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## Managing Landscape Change

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

Stage 3 Technical Report - Final



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# 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 are 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 Area of Surface Mineral Resource Potential (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 represents the output from Stage 3 of the project: analysis and environmental overview of each ASMRP.

1.8 The Stage 3 work involved eight individual tasks, as follows:

*Task 3(i):* **Key Environmental Characteristics** (Comparison of the key environmental characteristics of each sample area with the strategic descriptions of each ASMRP, and placement of the sample areas within local, regional and national contexts;

*Task 3(ii):* **Review of methodologies** (a review and discussion of the methodologies used in Stages 1 and 2, and discussion of alternative approaches);

*Task 3(iii):* **Discussion of potential to generalise for whole of ASMRP** (a discussion, for each sample area, of the potential for the results of the detailed study to be extrapolated across wider area(s), or not);

- Task 3(iv):* **Evaluation of the key characteristics of minerals development** (an evaluation of the key characteristics of minerals development associated with working and reclamation for each of the main minerals resource types identified in the study);
- Task 3(v):* **Assessment of the sensitivities of each ASMRP** (an assessment of the sensitivity of the whole of each ASMRP for each of the three environmental specialist subject areas (historic environment, biodiversity and landscape);
- Task 3(vi):* **Assessment of the capacity of each ASMRP** (an assessment of the capacity (in the context of landscape, historic environment and biodiversity assets and potential) of each ASMRP to accommodate minerals extraction and provide a strategic assessment of the degree of impact that further mineral extraction would have on each);
- Task 3(vii):* **Environmental research framework for each ASMRP** (to guide archaeological, landscape and biodiversity evaluation and mitigation works associated with future minerals applications); and
- Task 3(viii):* **Production of Stage 3 Highlight Report.**

- 1.9 This report deals with Tasks 3(i) to 3(vii), inclusive.
- 1.10 Task 3(viii) is reported separately and the output files from the Geographic Information System (GIS) will form part of the project's digital archive.

## **Chronological Context**

- 1.11 Table 1.1, on the following page, reproduced from the Stage 2 Predictive Landscape Modelling report, provides a summary of the various historical, archaeological, geological and palaeo-environmental time periods mentioned throughout the rest of this report.



Historical / Cultural period	Dates	Age (years BP) <i>(Calibrated radio-Carbon years Before Present, where 'Present'= 1950)</i>	Geological /Palaeo-environmental period		
Post-Medieval	Since 1540 AD	Less than 410 BP	Sub-Atlantic	Late Holocene	Holocene (= Flandrian)
Late Medieval	1066 – 1540 AD	884 – 410 BP			
Early Medieval	410 – 1066 AD	1,540 – 884 BP			
Roman	43 – 410 AD	1,907 – 1,540 BP			
Iron Age	BC 600 – 43 AD	2,550 – 1,907 BP			
Bronze Age	BC 2500 – 600	4,450 – 2,550 BP	Sub-Boreal	Mid Holocene	
Neolithic	BC 4000 – 2500	5,950 – 4,450 BP			
Mesolithic	BC 10000 – 4000	11,950 – 5,950 BP	Atlantic	Early Holocene	
			Boreal		
			Pre-Boreal		
Palaeolithic	Upper Palaeolithic	12,800 – 11,950 BP	Younger Dryas Stadial <i>(Late Glacial / Loch Lomond)</i>	Devensian glaciation	Middle and Upper Pleistocene
		26,000 – 12,800 BP	Dimlington Stadial <i>(includes the Bølling – Allerød (=Windermere) Interstadial, around 13,000 BP, and the Last Glacial Maximum (LGM) (=Oldest Dryas), around 23,000 BP)</i>		
		38,000 - 26,000 BP	Early Devensian		
	Middle Palaeolithic	110,000 - 38,000 BP			
		130,000 - 110,000 BP	Ipswichian Interglacial	Simplified subdivision of pre-Devensian Quaternary periods	
		200,000 - 130,000 BP	Wolstonian glaciation		
	Lower Palaeolithic	380,000 - 200,000 BP	Hoxnian Interglacial		
		455,000 - 380,000 BP	Anglian glaciation		
		Pre- 455,000 BP	Pre-Anglian		

**Important note:** dates and age ranges shown in this table are based on published information from various current sources but are constantly changing as new dating evidence is obtained. For this reason there are differences between different sources.

**Table 1.1: Correlation of historical/cultural and geological/palaeo-environmental periods, with corresponding approximate dates and age ranges**

## 2. Key Environmental Characteristics

### Introduction

- 2.1 In this Chapter, the descriptions of the characteristics of each sample area (from the Stage 2 Technical Report on Sample Areas) are compared with the wider characteristics of the corresponding ASMRP, as described in the Stage 1 Technical Report and with observations from a range of other previous studies, as detailed below. The comparisons are necessarily limited to those ASMRPs for which sample areas were investigated (that is, all except ASMRPs 10, 11 and 13, as explained in the Stage 1 report).
- 2.2 As a general observation, given the small size of the sample areas in relation to the surface area and spatial distribution of the ASMRPs, the sample areas could not be expected to reflect the full diversity of character exhibited by the corresponding ASMRPs in terms of landscape, biodiversity and the historic environment. Nevertheless, similarities and differences are identified and the detailed descriptions of the sample areas are placed within wider local, regional and national contexts through reference to a range of previous reports and through knowledge of both mineral characteristics and archaeological activity in areas with broadly similar geological resources elsewhere in the UK.

### Sources of Information

- 2.3 In addition to the wide range of sources referenced within the Stage 1 and Stage 2 reports, and others referenced within this report (as listed in Chapter 11), the analysis presented below has drawn upon the following key strategic documents:
- the UK Biodiversity Action Plan (JNCC 2010), which describes the biological resources of the UK, identifies broad habitat types, priority habitats and protected species, and provides a framework for the conservation of these resources, at national and devolved levels;
  - the Regional Biodiversity Audit (YHBF 1999), which sets a framework for the integration of biodiversity into regional and local policies, programmes and processes, and promotes a more joined up approach to biodiversity;
  - the Historic Environment Study prepared to inform the former Yorkshire and Humber Regional Spatial Strategy (RSS) (Land Use Consultants 2005), which subdivided the region through the use of the 21 National Character Areas (NCAs) within this region, and then identified the regionally significant characteristics of the Historic Environment within each of these divisions;

- The Yorkshire Archaeological Research Framework draft resource assessment (Roskams & Whyman 2005), which brought together the regional SMRs (now HERs) and other data sources to give a spatial overview of the known archaeological resource across the Yorkshire and The Humber Region; and
- The Yorkshire and Humber Regional Sand and Gravel Study (McEvoy *et al.*, 2004, Land Use Consultants, 2007). The first of these identified the broad areas of sand and gravel resources in the region, and provided information on the potential environmental constraints and planning considerations associated with each of these areas. It also identified a potential methodology for environmental sensitivity analysis. The second study sought to develop and appraise spatial options for the sub-regional apportionment of the shortfall of land-won sand and gravel in the region, to 2016.

