considerable uncertainty as to whether underlying archaeological remains extends into the extraction areas. One approach, as seen in the example from Nosterfield referred to in paragraphs 5.10 *et seq.* in the previous chapter, is to develop a landscape model, which entails an assessment of the distribution of the documented archaeological resource in relation to the topography, hydrology and palaeo-environment. Such a model may be able to indicate those areas of the landscape that have the greatest and least potential for underlying remains, which can then be tested by a targeted programme of

evaluatory trial trenching. The process achieves a relatively high level of confidence for the definition of the resource and has the potential to enable the placement of extraction areas so as to minimise the impact on the heritage, despite being within the proximity of a rich resource.

Natural Environment Research & Baseline Monitoring

- 6.21 Research needed to inform the natural environment aspects of any proposal for mineral development relates primarily to the desk studies, field surveys, baseline monitoring and consultations that are needed to establish a good understanding of existing conditions.
- 6.22 This generally involves making (or acquiring, if they already exist) a sequence of observations over a period of time, in order to establish the existing range of variation in the parameters concerned (such as species populations, groundwater levels or water quality indicators). The work may also include 'one-off' surveys to establish the details of factors which are either static or which change only gradually (such as the distribution of notable landforms, geodiversity exposures or surface water features). In both cases, the essential purpose is to contribute to the development of a conceptual model of the local environment and, in particular, to characterise the baseline conditions against which subsequent changes can be compared.
- 6.23 Local record centres - in this area, the North and East Yorkshire Ecological Data Centre, in York, - provide a vital source of existing knowledge for relevant species and habitats within a specified radius around any given site.

Ecological Surveys

- 6.24 If a site does not have adequate existing data, an ecological survey will need to be carried out. In situations where a habitat is to be lost altogether as part of a proposed development, a comprehensive ecological survey will be required. If the proposed development is likely to have only a minor, short-term impact on the habitat within the development boundary, and if permanent or long-term effects on the habitats and wildlife within and beyond the site boundary can be avoided, then a more general habitat survey may suffice. Comprehensive guidance on the methodologies recommended for plant and animal groups is contained in the IEEM (2005) guidelines and is summarised within Appendix 1 of this report.
- 6.25 Baseline evaluation for ecology is complicated by the high mobility of many species and their dependence on the wider countryside rather than individual sites which happen to be proposed for development. Moreover, changes over time to the habitats and species present (or potentially present) can limit the period of validity of an ecological report. Where an ecological survey is more than a few years old, a new survey is likely to be needed, to validate or revise the original findings.

- 6.26 In carrying out an ecological survey, special attention will need to be given to statutory and non-statutory designated nature conservation sites (SACs, SPAs, Ramsar Sites, NNRS, SSSIs, ASSIs, Ancient Woodlands, LNRs and SINCs) and also to important ecological features, (habitats and species), which are identified in the UK, regional or local Biodiversity Action Plans (BAPs).
- 6.27 The initial scoping survey and report (Phase 1) usually involves a broad habitat survey, using the Phase 1 habitat survey guidelines (JNCC, 2010). This should identify the habitats present within the area of interest and the potential for particular species to be present within that area. For developments (including mineral extraction), which could have wide-reaching impacts, the area of interest should extend well beyond the boundaries of the proposed excavation. The Phase 1 survey map will usually be accompanied by target notes that identify and provide further information on habitat / wildlife features of particular value for individual species groups such as plants, fungi, lichens, mosses, mammals, amphibians, reptiles, fish and birds.
- 6.28 The Phase 1 ecological report will highlight designated sites and any potentially present protected species within or near to the site. The report should also provide relevant recommendations and mitigation measures to ensure that no protected species are harmed during the operational stage of the proposed development.
- 6.29 It may subsequently be necessary to conduct further, species-specific (Phase 2) surveys of the area of interest which target particular groups of plants and animals. This is to ensure that their presence is confirmed and to gauge species population numbers and potential receptor sites, if translocation measures are likely to be required. Phase 2 surveys need to be undertaken by qualified ecologists, holding appropriate licenses where required (e.g. for great crested newts, native white-clawed crayfish, otters, bats and kingfishers). The timing of these surveys is critical, as many plants and animals are not evident at certain times of year (and may also only be present during certain weather conditions), which limits the time when surveys can be conducted. Guidance on the timing of ecological surveys is given in the report by CIRIA (2004) and further details on species-specific surveys are provided within Appendix 1 of this report.

Biological and Water Environment Monitoring

- 6.30 Biotic parameters (flora and fauna) are important measures of ecosystem health. These biometrics include invertebrates, macrophytes, phytoplankton, protected species, habitats and fish. Invertebrate and macrophyte data can be analysed with physico-chemical parameters (i.e. water chemistry characteristics and physical parameters, such as altitude, geology and location) to provide quantified assessments of habitat and water quality. These assessments are undertaken using BMWP (Biological Monitoring Working Party) scores or, for more robust assessment, using RIVPACS¹⁰ (River Invertebrate Prediction and Classification System) for biotic

¹⁰ <http://www.ceh.ac.uk/sections/re/RIVPACS.html>

systems and PSYM¹¹ (Predictive SYstem for Multimetrics), the complementary equivalent for still waters in England and Wales. Phytoplankton analysis can be used to determine eutrophication levels of water bodies.

- 6.31 During the pre-operational stage, monitoring should ideally cover the widest area, and should include the largest number of parameters. In the case of the water environment, baseline monitoring will often be needed over a prolonged period of time (typically at least 1 year) in order to gain an adequate understanding of the processes involved, including the interactions between groundwater, surface water and water-dependent ecosystems, together with seasonal variations. This is a vital pre-requisite to the assessment of potential effects.
- 6.32 A longer period of baseline monitoring is generally desirable, in order to obtain some indication of variations from year to year. In practice, however, there is a limit to what is reasonable. This will be dependent on the type and scale of the proposed development and, more especially, on the likely significance of any adverse effects that this may have on sensitive receptors. In the case of a major new hard-rock quarry which is likely to continue for several decades, and which may have potentially serious impacts on important water resources or ecosystems, a baseline monitoring period of as much as five years may not be unreasonable (Thompson *et al.*, 2008). For much smaller quarry developments, such as short-term sand & gravel extraction or local building stone quarries operating above the water table, such a long period of baseline monitoring would generally be disproportionate, depending on local circumstances.
- 6.33 The amount of baseline monitoring required is also dependent on what information is already available in the vicinity. For a new development in an area where there has already been a number of similar developments, or where the proposal is for the extension to an existing site, there may already be enough information available to make a satisfactory assessment of the likely impact of the new proposal. If not, there may still be sufficient to justify a shorter period of baseline monitoring, perhaps in conjunction with some field investigations and testing. If a development is proposed in a totally new area, then a longer period of baseline monitoring is likely to be necessary.
- 6.34 In designing an appropriate monitoring scheme, consideration should always be given to cost effectiveness, e.g. by combining the requirements for groundwater level and groundwater quality measurements, for several different purposes (water resources, ecology and archaeology) in a single set of boreholes, rather than having several different monitoring networks for different purposes within the same area. Whilst this may involve the installation of more expensive individual wells, the number required will be reduced, as will the time and costs of obtaining monitoring data each month thereafter.

¹¹ brookes.ac.uk/pondaction/PSYM%20Manual%20May%202005.pdf

- 6.35 There will often be benefits to be gained from investigating existing sources of monitoring data and linking the new monitoring schemes into a wider network. This not only contributes to wider knowledge but it can help to differentiate the subsequent effects of quarrying from the general background trends associated with climatic and environmental change.
- 6.36 The information gathered from these various actions will feed into the development of a conceptual model for the site and its surrounding area. This will form the baseline against which any potential impacts then need to be assessed as part of the EIA process, and against which any actual impacts detected by operational monitoring will need to be judged.
- 6.37 Further information on hydrological, hydrogeological and biological monitoring is contained in the ALSF benchmark review on *“Reducing the Environmental Effect of Aggregate Quarrying on the Water Environment”* (Thompson & Howarth, 2008). This highlights important aspects of good practice and provides cross references to a much larger range of relevant research publications.
- 6.38 More general Practice Guidance relating to the implementation of the former PPS9 is set out in the accompanying practice guide: *Planning for Biodiversity and Geological Conservation: A Guide to Good Practice*¹², published by DCLG in March 2006. Reference should also be made to the *Practice Guide: Planning and Minerals*¹³, which accompanied MPS1. Together, these documents provide useful guidance regarding the issues which are relevant to the determination of planning applications and which therefore need to be considered and may need to be investigated during the development of proposals. Although the PPS9 and MPS1 policy statements have now been superseded by the National Planning Policy Framework (NPPF), the practice guides nevertheless provide much information and advice which remains valid.

RECOMMENDATIONS: Baseline Research & Monitoring

- 6.39 **In order to compile the detailed information needed to support the iterative development of a planning application for mineral extraction in North Yorkshire, based on an integrated understanding of the environment and landscape within and surrounding their proposed development, prospective applicants will need to undertake or commission a range of specialist research and baseline monitoring. The precise requirements will vary from one location to another but will be informed by the findings of initial desk-based assessments, including reference to the key environmental characteristics and special sensitivities identified in the Stage 3 report.**

¹² www.communities.gov.uk/documents/planningandbuilding/pdf/143792.pdf

¹³ www.communities.gov.uk/documents/planningandbuilding/pdf/153421.pdf

- 6.40 **The research needs to be carried out, in accordance with professional standards and guidance, by competent professional specialists who are able to judge what is required in order to deliver suitably robust and credible evidence at each iterative stage of developing the application and the accompanying Environmental Statement.**

Variations relating to specific minerals and/or geographical areas

- 6.41 Whilst most of the above techniques will be applicable in most areas, the detailed research and baseline monitoring requirements for any particular site or area will need to reflect the landscape and environmental characteristics of the locality involved. The information provided in the Stage 3 report offers a starting point for identifying the key issues which are likely to be of particular relevance in certain parts of each resource outcrop, and which may therefore need special attention, but it must be emphasised that those characteristics and sensitivities are neither limiting nor exclusive. In each case the research topics of particular significance will emerge from the initial desk-based assessments and from the development of a conceptual model which reflects the natural and historic environment and landscape character of the area involved.
- 6.42 There are, however, some general observations which can be made regarding differences in the likely importance of certain research techniques in different areas. In particular, some archaeological research techniques, such as aerial photography or GPR (Ground-Penetrating Radar) geophysics are likely to be of particular benefit in certain areas (though this does not preclude the use of other techniques in those areas). Similar generalisations can be made regarding the importance of certain hydrological and hydrogeological techniques in different topographic and geological settings; and certain ecological survey techniques in particular ecosystems; whilst other techniques, such as landscape character assessment, are designed to be standardised procedures applied to all areas.
- 6.43 Generalisations such as those mentioned above can, in some cases, be made in relation to the Land Categories identified in Table 4.2 and Figure 4.1 of the Stage 3 report. Where this is the case, relevant observations are made in the following sections.
- 6.44 With specific regard to archaeological research, Table 6.1, below, summarises the applicability of archaeological survey techniques to each of the Land Categories. Whilst some techniques (such as Desk Based Assessments and Evaluation Trenching) are applicable to all areas, others have limitations in certain types of types of deposit, depending on geology, soils, topography and age. This is indicated by the asterisks within the table. The table uses the terminology from the archaeology and minerals practice guide (MHEF, 2008), together with some additional measures, but arranges these in a sequence relevant to the development of an application (and subsequent stages of operation), rather than alphabetically. Further details of these and other techniques mentioned below are provided in Appendix 1.

Land Category	A	B	C	D	E	F	G	H	J	K	L	M	N	O
Technique	Floodplains	Gritstone Valley floodplains	Settled Industrial Valleys	River Terraces	Undulating lowland in Vale of York / Mowbray	Magnesian Limestone Ridge	Moorland Fringes	Vale of Pickering	Clay lowlands	Chalk Wolds and Broad Chalk Valley	Chalk Foothills and Narrow Chalk Valleys	Jurassic Limestone foothills	Pennine Moors & Fells	Wensleydale
Pre-application assessments														
Desk-based assessment	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Aerial photographic cropmark transcription				*	*	*		*		*	*	*		
Aerial photographic earthwork transcription and LiDAR	*	*	*		*	*	*			*	*	*	*	*
Archaeological walkover survey / detailed survey	*	*	*	*		*	*			*	*		*	*
Fieldwalking / artefact survey				*	*	*		*	*	*	*	*		
Geophysical survey: Magnetometry				*	*	*		*		*	*	*		
Geophysical survey: Ground-Penetrating Radar (GPR)					*				*				*	*
Geophysical survey: Resistivity					*								*	*
Geomorphology: landform mapping & sediment analysis	*	*	*	*	*				*					
Geomorphology: alluvium and clays					*				*					
Palaeoenvironmental analysis				*	*	*		*	*					
Topographic and Landscape characterisation model				*	*	*		*	*					
Evaluation trenching	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Test pits					*	*	*	*		*	*	*	*	*

Post-permission Design of Monitoring and Mitigation														
Strip, map and sample	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Excavation	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Detailed earthwork survey (Level 2-3 field investigations)							*		*	*	*		*	*
Watching brief	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Operational and post-operational phases (post fieldwork)														
Post-excavation, archive and dissemination	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Table 6.1: applicability of archaeological research techniques (MHEF, 2008) to land categories (as defined in Table 4.2 of the Stage 3 report)

Land Categories A-C (River floodplains, gritstone valley floodplains and settled industrial valleys)

- 6.45 A particular characteristic of the ASMRP 1 river floodplain deposits in all of these areas is that they have the potential for relatively recent fluvial deposition, which may overlie, at depth, earlier heritage assets. Examples from similar contexts in the flood plain of the Ribble in Lancashire have revealed waterlogged prehistoric canoes, artefact assemblages and human skeletal material at depths of up to 5m below surface (OA North and University of Liverpool 2006) which were preserved below layers of sediment deposited subsequent to the prehistoric period. There is though also a potential for a later, typically post-medieval, heritage resource above the aggregate deposits. This was demonstrated by the Stage 2 Surveys at Hunsingore (Stage 2 Technical Report Section 3.66) which for the most part had a direct relationship with the river. These included a corn mill driven by water from leats taking water off from the river, but also fords and bridges which enabled the crossing of communication lines over the river. This resource is considered to be fairly typical for ASMRP 1, and in particular with Category C, there is the potential for industrial processing sites that utilised water power. The strategy for identification of the heritage resource would need to recognise this potential.
- 6.46 In terms of wider heritage issues in Categories A-C, historic mapping provides an additional tool to be used in interpreting the post-medieval structures and land use that predominate as surface features. It can provide confirmation of site-based survey of water management features, the existence of older boundaries and administrative features, and the earliest historic mapping may in some cases reveal features that have since become buried beneath later alluvial deposits. Walk-over surveys, aerial photography and LiDAR can similarly reveal the post-medieval resource that would be evident on the surface.

- 6.47 Geomorphological mapping combined with sediment analysis of samples recovered from boreholes can help to determine the stratigraphy of alluvial deposits. When combined with dating techniques such as radiocarbon and OSL (Optically Stimulated Luminescence), this can be used to assess the potential for underlying archaeological deposits (OA North and University of Liverpool 2006).
- 6.48 With respect to the natural environment, research and monitoring techniques relating to rivers, streams and standing water bodies will have particular relevance in these Categories, including geomorphological surveys, river habitat surveys and various hydrological monitoring techniques, as detailed in Appendix 1.

Land Category D (River Terraces)

- 6.49 The river terrace sands and gravels of ASMRP 2 are well-drained and typically have good site visibility from aerial photography and LiDAR imagery, as seen in the sample area at Nunwick where there is a henge monument and wealth of prehistoric ceremonial / burial monuments revealed as crop marks (Stage 2 Technical Report Section 4.37). Magnetometry surveys may also be useful in revealing sub-surface resources.
- 6.50 However, there is also the potential for relatively recent terrace development to obscure earlier heritage features, so other investigative techniques such as geomorphological mapping, borehole sampling and sediment analysis may be needed to reveal the terrace stratigraphy and the potential for deeply buried assets.
- 6.51 Category D areas often incorporate a wealth of evidence relating to more recent historical land use including historical parkland and settlement. Such remains often survive on the surface and would benefit from walkover surveys and examination of LiDAR data.
- 6.52 Given that the river terraces have evolved during the course of human history, as explained within the Stage 2 Predictive Landscape Modelling report, there is particular benefit to be gained in these areas from developing a detailed model of the wider landscape surrounding the area of proposed extraction. As explained in the previous chapter (paragraphs 5.6 to 5.14), such models can bring together a wide range of relevant information and thereby assist with developing a sound, holistic understanding of the character, evolution and significance of the landscape and its archaeological potential.

Land Category E (Undulating lowland in the Vales of York & Mowbray)

- 6.53 The glacio-fluvial and glacial sands and gravels which dominate Category E across much of the Vale of York and Vale of Mowbray are typically well drained, with good site visibility (e.g. Stage 2 Technical Report Section 5.23), but there is nevertheless the potential for localised areas of poorer site visibility where the gravels are overlain by clayey 'flow till' deposits, especially within parts of ASMRP 4. Aerial photography and magnetometry geophysics can be less effective within these geological conditions. The survey of the Crakehall sample area (Stage 2 Technical Report Section 6.25) was significant in that it revealed extensive surface remains that

included areas of ridge and furrow associated with Crakehall village, but also a Bronze Age tumulus (Site 3030). Although the tumulus has been degraded by ploughing, the fact that any of it survives on the surface is an indication that the area has not been subject to recent intensive cultivation, although the ridge and furrow is an indication of historic cultivation which has the potential to have obscured remains. As the area presently has a pastoral land-use, this has restricted the identification of cropmarks.

- 6.54 Where there has been pastoral land-use, and/or where the sands and gravels are overlain by superficial flow till with relatively poor site visibility and poor drainage, the suggested exploratory techniques would put greatest emphasis upon recording the surface features by LiDAR, walkover surveys and potentially resistivity survey. However, where sands and gravels are present at the surface, there is the potential to use aerial photographic cropmark transcription and magnetometry survey techniques.
- 6.55 Given the mixture of different depositional environments within these areas and the resulting potential for highly variable site visibility, there are benefits to be gained from utilising the predictive landscape modelling approach (as described in paragraphs 5.6 to 5.14, above), so that information from a wider area can be brought together to inform understanding of any proposed extraction site and its environs.

Land Category F (Magnesian Limestone Ridge)

- 6.56 The applicability of archaeological techniques across the large expanse of the Magnesian Limestone ridge depends substantially on the extent to which superficial drift deposits (glacial tills, sands and gravels and / or alluvium) overlie the limestone. There are extensive crop marks in some areas and in others surface remains survive. The landscape has considerable diversity of character and has a significant heritage resource that dates back to the Neolithic (including the Thornborough henges, developed on overlying sand & gravel deposits), but also considerable numbers of Bronze Age funerary round barrows. The line of the ridge has been followed by the main north/south Roman road, largely coincident with the present A1, and there are considerable densities of settlements from the Roman and subsequent periods associated with that route corridor. Significant designed landscapes including the Fountains Abbey / Studley Royal parkland also occur within this area. The ASMRP 9 sample area study (Stage 2 Technical Report section 11.25) identified elements of the Ripon Park designed landscape, and parts of a medieval moated site associated with the village of North Leys.
- 6.57 Where the land is in pastoral use and/or where there are poorly-drained clay-rich soils at the surface, associated with glacial tills, then LiDAR and walk-over surveys are appropriate. Other areas of well-drained soils, underlain by sand & gravel or directly by limestone, have often been subject to intensive cultivation and, in these areas, aerial photographic transcription and magnetometry can both be effective. The topographic and landscape characterisation model approach that was used to address the very specific issues of variable site visibility around Thornborough is likely to be more widely applicable across other parts of the area.

- 6.58 Given that the Magnesian Limestone is a Principal Aquifer, used as an important source of groundwater resources for public and private water supplies and for ecosystems in the area, hydrological research and monitoring techniques will be of particular relevance throughout Category F.

Land Category G (Moorland Fringes)

- 6.59 Category G comprises for the most part land within the Craven Gap, which is both valley floor and upland margins, together with areas on the eastern flank of the Pennine uplands. In the Craven area, the land involved is almost all pasture land, and has not been subject to intensive cultivation within the recent past. The lower land was cultivated in the medieval periods and there are extensive remains of cultivation terraces and ridge and furrow that date back to this period. The areas on the eastern flank of the Pennines are also characterised predominantly by pastoral rather than arable farming. Given that the land has not, for the most part, been subject to recent cultivation, the investigative techniques in this category would favour the examination of surface features. Aerial photography, incorporating earthwork transcription, and analysis of LiDAR data would provide an initial indication of the heritage potential and the landscape would also benefit from a Level 1 walk-over survey (English Heritage 2007). There is the potential that resistivity geophysical survey techniques would also provide an indication of the sub-surface potential.