## Limitations of Archaeological Knowledge

- 2.4 As noted by Roskams & Whyman (2005) and demonstrated in various sub-regional studies (notably Howard *et al.*, 2008), there are great contrasts in topography and geology throughout North Yorkshire which affect the ‘visibility’ of surface and sub-surface remains: crop mark evidence does not show up well on certain types of soil - particularly those underlain by clay or clayey gravels - and this can distort our understanding of past human activity. Visibility has also been influenced by human activity, especially built development (which may have obscured and/or destroyed previous evidence) and intensive arable farming (which may have partially destroyed such evidence through repeated ploughing). Roskams & Whyman (*ibid.*) also recognise that parts of the region have benefitted from more evaluation and analysis of the archaeological resource than others, for a number of reasons. Examples of more intensive investigation include those which preceded the upgrading of the A1 trunk road to motorway standards, those associated with recent and ongoing mineral extraction (most notably around Nosterfield), and those associated with major, long term archaeological research (notably the work of the Landscape Research Centre in the Vale of Pickering). The latter has transformed what was once considered to be a noticeably ‘blank’ area, in terms of known archaeology, into what is now known to be an exceptional archaeological resource. For all of these reasons it is important to recognise that the archaeological characteristics of certain geographical areas and certain types of mineral resource will be much better known than others. Throughout this report it must therefore be emphasised that an **absence of evidence is not, necessarily, evidence of absence**.

## ASMRP 1: Sub-Alluvial Sand & Gravel Resources

- 2.5 The sub-alluvial gravels of ASMRP 1 occur beneath the floodplains of present day rivers, and are naturally developed to the greatest extent within the main valleys and their principal tributaries.

## Sample Areas

- 2.6 As explained in the Stage 1 report (paragraph 7.18), and in contrast to all of the other resources, two sample areas were available for ASMRP 1:
- sample area 1.1 was located within the floodplain of the River Tees, close to the village of Croft on Tees;
  - sample area 1.2 was located further south, where the River Nidd cuts through terminal moraine complex of the former Vale of York glacier, close to the village of Hunsingore.
- 2.7 The floodplain within sample area 1.1 was constrained by higher ground associated with deposits of ASMRP 4 – glacial sand and gravels. Sample area 1.2 was similarly constrained by deposits associated with ASMRPs 3, 4 and 6, with an area of river terraces (ASMRP 2) downstream of the sample area where the valley widened. Figure 2 within the Stage 2 Predictive Landscape Modelling (PLM) report provides a generic visual context for the occurrence of these different ASMRP deposits.

## Comparison of Sample Areas with the general character of ASMRP 1 and with wider contexts

- 2.8 The following sections briefly compare the key characteristics of the sample areas with the more general characteristics of ASMRP 1, as set out in the Stage 1 report, and with relevant information from other recent local, regional and national studies. The comparisons are made in relation to the three key topic areas covered by this project: landscape character, the historic environment and the natural environment. Whilst all three of these are inexorably linked together, it is useful to consider the separate components.

### Landscape Character:

- 2.9 The key landscape features observed within the two sample areas were as detailed below.
- 2.10 Sample area 1.1 was located in an area classified by the CBA Report as Landscape Character Type (LCT) 36 “Gritstone Valley” (but which, as noted in our Stage 1 and Stage 2 reports, would seem to have a much greater resemblance to LCT 24 “River Floodplain”). The site is located entirely within HLC type HNOY 4796 (Modern Improved Fields), characterised by large irregular fields defined by erratic hedgerows, subject to extensive boundary loss in the 20<sup>th</sup>/21<sup>st</sup> centuries. In terms of overall landscape character, the area is a lowland farmed river floodplain, with mature riparian vegetation. A flat landscape with views constrained within the woodland-fringed river corridor. Levees constructed for flood protection further define the landscape.
- 2.11 Sample area 1.2 was located in an area classified by the CBA Report as LCT 24 “River Floodplain”. Again, much of this area lies within HLC polygon HNOY4796 (Modern Improved Fields), but it also includes areas of Unknown Planned Enclosure, some part of this recognised

as a late medieval reorganisation of former piecemeal fields located close to the two villages. As with sample area 1.1 this is a lowland farmed river floodplain with mature riparian vegetation. Mature hedgerows and trees frame the river corridor. The landscape appears enclosed but opens up downstream of the sample area.

- 2.12 In terms of landscape character, including both LCT and HLC classifications, the two sample areas would seem to be broadly representative of the overall ASMRP 1 resource. Both sites are in low-lying areas and in agricultural use, and in both cases the landscape provides an important contribution to the setting of a conservation area located on adjoining higher ground. In broader terms, (i.e. including important historic buildings and designed landscapes as well as conservation areas) this is a characteristic feature of many ASMRP 1 floodplains throughout the County. The presence of rich riparian vegetation, as well as the mature trees, hedgerows and scrub vegetation fringing the two sites also forms an important part of the setting of these areas and is a common characteristic of ASMRP 1 landscapes.
- 2.13 Despite the broad similarities note above, the two sample areas are not representative of those parts of ASMRP 1 which fall within the more developed industrial valleys of the Wharfe and Aire. Nor are they representative of the more confined upland valleys seen in headwater areas such as the upper reaches of the Nidd. These differences, however, relate to areas which are less likely to be important in terms of mineral resources, either because of extensive existing development or because of the limited width of floodplain, respectively.
- 2.14 The regional-scale Historic Environment Study (Land Use Consultants 2005) which was used to inform the Regional Spatial Strategy (RSS) for Yorkshire and the Humber, was far less detailed than the more recent County landscape assessment (Chris Blandford Associates, 2011), which gave rise to the LCT classifications referred to above. It did acknowledge, however, that the regionally important landscape characteristics within the Tees Lowland, the Vales of Mowbray and York and the Humberhead Levels, are part of a wider river floodplain landscape which includes designed landscapes and parks, and battlefield sites, in addition to man-made water related structures.

The Historic Environment:

- 2.15 The historic environment features observed within the two sample areas include evidence of weir and mill race works, bridges, and trackways - illustrating the significance of rivers and river crossings to human activity in the past. Both sites have early origins as important crossing points. Within each of the two sites, the built form is restricted to the peripheries of the area. Whilst there were other types of monument within the sample areas that do not relate to water power or communications, these were of limited number and generally of later date. This, in itself, is characteristic of ASMRP 1 in general, partly because of poor visibility of earlier remains, but also because areas prone to flooding were not favoured for agricultural or settlement activities, and because of the limited antiquity of these areas. As explained in the

Stage 1 report (paragraph 5.38) and more extensively in the Stage 2 Predictive Landscape Modelling report (paragraph 3.31), the visible archaeological/ heritage potential for ASMRP 1 is limited in terms of surface features to the last few hundred years, although a richer resource is likely to be concealed within and/or beneath the floodplain deposits which accumulated over this period.

- 2.16 The features that are visible within the sample areas are comparable to those which would be expected more widely within ASMRP 1 (i.e. relatively recent water management and utilisation features such as weirs and leats, together with communication routes and river crossings, and proximity to parks and other designed landscapes, usually on adjoining higher ground. In the industrial valleys of the Aire and Wharfe, the use of water power contributed to the dense industrialised settlement that characterises these areas.
- 2.17 In terms of wider, regional-scale comparisons, the study by Land Use Consultants (2005, *ibid*) did not attempt to differentiate between the various mineral resources within the Vales of York and Mowbray (corresponding to ASMRPs 2, 3, 4, 6 and 9, as well as ASMRP 1). It did, however, highlight the strong association between known archaeological evidence in these areas and the principal historic north/south transport route which evolved from the Roman roads known as Ermine Street and Dere Street. Except for essential river crossing points, the main roads and settlements were originally located predominantly on higher ground away from frequent flooding (Roskams and Whyman, 2005). This was the case until the widespread introduction of drainage schemes and flood controls in the Vale of Mowbray in the 18<sup>th</sup> century, and within the Humberhead Levels in the 17<sup>th</sup> century.
- 2.18 In terms of National context, the relatively recent origin of the floodplains within North Yorkshire is comparable to the situation found within much of Northern England, particularly those areas which fall inside the limits of the last (Devensian) glaciation or which were heavily modified by glacio-fluvial outwash deposition from the Devensian glaciers and subsequent reworking to form terrace deposits. Across much of central England, however, in areas affected only by earlier glaciations, and in areas further south which were ice-free throughout the Quaternary period, the chronology of fluvial deposition and incision is quite different. In these areas, there were still adjustments to changing climate, vegetation, sediment supply, land use and isostatic rebound, but the formation of the modern river floodplains began much earlier. In the Middle Thames Valley, for example, Gibbard (1985) and Bridgland (1994) have demonstrated that the most recent fluvial sediments (the Staines Alluvial Gravels) have accumulated since the start of the Flandrian (=Holocene) period and contain archaeological evidence from the Mesolithic period onwards. As in the Yorkshire rivers, Gibbard suggests that Mesolithic people colonised emergent gravel bars early in the Holocene and used the flint to manufacture implements which were later buried by the accretion of floodplain sediments. In the Thames, these were the sediments of the present-day floodplain, in marked contrast to

North Yorkshire where the sediments formed part of the still-developing cut and fill sequence of the river terraces.

- 2.19 Much of the evidence of Mesolithic activity in the Thames valley is contained within the basal part of the floodplain sediments and on the buried surfaces of underlying gravels, but also within the present-day course of the river, suggesting that the Thames has been relatively stable since that time. Throughout the Holocene, Gibbard's (1985) synthesis of previous work suggests that there was very little further input of fresh gravel but that there was considerable aggradation of fine-grained alluvium (silt and clay) in response to the clearance of woodland by Man for agriculture. This, again, appears to be comparable to the situation in North Yorkshire except that, in that case, the fine-grained sediments occur within the lowest river terraces as well as the modern floodplain. This difference may be explained, in part, by the fact that the rivers in Northern England have continued to cut down in response to continued isostatic uplift, whereas those further south (which were unaffected by Quaternary ice sheet loading) have either remained stable or experienced isostatic lowering.
- 2.20 In the Thames Valley there are significant numbers of Neolithic causewayed camps close to the river, and also some henges. Henges are found across much of Britain, often in close proximity to rivers (Richards, 1996), as is the case with Nunwick Henge in North Yorkshire (located on ASMRP 2), the Thornborough Henges (located in ASMRP 3, but still close to the River Ure) and the largely destroyed henge at Catterick. The Thames valley gravels have been extensively quarried for aggregate and, during the course of the last century, in particular, there has been a substantial loss of significant archaeological landscapes; some of which have been archaeologically recorded.

The Natural Environment:

- 2.21 The current land use within the two sample areas is predominantly agricultural, consisting of improved grassland and arable fields divided by species-poor hedges (in sample area 1.1) and of mostly arable land with some semi-improved pasture of calcareous origin, bounded by hedgerows (in sample area 1.2).
- 2.22 Vestiges of semi-natural habitat were found in both areas, including riparian vegetation, occasional mature trees and areas of wet woodland (including Ancient Woodland within site 1.1). Such areas are the fragmented remains of much more extensive and connected habitats which once existed in these areas, prior to the intensification of agriculture and the hunting to extinction of the European Beaver (*Castor fiber*) in the sixteenth century (see the Stage 2 Predictive Landscape Modelling report, paragraph 3.33). Nevertheless, the residual habitats are important for the survival of other European protected species including bats, otter and great crested newts, evidence for all of which was found in both sample areas. Additional evidence was found in both areas of domestically protected species including water vole and

badger. The spread invasive non-native species including Himalayan balsam was noted in both areas, with American signal crayfish, and giant hogweed also being found in sample area 1.1.