Land Category H (Vale of Pickering)

- 6.60 The undifferentiated sands and gravels of ASMRP 5 within the Vale of Pickering soils favour the formation of crop marks and afford excellent site visibility, but only by using a combination of different techniques including repeated aerial photography and intensive geophysics, as demonstrated in the sample area at Rillington and elsewhere (Stage 2 Technical Report Section 7.31). Investigations here have revealed extensive cropmark and geophysical evidence for Iron Age/Romano-British settlements, field-systems and burial sites (Powlesland, 2003, 275-291). The area has been subject to intensive cultivation over an extended period and so there is little or no surface expression to the monuments.
- 6.61 Repeated aerial photography can show crop marks which are temporarily revealed, by ploughing, although these same features are potentially vulnerable to destruction from further ploughing. Other parts of this area have reduced site visibility from crop mark evidence, not least in areas where former land surfaces have become buried beneath blown sand. Other applicable techniques would include magnetometry, and those areas that have localised poor site visibility would benefit from artefact surveys.
- 6.62 Hydrogeological (groundwater), as well as hydrological (surface water) research and monitoring techniques will be of particular importance in this area, not only in relation to waterlogged archaeological remains but also to the ecology of localised wetland habitats, including those which are being enhanced or re-established within the Vale of Pickering.

Land Category J (Clay Lowlands)

- 6.63 The Quaternary brick clay resources of ASMRP 6, along with some adjoining, low-lying parts of ASMRP 9 which also fall within this category, are characterised by poorly-drained soils. In these areas, techniques such as aerial photography and magnetometry are ineffective, as found at Monk Fryston (Stage 2 Technical Report Section 8.24) where there were no crop marks, and no identified heritage resource prior to the post-medieval period. It was recognised that the sample area has poor site visibility because of its clay soils. Only some techniques would be effective at revealing the heritage resource and would include artefact surveys to record underlying deposits disturbed by the plough. Most geophysical techniques, such as magnetometry and resistivity are likely to be of limited use on clay soils, but GPR can produce workable results.
- 6.64 As with Category H, the potential for waterlogged archaeological remains within some of these areas means that hydrogeological and hydrological research and monitoring techniques may be applicable.

Land Categories K and L (Chalk Landscapes)

- 6.65 The Cretaceous Chalk landscapes of the Yorkshire Wolds have, in the past, yielded a very rich archaeological resource, as reflected within the documented record and as found within and around the ASMRP 7 sample area (Stage 2 Technical Report Section 9.25). That area included the Duggleby Howe Neolithic barrow, set within a much wider ritual landscape incorporating a barrow cemetery and part of the Wold Entrenchments, which is a Late prehistoric (probably Bronze Age) boundary complex. There are also elements of Iron Age / Romano- British field systems revealed as crop marks. This resource is representative of that across the rest of the Wolds and overall reflects an extremely rich archaeological landscape. Historically many of the monuments were visible on the surface, and are well documented on nineteenth century mapping, but more recent intensive ploughing has degraded the remains and they are extant often only as crop marks.
- 6.66 Documentary work, from a Desk Based Assessment, would provide an insight into the landscapes prior to the plough damage and modern aerial photography can be effective at revealing former surface sites as crop marks (Stage 2 Technical Report Section 9.25). Magnetometry is also likely to be very effective. Earthworks can survive in areas that have not been too intensively ploughed and there is the potential that LiDAR and walk-over surveys can record the surface resource. While walk-over surveys will reveal the existence of the sites there is a need to implement more detailed earthwork surveys (Level 2 / 3 surveys (English Heritage 2007)) to understand the extent, character and significance of the resource
- 6.67 Given that the Chalk is a Principal Aquifer, used as a major source of groundwater resources for public and private water supplies and for ecosystems, hydrological research and monitoring techniques will be of particular relevance throughout these areas.

Land Category M (Jurassic Limestone Foothills)

- 6.68 The Jurassic limestone resources of ASMRP 8, directly to the north of the Vale of Pickering, have sustained deep ploughing in recent years, except on the steep, wooded slopes of the small valleys, and there is only patchy survival of surface remains. The sample survey north of Wrelton (Stage 2 Technical Report Section 10.21) revealed that there was a significant resource within the area including finds of prehistoric date, a burial cairn, and the line of a Roman road, but that this had been severely degraded within recent years as a result of intensive ploughing. There are though localised areas that have not been subject to the same level of cultivation and where there are still earthworks surviving.
- 6.69 Aerial photography and LiDAR surveys are effective for revealing heritage assets either as surface features in areas that have not been too heavily cultivated, or as cropmarks. Given the finds of prehistoric material brought up by the plough, artefact surveys would have the potential to reveal heritage assets.

Land Category N (Pennine Moors & Fells)

- 6.70 The Carboniferous sandstone of ASMRPs 12 and 13, and the Carboniferous Limestone resources of ASMRP 14 are typically exposed within these upland or marginal moors and fells that have historically not been subject to intensive arable agriculture and the heritage resource in these areas is for the most part exposed to some degree on the surface. Examples of monuments revealed during the Stage 2 surveys included a Bronze Age round cairn (Stage 2 Technical Report Section 12.26) and extensive rock art (Stage 2 Technical Report Section 13.27), but can also include earthwork remains of settlements and field systems. A notable example of one of these was an Iron Age hill top defensive enclosure identified within the sample area buffer zone. The heritage resource in these areas reflects a good survival of monuments that were peripheral to the main areas of settlement: burial monuments and rock art that were located on upland marginal areas remote from the farming land, and settlements that were only occupied in these upland areas where defensive needs or land pressure warranted them. Because they have been subject to low-intensity agricultural activity, the remains survive on the surface and there is accordingly good site visibility. The emphasis of any archaeological strategy is thus upon the recording the surface components.
- 6.71 The most appropriate techniques are aerial photography, looking for earthworks, LiDAR (where available), and walk-over surveys. While walk-over surveys will reveal the existence of the sites there is a need to implement more detailed earthwork surveys (Level 2 / 3 surveys (English Heritage 2007)) to understand the extent, character and significance of the resource.
- 6.72 Given that the Carboniferous Limestone is a Principal Aquifer, used as an important source of groundwater resources for public and private water supplies and for ecosystems in the area, hydrological research and monitoring techniques will be of particular relevance throughout the limestone outcrops within Category N.

Land Category O (Wensleydale)

- 6.73 This Category relates to part of the Carboniferous Limestone outcrop within Wensleydale. The likelihood of future quarrying proposals on the valley floor is considered to be very small, not least because of the much greater thickness of overburden which overlies the limestone. The land is almost all pasture land, and has not been subject to intensive cultivation within the recent past. The investigative techniques in this category would, for the most part, favour examination of surface features and would include aerial photography, looking for earthworks, LiDAR (where available), and walk-over surveys. While walk-over surveys will reveal the existence of the sites there is a need to implement more detailed earthwork surveys (Level 2 / 3 surveys (English Heritage 2007)) to understand the extent, character and significance of the resource.

7. Environmental Impact Assessment

Introduction

- 7.1 The assessment of likely significant effects, through the Environmental Impact Assessment (EIA) process, will usually be required in relation to planning applications for minerals development. EIA was introduced following the European Directive 85/337/EEC on the 'Assessment of the Effects of Certain Public and Private Projects on the Environment'. The amending Directive (97/11/EC) subsequently made the EIA process mandatory for all quarrying operations exceeding 25ha. EIA may also be required for smaller sites if the MPA considers that the proposal is likely to give rise to significant environmental effects. In England & Wales the requirements of both Directives are implemented through the *Town and Country Planning (Environmental Impact Assessment) Regulations 2011* (which has replaced the previous (1999) Regulations). CLG Circular 02/99¹⁴ provides guidance on the 1999 Regulations, and Guidance on EIA procedures was published in January 2000¹⁵.
- 7.2 The EIA process depends critically on understanding the existing environment and the many different ways in which the proposed development is likely to change it. This, in turn, depends on the activities likely to be involved (i.e. the **source** of the potential impacts); the processes and mechanisms (often referred to as **pathways**) by which those activities might affect various aspects of the environment; and the characteristics and sensitivities of the individual **receptors** within the environment. All three components of this 'source-pathway-receptor' model need to be understood in order for the EIA process to be effective. Moreover, as explained earlier, there needs to be an appreciation of the potential interactions between different types of effects, and of the secondary consequences that may be involved (for example damage to waterlogged archaeological features or water-dependent ecosystems as a consequence of changes to the local water table induced by quarrying).
- 7.3 A number of tools are available to bring this information together. Developing an integrated **conceptual model** of the wider landscape surrounding the proposed development (as outlined above) can greatly enhance the effectiveness of the EIA process. Equally, the use of an **ecosystems approach** and the recognition of individual **ecosystem services** (as described earlier) will provide a much better insight into the inter-relationships involved, and the development of a **long-term vision** will enable consideration to be given to the changing nature of those relationships over time.
- 7.4 Once the relevant information has been gathered, it is essential that the EIA process is carried out in parallel with, and as an integral part of, the design process (as detailed in the following

¹⁴ communities.gov.uk/documents/planningandbuilding/pdf/155958.pdf

¹⁵ communities.gov.uk/documents/planningandbuilding/pdf/157989.pdf

chapters. It is only by developing an initial, outline proposal that NYCC can provide the operator with screening and scoping opinions at the start of the process. Thereafter, the design of the excavation, methods of working, mitigation and monitoring strategies, reclamation plans and long term management regimes may need to be modified, in an iterative fashion, as the EIA process unfolds.

- 7.5 General information on the range of effects which need to be considered with respect to mineral extraction, including consequential and cumulative effects, is given in Chapter 6 of the Stage 3 report.

RECOMMENDATIONS: Environmental Impact Assessment

- 7.6 **In most cases, proposals for mineral extraction are likely to be subject to Environmental Impact Assessment (EIA) and, where this is the case, the information must be sufficient to support a comprehensive Environmental Statement.**
- 7.7 **The EIA should be based on a detailed, holistic understanding of the existing environment within and around the application site, prepared by competent experts through an integrated, multi-disciplinary approach, and supported by a strong evidence base.**

Variations relating to specific minerals and/or geographical areas

- 7.8 The basic scope and applicability of the EIA process will apply equally across all areas. However, the particular sensitivities identified in Tables 7.2 to 7.15 of the Stage 3 report, together with the general capacity indicators shown in Table 8.4 of that report, will help to refine the EIA scope in particular areas and to identify the likely areas in which detailed assessments will be required.
- 7.9 It is therefore recommended that NYCC should make use of the Stage 3 report to inform their screening and scoping opinions and to guide their requirements for pre-application information.

8. Quarry and Reclamation Design

General Principles and Design Concepts

- 8.1 Understanding of the landscape and environment, and of the potential impacts of the proposed development upon these, will inform the detailed design of both the extraction and reclamation¹⁶ phases of the intended development and in the suggested after-use of the site.
- 8.2 The reclamation of quarries has, in the past, sometimes been considered quite separately from, and subsequent to, the determination of applications for mineral extraction. However, given the emphasis in National planning policy for the creation of environmental benefits as an essential aspect of mineral development, and given that many of these can only be realised during the reclamation process, it is important to consider, at least in general terms, the likely strategy for reclamation at the time of the initial application for mineral extraction.
- 8.3 This echoes the more general advice in MPG7 which notes, in paragraph 36, that *“to enable the MPA to assess the appropriateness in landscaping terms of the final restored landform, and to identify opportunities for advance planting of vegetation, it is sensible to have, at least, a general outline of the final landform and intended after-use”*. As acknowledged in MPG7, however, it may not be appropriate to be too definitive at that stage, particularly in view of the potential impacts of climate change and of other land uses / development in adjoining areas, all of which may influence what may be achievable within a particular site in future years.
- 8.4 There is therefore a need for reclamation designs and after-use proposals to incorporate flexibility and for them to be amended, as necessary, during periodic reviews of the agreed planning conditions (as suggested in MPG7, para 36).
- 8.5 Traditional quarry design concepts have generally focused on optimising mineral recovery from a given area of planning permission (which is an important aspect of the efficient use of mineral resources). However, additional factors can also be considered in order to provide a much better overall balance of sustainability benefits. This goes beyond simply generating biodiversity, geodiversity and public amenity or commercial benefits at the reclamation and after-use stages: it incorporates the deliberate design of the excavation itself in such a way as to optimise those and other benefits and to avoid or mitigate any significant adverse impacts.
- 8.6 Examples include reducing the depth of mineral extraction within a given area in order to avoid excessive dewatering during the operational phase, and obtaining sufficient land around the proposed excavation to allow for the provision of shallow margins to areas of open water

¹⁶ **Reclamation**, as defined in MPG7 ‘*The Reclamation of Mineral Workings*’, includes both restoration and aftercare. **Restoration** comprises any work undertaken on completion of (or in parallel with) quarrying operations, which involve the placement of subsoils, topsoils or soil-making materials. **Aftercare** comprises any subsequent operations that involve bringing the land to the required standard for the intended subsequent use of the land.

reclamation and other forms of mitigation and enhancement that will be beneficial to biodiversity and allow the site to be better integrated into the landscape. This may, for example, allow operators to avoid the excessive use of steep, inaccessible rock faces in the final restoration design. Whilst there might be some situations in which maximum mineral recovery might take priority (e.g. where the mineral resource is particularly scarce and where environmental sensitivities are low), and whilst steep faces provide niche habitats for certain species as well as geodiversity exposures, there are many other situations in which a better overall balance can be reached through the use of more varied landforms.

- 8.7 Alternative designs which incorporate shallow margins to areas of open water, for example, are likely to encourage much greater biodiversity, including both aquatic and wet terrestrial habitats. Similarly, designs which allow key heritage assets to be retained in their existing landscape setting, with extraction being focussed on less critical areas nearby, may allow for a much better outcome for the historic environment. In such cases, the lessons learned from the recovery of archaeological evidence prior to and during excavation (as part of the mitigation works) can enhance the overall understanding and narrative relating to the main assets which are preserved. Planting schemes and other aspects of design can then be used to tell the story of how the landscape used to be, as evidenced by archaeological/ palaeo-environmental investigations.
- 8.8 Whilst it is beneficial to design with the final reclamation and after-use schemes in mind, it is also important to protect existing habitats and wildlife at and beyond the margins of the quarry throughout the operational stage. This may partly be accomplished by avoiding sensitive habitats in the location and detailed design of the excavation, or in some cases by retaining areas of habitat to act as refugia for certain species, but it may also need to include modification of extraction and related operations in certain areas, as part of a mitigation strategy (see below). In the same way, the wider cultural landscape, whether it be distinct archaeological monuments, a traditional farmed landscape or designed parkland, is part of the special distinct landscape character in which new working will be located and should be considered carefully within the quarry design process.
- 8.9 In terms of creating long-term ecological benefits, it may be advantageous to link design proposals in with company, local and/or national Biodiversity Action Plans. However, the emphasis should be on creating the most appropriate, and most sustainable, habitats for the site in question. Cripps *et al.* (2004) note that natural recolonisation of abandoned quarries often results in some of the best local biodiversity outcomes, even though this may not necessarily be the best contribution to BAP priority targets. Whilst BAP targets are important, and whilst quarry reclamation has the potential to deliver a very high proportion of these (Bradford & Deeming, 2010), an overriding requirement is to ensure that habitat creation is both suitable and sustainable, in terms of the environmental conditions available at the site. A self-sustaining solution which fits in with and contributes to the biodiversity and ecosystems that are already present within the surrounding landscape will generally be preferable to

creating isolated pockets of priority habitat which are out of place. This highlights the importance of developing a detailed, integrated understanding of the surrounding environment at the pre-application stage, and putting this information to good use in design.

- 8.10 The ALSF benchmark review on *“Creating Environmental Improvements through Biodiversity”* (Davies & Weir, 2008) also notes that, where habitat creation is the main focus of mineral reclamation schemes, the creation of large areas of the most suitable habitat is generally preferable to creating an intricate mosaic of different ones designed by landscape architects. It follows from this that other appropriate specialists (geomorphologists, ecologists, hydrologists, etc.) need to be intimately involved at the design stage, as well as landscape architects, so that the conditions created (in terms of slopes, aspect, landforms, soils and hydrology) are suitable for the intended habitats and species (and *vice-versa*). This will also allow the need for specialist supervision of the reclamation and long term management of the site to be recognised at the design stage.
- 8.11 Davies & Weir (*ibid.*) also advise that specific consideration should be given to the less obvious species, particularly invertebrates. Even where habitat creation is not the principal goal of a reclamation scheme, there will usually be scope for enhancing biodiversity on a smaller scale within other types of after-use, including agriculture, forestry and commercial or residential development.
- 8.12 In all cases, reference should be made to the detailed information and guidance available in publications such as the RSPB good practice guide on habitat creation (White & Gilbert 2003), the Nature after Minerals Website¹⁷ created by RSPB and Natural England, the related publication on how mineral site restoration can benefit people and wildlife (Davies, 2006), and to the advice available from organisations such as Buglife – for example its online information on managing priority habitats¹⁸. Other useful guidance can be found in the practical handbook on “Extracting the Best for Wildlife”, produced by West Sussex County Council (2005), and on the aggregates section of the Million Ponds Project website¹⁹.
- 8.13 The ALSF benchmark review on “Creating Environmental Improvements through Geodiversity” (Scott et al., 2008) provides a comprehensive overview of the concept of Geodiversity, and more detailed advice for quarry operators is provided in the publication: *“Geodiversity Action Plans for Aggregate Companies: A Guide to Good Practice”* (Thompson et al., 2006).

Ecosystems Approach

- 8.14 One way of developing ideas for more beneficial, imaginative design and the creation of environmental benefits is through the utilisation of an **‘Ecosystems Approach’**. In practice there are a number of different approaches which vary in detail, but the origins of this general

¹⁷ www.afterminerals.com/

¹⁸ www.buglife.org.uk/conservation/

¹⁹ [adviceonmanagingbaphabitats
pondconservation.org.uk/millionponds/aggregates](http://adviceonmanagingbaphabitatspondconservation.org.uk/millionponds/aggregates)

concept can be traced back to the 1992 Earth Summit in Rio de Janeiro. It is defined, under the Convention for Biological Diversity (CBD)²⁰ as: *“a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way.”*

- 8.15 An ecosystem, in this context, is defined by Defra (2007) as: *“a natural unit of living things (animals, including humans, plants and micro-organisms) and their physical environment. The living and non-living elements function together as an interdependent system.”*
- 8.16 The more general concept of ‘ecological planning’ can be traced back much earlier - notably in the work of Ian McHarg, a Landscape Architect from Glasgow who practiced in the United States from the 1960s until the end of the 20th century. His book *‘Design with Nature’*, first published in 1969, promoted his “ecological planning method” which identified geological features such as slope, drainage, bedrock characteristics, together with climatic and ecological factors for a given area of land, and used these to determine the type(s) of development most appropriate for that location. McHarg’s method also recognised historic value and allowed for other social values to be taken into account. This integrated approach to landscape design, working with natural elements with a view to achieving sustainable outcomes, is manifested in McHarg’s work. In the Potomac River Basin Project, USA, his design was considered to be the *“first study to combine the physiographic region and the river basin as the primary organising context for ecological planning and design – a framework that linked past, present and anticipated future actions”* (Whiston, 2000). His processes of site analysis and understanding of the environment also laid the foundations for today’s Geographic Information Systems.
- 8.17 Maltby (2000) suggested that ecosystem-based management involves defining a *“clear vision of future desired”* and developing a strategy for integrating and balancing environmental, social and economic factors.
- 8.18 Adopting an ecosystems approach in the modern context means looking at whole ecosystems during decision-making and valuing (or at least recognising) the **‘ecosystem services’** which they provide. These are the various aspects of an ecosystem which have value to people (Parliamentary Office of Science and Technology, 2007). These are not confined to ecological features; they include many different aspects of the ‘non-living’ environment, including landscape, heritage and culture. They can be grouped into four main categories:
- **Supporting services:** those which are necessary for the functioning of all other ecosystem services e.g. nutrient cycling, soil formation and photosynthesis;
 - **Regulating services:** benefits obtained from the regulation of natural processes e.g. climate regulation, flood regulation and water purification;
 - **Provisioning services:** the products (including those derived from both renewable and

²⁰ <http://cbd.int/ecosystem>

finite resources) that can be obtained from ecosystems e.g. food, fresh water, wood and fibre, fuel and minerals; and

- **Cultural services:** including non-material or intrinsic benefits e.g. educational and recreational opportunities, cultural heritage, tranquillity, sense of place, landscape aesthetics and spiritual values.