- 2.23 All of these features are consistent with the characteristics to be found more widely across many parts of ASMRP 1 (though less so in the case of areas which have been heavily urbanised, such as those parts of the Wharfe and Aire valleys which fall within LCT 31 - settled, industrial valleys). All ASMRP 1 areas (including at least some parts of those within LCT 31) share the potential for the creation or enhancement of habitats such as Rivers, Wet Woodland and (Coastal and) Floodplain Grazing Marsh, which meet national BAP criteria. Furthermore, much of the agricultural land in close proximity to small towns presents additional potential for BAP habitats such as Arable Field Margins, Hedgerows, Traditional Orchards, Wood Pasture and Parkland and Lowland Meadows. The potential for BAP plant species associated with the river corridors may be limited by the abundance of non-native species throughout this ASMRP.
- 2.24 The broad characteristics of the North Yorkshire floodplains, where a wide range of priority habitats exist, but survive only as scattered remnants in limited areas, is a common factor across most river floodplains in England & Wales. With very few exceptions, rivers have been heavily managed in all but their uppermost reaches and, for many decades or even centuries, have ceased to fulfil their 'normal' role in creating the mosaic of subtle landforms and associated habitats which characterise truly natural floodplains (Peacock, 2003). The watercourses are now largely disconnected from the floodplains, except in times of severe floods, by artificial embankments flood defences and training walls. This has allowed agriculture and/or urban land uses to replace the diverse habitats which once existed and has prevented their natural regeneration.
- 2.25 A report by the former English Nature (2004) notes that *"Floodplain wetlands used to occupy a quarter of the country. They now occupy an area less than the size of Norfolk"*. Whilst not giving a very precise comparison, it conveys a similar message to that found within the study area. It also points out that many of the remaining wetland habitat fragments are unsustainable, and need to be increased in size, if further wildlife losses are to be avoided. The same document draws further attention to the resulting loss of ability for floodplains to accommodate flood water and thereby reduce flood risk to other areas.
- 2.26 If anything, the rivers of North Yorkshire, and other areas with high upland catchments which have steep, active, gravel-bed rivers such as those of the Swale and the Ure, are likely to maintain a greater range of both morphological and habitat diversity than the more sluggish lowland rivers in other parts of the country.
- 2.27 Unfortunately, although national, regional and local Biodiversity Action Plans now exist to provide a framework for monitoring the health and extent of priority habitats within many areas, the available statistics are for individual habitats and species, most of which are not unique to floodplain environments. They do not, therefore, allow for a quantitative



comparison of the extent and diversity of habitats within floodplains, either spatially, across the country, or over time in any given location. Floodplains support seven priority habitats, as listed within the updated UK Biodiversity Action Plan (BRIG (ed. Ant Maddock, 2008): *rivers, wet woodlands, lowland meadows, coastal & floodplain grazing marsh, lowland fen, reedbeds and lowland raised bog*. They may also support *ponds* and *eutrophic standing waters*. None of these, however, is exclusive to floodplain environments.

- 2.28 A more integrated approach is now emerging, however, with much greater emphasis on ecosystems, habitat networks and interconnectivity. This is reflected in Natural England's Green Infrastructure Corridors initiative (Natural England 2009), including the Yorkshire and Humber Green Infrastructure Mapping Project<sup>1</sup>. As noted in the Stage 1 report, 66% of the ASMRP 1 resources overlap with Regional-level Green Infrastructure Corridors that are associated with each of the main river valleys, whilst additional, smaller proportions overlap with Sub-Regional (12.8%) and District (6.7%) Green Infrastructure Corridors
- 2.29 These initiatives are also echoed in the Yorkshire and Humber Regional Biodiversity Strategy (Yorkshire & Humber Biodiversity Partnership, 2009) which recognises the problems of habitat loss and fragmentation - especially but not only within floodplains - and seeks specifically to encourage the improvement of functional habitat networks through working at a landscape scale as well as at a local scale: both levels of connectivity are recognised as being of vital importance.

### **Conclusions for ASMRP 1**

- 2.30 Table 2.1, below, summarises the key observations resulting from the comparison of desk study (predictive landscape modelling) and limited field observations within sample areas.

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<sup>1</sup> [http://www.naturalengland.org.uk/regions/yorkshire\\_and\\_the\\_humber/ourwork/yandhgreeninfrastructuremappingproject.aspx](http://www.naturalengland.org.uk/regions/yorkshire_and_the_humber/ourwork/yandhgreeninfrastructuremappingproject.aspx)

Predictive Landscape Modelling - summary profile	Sample Area evidence	Comparison and Key Observations
<ul style="list-style-type: none"> <li>• Flat landscapes adjacent to rivers, characterised by frequency of flooding</li> <li>• Remnants of semi-natural habitats occur within river channels, riparian vegetation and localised fen, grassland and wet woodland communities, often forming important wildlife corridors.</li> <li>• Present-day floodplain surfaces are of limited antiquity but evidence of earlier human activity may be found within and beneath the underlying sediments.</li> <li>• Historical structures are primarily linked to communications (bridges, paths, roads) and water management (drainage, flood defences and water power)</li> <li>• Traditional land use has been for seasonal grazing and hay meadow but flood defences now facilitate more intensive agriculture and built development</li> </ul>	<ul style="list-style-type: none"> <li>• Both sample areas are low lying, and in agricultural use, with rich riparian vegetation, fringed by hedgerows and mature trees</li> <li>• Upstanding monuments within the floodplains are primarily related to river crossings (bridges and fords) and to water-related buildings and structures, including mills, weirs and leats</li> <li>• A greater richness of historic environment resource, covering a much greater time period, is found close to the rivers but on adjoining higher land, with reduced flood risk.</li> </ul>	<p>The sample areas accurately reflect the summary profile for ASMRP 1, which seems likely to be typical of much of resource, except for those areas within the settled industrial valleys of the Aire and Wharfe, where much greater urbanisation is evident.</p>

**Table 2.1: Summary of the comparison of sample area evidence with predictive landscape modelling results for AMRP 1**

## ASMRP 2: River Terrace Sand & Gravel Resources

2.31 The river terraces of ASMRP 2 are the remnants of older floodplains into which the present-day rivers have incised. They are therefore found, sporadically, along parts of the same major valleys as the ASMRP 1 deposits, between the modern alluvium and the valley sides. In some cases they are also mapped along valleys where there are no significant alluvial deposits.

### Sample Area

2.32 Sample area 2 was located on river terrace deposits of the River Ure north of Ripon. The buffer zone included the small village of Nunwick and abutted the registered Park and Garden around Norton Conyers Hall.

### Comparison of Sample Area with the general character of ASMRP 3 and with wider contexts

2.33 The following sections briefly compare the key characteristics of the sample area with the more general characteristics of ASMRP 2, as set out in the Stage 1 report, and with relevant information from other recent local, regional and national studies.