- 8.19 Once the ecosystem services within a given area have been understood, alternative designs for the intended development can then be examined and compared with each other to identify which is likely to provide the optimum combination of long-term benefits. This avoids the controversial issue of assigning specific, absolute values to individual services by focusing instead on relative values (it is much easier to assess whether one alternative provides more (or less) of a particular service than another one, than it is to assign absolute monetary values to each one). Once this has been done for a range of different services, comparisons between two or more alternatives can be made by developers, planning officers, elected members or any other stakeholders as part of the normal requirement for balancing the pros and cons of a particular scheme. In the case of mineral development this would include balancing mineral recovery with all other ecosystem services. Worked examples of this approach, including the comparison of alternative excavation and reclamation designs for several hard rock quarries in the Mendip Hills, are provided in the report by Thompson *et al.* (2010), and associated appendices.

Long-term Vision

- 8.20 Mineral extraction is a long-term process, whether associated with the ongoing deepening and lateral extension of a major hard rock quarry, and its eventual reclamation, or the successive phased development and 'rolling restoration' of sand & gravel resources within adjoining parts of a river valley. The landscape and environment are also dynamic, however, changing over time in response to a wide range of factors, including natural (geomorphological and biological) processes, climate change (and its influence on natural processes), ongoing development and land use (e.g. agriculture), and changes in land use and land management practices (including adaptation to climate change). All of this is part of the continuum of change which has shaped the existing landscape over many thousands of years, as explained in the Stage 2 'Predictive Landscape Modelling' report.
- 8.21 In seeking to manage landscape change there is an implicit acceptance that, where assessment has led to the in-principle decision that some mineral extraction may be acceptable, change will occur at a faster and more dramatic pace than that associated with natural processes. Nevertheless, there is a need to ensure that such change is kept within acceptable environmental limits by means of well-planned, sympathetic design and effective control and mitigation of impacts. There is therefore a need to consider how minerals development, including proposals for extraction, long-term reclamation and potential after-use, will impact upon the surrounding landscape and environment, both now and in the future.

- 8.22 In order to plan for sustainable development - i.e. that which does not compromise the needs of future generations, there is therefore a need for a long-term and sustainable vision, by both planners and developers. This vision will need to be developed for a specific site and its' setting in its geographical context and, where relevant, for existing or future extraction complexes where cumulative impacts and change are significant issues. The vision, in each case, should be informed by understanding and will need to include the consideration of effective mechanisms for long term management and legally binding commitments to ensure delivery.
- 8.23 Given the frequently-cited need by mineral operators to have long-term certainty in order to justify investment in efficient production and optimal mitigation methods, there are clear benefits to the industry in engaging with the planning authority and other relevant stakeholders (including local communities) in adopting a long-term approach based on a clear understanding of the nature of the land and landscape in which the proposed operations are intended to take place.
- 8.24 Although future climatic, environmental and land use changes cannot be predicted with any confidence over several decades, recent trends and medium-term predictions can be identified and taken into account. Moreover, consideration can be given to the concept of 'dynamic baseline monitoring', in which the actual impacts of mineral operations can be monitored against the observed background of other, ongoing, independent environmental change. This, in combination with some flexibility in reclamation design, would avoid the necessity for long-term reclamation schemes to be obliged to achieve outcomes which would no longer be achievable or sustainable as a consequence of background changes over which the operators have no control. This concept has been proposed within guidance relating to the control of impacts of surface mineral workings on the water environment (Thompson *et al.*, 2007, 2008) but, in principle, has much wider applicability to other aspects of the natural environment and land use change.
- 8.25 From an operator's perspective, the concept of a long-term vision need not be confined to the area adjoining an individual planning application: it could encompass adjoining resources which the operator may have longer-term interests in. Subject to appropriate mechanisms to preserve confidentialities and to maintain fair competition, the concept might also be extended to include the long-term plans of rival operators within a given area.
- 8.26 Where there is likely to be significant ongoing demand for mineral extraction in a particular area, for example because of the extent of available resources and proximity to markets, there would be benefits in NYCC working with industry to develop its own integrated long-term strategy to address the issue. This would allow decision-making to be fully informed about potential opportunities - not only for mineral extraction but also for mitigation, reclamation, habitat creation and after-use / long-term management within particular areas. This need not be part of the Minerals Core Strategy, since it is likely to extend beyond the term of the

Development Plan. Instead it could form one or more Supplementary Planning Documents within the overall MWDF, and kept under review. Strategies of this sort would be of particular benefit for areas of sand & gravel extraction within the Vale of York and the Swale and Ure valleys (where demand is strengthened by proximity to the A1(M) route corridor), and within the Vale of Pickering (where demand is lower but the sensitivities relating to the historic environment are exceptionally high).

- 8.27 Any long-term vision should also encompass the coordinated use of monitoring results, as detailed in the next section.

RECOMMENDATIONS: Quarry and Reclamation Design

- 8.28 The scheme design submitted with any planning application for mineral extraction should cover all aspects of the proposal, from preparatory works such as soil stripping and initial landscaping through to mineral extraction, restoration, aftercare, after-use and long-term management.
- 8.29 The design should be informed by a good, integrated understanding of the existing landscape, natural environment and historic environment surrounding the site and of the linkages between them, including an understanding of how the landscape has changed over time and how it is likely to change within the lifetime of the proposed development. This provides the context for the development of the extraction proposal and contributes to the development of a long term vision for the reclamation of the site.
- 8.30 Designs should incorporate preliminary reclamation plans, incorporating both restoration and aftercare proposals. These should be prepared in parallel with the excavation design as an integral part of the proposed scheme, and should be sufficiently detailed to demonstrate how benefits will be created, but should allow for some flexibility to accommodate changes in design that may be needed during the lifetime of the scheme, not least to allow for adaptation to climate change. Such changes would be subject to agreement during Periodic Reviews of any planning permission obtained.
- 8.31 Reclamation designs should aim to fit in with, and (as far as possible) enhance the natural environment, historic environment and the wider landscape in which the proposed extraction is intended to take place. The design, including that of the excavation itself, should seek to optimise the delivery of ecosystem services, balancing the economic benefits of mineral extraction with the wider benefits associated with other services. These may include benefits associated with the intended after-use of the site and those associated with off-site benefits (as may be achieved, for example by re-connecting previously fragmented habitats in adjoining areas). Consideration should also be given to cumulative effects where there would be two or more active or restored quarries in close proximity, seeking to

minimise the adverse impacts and optimise the environmental benefits through complementary design.

- 8.32 **It is crucial that, at the design stage, clear objectives are set out, long-term visions are developed and delivery and long-term management mechanisms are clearly established. This fundamental framework and the subsequent development of details, timescales and commitments for delivery will then be enshrined into a Section 106 Agreement.**
- 8.33 **The proposal should also show how the development would fit into a longer-term strategy for mineral extraction in the surrounding area, whether this is the operator's own internal strategy or one developed by (or in conjunction with) NYCC. This should include an indicative assessment of potential or likely cumulative effects.**
- 8.34 **NYCC, in turn, should consider developing integrated long-term strategies for minerals development within particular areas where there are likely to be high levels of ongoing demand and/or high levels of environmental sensitivity.**

Variations relating to specific minerals and/or geographical areas

- 8.35 Quarry and reclamation design will always be a site-specific matter, to which the foregoing generic principles and recommendations can be applied. However, there are also specific additional observations which can be made relating to individual types of minerals, types of landscape and types of natural and historic environment settings. Information relating to existing operations has already been given in Chapter 6 of the Stage 3 report. The following observations draw upon that material, and on the information relating to environmental character, sensitivities and capacity in Chapters 2, 4, 7 and 8 of that report, and relate specifically to the design of future mineral workings and reclamation schemes. They seek to encourage sympathetic designs which are appropriate for their location, in keeping with the general ethos of managing future landscape change.
- 8.36 The observations are presented for each of the Land Categories identified in Table 4.2 and Figure 4.1 of the Stage 3 report.

Land Categories A-C (River floodplains, gritstone valley floodplains and settled industrial valleys)

- 8.37 The ASMRP 1 sand & gravel resources in all three of these Categories are characterised by the fact that they exist largely below the water table within modern river floodplains. From a design perspective this dictates a need to consider both the practicalities of mineral extraction and the particular sensitivities associated with this environment. These issues include:
- the need for mineral extraction beneath the water table;
 - the need to protect and enhance existing floodplain habitats (both terrestrial and aquatic, including surface watercourses and riparian habitats);

- the potential need to protect waterlogged archaeological remains within adjoining areas;
- the need to deal with presently unknown archaeological remains concealed within the surface layers of alluvium and within or beneath the sub-alluvial gravels;
- the need to consider the impacts of excavations, stockpiles and landscaping bunds on the ability of the floodplain to store and convey flood water;
- the need to consider the setting of historic structures and villages in proximity to rivers; and
- the need to conserve and enhance the special landscape character of floodplain areas, including the potential cumulative effects of mineral extraction and open water reclamation schemes.

8.38 As explained more fully in Chapter 6 of the Stage 3 report, sand & gravel extraction beneath the water table can be undertaken in dry conditions, with the aid of pumped dewatering schemes which lower the local water table; or by 'wet working', where material is dredged from the sides and bed of an expanding area of open water. The latter system leaves the water table largely undisturbed, but is a less efficient means of extraction and precludes the careful *in-situ* examination of any buried archaeological remains which might otherwise be discovered. Dewatering, on the other hand, can have an irreversible damaging effect on waterlogged remains within adjoining areas, as well as on surface water features, aquifer storage and water-dependent habitats and ecosystems. These adverse effects can often be controlled through the use of best practice mitigation techniques (see Thompson *et al.*, 2008). However, depending on local circumstances, wet working may be the preferred approach, or a decision might be made that none of the available design options would be able to provide adequate protection of the natural and/or historic environment. The choice will always be site-specific, informed by detailed analysis and balanced judgement and will need to take into account other relevant factors such as potential permanent loss of agricultural land.

8.39 The issue of flood risk may be equally serious and contentious. The Environment Agency will expect to see a very detailed flood risk assessment applied to the design of any development which takes place in the floodplain, including mineral extraction and reclamation schemes. Aspects of the design which obstruct or divert the conveyance of floodwater, or which reduce floodplain storage capacity are likely to give rise to objections from the Agency, although short-term impacts are more likely to be acceptable than those associated with permanent development, subject to detailed design and modelling of impacts. Longer-term impacts, such as those associated with mineral reclamation, will often give rise to stronger objections, and the designs of these should therefore aim to have a neutral impact on flood risk (taking account of any increase in flood storage that may be provided by the quarry void - though this will often be very limited for floodplain excavations, once these have filled with water).

- 8.40 Mineral working in sensitive floodplain landscapes present significant challenges in terms of both landscape and biodiversity. There is a particular need to avoid the transformation of existing land into large expanses of deep, open water which have limited ecological value and which are discordant with the present landscape. This applies not only to existing floodplains, but also to areas where there is (or has been) additional mineral extraction in adjoining landscapes - particularly the river terraces of Category D (see below). In such areas, cumulative impacts will need to be carefully considered in relation to both the location and detailed design of any new proposals.
- 8.41 Alternatives to open water reclamation can be achieved, however, particularly where shallow margins are created as part of the design and where adjoining land beyond the excavation is incorporated into the design. Such schemes may include the re-creation of formerly extensive floodplain habitats (such as wet woodland, carr, marsh, fen, species-rich wet grassland and reedbed) and may be able to contribute to the re-establishment of connections between previously fragmented habitats. There is considerable scope for such schemes to contribute positively to existing biodiversity and 'green infrastructure' initiatives.

Land Category D (River Terraces)

- 8.42 Many of the design issues outlined above will also apply to the river terrace deposits of ASMRP 2, especially regarding dewatering and cumulative effects. Cumulative effects are more likely to occur here than in the river floodplains because the resources are generally more extensive and have already been widely exploited - especially in certain parts of the Swale and Ure valleys (as noted in Chapter 8 of the Stage 3 report). Those specific areas clearly have reduced capacity for further extraction, but this does not apply to the same extent elsewhere. Where extraction is proposed in new areas, and especially where this extends beneath the water table, it will be important to anticipate future cumulative issues and to allow for this by producing designs which limit the area of open water on final reclamation. This can be achieved, for example, through the greater use of shallow margins, indented shorelines, islands and fringing reed margins to soften outlines and to create additional biodiversity gains. As with Categories A-C above, much greater mitigation can be achieved where adjoining land beyond the margins of the excavation is incorporated into the reclamation scheme, allowing for a much greater surface area of terrestrial wetland habitats to be created around the margins of any new lakes.
- 8.43 The dewatering issue is similar to that described for Categories A-C, especially where the zone of influence will extend into adjoining floodplain areas. The likelihood of waterlogged archaeological remains within Category D is much less than within the floodplains, but may still need to be addressed. The terrace gravels are, however, likely to be important as aquifers - especially (but not only) where they directly overlie principal aquifers such as the Magnesian Limestone of ASMRP 9 or the Carboniferous Limestone of ASMRP 14 - and this may dictate a need to avoid (or at least control) dewatering in some areas.

- 8.44 Subject to the avoidance of cumulative impacts, mineral extraction in Category D sites which are directly adjacent to river floodplains offers potential for increasing flood storage capacity (and increasing floodplain habitats) through lateral expansion of the floodplain. Such schemes are likely to be far more effective, in terms of flood storage, than excavations within the existing floodplain. Elsewhere, if extraction within Category D does not extend below the water table, the reclamation design may need to consider a much wider range of options including reversion to agricultural land, terrestrial habitat creation (such as lowland meadows, lowland dry acid grassland, lowland mixed deciduous woodland or lowland heath), and, *where appropriate*, the possibility of commercial or industrial built development.

Land Category E (Undulating lowlands in the Vales of York & Mowbray)

- 8.45 Quarrying at an appropriate scale within the various mineral resources in this area (primarily ASMRPs 3 and 4) may provide opportunities for creating locally distinctive landscapes and enhancing biodiversity within an otherwise large expanse of pleasant but unremarkable, gently undulating terrain that is currently dominated by arable farming. The Vale Farmland generally retains its historic landscape character of hedgerows and hedgerow trees, small settlements and scattered farm houses, and certain areas (notably Aldborough and Catterick) contain important heritage assets. But there are also areas where the hedgerows are degraded, the landscape is dominated by large, modern improved fields, heritage resources have been degraded by intensive ploughing, and semi-natural habitats are either absent or highly fragmented. It is these areas, in particular, where there may be scope for future mineral extraction to make positive contributions to the landscape, historical environment and nature conservation through good design. As always, such design needs to be informed by detailed research so that habitat creation (for example) reflects the remnant habitats within the area concerned.

Land Category F (Magnesian Limestone Ridge)

- 8.46 For the sand & gravel resources of ASMRPs 3 and 4 which are sometimes found at the surface in this area, overlying the Magnesian Limestone resources of ASMRP 9, similar observations and design principles to those described above will generally apply. Additional considerations also need to be taken into account, however, in recognition of the very high archaeological potential which exists in parts of this area - notably the Thornborough Henges, associated parts of the ritual Neolithic landscape which extends throughout much of this area, and the additional heritage assets associated with the A1 route corridor. Quite apart from the additional requirements for investigation which these factors justify, there is likely to be much greater necessity in these areas for detailed quarry design to reflect the archaeological potential of the area concerned - avoiding the most significant sites and preserving their settings.
- 8.47 Additional considerations will also apply where the gravels are in direct contact with the underlying limestone. In such cases they may effectively form an extension of the principal

Magnesian Limestone aquifer, and may thus be subject to similar constraints regarding water abstraction for dewatering purposes (where this is necessary).

- 8.48 Where limestone is extracted below the water table, depth restrictions or dewatering restrictions might need to be applied in order to protect and conserve groundwater resources. Whilst a number of mitigation solutions can be applied to control dewatering impacts (Thompson *et al.*, 2008, *ibid*), there is usually much more uncertainty in the case of limestone aquifers, than is the case with sand & gravel, and depth restrictions might therefore be the best manifestation of the precautionary principle in these areas. As always, however, the details will be site-specific and designs will need to be informed by comprehensive baseline monitoring data and impact assessments for the site in question.
- 8.49 The reclamation of mineral sites in Category F will often provide opportunities for the creation of new habitats, including species-rich calcareous grassland, calcareous scrub, rock outcrop and scree habitats and mixed ash or beech woodlands.
- 8.50 More imaginative designs could be also considered, including the creation of new limestone gorges to replicate the natural landforms seen in parts of the Magnesian Limestone outcrop, with exposed crags, scree slopes and hanging woodlands. Such initiatives would be difficult to create within a single quarry, but could be generated as part of a sequential, long-term vision to create a linear feature through successive adjoining phases of mineral extraction. Additional benefits could be derived from the creation of safe access to features of geodiversity interest and interpretation of these exposures in the context of the surrounding geology and landscape, including links with the extensive use of the Magnesian Limestone in vernacular architecture, stone walls, as well as in major historic buildings (such as York Minster and Ripon Minster) elsewhere in the County.
- 8.51 Where the landowner requires the land to be returned to a profitable after-use, reversion to agriculture may need to be considered. This option will only be feasible where the extraction is limited to above the water table, and where sufficient overburden is available to create suitable terrain and substrates for agriculture. However, such end uses are unlikely to generate as wide a range of ecosystem service benefits as those relating to nature conservation.

Land Category G (Moorland Fringes)

- 8.52 These various mineral resources are linked by the fact that they occur at the fringes of upland areas, but in a range of different landscape types (Moors Fringe, Drumlin Valleys and Rolling Upland Farmland). Landforms are varied but often prominent and distinctive. Design concepts will therefore need to reflect the particular topography and character of the specific area concerned. These areas also tend to contain a greater density of remnant semi-natural habitats than is the case for the more intensively farmed lowlands. This increases the importance of avoiding biodiversity impacts through careful site selection, informed by

comprehensive research and surveys. It also provides opportunities for enhancing biodiversity and reconnecting fragmented habitats and wildlife corridors through well-designed reclamation schemes. Particular opportunities for priority habitat creation in these areas may include upland heathland, upland flushes, fens and swamps, purple moor grass and rush pastures, lowland raised bog, upland hay meadows, and various types of woodland.

Land Category H (Vale of Pickering)

- 8.53 In this area, at the margins of the Vale of Pickering, the capacity for future mineral extraction is limited (in particular) by the very high level of archaeological potential. However, where proposals are brought forward, the emphasis in terms of design should be on capturing detailed archaeological information within the site; minimising archaeological impacts in adjoining areas (especially through the control of dewatering); and maximising the potential for reclamation schemes to contribute to (or stimulate) other biodiversity initiatives.
- 8.54 Where extraction extends below the water table, as would be likely in most if not all areas, areas of open water would, almost inevitably, be a significant feature of any practical restoration scheme. Through the application of modern good practice techniques, however, such schemes could be designed to create a much greater range of benefits, in terms of ecosystem services, than might otherwise be the case. Extensive use of broad, shallow margins, deeply-indented shorelines and low islands would provide opportunities to re-create the kind of wetland habitats which once existed in these areas prior to the intensive drainage of the land for agriculture from medieval times onwards (see the Stage 2 Predictive Landscape Modelling report, paragraphs 3.76 to 3.83, and the Stage 3 report, paragraphs 2.123 and 2.124). Such schemes could be linked in with other biodiversity enhancement initiatives which are already taking place in some areas, with similar objectives.
- 8.55 For reclamation designs to achieve optimum benefits in this area, in terms of landscape, ecology and the historic environment, it may be advantageous for operators to be encouraged to seek planning permission for a larger area than that required for extraction, so that a broad marginal area can be utilised to create a gradual transition from the surrounding agricultural landscape through new, marginal wetlands (e.g. a mixture of lowland fens, wet woodlands, grazing marsh and ponds), to reedbeds and open water. Compared with traditional approaches of creating simple open water bodies screened by narrow incongruous plantations it would be far more beneficial to the natural environment. It could also be of considerable benefit in terms of the historic environment: in the marginal areas, only the surface layers (above the water table) would be disturbed, enabling both the investigation (e.g. by geophysics) and *in-situ* preservation of underlying, waterlogged heritage assets.

Land Category J (Clay lowlands)

- 8.56 The extraction of brick clay from the Quaternary glacio-lacustrine deposits in these areas has traditionally been a small-scale and very localised industry, as exemplified by the York

Handmade Brick Company, currently based at Alne near Easingwold. Any proposals for future extraction, however, whether on a large or small scale would need to incorporate design features which minimise operational impacts and maximise opportunities for beneficial reclamation. Many of the observations made above for Category H could apply to Category J as well, including the deliberate re-creation of marginal wetland habitats and making most of the opportunities to learn more about the past. As noted in the Stage 3 report (paragraphs 2.139, 2.140 and Table 2.6), existing knowledge of the archaeological potential of ASMRP 6 deposits is hampered by poor site visibility but also by the absence of previous detailed research in these areas. Any future proposal for extraction would therefore provide opportunities to gain a much better insight into the true potential of these areas.

Land Categories K and L (Chalk Landscapes)

- 8.57 The chalk Wolds of ASMRP 7 contain many old quarries that are now valued as protected wildlife habitats and/or geodiversity exposures. Although further chalk extraction within these areas is likely to be limited by distance from markets, any future extraction which does take place will need to respect the special landscape characteristics of the area; the very high level of archaeological potential; and the opportunities for reverting intensively managed arable land back to semi-natural calcareous grassland. Where extraction is required, emphasis should be placed on avoiding impacts on the characteristic open, extensive skyline; optimising the opportunities for creating smooth, gently rounded slopes which fit in with the surrounding landscape; and, in particular, to creating (replicating) 'narrow chalk valley' landscapes (as in LCT 21) within the broader landscapes of LCTs 18 and 20. Such landscapes would diversify the general topography, but in a harmonious way, and would create steeper slopes as ideal chalk grassland habitats.

Land Category M (Jurassic Limestone Foothills)

- 8.58 The ASMRP 8 Jurassic Limestone resources within these areas, provides both traditional building stone and general-purpose aggregates. There are numerous small former quarrying sites where building stone was extracted for local construction of buildings and walls. This has contributed significantly to the area's character and sensitivity. Combined with the high landscape quality, distinctive built environment, diverse ecological character and limited resource outcrops, this would suggest that the design of any further extraction site would need to be sympathetic to these aspects of the landscape and limited to small-scale extraction.

Land Category N (Pennine Moors & Fells)

- 8.59 Within these areas, crushed rock aggregates and building stone extraction are generally above the water table but have the potential for greater visual and noise impacts compared with lower-lying areas. Where crushed rock aggregate is the end product there will also be crushing and screening plant on site, and there may also be concrete batching and asphalt coating plants. Potential impacts associated with all of these features will need to be taken into account in the design of any future quarrying operations. Where screening bunds and off-site

planting are used to reduce noise and visually screen plant and exposed workings, these need to be designed in such a way as to blend in with the surrounding landscape character; replicating and strengthening existing landforms and established, localised plant communities, as far as possible. Where this cannot easily be achieved, perhaps due to land ownership issues or adjacent planning designations, there may be merits in designing screens as temporary features; to be removed or modified once the quarry itself is deep enough to contain the plant area and once restoration of the uppermost benches has been carried out so as to limit visual impacts.

- 8.60 Consideration also needs to be given to the long-term reclamation plan, however, including the design of the excavation itself in such a way as to optimise the potential for creating landforms and vegetation patterns which are harmonious with the wider landscape. The observations made above with respect to the design and reclamation of Magnesian Limestone quarries (paragraphs 8.48 *et seq.*) may also be applicable here - especially in the case of Carboniferous Limestone quarries. The Carboniferous Limestone is much harder than the younger Magnesian Limestone and characteristically gives rise to bold limestone scars separated by partially vegetated scree slopes colonised by calcareous grassland and/or deciduous woodland, and diversified by steep-sided gulley's and caves. All of these features are easily capable of replication within limestone quarries, but will only begin to blend in with the existing landscape if the quarry itself is shaped accordingly - with irregular rather than box-like outlines, and with transitional features at the margins which allow the slopes to grade into those on adjoining land. As in Category F, additional benefits can be derived from the creation of safe access to features of geodiversity interest and interpretation of these exposures in the context of the surrounding geology and landscape.
- 8.61 In the case of sandstone quarries - which are more likely to be used for building stone than for aggregates - the excavations are typically much smaller, and the adjoining landscapes generally have scattered small outcrops of sandstone, including many small disused quarries which have partially become vegetated through natural colonisation, rather than major cliffs and scars. In such areas, reclamation designs can aim to create similar landforms and landscapes by using overburden to soften the outline of exposed quarry faces (e.g. buttressing the lower slopes with an irregular concave 'apron' of material) and allowing natural regeneration to provide most if not all of the vegetation cover. Once again, features of geodiversity interest can be created and interpreted in relation to geology, landscape and the past use of building stone. These could also be linked to other heritage aspects of the landscape, including rock art exposed on existing natural and man-made outcrops.

Land Category O (Wensleydale)

- 8.62 This Category relates to part of the Carboniferous Limestone outcrop within Wensleydale. As noted earlier, the likelihood of future quarrying proposals on the valley floor is considered to be very small, not least because of the much greater thickness of overburden which overlies

the limestone. Where extraction is proposed on the adjoining valley sides, similar design concepts to those outlined in paragraph 8.60, above, would generally be applicable.

9. Design of Monitoring, Mitigation and Compensation Strategies

Introduction

- 9.1 Throughout the operational stage of mineral development, and continuing into and beyond the final reclamation stage, there will be a need for detailed monitoring of potential impacts and of the effectiveness (or otherwise) of the planned mitigation works. Strategies for both monitoring and mitigation, as well as any compensation works that may be necessary to justify planning permission being granted, need to be developed at the pre-application stage, as an integral part of the design and EIA processes relating to the planning application.
- 9.2 Monitoring results may need to be linked in to the implementation of particular mitigation requirements, through the use of thresholds or trigger levels. Further details and corresponding recommendations are set out in each of the following sections.

Design of Operational Monitoring Strategies

- 9.3 Mineral working is different to most other forms of development in that it is an ongoing process which continues throughout the lifetime of the planning permission. In most, but not all cases, the potential impacts of a quarry on the surrounding environment progressively change during this period, as the excavation is gradually enlarged or deepened. In the case of hard rock quarries, especially, the quarrying process may continue for many decades, through successive planning permissions. On such a timescale, other land use, environmental and climatic changes are likely to take place within the surrounding area, and there are also likely to be changes in the level of understanding and awareness of environmental issues, matched by changes in legislation relating to the control of potential impacts.
- 9.4 For all of these reasons, the control of impacts cannot rely solely on the assessment of original design proposals, or even on the periodic review of planning conditions at fifteen year intervals, as required under the Environment Act 1995. Ongoing monitoring is needed to ensure that the actual impacts of quarrying and the performance of mitigation measures are properly recorded and that further actions can be taken to control or reverse those impacts if the need arises. In most cases, it is only by securing such requirements through planning conditions and/or 'Section 106' legal agreements that planning permission for quarrying can be justified.

- 9.5 Operational monitoring is quite separate from the periodic monitoring of compliance with planning conditions that is carried out by North Yorkshire County Council as the Mineral Planning Authority.
- 9.6 In most cases, operational monitoring needs to serve a number of different purposes simultaneously. These are likely to include:
- to inform the ongoing continual improvement or refinement of the conceptual model of the surrounding environment (and of computer models, where used), throughout the lifetime of the operations;
 - to predict and keep track of evolving baseline conditions (e.g. in response to climate change) against which the effects of mineral operations should be judged;
 - to assess whether or not progressive changes brought about by quarrying activities are having an adverse effect on the environment;
 - to distinguish potential and actual impacts attributable to mineral operations from those of other development and land uses in the surrounding area, and to provide supporting evidence;
 - to trigger (when necessary) the appropriate stages of a mitigation strategy in response to observed changes in the environment; and
 - (more generally) to gather the monitoring data required for compliance with planning conditions, legal agreements and any operational licences that may be required (e.g. abstraction licences, discharge consents or environmental permits).
- 9.7 It is essential that, when a monitoring programme is designed, it includes a programme for data processing and regular reporting by suitably qualified experts. The collection of monitoring data is of little value if it is not assessed immediately for significant anomalies, which may be due to errors in sampling, recording or in the laboratory, or may represent a genuine environmental change.
- 9.8 The coordinated use of monitoring results, including records of the success (or otherwise) of mitigation and reclamation schemes, can help to inform future development proposals. The operational and post-operational monitoring results from one development can usefully contribute to the baseline monitoring of a subsequent proposal in the same general area, and can also contribute to the assessment of long-term trends in such things as hydrology, groundwater and ecology, ensuring that enhanced knowledge is fed into future decision-making.
- 9.9 Monitoring the impacts of development (including reclamation), as well as any necessary mitigation measures is also crucial to understanding the overall, long-term impacts of minerals development. For example, the restoration of natural and designed landscapes should be reassessed and their success or issues raised should provide understanding of future projects.

The development proposal should be viewed as a learning process - a consideration of how knowledge of the history of that landscape has been increased after the event as compared to before it, and how public benefit can be delivered. From a biodiversity perspective, for example, this will entail considerations of how the site will function within the landscape in the longer term with regard to habitat connectivity, using source-pathway-receptor models. Many of the larger mineral operators produce a restoration audit at the end of a project and hold data about the implementation of the reclamation scheme. Access to this kind of data could be gathered by NYCC as part of its role in maintaining an overview of mineral operations within the County and developing a wider awareness of desirable outcomes.

RECOMMENDATIONS: Monitoring Design

- 9.10 **A scheme of monitoring needs to be put forward by the applicant at the time of submitting a planning application. It is important that the scheme is specific to the site in question and that standard conditions are avoided.**
- 9.11 **In general, the following basic principles should be followed:**
- **The objectives of the monitoring plan should be defined before the start of mineral operations;**
 - **The design should be based on the best conceptual understanding at that time;**
 - **Allowance should be made for the plan to change (e.g. reduction in monitoring points or frequency) as understanding is improved with new information over time;**
 - **The design (monitoring point location, data parameters and frequency of collection) should be risk based (i.e. targeted, fit-for-purpose monitoring rather than precautionary blanket monitoring);**
 - **The function of each monitoring point and type of data collected should be clearly defined;**
 - **Quality control measures should be incorporated into the monitoring plan, together with regular calibration of all monitoring instrumentation (e.g. automated data loggers, *in-situ* water quality monitoring equipment); and**
 - **Monitoring data should be reviewed, interpreted and reported on by a competent person, on a regular basis (e.g. monthly or quarterly, as appropriate) to identify any trends or breaches in trigger levels.**
- 9.12 **NYCC should encourage and facilitate the sharing and coordinated use of monitoring data, including records of the success or otherwise of mitigation and reclamation schemes, so as to enhance future development proposals and decision-making.**

- 9.13 **An overview of minerals consents over the past 30 years should include an examination of the original reclamation plan and the outcome, including current condition. This will then inform future minerals-related landscape restoration projects and assist in the process of managing landscape change.**

Design of Mitigation Strategies

- 9.14 As noted earlier, current guidance promotes a sequential approach of avoiding impacts, mitigating impacts and compensating for any remaining impacts, where appropriate. Where impacts cannot be avoided, through spatial planning and/or good design, they need to be mitigated, as far as possible, before consideration is given to the issue of compensation.
- 9.15 Mitigation needs to be considered as an integral part of both the design and EIA processes, so that its effectiveness can be optimised. In particular, it is important to understand the significance of environmental and landscape assets, and the degree of potential impact of a proposal upon that significance before deciding how to proceed with mitigation. It is also important to consider a wider context than simply the effects on the site and close environs, and to consider landscape-scale mitigation strategies where there are likely to be cumulative effects. Where a large area of the landscape has already been affected by similar development and mitigation strategies for each site have been developed independently, opportunity to develop integrated and holistic mitigation strategies will exist. Such strategies could include an overall approach to enhancing landscape character, biodiversity and habitat development, infrastructure and access and interpretation of the heritage value of an area.
- 9.16 Whilst many impacts can be dealt with through well-designed and properly implemented mitigation measures, this is not always the case. Prospective developers therefore need to understand that there will be some situations in which no amount of mitigation will be able to overcome the potential impacts or concerns that are identified during the EIA process or by objectors. In such cases, unless adequate compensation is appropriate and can be agreed (see below), or unless there is a need for mineral extraction which overrides these concerns, planning permission is likely to be refused.
- 9.17 In the case of heritage assets, which cannot be replaced, where the loss of the whole or a material part of a heritage asset's significance is justified, local planning authorities should require the developer to record and advance understanding of the significance of the heritage asset before it is lost, using planning conditions or obligations, as appropriate (NPPF, paragraph 141). In such cases, mitigation works largely comprise investigation, recording and learning from the results in order to enhance public understanding of the historic environment within the area. Where a site is already under threat of loss or degradation through other causes (as is the case with waterlogged archaeological resources or the impacts of deep ploughing in some parts of the Vale of Pickering, for example), mineral extraction - if justified

on other grounds - would allow part of those resources to be thoroughly investigated and recorded, resulting in enhanced information and knowledge about the wider area. Whilst (as noted in paragraph 141 of the NPPF), the acquisition of such knowledge can never be used as a *prima-facie* justification for mineral extraction, it can help to mitigate and compensate for the impacts associated with extraction that is justified on other grounds.

- 9.18 In the case of biodiversity impacts, mitigation can partly be accomplished through the creation of replacement or additional habitats, the establishment (or re-establishment) of connections between fragmented habitats, or the careful translocation of species. As noted in the Stage 3 report, however, translocation is not always successful, and it takes many decades to re-establish mature vegetation communities and the complex ecosystems which they support. This needs to be balanced against the significance of the short term loss.
- 9.19 In many cases, the mitigation required can be built in to the design of the proposed development. In the case of landscape issues, this may range from the simple use of screening bunds to more imaginative, sympathetic landform design which allows the quarry to blend in more naturally with the surrounding landscape. For biodiversity and heritage concerns it may involve designing the overall shape of the quarry in such a way as to avoid the disturbance of sensitive assets nearby.
- 9.20 In other cases, however, where there is uncertainty over the likely occurrence or scale of a particular impact at the EIA stage, mitigation may only need to be applied under certain circumstances, as the quarry is developed. This cannot be left to chance, however: a clear mitigation strategy needs to be identified in advance, linked to ongoing monitoring, and incorporated into the proposal. This approach is commonly used in relation to water environment or air quality impacts, where low thresholds of impact, observed through routine operational monitoring, provide early warnings of the risk of more serious potential effects, and trigger the implementation of an agreed mitigation strategy, which may have two or more successive stages.
- 9.21 Ideally, the effectiveness of the strategy needs to be demonstrated within the proposal, by reference to previous successful examples and, if accepted by the planning authority, will need to be reflected in enforceable planning controls. Where uncertainty remains, the mitigation strategy will need to reflect the ***precautionary principle***. For example, planning permission may be granted but with very strict controls which impose staged requirements for mitigation if exceptional levels of impact are found to occur.
- 9.22 More generally, and as indicated in paragraph 21 of MPS2, planning conditions should, wherever possible, seek to identify ***performance requirements*** in terms of avoiding or minimising unacceptable environmental effects. These should identify any critical thresholds of impact that need to be avoided at specific locations in order to justify permission being granted. Where used, such conditions should clearly identify the consequences, in terms of

enforcement measures, that would apply in the event of the proposed operations causing those thresholds to be exceeded. If no other satisfactory options can be found, such consequences may need to entail the cessation of whatever activity (e.g. dewatering) is giving rise to the unacceptable impact(s)

- 9.23 Further information on specific types of mitigation associated with particular types of impact, is provided in Chapter 6 of the Stage 3 report.

RECOMMENDATIONS: Mitigation Design

- 9.24 **Mitigation should be considered as an integral part of the design processes, so that its effectiveness can be optimised, and it should be informed by (and feed back into) the EIA process.**
- 9.25 **Landscape-scale mitigation strategies may be needed where significant effects would otherwise be likely to extend over wide areas and/or where there are likely to be significant cumulative effects from incremental expansion or from two or more sites in close proximity.**
- 9.26 **Where development is justified, unavoidable impacts may be agreed subject to mitigative recording measures which ensure that a site or place is fully understood and recorded and that the information enhances public knowledge.**
- 9.27 **Mitigation measures involving the development of replacement or enhanced habitats, or the translocation of species must recognise the length of time needed for these to become properly established. This needs to be balanced against the significance of the habitats which would be lost through the proposed extraction.**
- 9.28 **Measures relating to the natural environment may need to respond to changing conditions and circumstances as the excavation is developed. In view of the uncertainties involved, the mitigation strategy should reflect the precautionary principle by incorporating staged or tiered mitigation measures linked to operational and post-operational monitoring by suitable thresholds (trigger levels) which provide an adequate early warning of the need for action. These should allow for the cessation of operations in exceptional cases if unexpected and unacceptable impacts are found to occur.**
- 9.29 **The effectiveness of the mitigation strategy should be demonstrated within the proposal, by reference to previous successful examples and, if accepted by the planning authority, will need to be enshrined within planning conditions or obligations.**
- 9.30 **It should be recognised that adequate mitigation may not always be possible and that, where this is the case, planning permission may be refused.**

Design of Compensation Strategies

- 9.31 Where it is agreed that there is an over-riding need for mineral extraction but where the planning authority has concerns about certain impacts which cannot be avoided, and where adequate mitigation cannot be achieved, it may be necessary to provide suitable compensation in order to justify planning permission being granted.
- 9.32 Compensation goes beyond the mitigation of negative impacts – it includes benefits to other aspects of the place, site or wider area (English Heritage, 2008b). The planning system recognises that there is a role for compensatory measures, particularly in relation to local communities, heritage assets and enhancement of the natural environment. The public benefit from these additional works can include such things as building restoration and maintenance, provision of new facilities and improved interpretation, and provision of enhanced public access to local landscapes and sites.
- 9.33 Compensation can also apply where the operation of a minerals planning permission would result in an adverse economic impact to an existing on-going development or land use. One example of this is where dewatering operations associated with mineral development might result in the derogation of existing, licensed water abstractions within the area. In order to allow for this possibility, a mineral operator might propose, or be required to construct, a compensation storage reservoir, such that the water abstracted for dewatering purposes is available to provide a replacement water supply in the event of derogation. This approach has been used in the case of a large limestone quarry in the Mendip Hills, Somerset, in relation to the potential risk of derogation to a pre-existing public water supply borehole (Thompson *et al.*, 2008).
- 9.34 Compensation may also need to deal with cumulative impacts and landscape-scale issues, for example through commitments that address wider landscape context issues, including enhancement, delivery and sustainability.
- 9.35 Overall, compensation measures must be relevant to planning; necessary to make the proposed development acceptable in planning terms; directly related to the proposed development; fairly and reasonably related in scale and kind to the proposed development; and reasonable in all other respects.
- 9.36 Compensation measures are frequently arranged through Section 106 agreements (also known as planning obligations), under the terms of the Town & Country Planning Act 1990 and as amended by the Planning and Compensation Act 1991. These are legal agreements linked to a specific planning permission. They are used in mineral planning to deal not just with compensation but also with a wide range of issues which cannot adequately be controlled by planning conditions. The agreement can either be between the landowner/developer and the

planning authority or between the developer and a third party - such as a neighbouring landowner or an affected stakeholder.

- 9.37 Section 106 agreements are not attached to the land - they bestow a personal obligation to ensure measures identified in the agreement are carried out.
- 9.38 Compensation agreements will normally include measures which are informed by the geographical context and environmental objectives outlined in the wider mitigation strategy. They will therefore form an integral part of an overall package that is needed to justify the granting of planning permission. An essential component of such agreements is that they should include a commitment by the developer and/or landowner to implementing the specified measures.

RECOMMENDATIONS: Compensation

- 9.39 **Where there is an over-riding need for mineral extraction but where the planning authority has concerns about certain impacts which cannot be avoided, and where adequate mitigation cannot otherwise be achieved, opportunities for appropriate compensation should be discussed with the operator, in order to justify planning permission being granted.**

Variations relating to specific minerals and/or geographical areas

- 9.40 Detailed variations on the foregoing generic requirements for monitoring, mitigation and compensation will be specific to each individual site, taking account of the local sensitivities within the area concerned. There are, however, some broad generalisations which can be made regarding variations in emphasis on appropriate types of monitoring or mitigation in each of the Categories, in recognition of the differences in their predominant characteristics.

Land Categories A-C (River floodplains, gritstone valley floodplains and settled industrial valleys)

- 9.41 The floodplains of Categories A to C will require particular emphasis on:
- Maintenance and enhancement of river corridors as components of wider green infrastructure initiatives
 - Hydrological monitoring of surface watercourses, ponds and lakes with mitigation as necessary to control any impacts on water levels, flows or quality
 - Groundwater monitoring of the superficial (sand & gravel) aquifer between the excavation and any sensitive natural or historic environment receptors, linked to a staged mitigation strategy by means of thresholds or trigger levels
 - Mitigative recording of any previously unknown heritage assets contained within or beneath the extracted mineral, and of any waterlogged archaeological features that may

be affected by fluctuating water tables;

- Consolidation and on-going management and establishment of landscape features such as hedgerows which contribute to the value and character of the landscape;
- The setting of historic parks and gardens, and older structures, buildings and settlements associated with strategic locations such as river crossings and impacts on adjacent buildings and sites need to be consistently monitored during operations (for example lorry traffic over narrow historic bridges)

Land Category D (River Terraces)

9.42 The River Terraces of Category D will require particular emphasis on:

- Hydrological monitoring, as for Categories A-C
- Groundwater monitoring, as for Categories A-C
- Mitigative recording of any previously unknown heritage assets contained within or beneath the extracted mineral;
- Consolidation of and long term management of landscape features as for Categories A-C;

Land Category E (Undulating lowland in the Vales of York and Mowbray)

9.43 The mixed lowland landscapes associated with the sands & gravels and underlying limestone in these areas will not generally require special variations to the generic requirements outlined in the preceding sections of this chapter. Any foreseen immediate visual impacts on low lying and undulating landscape should have been addressed by screening but will need to be reviewed during operations.