Landscape Character:

- 2.34 The key landscape characteristic of the sample area is that of a low-lying farmed river terrace. This site falls within LCT 24, (River Floodplain), which covers many of the low terraces of ASMRP 2 as well as the true (active) floodplain of ASMRP 1. The buffer zone also extends into LCT 6 Magnesian Limestone Ridge.
- 2.35 In terms of Historic Landscape Characterisation, the sample area falls almost entirely within *HNY9092* - Modern improved fields, with irregular field boundaries and large-scale boundary loss. The area had previously been planned enclosure. The northern edge of the sample area is *HNY22408* Piecemeal enclosure of 18th – 19th century date with large-scale boundary loss. This area skirts the 17th- 18th century ornamental parkland of Norton Conyers Hall.
- 2.36 The sample area is predominantly characterised by arable fields bounded by hedgerows with some mature trees. In the adjoining buffer zone are the buildings of Nunwick village and Plaster Pitts Farm and the designed landscape park of Norton Conyers. There are a number of ponds created by subsidence associated with the natural dissolution of underlying gypsum deposits. It is an almost flat terrain with medium to long distance views.
- 2.37 The landscape is slightly higher, better drained and intrinsically older than that of the adjoining floodplain of ASMRP 1. The Neolithic monument of Nunwick Henge, located just outside the sample area but on a continuation of the same terrace, suggests that the depositional surface may be at least 4,450 years old and thus associated with the major phase of fluvial aggradation which resulted from early forest clearances (see Chapter 3 of the Stage 2 Predictive Landscape Modelling report). The landscape here is therefore much older and more mature than that of ASMRP 1. Whilst this allows for the survival of much older landscape features within ASMRP 2, greater influences on the development of the present day landscape here are likely to have been the reduced likelihood of flooding and the superior natural drainage, compared with ASMRP 1. These are the factors responsible for the predominance of arable, cultivated land on ASMRP 2, and the presence of traditional farm buildings (largely absent on the adjoining floodplain because of increased flood risk and, in this particular area, increased likelihood of subsidence associated with gypsum dissolution). The creation and subsequent survival of the designed parkland landscape of Norton Conyers Hall is probably a reflection of all of these factors.
- 2.38 In most of these respects, the sample area exhibits many of the expected landscape characteristics of the wider ASMRP 2 resource. The main exception relates to the phenomenon of gypsum-related subsidence, which is not characteristic of the whole ASMRP. Although such subsidence does occur elsewhere within this and other ASMRPs, it is not a diagnostic feature of any of them, occurring only where deep buried valleys cut through the succession of gypsum-bearing Permian strata. Another important exception is the contrast between rural and urban parts of the ASMRP 2 resource. Whilst the sample area is broadly representative of

other rural parts of ASMRP 2, it is quite different to those which fall within LCT 31 Settled Industrial Valleys.

The Historic Environment:

- 2.39 The main historic environment features known to occur within the vicinity of the sample area are the scheduled Neolithic henge monument close to Nunwick (site No 2001) and the registered Park and Garden and historic Hall at Norton Conyers. Within the park is known to be the site of an earlier medieval village, relocated when the park was created. There are also extensive crop mark identified features associated with ceremonial/burial sites.
- 2.40 As noted above, under landscape, there is greater archaeological potential for surface features within the terrace deposits of ASMRP 2, compared with ASMRP 1, especially in the case of those such as the one at Nunwick, which date from at least the Neolithic period. There is also still potential for older, buried archaeological evidence within and beneath the terrace gravels.
- 2.41 The degraded remains of Nunwick henge are directly aligned with the series of three prominent Neolithic henge monuments at Thornborough, some 5km to the north-west, and form part of a larger group of henges which extend, largely along along the Magnesian Limestone Ridge, from Catterick in the north to Hutton Moor and Cana Henges to the east of Ripon, in the south. Although part of the sample area was included within the NMMP and extensive crop marks were identified, the links between this site and the wider ritual landscape associated with the henge alignments have not previously been fully examined.
- 2.42 The area falls within English Heritage's ongoing 'Yorkshire Henges and their Environs Air Photo Mapping project (3908)', due for completion in March 2012, and there have been many previous archaeological studies of the area, including the very comprehensive Swale-Ure Washlands project (Bridgland *et al.*, 2011) and more detailed work focusing on application sites such as Nosterfield (see the Archaeological Planning Consultancy website for a full list of reports). The Swale-Ure Washlands report provides a detailed synthesis which links archaeological and palaeo-environmental evidence to the chronology of fluvial erosion and deposition within the area. More generally, however, with the exception of application-related projects, previous studies have tended to have a geographical focus, rather than being specific to individual geological units, such as the ASMRP 2 river terraces.
- 2.43 In terms of National context, the chronology of terrace formation within North Yorkshire is broadly comparable to the situation found within much of Northern England, particularly in valleys which received glacio-fluvial outwash deposition during the Devensian glaciation (subsequently to be reworked to form terrace sequences). As noted for ASMRP 1, however, across much of central England, in areas affected only by earlier glaciations, and in areas further south which were ice-free throughout the Quaternary period, the chronology of fluvial deposition and incision is quite different and extends over much longer periods of time,

frequently incorporating evidence of Palaeolithic occupation. One of the most comprehensive examples of this is seen in the terraces of the Middle Thames Valley, where Gibbard (1985) demonstrated, through a synthesis of many previous studies and new geological evidence, a complex sequence of alternate fluvial deposition and erosional episodes extending back several hundred thousand years to the early Pleistocene period. Palaeolithic implements have been found within the middle and latter parts of this sequence, extending back to the late Anglian stage, more than 424,000 years before present.

- 2.44 As noted under ASMRP 1, above, the Thames Valley contains significant numbers of Neolithic causewayed camps close to the river, and also some henges, comparable in their valley floor locations to the henge at Nunwick in ASMRP 2.

The Natural Environment:

- 2.45 The ASMRP 2 sample area predominantly comprises arable land with some semi-improved calcareous grassland and improved pasture bounded by hedgerows. The site lies close to the River Ure which, along with adjoining land on the opposite side of the valley, forms part of the Ripon Parks SSSI, designated for a wide range of habitats including running water, riverbanks, scrub woodland, marsh and ponds, permanent pasture and calcareous grassland. A number of ponds, created through gypsum-related subsidence, occur immediately adjacent to the sample area, including the Hall Garth Ponds SINC
- 2.46 The sample area and its immediate surroundings are either known (from previous records) or very likely to provide important habitats for a number of European Protected Species, including bats, otter and great crested newts, and for domestically protected species including water vole and badger.
- 2.47 With the exception of the subsidence-related ponds, all of these features are consistent with the characteristics to be found more widely across many parts of ASMRP 2 (though, as noted for ASMRP 1, this is less likely to be the case in areas (e.g. parts of the Wharfe and Aire valleys) which fall within LCT 31 - settled, industrial valleys). Wood Pasture and Parkland BAP habitat is found in a number of areas and the terraces of the Lower Derwent Valley contain a greater area of high quality examples of Lowland Hay Meadows than any other UK site (Yorkshire & Humber Biodiversity Forum, 2009). BAP habitats typically associated with agricultural land, such as Arable Field Margins and Hedgerows, are also likely to occur, as are Lowland Mixed Deciduous Woodland and Lowland Dry Acid Grassland (the latter, in particular, being frequently associated with nutrient-poor, free-draining soils overlying superficial deposits such as sands and gravels). Furthermore, where ponds exist (whether or not they are caused by subsidence) these are likely to qualify as BAP habitat (Ponds). There is moderate potential for BAP species such as Badger, Common Toad and various farmland birds. Brown Hare are likely to occur on all lowland arable land in this ASMRP.

- 2.48 In terms of wider, regional and national contexts for the biodiversity of river terraces, no directly relevant, strategic-level data is known to exist. However, many of the observations made earlier in relation to the floodplains of ASMRP 1 are also likely to apply here. If anything, there is likely to have been a much greater loss and fragmentation of habitats within ASMRP 2 because of the much greater suitability of these more elevated and better-drained areas for cultivation, infrastructure and built development.
- 2.49 There is, nevertheless, scope for significant biodiversity enhancement. In most cases (more than 80% in total), the ASMRP 2 resources fall within areas covered by the Yorkshire and Humber Green Infrastructure Corridors, testifying to the considerable potential in these areas for re-establishing and re-connecting important habitats and wildlife corridors. Unlike the river floodplains of ASMRP 1, it would not generally be possible (or sensible) to attempt to re-create the wetland environments which would once have existed in these areas, prior to the incision of the rivers to their present levels (the land on ASMRP 2 is now naturally well-drained and far less frequently flooded). But there is considerable scope for expanding many of the drier habitat types mentioned above. There may also be scope for gravel extraction on river terraces, at the edge of a floodplain, to locally expand the floodplain environment and its associated habitats (e.g. areas of Wet Woodland, Lowland Meadows, Lowland Fen or Reedbeds). Not only would this provide biodiversity benefits, it would also help to increase floodplain storage and thereby reduce flood risk.

#### **Conclusions for ASMRP 2**

- 2.50 Table 2.2, below, summarises the key observations resulting from the comparison of desk study (predictive landscape modelling) and limited field observations within sample areas.

<b>Predictive Landscape Modelling - summary profile</b>	<b>Sample Area evidence</b>	<b>Comparison and Key Observations</b>
<ul style="list-style-type: none"> <li>• River terraces represent the depositional surfaces of former floodplains, constructed at elevations higher than those of today.</li> <li>• They have developed throughout the post-glacial period, in parallel with human activity, and demonstrate a complex response to changes in climate, isostatic uplift, natural vegetation and land use.</li> <li>• The oldest terraces preserve important evidence of early human activity from at least the Neolithic period.</li> <li>• Later terraces bear witness to episodes of human impact including forest clearances and the spread of agriculture.</li> <li>• Site visibility is generally good on the light, well-drained soils.</li> <li>• The well-drained nature of the land and much reduced frequency of flooding have made these surfaces attractive for a wide range of more recent land uses, including historic buildings, parks and gardens and permanent settlement, as well as intensive agriculture.</li> <li>• All of these have greatly reduced the rich biodiversity which once would have characterised the terrace surfaces, although small, fragmentary remnants of semi-natural habitats still occur - often protected by environmental designations.</li> </ul>	<ul style="list-style-type: none"> <li>• The river terrace represents an older and more mature landscape at a higher elevation than the adjoining floodplain, with intensive arable agriculture on well-drained gravelly soils.</li> <li>• The sample area included the Registered Park and Garden associated with Norton Conyers Hall, and the Neolithic monument Nunwick Henge.</li> </ul>	<p>The sample area broadly reflects the summary profile for ASMRP 2, which seems likely to be typical of much of resource, except for those areas within the settled industrial valleys of the Aire and Wharfe, where much greater urbanisation is evident.</p>

**Table 2.2: Summary of the comparison of sample area evidence with predictive landscape modelling results for AMRP 2**

### **ASMRP 3: Glacio-Fluvial Sand & Gravel Resources**

2.51 Glacio-fluvial sands and gravels are the deposits of meltwater streams and rivers which issued from former glaciers and ice sheets. As explained in the Stage 1 and Stage 2 reports, during the last (Devensian) glaciation, valley glaciers occupied most of the major river valleys draining from the high ground of the Pennines and coalesced into a much broader ice sheet which extended across the Vale of York and down into South Yorkshire. A combined Scottish and Scandinavian ice sheet which flowed across the North Sea also impinged onto the coast of the North York Moors and East Yorkshire, extending inland from Filey across part of the Vale of Pickering. Meltwater from these various ice fronts generally followed the topography of the present-day valleys, often at a higher level, and also extended across some of the ‘interfluvial’ areas of higher ground between the valleys. The resulting deposits have been reworked in

many places by subsequent (post-glacial) river activity, leaving behind a more sporadic pattern of glacio-fluvial sediments.

### **Sample Area**

2.52 For ASMRP 3, the selected sample area comprised the outcrop of glacio-fluvial sand & gravel near Coneythorpe, to the north east of Knaresborough in Harrogate District.

### **Comparison of Sample Area with the general character of ASMRP 3 and with wider contexts**

2.53 The following sections briefly compare the key characteristics of the sample area with the more general characteristics of ASMRP 3, as set out in the Stage 1 report, and with relevant information from other recent local, regional and national studies.

#### Landscape Character:

2.54 The sample area falls within LCT6 (Magnesian Limestone Ridge), although the surface features in this area are controlled primarily by the superficial drift deposits (glacio-fluvial sediments) rather than by the underlying limestone bedrock. In terms of Historic Landscape Characterisation, the site incorporates HLC types HNY4958 and HNY4959 (Unknown planned enclosure consisting of medium sized irregular fields bounded by hedgerows dating from the 18th and 19th centuries), and HNY4901 - Modern improved fields – large irregular fields bounded by hedgerows but with significant boundary loss in the 20th century.

2.55 The topography of the site is dominated by a long dry valley running from south to north with adjoining land (including ASMRP 4 deposits) rising to the east and west, creating some enclosed views. There is evidence, in the presence of mature, scattered trees, of former use as estate land. Established farms (which show signs of modernisation) within the buffer zone strengthen the character of the area as a working, agricultural landscape.

2.56 The key landscape features observed within the sample area were:

- Gently rolling farmland with medium sized fields;
- Mature field boundaries, some containing mature trees as a significant feature, and small pockets of woodland on slightly higher land;
- Enclosed views within the valley, however extensive views on higher land above the valley bottom;
- A network of public rights of way.

2.57 The landscape features identified within the sample area are broadly consistent with those for other parts of the ASMRP 3 resources where these overlie the Magnesian Limestone (LCT 6), and are not dissimilar to those for other parts of the resource which fall within LCT 28 (Vale Farmland with Plantation Woodland & Heathland) and LCT 25 (Settled Vale Farmland).



Together, these three landscape types account for more than 57% of the ASMRP 3 resource outcrop and share a number of common features including gently undulating or flat topography, predominantly rural farmland with mostly arable fields, delineated by mature hedgerows. Differences, compared to LCT 6, relate to the generally lower elevation of LCTs 25 and 28, within the Vale of York, and the greater extent of woodland and dairy farming within LCT 28. Other differences, relating to some of the diagnostic features of LCT 6, such as wooded gorges, limestone crags and quarries, tend not to occur in the areas which are mantled by superficial drift deposits, such as those of ASMRP 3.