Land Category F (Magnesian Limestone Ridge)

9.44 The Magnesian Limestone ridge of Category F will require particular emphasis on:

- Monitoring of veteran trees which are a special landscape feature of this Category;
- Monitoring of ongoing visual, noise and vibration impacts on historic houses and parks, and designed landscapes such as Fountains Abbey that are also public attractions.
- Hydrological monitoring of surface water features, with mitigation as necessary to control any impacts on water levels, flows or quality
- Groundwater monitoring of the limestone aquifer within the full zone of influence of dewatering and/or other quarrying operations, linked to a staged mitigation strategy by means of thresholds or trigger levels.

Land Category G (Moorland Fringes)

- 9.45 The upland fringe landscapes of Category G will not generally require special variations to the generic requirements outlined in the preceding sections of this chapter.

Land Category H (Vale of Pickering)

- 9.46 The undifferentiated sand & gravel resources at the margins of the Vale of Pickering will require particular emphasis on:
- Groundwater monitoring of the superficial (sand & gravel) aquifer between the excavation and any sensitive receptors (waterlogged heritage assets, hydrological features and wetland ecosystems), linked to a staged mitigation strategy by means of thresholds or trigger levels
 - Hydrological monitoring of surface watercourses, ponds and lakes with mitigation as necessary to control any impacts on water levels, flows or quality
 - Palaeo-environmental research to inform reclamation options associated with the re-creation of historic wetland landscapes and ecosystems
 - Long term management of distinctive 'strip farmed' field patterns;
 - Long term study of settlement pattern along the spring line which could inform future development policy;

Land Category J (Clay Lowlands)

- 9.47 The brick clay resource areas of Category J will not generally require special variations to the generic requirements outlined in the preceding sections of this chapter.

Land Categories K & L (Chalk landscapes)

- 9.48 The Chalk resources of Categories K & L will require particular emphasis on
- Monitoring and maintaining the characteristic topography of the Wolds
 - Monitoring to ensure preservation of earthworks and remnant settlements.
 - Potential for preserved archaeological remains in the valley bottoms covered by more recent soil deposits, watching brief required on any excavation.
 - Groundwater monitoring of the Chalk aquifer between the excavation and any sensitive receptors, linked to a staged mitigation strategy by means of thresholds or trigger levels

Land Category M (Jurassic Limestone Foothills)

- 9.49 The Jurassic Limestone resources of Category M will require particular emphasis on
- Ongoing protection and monitoring of historic land use pattern and traditional boundaries.

- Maintaining strong landscape character and visual connectivity with surrounding landscape through long term management of any mitigation works. This may require removal of temporary screening;
- Ecological and fugitive dust monitoring of nearby ancient woodlands, linked to a staged mitigation strategy by means of thresholds or trigger levels.
- Groundwater monitoring of the limestone aquifer between the excavation and any sensitive receptors, linked to a staged mitigation strategy by means of thresholds or trigger levels.
- Mitigative survey of surface features, both within the impact areas and the immediate environs

Land Categories N and O (Pennine Moors & Fells + Wensleydale)

9.50 The Carboniferous Limestone resources within Category N will require particular emphasis on

- Long term monitoring of any adverse effects of extraction on the landscape character and strong visual connectivity between Landscape Character Types
- Screening and temporary structures should be designed to respect/not disturb strong use of local materials.
- Special attention will be required to preserve examples of rock art on existing outcrops
- Mitigative survey of surface features, both within the impact areas and the immediate environs
- Hydrological monitoring of surface watercourses, ponds and lakes with mitigation as necessary to control any impacts on water levels, flows or quality
- Groundwater monitoring of the limestone aquifer between the excavation and any sensitive receptors, linked to a staged mitigation strategy by means of thresholds or trigger levels.

10. The Operational Stage of Mineral Development

Introduction

- 10.1 Although the pre-application stage is vital in setting out good intentions, it is equally important that those intentions are properly implemented throughout the operational stage, once planning permission has been obtained.
- 10.2 Most aspects of the design which are critical to the justification of such permission being granted will be expressed in the form of planning conditions and (where appropriate) 'Section 106' legal agreements (Planning Obligations). Both of these can be applicable to any aspect of the operational stage, from site preparation to extraction, monitoring and mitigation, and should be specific to the site in question.
- 10.3 Whether or not all aspects of the agreed design are reflected in planning conditions and obligations, however, it is important that they are all implemented with the same attention to detail, and utilising the same expertise, as was used in creating the design. This requires the ongoing involvement of competent specialists who share responsibility with the operator for the implementation of critical design features, including monitoring and mitigation strategies.

Site Preparation

- 10.4 A number of aspects of the operational stage of mineral development will need to be carried out prior to the commencement of mineral extraction itself. These variously comprise replacement habitat creation (where this is needed as a specific mitigation or compensation measure); site vegetation removal (including the careful translocation of habitats and/or fauna, where this is feasible); mitigative archaeological recording; soil stripping; and preparatory landscaping works such as planting and the construction of screening bunds. In some cases, one or more of these tasks may be implemented many years before the commencement of extraction, sometimes as a specific requirement of a planning condition or Section 106 agreement.

Replacement Habitat Creation

- 10.5 Where a proposed mineral development would destroy or damage the integrity of an existing habitat, it is important to make provision for a replacement habitat to be created in a suitable location nearby. As a matter of general good practice, and as a formal requirement in the case of European designated sites (SPAs, SACs and Ramsar Sites), the replacement habitats need to be established (and functional) prior to the existing habitat being lost or damaged. In practice, for European sites especially, this needs to happen prior to planning permission being granted for the proposed development. This is an onerous requirement, especially for habitats that

will take decades or longer to become properly established, but is necessary to ensure that the overall coherence of the 'Natura 2000' network of European sites is maintained. Permission is only likely to be given if sufficient compensatory measures are in place that will provide fully the ecological functions that they are intended to compensate for. The adequacy of the measures will be considered by NYCC on a case-by-case basis with advice from Natural England.

- 10.6 As noted by Morris *et al.*, (2006), some wetland habitats may take just a few years to become established and some grasslands of conservation value are known to be relatively young (less than 80 years), but woodlands may need hundreds of years before they achieve a similar level of interest and are capable of supporting the fauna and flora associated with the existing habitat. Such timescales are far beyond the realistic expectation for any individual mineral operator. In areas where known mineral resources coincide with European habitat and wildlife designations, and where these are likely to be required at some stage in the future (assuming no other alternatives exist by then) a more strategic approach is likely to be required to the development of replacement habitats, led by North Yorkshire County Council itself.
- 10.7 Detailed practical guidance on habitat creation is provided in the Habitat Creation Handbook for the Minerals Industry (Gilbert & White, 2003).

Translocation of Habitats and Species

- 10.8 Habitats translocation is the movement of assemblages of species, particularly plants (typically including the substrates, such as soil or water, on and in which these species occur) from their original site to a new location. It has been proposed as a means of saving wildlife from areas threatened by development. As noted by McLean (2003), such translocations "*have been portrayed by some as a means of reducing the impact of developments (mitigation), whereas in reality they can only partly make amends for developments (as incomplete compensation)*".
- 10.9 McLean (*ibid.*) also points out that the translocation of habitats is considered by the statutory conservation agencies (e.g. Natural England) not to be an acceptable alternative to *in-situ* conservation and that those agencies will continue to make the strongest possible case against translocating habitats from within SSSIs (and other areas with significant biodiversity interest) elsewhere. The available evidence (as reviewed by Bullock *et al.* (1997)) indicates that habitats translocations have not been successful in maintaining the characteristic biodiversity of the assemblage that is moved, and for this reason, McLean (*ibid.*) points out that the practice is regarded as damaging by statutory and voluntary conservation organisations and many academic researchers.

Mitigative Archaeological Recording

- 10.10 The level of additional recording would vary according to the significance and character of the archaeological resource, coupled with the level of impact by the extraction. The mitigative

recording options (Minerals and Historic Environment Forum, 2008) are typically full excavation, strip, map and record, palaeo-environmental analysis, and watching brief. These are outlined in Appendix 1. The processes of strip, map, and record and area excavation may be lengthy, and could be implemented some time in advance of the extraction, or in stages in advance of each phase of extraction.

- 10.11 All archaeological mitigation work has to be done to an agreed Written Scheme of Investigation, in accordance with IfA standards & guidance. Ideally, this document will be submitted with the planning application and its implementation secured by use of a condition or other planning obligation.
- 10.12 The process of mitigative recording needs to have a clear research focus and to be targeted to research questions that have developed from the pre-application investigations and to have regard to the Regional Research Agenda (Roskams & Whyman 2005; 2007). The work needs to be implemented in accordance with professional standards and guidance, such as IFA (2008a and 2008b) and English Heritage 2006. This includes post-excavation assessment and analysis of results through to publication, dissemination and the deposition of the archive with a suitable archive repository. This work is intended to be widely available and to inform future development within the same minerals area.
- 10.13 The implementation of the archaeological excavation/mitigation strategies must be monitored with respect to the agreed written scheme of investigation by the NYCC Development Management Archaeologist. This would include site visits during the fieldwork, direct comment upon the excavation assessment reports and agreeing updated project designs. This is particularly pertinent where an iterative, flexible mitigation strategy has been agreed and where archaeological monitoring is part of an ongoing development process.

Soil Stripping

- 10.14 Soil stripping during site preparation needs to comply with a method statement (prepared at pre-application stage) which states the intended soil stripping depth; ways in which different layers of soils will be kept apart; how the soil will be handled during different weather conditions; where and how high soil mounds will be and how any contaminated soils will be dealt with. In addition to these requirements relating to the handling of the soil resources, there is also a need to consider the potential heritage resources within the soil, at the site in question, as informed by the pre-application research. The use of a bulldozer, for example, would immediately obscure any exposed remains and thereby hinder archaeological investigations.

Preparatory Landscaping

- 10.15 Preparatory landscape works may typically include on- and off-site planting; protection of existing vegetation communities and habitats which are to be retained; topographic profiling and stockpiling of soils and overburden materials for re-use; construction of new access routes

and possibly new field boundaries, footpaths/bridleways, watercourses and services diversions. Landscape works will be specific to a site and substantially agreed as part of the planning application process. Some design details which are informed by the works of other professionals, such as archaeologists or ecologists, may be subject to conditions attached to the planning permission. For example, a watching brief over an archaeological investigation may reveal heritage assets which have implications for the overall landscape design.

- 10.16 Comprehensive pre-application assessment and long-term planning will often allow preparatory landscaping works to be carried out far in advance of a phased sequence of extraction, so as to maximise its effectiveness in shielding the surrounding environment from potentially adverse effects during the operational phase (including the effects from noise and fugitive dust as well as potential visual and landscape impacts). Such planting and landscaping can, over time, become integrated into the long-term reclamation design for a particular site, so as to enhance the biodiversity of the area and create a transition towards a new assemblage of landforms and habitats which blend in with, and function as an integral part of, the wider landscape.
- 10.17 However, it is equally important to consider that such preparatory works, though important during the operational stage, need not necessarily be permanent features of the landscape. There may be benefit, for example, in utilising species which provide rapid growth for screening purposes, which can then be harvested (e.g. for timber or biomass fuel) as the development moves into the reclamation phase, when it might be desirable for views to be opened up to reveal newly-created landscapes and habitats and/or to reveal linkages between newly exposed geodiversity features and the wider landscape.

Mineral Extraction

- 10.18 The key points to consider (whether or not they are identified in conditions or obligations) will be those relating to:
- implementation of the agreed design, including phasing arrangements, restoration and aftercare;
 - Implementation of the agreed archaeological mitigation strategy and monitoring of this to ensure compliance with the WSI and discussions re iterative strategies;
 - implementation of agreed operational monitoring schemes for habitats, species and the water environment, including timely submission of monitoring results to the appropriate authorities and liaison with other data holders;
 - responding as appropriate to monitoring results which suggest the need for action, including implementation of agreed or additional mitigation measures (as necessary);
 - securing and managing the protection of existing habitats and species (especially but not

only those which are formally protected) in accordance with the agreed design;

- enhancement of biodiversity through landscaping, planting and progressive or final restoration, optimising the potential for the schemes to contribute to national and local Biodiversity Action Plan targets and/or to the development or improvement of 'wildlife corridors' to promote increased continuity between habitats;
- protection and enhancement of the water environment through good control of dewatering operations and of water quality and rate of discharge from the site;
- protection or enhancement of geodiversity, including ongoing liaison with local interest groups and researchers, responding where possible to important and / or unexpected discoveries, allowing these to be investigated and 'rescued' where possible or retained as conservation faces at the margins of the excavation;
- Maintaining access across and through the site where required. Mineral extraction sites are often located within farmed land and changes to access routes should allow unimpeded access to maintain normal activity; and
- Ensuring clean workings to minimise risks associated with earth moving and contamination.

10.19 In each case, the various guides to good practice referred to earlier should be consulted for further details of the issues which need to be considered and the options available for dealing with them. Specialist advice on particular issues and often on individual sites can be obtained through consultation and ongoing liaison with Natural England, The Environment Agency, local authority ecologists, RSPB, Buglife, local Wildlife Trusts and local RIGS groups.

10.20 A fundamental requirement in all of this is for the operator to secure the ongoing services of relevant specialists, so that the landscape, historic environment, biodiversity, geodiversity and water environment aspects of the intended scheme, including monitoring and mitigation works, are properly implemented and adequately maintained. Such requirements are clearly site- and scheme-specific but the following examples illustrate the attention to detail that is required:

- Noise, dust and vibration will affect the quality of life in historic houses, parks and settlements and affect the enjoyment and appreciation of these heritage assets. The management of extraction to mitigate against such adverse impacts by working to ensure that detrimental impacts are minimised through use of appropriate road routes and operating hours, and screening initiatives to protect assets during works may be able to provide a temporary solution, mitigating against environmental impacts until long-term appropriate restoration is in place. Particular initiatives will be site dependent and may include the active 'mothballing' and protection of buildings and monuments during the extraction phase where it is not possible for them to be retained in active use, and their restoration and active reuse following conclusion of mineral operations.

- Some of the heritage assets identified at the pre-application stage may not be directly affected, being close, but not within, the primary impact area, and may include earthworks, cropmark sites or even standing buildings. Such sites may, however, still be affected by ancillary activity, such as vehicle movements. There is a need that they are afforded protection by means of fencing and signage to ensure that they are preserved in the course of quarry operations. Standing buildings are particularly vulnerable to vibration from blasting, and vehicle movements, but also changes in hydrology and subsidence; they need to be constantly monitored for changes in condition, and need to be stabilised as appropriate.
- Waterlogged archaeological sites are of considerable archaeological significance because of their potential to retain the organic components of remains that, in other circumstances, would be lost to decay. If the groundwater conditions (levels and/or water chemistry) are changed as a consequence of activities relating to nearby mineral extraction - particularly dewatering - such sites may dry out and/or become subject to different chemical conditions and the organic material will decay. Sites some distance from the extraction site can be affected by the drawdown of the local water table in response to dewatering, and there is therefore a need to provide adequate groundwater monitoring linked to mitigation measures which control the effects of dewatering, allowing water levels and conditions to be maintained in the vicinity of waterlogged sites. Detailed guidance on this is provided by Thompson *et al.* (2008).

Implementation of Operational Monitoring and Mitigation

- 10.21 Many, if not all of the parameters that were monitored during the pre-operational stage are likely to require continued monitoring throughout the operational period. The density of observation points and the frequency of observations may, however, be different, depending on the findings of the baseline monitoring work and the outcome of any Environmental Assessment, Hydrogeological Impact Appraisal, or other studies carried out in connection with planning, abstraction licence or discharge consent applications.
- 10.22 Where such studies have demonstrated that any potential effects are likely to be contained within a smaller area than that covered by the baseline monitoring (which will often be the case), then monitoring may be able to be discontinued, or at least reduced to a low frequency, in some of the outlying areas. Conversely, of course, such studies may sometimes indicate a need for the monitoring network to be spread wider than had originally been envisaged.
- 10.23 Additional monitoring points may also need to be installed in certain areas, for example to monitor the success (or otherwise) of specific mitigation measures such as noise barriers, dust suppression, translocated habitats and species, or groundwater recharge trenches. They may also be needed to provide early warnings of developing impacts before they reach sensitive receptors and (if necessary) to trigger the timely deployment of further mitigation measures.

- 10.24 In many cases it will be advantageous to use continuous automated monitoring when changes are first introduced (e.g. at the commencement of Excavation or dewatering), or at periods of heightened potential risk (e.g. when the excavation is closest to a potential receptor) but then to revert to periodic manual monitoring at other times once the nature of the 'worst case' response has been adequately established. Consideration must also be given, however, to the sensitivity of particular receptors to such changes. For example, if a particular habitat or archaeological site is likely to be compromised by a critical reduction in groundwater levels or a change in groundwater quality over a particular period of time, then the monitoring frequency needs to be shorter than this in order to provide adequate warning and to prevent adverse effects from taking place.
- 10.25 The same principle can generally be applied to all forms of monitoring. For example, the geomorphological response of a river channel to a change in discharge regime, as a consequence of quarrying operations upstream, may not be measurable (or significant) for a number of years, and may therefore justify only occasional reassessments (depending on local circumstances). The changes in sediment load within the same river may become significant for fish and other aquatic species over a much shorter period, however, necessitating more frequent monitoring of turbidity and river bed conditions.
- 10.26 Details of the operational monitoring requirements and trigger levels will therefore vary substantially from one site to another and will always need to be informed by local knowledge and expertise, including the views of the Environment Agency, Natural England, English Heritage and other statutory consultees, as appropriate. For this reason, the use of standardised conditions should be avoided.
- 10.27 As noted earlier, the collection of monitoring data is of little value if it is not assessed immediately for significant anomalies, which may be due to errors in sampling, recording or in the laboratory, or may represent a genuine environmental change. Such assessment may involve checking against previous readings and against predetermined 'trigger levels' for the various parameters.
- 10.28 Additionally, data should be evaluated on a long-term basis, by suitably qualified specialists with a detailed understanding of the environmental implications, to determine any significant long-term trends. This may also highlight whether the monitoring programme needs to be either scaled up (to provide more frequent or more comprehensive data) or to be scaled down to a more focused and cost-effective programme.

RECOMMENDATIONS: Operational Stage

- 10.29 **Whether or not all aspects of the agreed design are reflected in planning conditions and obligations it is important that they are all implemented with the same attention to detail as was used in creating the design. This requires the ongoing involvement of competent**

specialists who share responsibility with the operator for the implementation of critical design features, including monitoring and mitigation strategies.

- 10.30 Preparatory landscape operations which will benefit the long-term landscape design objectives should be carried out at the earliest phase of site possession. These should be informed by a holistic understanding of the landscape and environment.**
- 10.31 Measures relating to the historic environment may be outside the immediate footprint of extraction but should be planned to protect the significance and fabric of heritage assets that might otherwise be damaged by operational works and traffic movements.**
- 10.32 Measures relating to the natural environment may need to respond to changing conditions and circumstances as the excavation is developed. In view of the uncertainties involved, the mitigation strategy should reflect the precautionary principle by incorporating staged or tiered mitigation measures linked to operational and post-operational monitoring by suitable thresholds (trigger levels) which provide an adequate early warning of the need for action. To allow for a worst case scenario, these should allow for the cessation of operations if exceptional and unacceptable impacts are found to occur.**
- 10.33 Regular liaison meetings should be organised between the site operator and specialists within NYCC to ensure that good working relationships continue throughout the operational stage and that monitoring results are jointly reviewed on a frequent basis.**

Variations relating to specific minerals and/or geographical areas

- 10.34 At this stage of development, it must be assumed that planning permission has been obtained and that detailed variations to the generic requirements outlined above will have been set out in site-specific planning conditions and legal agreements (obligations). Variations appropriate to specific minerals and geographical locations / land categories, will have been addressed at the design stage (see above).**

11. Reclamation and Long-term Management

Introduction

- 11.1 As noted in Chapter 4, it is important that reclamation designs are developed as an integral part of the excavation design, but allowing for some flexibility, so that they can be adapted, as necessary, to changing environmental conditions, changing reclamation priorities, improved reclamation techniques and/or improved knowledge gained through operational monitoring during the lifetime of the development. Adaptations will need to be negotiated during the periodic reviews of planning conditions or where justified by other significant changes in circumstances. The following sections outline some of the key aspects of implementing whatever schemes are in place at a given point in time.

Reclamation Works

- 11.2 As noted in the recommendations for the design stage (Chapter 8, above), reclamation requirements will normally be set out in Section 106 obligations attached to planning permissions (or conditions on environmental permits or licences pertaining to the site in question). The following generic requirements will usually be included, with site-specific modifications as appropriate:
- Completion of the agreed reclamation scheme, subject to any modifications that have been agreed with the local planning authority and other stakeholders during the period of extraction. As noted above, such modifications may be needed, for example, to take account of improved knowledge and techniques, changed priorities and/or the implications of climatic and environmental change since the scheme was originally proposed (as informed by dynamic baseline monitoring), but the likely scale and overall form of the proposed restoration is likely to remain fundamentally unchanged within the boundaries set by the particular landscape context.
 - Implementation of the required aftercare, including (where appropriate) arrangements for handing-over of the management of the restored site to new owners, and working with them to make sure that they are aware of the need for ongoing management of specific natural and historic environment features;
 - Continued protection of the water environment following the cessation of dewatering and other site operations, through careful monitoring of water levels and water quality until new equilibrium conditions are established;
 - Provision of permanent safe access, where possible, to any features of geodiversity or heritage interest, so that these can be visited and inspected by interest groups after the quarry has closed (subject to permission of the new site owners).

- 11.3 The various guides to good practice and organisations referred to earlier should be consulted for further details of the issues which need to be considered and the options available for dealing with them.
- 11.4 As with the operational phase of mineral working, a fundamental requirement for the post-operational stage is for the operator to secure the ongoing services of relevant specialists, (ecologists, hydrologists, archaeologists and/ or landscape architects) so that the various aspects of the intended reclamation scheme are properly implemented, adequately maintained and managed. Such requirements are clearly site- and scheme-specific but the following examples illustrate the attention to detail that is needed at this stage:
- Low-lying sites, particularly those in river floodplains, may be suitable for the development of reedbeds, as an alternative to open water, with much greater biodiversity potential. Pages 117 to 122 of the Habitat Creation Handbook for the Minerals Industry (White & Gilbert 2003) provide detailed guidance on the very exacting requirements for successful reedbed establishment and maintenance, from the initial design and choice of appropriate planting techniques to good control of seasonal (and spatial) variations in water depths, control of competing vegetation, protection of new growth, and rotational cutting and removal of reed during the winter. Other management techniques such as summer cutting, grazing and burning of parts but not all of the reedbed can help to conserve invertebrate populations. The implementation of these various techniques requires the close involvement of specialists in both hydrology and ecology - not only in the initial design but also throughout the subsequent implementation and management. Such specialists need to be on hand to check that the initial topography is created correctly, in order provide the required water levels; and to advise when the time is right to plant the reeds, when to remove fencing, and what to do in the event of a flood. Gilbert & White (*ibid.*, pp161-164) provide a detailed case study on reedbed establishment within former gravel workings at Needingworth in Cambridgeshire. Although that example is on a very large scale, and is being developed progressively as each phase of mineral working is completed, reedbed habitats can be created at any scale. Provided that they are properly established and maintained, reedbeds will always provide ecological benefits, with fringing reed margins acting to soften the outer edge and islands within an open water body.
 - Mineral workings which take place above the water table or where there is sufficient material to bring levels back above the water table, at least across some parts of a site, can be restored to a wide range of terrestrial habitats, making use of varied landforms, soil types and rock outcrops. Significant benefits are to be gained by considering a wide range of potential habitats in such cases, including seasonally wet habitats at the margins of a water body, including wet grassland, wet woodland, and fen/marsh habitats with intervening ponds.
 - A common reclamation design is to incorporate woodland plantation, particularly on

steep slopes which are unsuitable for other types of land use. White & Gilbert (2003) have noted, however, that woodland creation, as a discipline, has been “*subsumed under an avalanche of mediocre amenity planting schemes, designed to green mineral extraction sites: in the past, inappropriate tree planting has reduced the wildlife potential of some areas*”. Establishing a successful, species-rich woodland which functions as a healthy component of the local ecosystem can be achieved, however, if suitable guidelines (such as those in Table 4.11 of White & Gilbert (*ibid.*) are followed. These emphasise the preference for natural regeneration rather than planting and for blending in with what is already there. Other useful guidance is provided by Peterken (1993), Rodwell & Patterson (1994) and Bailey *et al.* (1998). Once again, ongoing, long-term management is important for woodland schemes, particularly in terms of managing scrub and areas of open ground within the woodland, so as to maintain a range of habitats and species diversity. Management may also require the removal of nurse species, and the periodic thinning-out and coppicing of pioneer species in order to allow the next stage of succession to become established. As with all types of habitat creation and management, this requires the ongoing utilisation of specialist advice. Appropriate specialists will be needed on site regularly to assist with final ground levels, substrate requirements, seeding mix/density, identification and treatment of invasive species and monitoring / control of hydrological and hydrogeological conditions.

- The requirements outlined above are especially important in situations where quarry reclamation, (or mitigation / compensation measures) involve re-establishing connections between previously fragmented habitats within the surrounding area. In such cases, particular attention to detail will be needed to prepare the topographic, substrate and hydrological conditions which will enable the new habitat to develop successfully.
- Where the reclamation design is aimed at providing additional flood storage capacity, for example within or adjacent to low-lying floodplain areas, the detailed advice of fluvial geomorphologists, hydrologists and hydraulic modellers will be required to ensure that the final landform achieves the desired effect. Recent ALSF-funded research by Clayton *et al.*, (2004) illustrated how the effectiveness of such schemes depends greatly on detailed topographic control, and that excavations within river terraces adjacent to floodplains offer much greater potential for beneficial storage than those within existing floodplains.
- The active maintenance and long-term management of heritage assets that are affected by the operational phase of working should be part of an ongoing management statement for those assets that sets out protection measures, monitoring of condition and restoration of setting within the reclamation site and its environs. Any existing Conservation Management Plan should be utilised to ensure that proposals are linked to the ongoing management of such places. Guidance provided by the Minerals and Historic Environment Forum (2008) notes that “*Restoration is a key element of mineral extraction and one that has been carried out to good effect on many sites, thereby improving the*

landscape and the quality of life of local communities. It is important that plans for quarry restoration are in keeping with the historic landscape character of the site's surroundings. In practice this has to be reconciled with a wider range of interests that may also include biodiversity, geodiversity and recreation".

- 11.5 Irrespective of the precise form of reclamation, there are benefits to be gained by an operator in employing an experienced project delivery manager and a specialist long-term management agent in order to secure successful implementation and establishment.

Post-operational Monitoring

- 11.6 It may be necessary for monitoring to continue after mineral extraction has ceased, for example to monitor the rebound of water levels after dewatering or the re-establishment of ecological habitats or archaeological preservation conditions during and after reclamation. The extent to which this is necessary will depend on the timescale of any impacts that have resulted from quarrying activities (some of which - e.g. from the release of contamination - may continue long after extraction has ceased); but also the nature of the reclamation scheme involved and the nature of the intended after-use of the site.
- 11.7 Where monitoring continues it is important that this includes the ongoing submission of monitoring results to the appropriate authorities, liaison with other data holders, and liaison with / handover to the new owners of the site. Long-term monitoring is of fundamental importance in judging the success or otherwise of habitat creation and other biodiversity improvement schemes, providing the feedback needed to improve best practice guidance and to measure the contribution to Action Plan targets. It is equally important that capacity is maintained by the operator or subsequent site owner to respond as appropriate to monitoring results which require the need for action, including the implementation of any further mitigation measures that may be necessary
- 11.8 Where dewatering has taken place, the rebound of groundwater levels may need to be monitored by periodic measurements in piezometers within and around the site or (in the case of sites reclaimed to open water), by monitoring surface water levels in the resulting lake or ponds. Such monitoring may be needed simply to confirm compliance with planning conditions, or to give warning of any threat to new development or after-use that may arise if the water table rebounds to significantly higher or lower levels than had been anticipated.
- 11.9 Landfill operations, which may commence after mineral extraction has ceased, or which may run in parallel to ongoing extraction in other parts of the site, have their own particular monitoring requirements. In general, these are likely to be more intensive than for other methods of reclamation, and will include monitoring for landfill gas and for specified leachate contaminants, both within the landfill site and in the surrounding environment. The requirements will also include a further monitoring phase after the site has been filled and

before the surrender of the Integrated Pollution Prevention Control (IPPC) permit. Detailed guidance on landfill monitoring is set out in Guidance on the Monitoring of Landfill Leachate, Groundwater and Surface Water (Environment Agency, 2003a).

Long-term Management

- 11.10 Normal planning procedures allow for a five year period of site management and aftercare once the extraction process ceases. In order to secure the long-term management of a site for periods exceeding 5 years, a Section 106 agreement (planning obligation), or a Section 39 agreement will normally be required. In both cases, however, a key factor is the need for management requirements to have been anticipated in advance and developed as an outline management plan on the basis of the integrated understanding of the site and its surroundings built up during the pre-application stage. As with the reclamation design itself, there is a need to keep post-closure management requirements under review throughout the lifetime of a mineral operation, in order to benefit from the increased knowledge brought about through operational monitoring within and around the site, and any 'dynamic baseline monitoring' of the wider environment. Where management requirements need to change, this may be able to be dealt with, in part, through the Periodic Review of planning conditions, but is also likely to require the re-negotiation of relevant S106 agreements.
- 11.11 Notwithstanding the need to maintain some flexibility, it is essential that the reclamation plan, proposed after-use and outline long-term management plan are considered in detail at the initial planning stage, to ensure that they are achievable, and to ensure that the necessary commitments for long term management are secured. Such things are likely to be material considerations with respect to the determination of an application for mineral extraction. As noted earlier (para. 10.6, above), some types of habitat may take many decades or even centuries to become fully established and, whilst it may sometimes be possible for an operator to provide a commitment in perpetuity, this will not always be feasible. An alternative solution is for the operator to sell or gift the land to a suitable organisation (e.g. RSPB or a local Wildlife Trust) with an interest in managing the site in perpetuity. Whatever the mechanism, there is a need to ensure that a reasonable period of good-practice aftercare and management is delivered and that longer-term management objectives are secured.
- 11.12 The initial plans for after-use of a site will need to be agreed following considerations of context, demand and financial viability, as well as landscape and environmental requirements. In some cases, a mix of uses may be the preferred solution to fit within the existing landscape and to provide optimum benefits in terms of ecosystem services, for example a combination of agricultural land, nature conservation and recreation. In other cases there may be greater benefits to be gained from focusing on a single primary after-use. These could be conservation organisations such as The Royal Society for the Protection of Birds (RSPB); the British Trust for Conservation Volunteers (BTCV); the Wildlife Trust; Heritage Trusts, Groundworks Trusts; The

Woodland Trust or a well-organised local voluntary organisation. Involving other parties from inception (pre-planning) to completion and into management of the site has clear environmental and social benefits, and enables the long term management objectives to be secured at an early stage.

- 11.13 As illustrated in the various examples quoted under paragraph 11.4, above, there is a need for the ongoing advice of relevant specialists during the post-operational stage, in order to ensure that the intended long term benefits are actually delivered. Each type of reclamation and after-use will have its own specific programme of requirements to establish the after-use and ensure a smooth transition between the existing landscape, the restored site and the margins of both.
- 11.14 The publication *"Knowing Your Place – heritage and community-led planning in the countryside"* (English Heritage 2011a) provides advice to local communities on understanding their villages and surrounding country side, but also on identifying opportunities for enhancement or reuse. It encourages communities to look at taking on some responsibility and possibly management of sites and buildings within the context of a community-led plan, and this is something that can be explored with minerals operators in terms of ongoing support to local management initiatives.
- 11.15 Another situation could be an ongoing commitment to the restoration and long-term maintenance and management of a registered park and garden and its landscape, structure, or other heritage asset. In the Stage 1 report, the evidence base indicated a higher incidence of such designations within ASMRPS 2 and 3 and therefore this type of management requirement is more likely to be required here than in for example ASMRP 14, on higher more exposed land, where features such as dry stone walls and remains of earlier mineral workings which are now recognised of historic value should be repaired as part of the long-term restoration of the site. In certain circumstances, establishment of a long-term fund for future management may be appropriate.

RECOMMENDATIONS: Reclamation and Long-term Management Stages

- 11.16 **Reclamation Plans should allow for flexibility to accommodate changes in design that may be needed during the lifetime of the scheme, not least to allow for adaptation to climate change. Such changes would be subject to agreement during Periodic Reviews of any planning permission obtained, or at other times where justified.**
- 11.17 **Improvements in knowledge during the lifetime of the scheme, including information obtained from routine operational monitoring and from archaeological and geodiversity discoveries should be taken into account to refine the final reclamation design.**

- 11.18 **Reclamation designs should integrate with and (as far as possible) enhance the natural environment, historic environment and wider landscape and should be informed by an understanding of the development of the landscape over time. The design, including that of the quarry excavation itself, should seek to optimise the delivery of ecosystem services, balancing the economic benefits of mineral extraction with the wider benefits associated with other services. These may include benefits associated with the intended after-use of the site and those associated with off-site benefits (as may be achieved, for example by re-connecting previously fragmented habitats in adjoining areas).**
- 11.19 **Cumulative effects associated with quarry reclamation and long-term management should be considered at the outset of the application process, with a view to minimising adverse impacts and optimising potential benefits. Where such effects (whether positive or negative) are likely to be significant over wide areas, a landscape-scale, area-based approach to the design and management of mitigation and enhancement is likely to be required, rather than one which focuses on an individual site.**
- 11.20 **Insofar as possible, reclamation works should take place in parallel with ongoing excavation (for example through 'rolling' restoration of a shallow excavation or through the early landscaping and treatment of the upper, completed faces and benches in a deep excavation), so that the associated benefits can be realised at the earliest opportunity.**
- 11.21 **Where reclamation schemes are intended to create or restore habitats for nature conservation, or to create land for public access and recreation, these must be demonstrably achievable (e.g. supported by clear evidence and by a firm commitment by the operator to provide the specialist expertise and long-term management required). Such schemes should also aim to be as sustainable as possible (by virtue of being well designed and adapted to the site conditions) but provision should also be made for effective and appropriate long-term management, to ensure that the benefits are fully delivered and maintained.**
- 11.22 **Where heritage assets are restored or reinstated as part of the reclamation of an operational site, the works should form part of a maintenance plan which sets out how the significance of the heritage asset will be preserved and maintained in its setting.**
- 11.23 **Mineral operators are encouraged, where appropriate, to develop relationships with conservation and/or voluntary organisations in order to secure long-term management and monitoring of restored sites.**

Variations relating to specific minerals and/or geographical areas

- 11.24 **At this stage of development, it must be assumed that planning permission has been obtained and that detailed variations to the generic requirements outlined above will have been set out in site-specific planning conditions and legal agreements (obligations). Variations appropriate**

to specific minerals and geographical locations / land categories, will have been addressed at the design stage (see above).

12. Conclusions

- 12.1 This stage of the project has drawn on information gathered in earlier stages; such as understanding the key environmental characteristics, sensitivities and capacity of the different mineral resources, to produce recommendations for planning.
- 12.2 The detailed appreciation that has been gained of the complex inter-relationships between all aspects of the landscape, the natural environment and the historic environment, and of the varying degree and nature of the environmental sensitivities involved, has enabled a number of key principles to be identified as important components of a successful strategy for managing landscape change. Whilst these key principles are largely strategic, the recommendations which flow from them have in many cases been able to incorporate variations between different mineral resource areas and landscape types, based on the detailed, area-specific information obtained throughout the study.
- 12.3 The recommendations relate to each stage of the development of a minerals operation from pre-application considerations through formal application and on to the operational stage of quarrying, implementation of reclamation schemes and the long-term management of a site post extraction.
- 12.4 Emphasis throughout the recommendations is placed on the integration of knowledge relating to all different aspects of the landscape and the environment. This is needed in order to build understanding and to engender high quality, imaginative designs and mitigation measures which enable potential adverse impacts to be avoided or adequately controlled, and which allow for optimum enhancement of existing features. In this way, future mineral extraction will be able to contribute as fully as possible to the delivery of ecosystem services and to the goal of sustainable development.
- 12.5 The recommendations are deliberately front-loaded, in line with the requirements of the planning system itself. Particular emphasis is therefore placed on the importance of the pre-application research and investigation to ensure that development proposals are brought forward in the most suitable locations, and to facilitate the creation of sympathetic designs which are compatible with the surrounding landscape and environment.

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Appendix 1: Research, Investigation and Monitoring Techniques

Brief details are given below of some of the research and investigative methods and monitoring techniques that may need to be used in connection with minerals development. Archaeological techniques are discussed first, followed by others relating to the natural environment. Both of these groups of techniques may contribute to the more general understanding of the landscape, supplementing the established methods of Landscape Character Assessment (Swanwick & Land Use Consultants, 2002). References to other sources of guidance are mentioned where they are relevant but, for most of the historic environment techniques, reference should be made to the Mineral Extraction and Archaeology practice guide (MHEF, 2008).

Pre-Application Archaeological Techniques

Desk-Based Assessments

The first stage of historic environment research is to capture existing data about the site and its environs from, and would typically include digital datasets, such as the NYCC Historic Environment Record (HER), Historic Landscape Characterisation (HLC) data, together with digital and paper-based grey literature reports, secondary sources, and primary historic documents and cartography, usually held in the county record offices, as well as aerial photographic collections (both current and historic) and material held in the National Monuments Record (IfA 2011). The study would also access not only heritage data but also topographic datasets, geological data, and environmental data. It would also provide an in-depth synthesis of the various data and develop predictions of the type of archaeological remains that could be expected to be found within the area, and their potential significance. Typically, this would be implemented by commissioning appropriate specialist consultants.

Aerial Photography Transcription and LiDAR

One of the most important tools for the remote identification of archaeological sites is aerial photography which can reveal either surface features, such as earthworks, or buried features from cropmarks (subject to soil conditions). Depending upon the availability of National Mapping Programme (NMP) data for the site, there may be a need to undertake additional aerial photographic plotting from aerial photographs held by the National Monuments Record (NMR) or undertake a targeted aerial photographic sortie to obtain new aerial photography for the site. This would typically be undertaken in conjunction with LiDAR data, where available, which provides very precise digital terrain models of the ground surface sufficient to reveal subtle surface features and even crop marks. Crop marks are typically only revealed on some soils and geology and earthworks are rarely revealed in areas that have been subject to intensive ploughing, so this process alone cannot be relied upon to reveal heritage assets in all areas.

Site Surveys

Although there is a considerable understanding to be obtained from the desk-based sources, there are limitations also and the procedure cannot be relied upon to identify all archaeological remains. The desk-based studies will review all available surveys and investigations, but these are inevitably localised and will not provide coverage across all mineral rich areas of the county. In order to address the research questions of the ERF there will be a need to undertake additional survey work in order to redress the imbalance within the archaeological record. The following survey techniques are recommended in selective ASMRPs and where there have previously been no previous surveys. Where the surveys are unproductive, this may indicate that the area has poor site visibility and reflects that the soils / geology are not conducive to revealing sub-surface remains by crop marks or from the application of magnetometric techniques, rather than an absence of archaeological remains. Where there is poor site visibility a different range of survey techniques can be applied, or more reliably a process of archaeological evaluation trenching can be implemented.

Geophysical surveys, particularly the use of magnetometry, can be effective at demonstrating the underlying archaeological resource on certain geologies and its effectiveness has been demonstrated in the environs of West Heslerton, in ASMRP 5 (Powlesland *et al.* 2006), as well as many other areas. The technique is most applicable for ASMRPs 2, 3, 5, 7, 8 and 9, and includes areas of well drained sands and gravels. In certain areas, however, the geology and soils are less conducive for the application of magnetometry, particularly clay soils, and results in poor site visibility. As an alternative other geophysical techniques, such as resistivity or Ground Probing Radar (GPR) can be applied.

Archaeological Walkover Surveys: In upland or fringe areas there has historically been a preference for pastoral farming, and the absence of ploughing has enabled the preservation of surface features (earthworks). Such features can be revealed by LiDAR and aerial photography, but these cannot provide a comprehensive record of surface features and cannot necessarily provide the interpretation of features. The preference is for the implementation of a walk-over survey by experienced archaeologists to identify and interpret the physical remains. The technique is most applicable for ASMRPs 7, 10, 12, 13 and 14.