- 2.58 A further aspect to consider is the intimate relationship which typically exists between the ASMRP 3 landscapes and those associated with other glacial and glacio-lacustrine deposits in adjoining areas. As illustrated in Figure 7 of the Stage 2 PLM Report, the close juxtaposition of ASMRPs 1, 2, 3, 4 and 6 deposits, and of glacial tills, frequently gives rise, overall, to a complex, undulating landscape. This is clearly seen in the sample area and its buffer zone and is a characteristic feature throughout the Vale of York. Similar complexity exists elsewhere, as the deposits are traced up into the tributary valleys of the Swale and the Ure, and also within the Ribble and Wenning valleys in Craven District.
- 2.59 It can therefore be concluded that the sample area is reasonably representative of more than half of the wider ASMRP 3 resource, but not all of it. Other parts of the resource are associated with many different landscape types (in total, all but two of the 31 LCTs identified in across North Yorkshire). For the most part, these individual LCTs relate only to very small parts of the resource (less than 3% each) but two of them are more significant: LCT 13 (Moors Fringe) accounts for just over 8% of the resource, primarily that within the valley of Gilling Beck to the north of Richmond; and LCT 24 (River floodplain), which accounts for 18.6% of the resource. Each of these are quite different landscapes for which the sample area is not representative.
- 2.60 In terms of wider comparisons with other areas, the Cheshire Plain is a low-lying rolling landscape, comparable in many respects to the Vales of York and Mowbray, with extensive river systems draining northwards into the Dee and Mersey estuaries. The North Cheshire Plain, in particular, contains extensive sand & gravel aggregate resources, representing glacio-fluvial outwash deposits associated with meltwater from Devensian Ice sheets. This area, located between Frodsham, Macclesfield, Congleton and Tarporley, comprises gently rolling lowland farmland dominated by permanent dairy pasture, with extensive areas of forestry plantation in the west (e.g. Delamere Forest). Most woodland is on higher ground, however, and there are few traces of the ancient Royal Forest which formerly covered sixty square miles and was originally maintained for hunting by the Earls of Chester. This was largely cleared for farming by the post-medieval period. Similarly, the formerly extensive areas of lowland raised bog at Danes Moss and Lindow Moss in the North West of the County have been greatly reduced in size by agricultural reclamation. The Cheshire Historic Landscape Characterisation

(Cheshire County Council Historic Environment Team and English Heritage, 2007) identifies the main HLC type for the Cheshire Plain as Post Medieval Fields, not dissimilar in overall pattern to that seen within ASMRP 3. The land use is quite different, however, to that seen in ASMRP 3, on the much drier, eastern side of the Pennines, where arable farming predominates.

The Historic Environment:

- 2.61 The sample area may have all originally lain within a medieval deer park created out of part of the Royal Forest of Knaresborough. This area and the rest of the buffer zone were depicted in 1771 as being part of an area called 'Hay Park Farms'. The origins of at least some of the farms may relate to medieval lodges associated with Hay a Park. An extensive sinuous boundary was named as 'The Rampart' on the historic OS mapping (Site 4014). This may have originally formed the eastern boundary of Hay a Park, rather than the parish boundary located further to the east.
- 2.62 The historic environment features observed within the sample area were:
- evidence of sub-surface archaeological remains of prehistoric and undated field-systems, enclosures, and ring ditches surrounding the sample area (Sites 4002-4013) and potential for further sub-surface deposits;
  - location within the medieval Hay a Park (Site 4001); there are surface remains of a possible eastern boundary crossing through the area (Site 4014);
  - within the buffer zone there are good examples of late Georgian brick farm houses which are characteristic of the Vale of York, and which are of local historic value, and are important features of the historic landscape;
  - HLC type 'Modern Improved Fields' is predominant across the Vales of Mowbray and York, there is an underlying HLC character relating to the earlier designed landscape of Hay a Park (NYCC and EH 2010) and evidence of a random field pattern that may relate to assarting;
  - the rolling terrain creates intervisibility with more distant designated sites such as Allerton Park and House beyond the buffer zone.
- 2.63 Many of these characteristics are also found, in more general terms, across most of the ASMRP 3 deposits, with spectacular scheduled monuments, including the Thornborough Henges, being found in places. The earliest evidence for human activity is associated with nomadic hunter gatherer communities of the Mesolithic, and the surfaces of ASMRP 3 which remain intact may be expected to contain archaeological evidence of all periods from the Mesolithic onwards.
- 2.64 However, the nature of the sedimentary deposits in ASMRP 3 generally means it has a long history of cultivation and ploughing. Where archaeological features survive they are rarely identified as surface features. (In the ASMRP 3 sample area 'The Rampart' a now redundant

landscape feature associated with the boundary of Knaresborough Park was the only feature that was identifiable in the field because it had not been ploughed out). The low level of archaeological resource identified so far in this ASMRP, despite the large area studied as part of the Yorkshire Henges Mapping Project (NMMP), might be due, in part, to the fact that crop marks do not show well on certain soils. The National Mapping Programme in conjunction with the Vale of York Visibility Project (Howard *et al.*, 2008) has demonstrated that the visibility and preservation of archaeological remains across the Vale of York are closely related to the underlying substrate. Particular contrasts were observed in that study between the sandy components of the '25 foot drift' deposits of the former glacial Lake Humber (which generally exhibit high concentrations of findspots, from the Neolithic period onwards) and glacial tills (which, in common with the glacio-lacustrine silts and clays within 25ft drift, show very low concentrations across all periods). None of these deposits correspond to the glacio-fluvial sediments of ASMRP 3. However, although those sediments frequently do give rise to fairly light, well-drained soils, which may be expected to be generally conducive towards good visibility of cropmarks, they are often overlain by thin surface deposits of 'flow till' which, following the logic used by Howard *et al. (ibid)* would give rise to heavier soils and poorer visibility.