Detailed Archaeological Survey (Field Investigation and Analysis): following on from the walkover survey, there is in some instances a need to undertake a more detailed archaeological survey which allows analysis of the interpretation, character and in some instances chronology of individual sites or elements of a wider landscape. The archaeological recording should be undertaken in accordance with either English Heritage Level 2 or Level 3 guidelines (English Heritage 2007) depending upon the significance or complexity of the site or landscape. The recording would typically be undertaken in the field using survey grade GPS or total station equipment and would result in accurate plans of the individual features and their relationships to the wider topography.

Where heritage assets exist on the surface it is appropriate that they be recorded by detailed survey at the Post Permission Mitigation phase, but in some instances it is necessary to undertake such

surveys at the Pre-application phase to provide a level of understanding of the heritage assets sufficient to inform the planning process.

Fieldwalking / Artefact Surveys: In areas that have been subject to intensive cultivation, there are rarely surface features surviving, but the plough brings to the surface artefacts from underlying deposits. The artefacts can be revealed by systematic fieldwalking across fields that have been recently ploughed. The technique will provide an indication of archaeological potential for those ASMRPs which have poor site visibility and where the soils normally mask crop-marks and some geophysical survey techniques. The technique is most applicable for ASMRPs 2-9, and 11.

Geomorphology

As noted in the Minerals and Archaeology practice guide (MHEF, 2008), **geomorphological mapping** of landform units can be used to identify potential palaeo-environmental remains, assess sediment units, and to produce both surface and buried-terrain models that can inform predictive models of sites and their wider landscape setting. Such work can reveal how the landscape was formed and how it has evolved through time in response to changing environmental conditions and anthropogenic influences. This, in turn, allows for the prediction of the survival of remains of different periods at different depths, together with an assessment of their likely state of preservation and the techniques likely to be most appropriate for their evaluation. Geomorphological mapping usually requires a programme of fieldwork and survey by appropriate specialists, supported by desk-based analysis of topographic maps, geological maps, aerial photographs and Digital Elevation Models produced from remote-sensing techniques - particularly LiDAR. Such mapping, and the development of associated models, can be greatly enhanced through the skilled interpretation of sub-surface information from hand augering and boreholes. Analysis and interpretation of borehole data and other evidence of sub-surface conditions may include:

Sediment Analysis: In some instances there is the potential for sediments deposited by relatively recent fluvial activity obscuring earlier land surfaces and associated archaeological remains. This applies primarily within the floodplains of ASMRP 1, and in some parts of the river terrace deposits which form ASMRP 2. In this situation, geological borehole sampling, combined with appropriate dating techniques, may be able to establish the sequence and chronology of deposition, and therefore determine the potential for deeply buried archaeological deposits beneath more recent sediments. Appropriate dating techniques include radiocarbon dating (where suitable organic remains are present above and below specific layers or landform units) and OSL (Optically Stimulated Luminescence) techniques, which are applied directly to the mineral grains.

Modelling Alluvium and Clays: The soils of certain geologies, notably ASMRPs 4 and 6, retain water and inhibit the formation of crop-marks that might otherwise be revealed by aerial photography, and also geophysical survey techniques. As a consequence the visibility of the archaeological monuments is impaired and there are distinct lacunae within the record that coincide with areas of clay and alluvial geology (Whyman *et al.*, 2005; Howard *et al.*, 2008). This restriction of knowledge, however, does not reflect an absence of archaeological resource and alternative techniques are necessary to reveal them. It is therefore recommended that a process of modelling the depth of alluvium and

clays be implemented as these can highlight where archaeological remains are masked, and therefore highlights the need for further investigation. This can be undertaken by examining deep drainage ditches across low lying areas, where available. This method is most applicable for ASMRPs 4 and 6.

Palaeoenvironmental Analysis: In many low-lying areas there is the potential for the survival of waterlogged deposits, and this has allowed the organic survival of archaeological materials which would otherwise have decayed over time. The archaeological potential for such remains is considerable and it is important that the water table be maintained so as to afford the preservation of the waterlogged deposits. However, mineral extraction has the potential to dewater the local area and may adversely impact the survival of waterlogged remains some distance from the extraction site. Even in areas of sands and gravels, which are typically well-drained, there is the potential for the survival of organic deposits, particularly in palaeochannels, and it is important to identify areas of potential waterlogging. It is therefore recommended that a process of palaeobotanic / hydrological research be undertaken to establish the potential for waterlogged remains, and to demonstrate the impact of dewatering on the underlying organic heritage resource. This entails a process of augering to establish the survival of waterlogged deposits and then a process of laboratory based palaeoenvironmental analysis to reconstruct the changing patterns of vegetation in the environs of the site. This method is most applicable for ASMRPs 1-6 and 9.

Aerial photography and LiDAR can be used to identify palaeochannels which have the potential to retain waterlogged deposits. This method is most applicable for ASMRPs 1-6 and 9.

Intrusive Investigations - Evaluation

All the survey techniques have some limitations and although they can be effective, they cannot be relied upon to reveal potentially deep buried archaeological remains which could be affected by extraction, or archaeological remains in areas of poor site visibility. In any case the survey techniques often identify the existence of archaeological remains, but cannot interpret them, establish their significance or define their condition. In this instance the most reliable technique, for all ASMRPs, is to implement a programme of excavation; the following technique is appropriate.

It is typically recommended that a programme of evaluation be undertaken, which entails the excavation of archaeological trial trenches. It would typically follow on after programmes of survey work and the location and extent of the trenching would typically be informed by the earlier survey work. In particular it can be used to test a landscape model or to be targeted to areas of potential highlighted by the earlier studies.

Impact Assessment

In conjunction with the above archaeological investigations a process of assessment would examine the identified archaeological resource in relation to the wider landscape, topography, and geology (Lambrick & Hind 2005). It would assess the significance of the remains in relation to other sites and landscapes

across the country and region. It would assess the impact of the proposed mineral extraction upon the identified archaeological remains, and the cumulative impact on the wider landscape. It would examine the visual impact of the extraction on the heritage of the environs. This procedure would inform part of Key Environmental Research Questions 1-14, as described in Chapter 4.

Archaeological Research during the Operational Stage

Mitigation Recording Techniques

Once a planning permission and/or other development consent has been awarded there will typically be a requirement for the recording of the archaeological resource that will be impacted by the development. This can take the form of full excavation, strip and record, palaeo-environmental analysis, and / or watching brief, and will be subject to the written scheme of investigation for the agreed mitigation strategy and the planning conditions.

Excavation: if the agreed mitigation scheme entails preservation by record, there will typically be recourse to a process of full excavation across the overlap between the extent of the extraction impact zone and that of the heritage asset. This entails the systematic loss of the heritage resource, which would be comprehensively recorded in the process. It would entail selective environmental and scientific analyses on the deposits to establish the character of the early activity and a robust chronology. Following on from the fieldwork phase is what can be an extensive post-excavation phase, dependent upon the results of the excavation, which would entail a process of analysis to understand and characterise the excavation data. The results would be subject to publication to enable a wide and durable dissemination of the archaeological material. This procedure would inform part of Key Environmental Research Questions 15, as described in Chapter 4, above. For sites containing evidence for fossil and archaeological remains of the Ice Age, the information and guidance within Buteaux *et al.* 2009 will be of interest and use.

Strip, Map and Record: an alternative to full excavation is a process of strip, map and record which entails the supervised stripping of topsoil across the site, and any features exposed are cleaned and planned. A sampling strategy is then formulated in accordance with the research questions to determine what proportion of the features are excavated. The method allows for the recording of all archaeological features and is targeted by the research questions.

Watching Brief: this procedure is appropriate to the recording of areas that have no known archaeological resource but which have some very limited potential for remains. It entails the observation of the top soil stripping and the rapid recording of any features revealed.

Detailed Archaeological Survey: where the archaeological features are exposed on the surface there is a need for detailed survey, and the technique is described further in the section on Pre-Application Historic Environment Techniques.

Palaeo-environmental Analysis: the technique allows for the investigation of the historic environment by coring through waterlogged deposits and determining the macrofossil and pollen at stratigraphic intervals and key horizons. It enables a determination of the changing pattern of vegetation over time and is a key tool to understand the development of the landscape and man's influence upon it. It is appropriate for the recording of waterlogged deposits that may be impacted by changes in the water table.

Natural Environment Research

Many different types of environmental monitoring are likely to be required in order to deal with the various hydrological, hydrogeological, hydrochemical, geomorphological and ecological parameters associated with the natural environment. Some of these, such as daily rainfall measurements (British Standards Institution, 1996), and Phase 1 Habitat Surveys (JNCC, 2010) are well established standard techniques but others may require adaptation to the circumstances involved, as explained below.

Habitat Surveys

The initial scoping survey and report (Phase 1) usually involves a broad habitat survey, using the Phase 1 habitat survey guidelines (JNCC, 2010), which highlights the habitats present on site. The Phase 1 survey map is usually accompanied by target notes that identify and provide further information on habitat / wildlife features of particular value for individual species groups such as plants, fungi, lichens, mosses, mammals, amphibians, reptiles, fish and birds.

More detailed surveys of rivers and streams can be undertaken with a River Habitat Survey (Environment Agency, 2003b) by an accredited surveyor. This survey is designed to characterise and assess the physical structure of freshwater streams and rivers by surveying a 500 m reach of river channel at ten equidistant spot-checks. The survey results are audited for quality control by the Environment Agency and included on their database. The range of data recorded in this survey includes valley form, geology, flow type, natural features (e.g. pools, riffles, bars), artificial features (e.g. weirs, bridges), channel and bank modifications (e.g. reinforcements), bank-top land use and vegetation structure, channel vegetation type, bank profile, river dimensions (e.g. depth, width), features of interest (e.g. braided channels, debris dams), invasive species and diseased alders present and any other points of note. This standard survey methodology provides a consistent framework for other surveys (e.g. invertebrates, macrophytes, fish, geomorphology) and data for SERCON (System for Evaluating Rivers for Conservation) to be contextualised within.

Species Surveys

It may subsequently be necessary to conduct further, species-specific (Phase 2) surveys of the site which target specific groups of plants and animals. The timing of these surveys is critical, as many plants and animals are not evident at certain times of year (and may also only be present during certain weather conditions), which limits the time when surveys can be conducted (CIRIA, 2004).

The following summaries provide an overview of the appropriate survey methodologies for the main plant and animal groups at a detailed pre-operational, ecological stage.

Vegetation

The term vegetation encompasses a wide range of taxa including flowering plants and ferns (vascular plants), lichens, mosses and liverworts (bryophytes) and algae including stonewort. Prior to the following more detailed survey work, it is assumed that a phase 1 habitat survey has been carried out.

Vascular plants

Further surveys of vascular plants should be undertaken where protected, Red Data Book (RDB), Nationally Scarce species and / or where national or internationally protected habitats are present. (Plants and habitats may also have significance to nature conservation at a regional and / or local level, these too would need adequate surveys.

These important plants and habitats would have been highlighted by the initial ecological survey (Phase 1) report.

The survey method adopted should involve a detailed recording of the species present, (which would include vascular plants, bryophytes and macro-lichens). The standard survey involves the use of quadrats, which come in various sizes and assigned a measure of percentage cover for each species recorded within the quadrat survey. In conjunction with the recorded quadrat data, additional species data is requested from local record centres. From this information, the National Vegetation Classification (NVC) plant communities and sub-communities described in the various handbooks²¹ can be determined. Transitional and disturbed habitats can pose difficulties when assigning NVC communities. Similarly, for certain habitats there are also specific survey methods that may be more suitable, depending on the aims of the survey e.g. ditches, dykes and rhynes, standing water and canals, rivers, hedgerows, and woodlands.

For sites where protected or rare species are found to be present, a detailed survey of the species distribution and abundance would be more appropriate than undertaking a general site survey of the current plant communities.

Lichens and Bryophytes

Further surveys of lichens and bryophytes should be undertaken where protected, RDB or Nationally Scarce species may be affected, or where habitats recognised as having significant conservation interest for lichens or bryophytes are found within the site. The proposed development may cause a significant impact on the communities.

²¹

JNCC website – NVC handbooks (accessed February 2012): jncc.defra.gov.uk/default.aspx?page=4268

No standard quantitative survey technique exists for lichens and bryophytes. However, semi-quantitative studies should be carried out where possible and where important lichen communities are identified, a photographic baseline monitoring programme should be implemented.

Freshwater algae

Further surveys of freshwater algae should be undertaken where there is a predictable impact on a protected, RDB or Nationally Scarce species of stonewort. No standard method for undertaking general surveys of macro-algae including stonewort exists. Although one for assessing water quality using aquatic macrophytes is available²².

Evaluation

For all vascular and non-vascular plant populations, after the survey work has been completed, it is important to determine the number of sites supporting a population and the size of each population, both in a local and national context. This will provide a measure against which to compare the population size/number of sites likely to be impacted and whether the sites themselves are of SSSI status.

Birds

Wild birds can be found within the majority of habitats across the UK. Although geographically significant numbers and/or species of birds often occur in association with protected sites, potential impacts and opportunities should be considered at an early stage at all sites in order to fulfil legal obligations and planning requirements.

The need for, and design of detailed bird surveys is intimately linked to the context (geographical location, prevailing habitat types, proximity to protected site, connectivity etc.) of a given site and the proposed operations.

In order to assess the impact of a given operation on bird populations and individually protected species, numerous standardised generic survey methods should be applied, these are largely defined within the RSPB's Bird Monitoring Methods, these include notably:

- i. Common Bird Census;
- ii. Breeding Bird Survey;
- iii. Wetland Bird Survey (WeBS); and
- iv. Low Tide Counts.

²² Environment Agency (2002), *A guide to monitoring the ecological quality of ponds and canals using PSYM*. Environment Agency Midlands.

It should be stated that these standardised methodologies are designed for long-term monitoring and are generally adapted in consultation with key stakeholders to provide a robust and cost effective strategy.

Where a development is likely to affect scarce breeding species, appropriate survey techniques should be used (the timing of the surveys are dependent on the species and habitat concerned). Where the development is likely to affect an assemblage of local or regionally important species the survey method used will typically involve identifying the breeding behaviour of the species present, as defined by the British Trust for Ornithology (BTO)²³ during the suitably timed survey visits.

Use of the Common Bird Census or Waterways Birds Survey methods, which involve eight or more visits during the breeding season, these are only of value when the location of breeding territories for all species present on a site is important. Even under these circumstances, the census is rarely cost effective in the ecological assessment context. The number of survey visits is dependent on the site, as number of survey visits is conducted by a site by site basis. In general 3 to 4 survey visits to the site is sufficient, and usually takes a maximum of 3 hours to conduct the bird survey.

Wintering bird surveys should, if possible, provide several years of data from existing records; when not available, monthly counts identifying both roosting and feeding sites should be undertaken.

Breeding bird population data should be presented as a percentage of both UK and local/regional totals (where available) for the appropriate season. For wintering populations or migratory birds, baseline data should be presented as a percentage of the local/regional populations and the UK/relevant international population.

Mammals

Further information about mammal populations should be presented where protected species may be affected, or where mammals are likely to interact with the operation of a project, or are important for influencing surrounding ecosystems, or where species not covered by existing legislation but perceived as being of local importance, may be affected.

Survey methods for mammals will be different for different species and will also vary as a result of the specific requirements of individual studies. The species of mammal most likely to require further study are badgers, bats, dormouse, water voles, otters and red squirrel. For all species, appropriate survey methods, carried out at the correct time of year should be used. A summary of these methods are given below:

Badgers

²³ British Trust for Ornithology (accessed February 2012): www.bto.org

There are several descriptions of survey methods for badgers; the most recognised method is described within *The Inverness Badger Survey*²⁴. The most effective time to undertake surveys for badger dwellings (setts) is between October and February when vegetation is less dense. Surveys of feeding areas and habitual runs are best carried out between March and late September^{25,26} when the animals are most active.

Bat

Bat surveys should identify summer roosts, winter hibernation roosts and evidence of feeding areas and important flight routes. These surveys may be required if the proposed development impacts upon local bat commuting routes. The most appropriate time to survey for roosting sites and feeding areas is between March and October. Hibernation sites are best surveyed during the winter months (between November and mid-February²⁷).

Dormouse

Dormice surveys are best conducted between May and October. Presence / absence surveys require the use of hair tubes, while population studies and monitoring schemes require the use of nest boxes. Surveys for dormouse presence / absence should be undertaken outside the hibernation period (generally considered to be between November and April²⁸).

Water vole

Surveys should look for holes above and below the water line, which are the entrances to their burrow systems. Surveys for their latrines (where they leave their droppings), feeding stations, (cut vegetation), tracks and runs are looked for within the bankside vegetation²⁹. Direct observation of the species is also looked for, alongside other similar signs such as the characteristic 'plop' sound water voles make when they dive into the water to evade detection. A helpful information sheet can be found on the Mammal Society website and Scottish Wildlife Trust website.

Otter

Survey methods for otters involve surveying water courses, for otter faeces (spraints), direct observations and signs for otter dwellings (holts).

²⁴ Scottish National Heritage (2003). *Best Practice Guidance - Badger Surveys. Inverness Badger Survey*. Scottish National Heritage, Scotland.

²⁵ Ernest Neal and Chris Cheeseman (1996) *Badgers*, Poyser Books.

²⁶ Badger activity calendar (accessed February 2012): lancashirebadgergroup.org.uk/badgers/calendar.html Bat

²⁷ Conservation Trust. (2007). *Bat Surveys – Good Practice Guidelines*. Bat Conservation Trust, London.

²⁸ English Nature. (2006). *The dormouse conservation handbook – second edition*. English Nature, Peterborough

²⁹ Strachan R and Moorhouse T. (2006). *Water Vole Conservation Handbook, 2nd Edition*. Wildlife Conservation Research Unit (WildCRU), Oxford University.

Red squirrel

Squirrel drey counts are best carried out in late winter, while non-invasive squirrel surveys can be conducted throughout the year (weather permitting) but optimum surveying times, to conduct visual, hair-tube, feeding and whole maize bait surveys³⁰, tend to be between March and October, while the optimum time to survey breeding females is between December and September.

Amphibians and Reptiles

Surveys for amphibian and reptile presence should be undertaken where sites contain suitable; amphibian/reptile habitat, and / or where protected species have been recorded within or near to the site³¹.

For amphibians, this means any of the following:

- sites with great crested newts, natterjack toads, (and in Northern Ireland, smooth newts);
- sites in an area where an amphibian is rare or at the edge of its geographical range.

For reptiles, this means any of the following:

- sites with common lizard, adder, grass snake, slow worm, sand lizard and smooth snake³²;
- sites in an area where a reptile is rare or at the edge of its geographical range.

Survey methods for amphibians are typically based on counts of adults and spawn and are detailed in the Handbook of Biodiversity³³.

- Natterjack toad - several evening surveys to collect data on the number of adult individuals and spawn numbers within breeding pools / ponds, these are generally carried out between the end March and mid-July.
- Newts - netting, torch surveys, egg searching and bottle trapping; the method used depends on the characteristics of the water body. Surveys of newts should be undertaken between March and July.
- Common toad - Counts in March/April should be carried out during the night for adults and during the day for spawn strings.
- Common frog - spawn clumps should be counted during the day between February and April.

³⁰ Forestry Commission (2009) *Practical techniques for surveying and monitoring squirrels*. Forestry Commission Research, Farnham.

³¹ Froglife (1999) *Froglife Advice Sheet 10 – Reptile Survey, an introduction to planning, conducting and interpreting surveys for snake and lizard conservation*. Froglife, Peterborough.

³² Froglife (1999) *Froglife Advice Sheet 10 – Reptile Survey, an introduction to planning, conducting and interpreting surveys for snake and lizard conservation*. Froglife, Peterborough.

³³ David Hill *et al* (2005) *Handbook of Biodiversity Methods: Survey, Evaluation and Monitoring*, Cambridge University Press.

For some protected species (such as the Great Crested Newts) it is necessary to get a licence before carrying out a survey or handling them. Further information can be obtained from the Natural England website³⁴ and from the GCN Guideline publication³⁵.

At present there are several standardised methods for surveying reptiles, these include walk over surveys, using direct observations or more quantitative methods which involve searching artificial reptile refugia, more details on these survey techniques are available from the Froglife³⁶ and Kent Reptile and Amphibian Group (KRAG)³⁷ publications.

To establish species presence on a site, refugia can be used within and near to suitable terrestrial habitat. The best time of year to survey reptiles is between May and early October, (during suitable weather conditions).

Survey data should be presented as adults, eggs/spawn or young recorded during the specified time period. Additional information to aid in the evaluation of survey results should include:

- assemblage scores;
- population size in local, regional and national terms;
- site location (refers to the isolation and position in a species range as well as the potential function of the site as a corridor, to bridge two or more areas/sites with suitable habitat);
- historical perspective in terms of the number of former records.

Fish

Fish populations and their sensitivity to impacts should also be assessed as part of the baseline characterisation process. There are a number of organisations that routinely carry out fish monitoring surveys in the UK and that hold relevant information and data. These range from Government Agencies through to Rivers Trusts, Angling Clubs and private land owners. The Environment Agency has a statutory duty to maintain, improve and develop fisheries in England and Wales. As part of this duty they carry out an extensive fisheries monitoring programme which aim to determine the long-term status of a range of freshwater and migratory species using various techniques. It is possible that they may already have a suitable monitoring programme in place. If the baseline desk study identifies gaps in existing data, or the statutory bodies recommend the need for more specific information, further monitoring may be required. It is important that this monitoring programme is well designed and 'future proof' as trends in fisheries data may only be seen over long periods and rely on year to year comparison. The data collected should be specific to the particular need, and meet predetermined statistical criteria. As a statutory planning consultee, the Environment Agency will advise on the

³⁴ Natural England licensing website (accessed February 2012),

<http://www.naturalengland.org.uk/ourwork/regulation/wildlife/licences/default.aspx>

³⁵ English Nature (2001) *Great crested newt mitigation guidelines*, English Nature

³⁶ Froglife (1999) *Froglife Advice Sheet 10 – Reptile Survey, an introduction to planning, conducting and interpreting surveys for snake and lizard conservation*. Froglife, Peterborough.

³⁷ KRAG (2003) *Protected Reptiles and Built Development* KRAG and Kent Wildlife Trust, Maidstone.

requirements for monitoring and use their powers under the Salmon and Freshwater Fisheries Act 1975 (SAFFA) to protect fish populations. Before surveys are carried out in England and Wales prior consent will be required from the EA under the SAFFA. These applications can take up to 20 days to be processed and are usually date specific, so previous consents will no longer be valid.

More detailed information on fish populations or fisheries should be presented where the desk study indicates that the site contains (or has contained in the past) protected species, species known to be in decline, unusual races of species or important fish communities.

Appropriate methods should be used but these vary greatly according to fish species, life stage and aquatic habitat.

For some species, estimates of the numbers of eggs (eg. Smelt) or nests (eg. Salmonoid redds) may be obtained by direct counts immediately after spawning.

Evaluation - quantitative data should be presented as eggs/nests, young (larvae and juveniles) or adults estimated per unit area at a particular time. With fish counters or traps for migratory species, the data can be expressed as numbers passing per unit of time.

Terrestrial and Aquatic Invertebrates

Surveys of freshwater aquatic invertebrates should be undertaken whenever a proposed development is predicted to have an impact on freshwater quality.

Further surveys of terrestrial invertebrates should be under-taken where RDB or Nationally Scarce species may be affected or where habitats similar to nearby areas of known invertebrate interest lie within the impact area.

Terrestrial Invertebrates

Optimally three periods of sampling surveys should be carried out during the ecological season (between May and September) and should be carried out in early, mid and late season.

Because of the vast number of species and the range of different invertebrate organisms involved, field surveys should initially be restricted to a few target groups which are characteristic of the habitats present on site and for which good biological/ecological data and identification keys are readily available. Suggested groups include:

- *Carabidae sp.* (ground beetles),
- *Lepidoptera sp.* (butterflies and moths),
- *Orthoptera sp.* (crickets and grasshoppers),
- *Syrphidae sp.* (hoverflies) and

- *Odonata sp.* – adults only (dragonflies and damselflies).

The target groups used will, however, vary according to the habitat type being investigated. These groups can then be used as bio-indicators to characterise the main invertebrate communities under investigation.

Aquatic Invertebrates

There are various methods for assessing the conservation value of water bodies based on aquatic invertebrate sampling. These have been described for ditch systems and ponds. All invertebrates should be identified to species level where practicable as this will allow the identification of RDB species and / or locally rare / uncommon species.

Aquatic invertebrates can be sampled throughout the year and preferably on a seasonal basis. Methods such as the BMWP (Biological Monitoring Working Party Score³⁸) and the Environmental Quality Index³⁹ can also be used to monitor the water quality of freshwater but they also reflect general environmental and habitat quality. A detailed description of these methodologies is outside the scope of this text.

All notable and RDB species should be detailed with an assessment of their abundance on the site. If possible their status should be compared with existing records for the study area, district or county/region.

Water Environment Monitoring

The following guidance is summarised from Thompson *et al.* (2008).

Groundwater Levels

Groundwater levels can be measured in purpose-designed monitoring boreholes, but they should also be measured if possible, perhaps on a less frequent basis, in existing water wells within the surrounding area. Monitoring boreholes may range from relatively simple open wells, screened across two or more geological horizons to give average groundwater levels, to more complex installations with separate sealed piezometers which can monitor the hydraulic head separately at one or more specific depths. A multi-level installation is likely to be appropriate where there are distinctly separate aquifer units, major fissures or conduits at different depths, which are likely to have different hydraulic heads. In such cases drilling techniques need to be adapted to avoid the risk of vertical flows and mixing of the different waters via the borehole.

Groundwater levels are normally measured using a hand-held electronic dip meter but, depending on the frequency of monitoring required, it may be both desirable and cost-effective to install automatic water level recorders to provide timed continuous data for the periods between successive monitoring

³⁸ BMWP score methodology is available from, (accessed February 2012):
who.int/water_sanitation_health/resourcesquality/wqmchap11.pdf

³⁹ Freshwater Biological Association (2000) *Assessing the biological quality of fresh waters: RIVPACS and other techniques*. Freshwater Biological Association, Ambleside.

visits. The preferred frequency and method of groundwater level monitoring will be influenced by a number of factors and may change over time. Continuous automated monitoring is likely to be particularly useful when new procedures (such as dewatering) are first introduced, and/or at periods of maximum potential risk.

Whatever the method or frequency of observation, there should always be a fixed datum at the top of each borehole from which the depth to water is measured. Each of these should be accurately levelled in relation to Ordnance Datum so that all water level measurements can be expressed in terms of metres AOD (Above Ordnance Datum). This is so that water levels at each borehole can be compared with each other and so that contour maps of groundwater levels can be produced. When monitoring groundwater levels, date and time should be recorded as standard in order to facilitate seasonal comparisons within and between years, and to identify any tidal variations in groundwater levels for sites that are near to the coast or tidal rivers.

In geological formations that are likely to be dominated by intergranular flow, groundwater level measurements should always be taken from at least three different points (in a triangular formation) in order to allow groundwater gradients and flow directions to be calculated. Where fissure flow is dominant, and especially in karstic environments, it may not be possible to calculate gradients and flows in this way. In such cases, greater attention may usefully be given to the identification and location of major fissures or conduits (perhaps using appropriate geophysical techniques) so that these can be intercepted and monitored by carefully positioned boreholes.

Each monitoring borehole should be clearly labelled with a unique identifier to avoid confusion, and should be secured with a lockable cover to prevent vandalism. When selecting monitoring borehole locations, suitability for the intended purpose must be the main criterion but practical issues such as ease of access (including health & safety considerations) and long-term availability of access (e.g. in relation to future quarrying intentions or subsequent development) should also be considered, so that each borehole can provide a reliable and consistent data record over as long a period as possible.

Groundwater Flows

Groundwater flows are usually calculated from empirical equations (see Thompson *et al.*, 2008) rather than being measured directly. This is because of the difficulty of obtaining reliable and representative measurements. Such measurements can be obtained, within boreholes which intersect flowing groundwater within permeable strata or along well-defined fissures or conduits, using a variety of instruments. Recent work in the USA (Wilson *et al.* 2001) compared three different types of directional groundwater flow meters (a horizontal heat-pulse flowmeter, an acoustic Doppler velocimeter, and a colloidal borescope flowmeter) but found numerous practical difficulties and a lack of agreement in the results obtained by each method. They also highlighted the need for multiple measurements to be taken at different depths and averaged over an extended time period in order to gain any reasonable approximations of average flow velocities.

Groundwater Quality

Groundwater quality data should, ideally, be obtained from samples taken from purpose designed boreholes, normally the same boreholes as used for water level monitoring. Prior to taking the sample to be analysed it is necessary to purge a borehole adequately to remove “stale” groundwater from the hole and to ensure that the sample is representative of the groundwater. Purging three times the borehole’s volume is a commonly accepted procedure.

Prior to, and during purging, it is good practice to monitor *in-situ* quality parameters (such as electrical conductivity, pH, Eh (or redox potential), dissolved oxygen, and temperature). These parameters will change during purging, and should ideally be stable (indicating that they are representative of the native groundwater rather than ‘stale’ groundwater) when a groundwater sample is collected. The monitoring of these parameters will also inform the interpretation of laboratory results at a later stage.

Groundwater samples must be properly stored in accordance with the appropriate standards and with any additional protocols required for the specific parameters which are to be analysed. They should be kept cold, out of sunlight and returned to the laboratory within 24 hours. More detailed advice can be provided by the laboratory carrying out the chemical analyses. Laboratories must be experienced and competent for the type of analysis required, with UKAS accreditation for the tests concerned. Duplicate samples and trip blanks should be sent as part of an analytical monitoring round for quality control purposes (testing for reproducibility of results and laboratory equipment contamination respectively).

In terms of the parameters that need to be monitored, this will depend on the nature of the mineral working and the type of potential impacts on water quality that could occur if the mitigation measures intended to control them were to fail. This, in turn, will depend on the geological and other characteristics of the local area, and on a wide range of site-specific factors relating to the excavation, reclamation and after-use of the quarry. In addition to the field measurements noted above, the requirements for laboratory analysis will often need to include: dissolved metals (including speciated iron), alkalinity, pH, Eh, dissolved oxygen, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Hazardous Substances (as defined by the European Groundwater Daughter Directive, akin to the “List I” substances in the earlier (1980) Groundwater Directive), ammonia, nitrate, nitrite, sodium, chloride, calcium, magnesium, potassium, sulphate and organics that may be associated with existing or historical rural land uses). Additional parameters may need to be monitored in particular circumstances, not least in relation to the wide range of potential pollutants that may be associated with subsequent after-uses of the site. Specific advice for each individual site should be obtained from the Environment Agency’s local area office. As part of the initial baseline characterisation process, it will generally be appropriate for a wide range of determinants to be assessed. Operational monitoring would then normally focus on a more limited range of parameters identified as being the most relevant indicators of potential change for the site in question.

Surface Water Levels

Surface water levels are critical indicators for both flowing watercourses and all other surface water features, from lakes, ponds and reservoirs to a multitude of wetland environments. Such levels are naturally variable, particularly in the case of streams and rivers, and especially those which are primarily dependent on rapid surface run-off, as opposed to the relatively slow 'baseflow' input from groundwater sources. In the case of reservoirs and canals, there are clearly human as well as natural influences to consider, and to a lesser extent this may also be true of streams and rivers which are supported, in part, by irregular discharges from other forms of development. In all cases, however, it is important to be able to monitor and understand the natural (or existing) baseline conditions (including water level range and hydrograph characteristics) and then to ensure, through operational monitoring, that those conditions are maintained as closely as possible.

In the case of large open water bodies in the UK (other than reservoirs), the degree of natural variation in surface water levels will be limited (controlled by the outlet elevation and the rate of input from surface run-off). Monitoring, in such cases, can easily be achieved by periodic topographic surveying of levels at the water's edge or (more commonly) by readings from a calibrated, permanently installed gauging board or staff. Ideally, this should be accurately levelled in relation to Ordnance Datum, so that observed levels can easily be converted and compared with groundwater levels measured in nearby boreholes. Where necessary, for example to demonstrate whether or not there is a correlation between lake levels and a nearby quarry dewatering scheme, an automatic recording device can be installed within a stilling well at the edge of the lake to provide a continuous data record over a particular period. The stilling well helps to eliminate short term fluctuations in water level that may be caused by waves.

In the case of streams and rivers, where the water level is more naturally variable, the same general principles still apply: gauging staff readings or measurements taken from a fixed feature adjacent to the watercourse, such as a bridge or wall can be used for periodic (e.g. daily) measurements, whilst data loggers installed within stilling wells can be used to record more frequent or continuous measurements. In all cases, however, the choice of monitoring location becomes significantly more important than in lakes or ponds, because of the tendency of rivers to change in morphology in response to different flow conditions. Scouring or deposition on the bed of the stream, or changes in channel width can give rise to changes in water level at the monitoring point, making it difficult to quantify any systematic trends over time and thereby disguising any impact on water levels that may be induced by other causes. River gauging points therefore need to be located where there is a natural or artificial restriction of the channel's cross-sectional shape. This becomes less important for short term measurements (such as the recording of overflows from a recharge experiment) and in very small streams, where simple temporary installations such as V-notch weirs (see below) can provide adequate control, but it may be critical to the success of river gauging on larger streams.

Surface Water Flows

Where permanent gauging stations are installed, either for use by the Environment Agency on main rivers, or by individual operators for the monitoring of local streams, stage-discharge relationships can be established so that simple measurements of water level (stage) can be converted into rates of flow (discharge). On small streams, discharge can be calculated in a similar way from measurements of stage height over a calibrated sharp-crested weir. Where such facilities do not exist, discharge can be calculated from measurements of cross-sectional area and flow velocity. Velocity, in turn, can be measured using a mechanical or electromagnetic current meter (the most accurate methods for one-off or occasional measurements, and for calibrating stage-discharge relationships), or by means of an Acoustic Doppler Current Profiler (ADCP), which records average velocities at a particular depth across the width of the channel. ADCP measurements are sometimes less accurate but the technique has the advantage of being able to generate a continuous series of measurements at any pre-determined monitoring frequency (e.g. hourly or daily) which can be captured or relayed using a variety of computer, data logger, or telemetry systems.

Monitoring of discharge may be important in terms of quantifying the overall water balance of a local hydrological system, although individual components such as the rate of discharge of site water can more easily be measured using in-line flow gauges within discharge pipes. For the purpose of ensuring that the normal range of discharge variation within a stream is being maintained, it may be adequate simply to monitor water levels within a fixed cross section, as described above, since these will be directly proportional to discharge.

In some cases, the critical issue is likely to be water velocity, rather than discharge, since it is this which has a direct bearing on the shear stresses exerted by the flow on the bed and banks of the river. Where velocity measurements are needed, the ADCP current profiling technique outlined above can be used in a variety of configurations to monitor velocities at different depths and locations within a stream.

Surface Water Quality

Samples for monitoring surface water quality are relatively simple to obtain, in that (unlike groundwater sampling, which generally requires boreholes) no special facilities (other than bridges or boats, in some cases) are required to gain access to the water. Care needs to be taken, however, to ensure that the samples are representative of the water body and to identify precise sampling points that can be measured on multiple occasions, so as to identify genuine trends (as opposed to locational differences) in any changes that may be detected from one occasion to the next.

Certain criteria, such as temperature, turbidity and dissolved oxygen content, can vary substantially over short distances - for example between the surface and the bed of a lake or pond, or between pools and riffles within a stream - and it is important to eliminate these complications by either sampling from exactly the same point on each occasion or by obtaining composite samples, obtained from several points within a given cross section. Generally, the more points that are sampled, the more

representative the composite sample will be. In the case of flowing watercourses, sampling at three to five points is usually sufficient and fewer points are generally needed for narrow and shallow streams.

In order to measure the effects of a particular site on surface water quality, it is necessary to sample both upstream and downstream of the site discharge point, and from the site discharge itself. Upstream measurements will enable the background conditions to be monitored, as a dynamic baseline against which the downstream changes (if any) can be compared, whilst site discharge monitoring is needed to check for compliance with discharge consent criteria, and to correlate with any changes that may be detected downstream. Where compliance with the stipulated criteria can be demonstrated, and where there is a lack of correlation between site discharge and downstream effects, alternative explanations for those effects may need to be sought. The location selected for downstream monitoring must be such that there has been adequate mixing of the site discharge with water from further upstream, but also that no further discharges (e.g. from other development sites or tributaries) have been added to the flow.

In the case of lakes and reservoirs, the situation can be more complicated, and it may be necessary to conduct preliminary investigations to ensure that sampling stations chosen are properly representative of the water body. Isolated bays and narrow inlets of lakes are frequently poorly mixed, whilst wind action and the shape of a lake may lead to a lack of homogeneity; for example when wind along a long, narrow lake causes a concentration of algae at one end. If there is good horizontal mixing, a single station near the centre or at the deepest part of the lake will normally be sufficient for the monitoring of long-term trends. However, in temperate zones, such as the UK, thermal stratification of large, open water bodies can give rise to significant differences in water quality at different depths. In such cases, more than one sample may be necessary to provide an adequate description of water quality.

As with groundwater quality sampling, when taking surface water samples it is good practice to obtain *in-situ* field measurements of electrical conductivity, pH, dissolved oxygen or redox potential and temperature, in order to inform the interpretation of laboratory results at a later stage. Similarly, the above comments with respect to sampling and storage protocols and laboratory analysis will apply.

In terms of the parameters that need to be monitored, this again will depend on the nature of the mineral working and the type of potential impacts on water quality that could occur if mitigation measures were to fail. Analysis of suspended sediment content (Total Dissolved Solids - TDS) is normally a standard requirement, but other requirements may include dissolved (and precipitated) metals, alkalinity, pH, Eh, dissolved oxygen, BOD, COD, Hazardous Substances, ammonia, nitrate, nitrite, sodium, chloride, phosphorous, calcium, magnesium, potassium, sulphate, organics associated with historic activities and any other chemical parameters which are likely to be important indicators of potential ecological impacts. Again, additional parameters may need to be monitored in relation to certain after-uses and specific advice for each individual site should be obtained from the Environment Agency's local area office.

In addition to the monitoring of physical and chemical parameters, surface waters will generally need to be monitored for biological quality indicators as well. Whole communities of organisms, or the individuals that normally belong to that community, can be studied as indicators of water quality. Alternatively, the physiology, morphology or behaviour of specific organisms can be used to assess the toxicity or stress caused by adverse water quality conditions, or organisms and their tissues can be used as a medium for chemical monitoring of contaminants in the aquatic environment. Benthic invertebrates and other organisms within the hyporheic zone of streams and rivers are likely to show the effects of pollution before those within the water column and so can provide an early indicator of the impact of contaminated groundwater. In large rivers, lakes and reservoirs, the determination of phytoplankton chlorophyll pigments may be used as a measure of algal biomass (a good indicator of biological productivity and potential eutrophication).

As with groundwater, the initial baseline characterisation process may require a more complete suite of analyses to be undertaken, whereas operational monitoring may be able to be restricted to a smaller range of key parameters, as agreed with the Environment Agency.

Geomorphological Surveys

Geomorphological surveys may be required where there is a risk of impacting upon landforms which have potential geodiversity interest, or on active geomorphological processes which may additionally have implications for such things as land stability, erosion, deposition or flood risk. In the first case, where the features of interest are effectively static (at least on an engineering timescale) the surveys required will generally be 'one-off'. For active processes, however, there may be a need for repeated monitoring in order to detect any systematic changes that are being produced, whether by the proposed development and/or by other background environmental or land use changes.

Geomorphological (or hydromorphological) monitoring of surface watercourses may be needed in order to identify any changes induced, either directly or indirectly, by quarrying activities. **Direct changes** would include the deliberate diversion of the watercourse to permit quarrying or opencast extraction and subsequent reinstatement if the diversion is temporary. In such cases, the objective may be to replicate the original geomorphological characteristics of the stream or river (by reference to a baseline geomorphological survey), or it may be to improve the characteristics of a stream which has, in the past been heavily modified in one way or another. In both cases, the requirement will not usually be to create or replicate a precise channel pattern, with meander bends in specified locations; but rather to ensure that the design provides the necessary *morphological characteristics* in terms of parameters such as channel sinuosity, meander wavelength, width/depth ratios, the spacing of major bedforms (pools, riffles and gravel bars), sediment characteristics and typical rates of erosion. As well as ensuring that the appropriate characteristics have been achieved by the restoration design, subsequent monitoring of these parameters can help to determine whether the morphology remains stable in subsequent years. In this respect, it must be recognised that river channels are naturally dynamic features which change in response to the flow of water through them, but generally maintain consistent geomorphological characteristics unless there is a systemic change in the controlling variables, such as climate, vegetation cover and land use. Monitoring of the geomorphological parameters can thereby provide indications of

whether indirect effects of quarrying (and/or the effects of other nearby development or climatic changes) are causing a more progressive change in the characteristics of the stream or river.

Other types of geomorphological and geotechnical monitoring, e.g. of slope instability, settlement and subsidence, may also be important in certain situations, particularly when excavations are located close to buildings or other structures.

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