- 2.65 As noted above and explained more fully in the Stage 2 PLM report, there is likely to be little distinction between landscape character, land use and archaeological potential between ASMRPs 3 and 4, especially where these occur in close juxtaposition, across the Vale of York and elsewhere.
- 2.66 The North Cheshire Plain (as described within the landscape section above, provides a national comparator with the ASMRP 3 sample area. The Cheshire Historic Landscape Characterisation (CCC and EH 2007) and A New Historical Atlas of Cheshire (Phillips & Philips (eds), 2002) provide evidence of the many similarities between the two areas. From present day hedged rolling farmland, to past Royal Forest, and Monastic farming and industrial farming from the Cistercian Abbey at Vale Royal and others. The influence of Roman road building on the creation of small scale settlements at important river crossing and strategic sites – five Roman Roads meet at Middlewich (Strickland, 2001).
- 2.67 The earliest archaeological finds in this part of Cheshire are of Neolithic stone axes and these appear to be concentrated on former lake shores where the land was drying as the climate warmed. By the Bronze and Iron Ages, dense forest covered the Plain and Bronze Age axe finds and burial sites are more extensive on the higher sandstone areas, In the Iron Age defensive sites were located on the highest of the sandstone ridges with scattered farmsteads on the plain below (Phillips and Philips, *ibid*). The Cheshire Plain remained relatively lowly populated with Chester developed as a key fort and port by the Romans and developing as an ecclesiastical centre in the Anglo Saxon period, and other industrial related settlements continuing and developing the Roman salt industry (salt deposits are found on the earliest

crude Bronze Age pottery where salt had been gathered from the boiling of brine) (Strickland, 2001).

- 2.68 Medieval moated manor houses are also characteristic of this low lying plain, although like similar sites within North Yorkshire are largely preserved as earthwork platforms, as new houses were built elsewhere.

The Natural Environment:

- 2.69 The ASMRP 3 sample area and buffer zone consist of gently undulating arable and improved / semi-improved grassland, bounded by hedges. A small stream known as The Rampart flows through the sample area. Some small areas of semi-natural broadleaved woodland exist within the buffer zone. High proportions of the hedgerows in this area are species-rich and appear to be old. No Biodiversity Action Plan (BAP) priority habitat has been previously identified in the sample area and (other than the species rich hedgerows) no habitat or habitat features of specific conservation interest were identified during the site inspection.

- 2.70 The natural environment features observed or previously recorded within the sample area were:

- evidence of European Protected Species (EPS) including bats, otter and great crested newts;
- evidence of domestically protected species including water vole and badger;
- evidence of hedgerows qualifying as 'special' under the Hedgerow Regulations 1997;
- spread of invasive non-native species including Himalayan balsam.

- 2.71 The foregoing characteristics of the sample area suggest only limited biodiversity interest, associated primarily with mature hedgerows between agricultural fields and small areas of woodland. From the limited data available, including the landscape character descriptions noted earlier, this may well be characteristic of much wider areas of the ASMRP 3 resources - particularly the 57% of these which fall within LCTs 6, 25 and 28: these all share similar characteristics in terms of agricultural land use and field boundaries. Mature hedgerows throughout these areas are likely to meet the selection criteria for BAP habitats, and where ponds occur, these may also meet selection criteria due to the potential presence of BAP species. The species of principal importance in these areas will include bats (various species) which will utilise the numerous isolated farm steadings for roosting purposes and hedgerows for foraging and commuting. Badgers are likely to occur due to the abundance of improved and semi-improved grassland. The density of species-rich hedgerows is likely to support a wide variety of farmland bird species.

- 2.72 It is unlikely that the sample area will be representative of those parts of the resource which fall within LCT 13 (moors fringe) and LCT 24 (river floodplain) since these have quite different

land use and vegetation characteristics which, in both cases, are likely to support a much richer biodiversity.

- 2.73 Unfortunately, in the absence of any county-wide, GIS-based information sources relating to the distribution of habitats, species or vegetation communities it has not been possible, within the present study, to confirm any of the above suggestions or to compare the sample area with the biodiversity characteristics of the remaining parts of the resource.
- 2.74 The only other indications, as noted in the Stage 1 report, are that just 1.8% of the overall ASMRP 3 resource falls within one or more (mostly local) natural environment designations, whilst much larger areas (covering just under one third of the resource, mostly on the Magnesian Limestone Ridge) fall within one or another of the currently identified Biodiversity Landscape Areas and a similar proportion overlaps with the Regional-level Green Infrastructure Corridors associated with the main river valleys (particularly the Swale and the Ure).
- 2.75 These various observations suggest that ASMRP 3 as a whole may have only limited biodiversity interest at present, certainly by comparison with the mosaic of more extensive and inter-connected habitats which would have existed prior to the spread of cultivation (see the Stage 2 Predictive Landscape modelling report, Chapter 6) but that there is considerable potential for this to be enhanced. As noted in the Stage 1 report, many of the ASMRP 3 resource areas (almost 58% in total) fall within identified Green Infrastructure Corridors at regional, sub-regional or district levels, and similar observations to those given earlier for ASMRP 2, regarding opportunities for habitat creation and expansion, will therefore also apply here. Just under 30% of the resources - mostly those which overlie the Magnesian Limestone ridge, also fall within the currently identified Biodiversity Landscape Areas, giving further impetus to habitat regeneration projects.
- 2.76 In terms of wider contexts, biodiversity comparisons are extremely difficult because of the wide range of different habitat types involved and the fact that none of them is unique to this (or any other) specific mineral resource. Estimates of the cover of individual habitats within each National Character Area are readily available within the associated Natural Area Profiles produced by the former English Nature (now Natural England). These enable comparisons to be made, for example, between the relative extent of individual habitat types within the Vale of York and in the Cheshire Plain where, as noted earlier, there are broadly similar glacio-fluvial sand & gravel deposits with a lowland plain. However, because the habitats involved are common to several different ASMRPs within the Vale of York, and because the ASMRP 3 resources also occur within other NCAs, such a comparison would not be specific to those resources and would therefore not provide a relevant context. At a more general level, reference to the National Character Area profiles for the Vale of York and the Cheshire Plain (NCAs 28 and 61, respectively) confirms that both areas have suffered extensive loss of natural habitat at the expense of modern land uses, the main difference being in the type of land use

involved (predominantly dairy pasture in Cheshire and predominantly arable farming in the Vale of York).

### Conclusions for ASMRP 3

2.77 Table 2.3, below, summarises the key observations resulting from the comparison of desk study (predictive landscape modelling) and limited field observations within sample areas.

Predictive Landscape Modelling - summary profile	Sample Area evidence	Comparison and Key Observations
<ul style="list-style-type: none"> <li>• The ASMRP 3 sand &amp; gravel resources were laid down prior to any known human activity in the area. They are therefore unlikely to contain buried archaeological evidence.</li> <li>• The depositional surfaces, however, are likely to have been attractive sites for occupation by early humans in the immediate post-glacial period.</li> <li>• They can be expected to contain evidence for all periods of activity from the Mesolithic onwards.</li> <li>• The most notable prehistoric monuments are the Neolithic Thornborough Henges.</li> <li>• Site visibility is generally good on well-drained soils, but may be reduced where the sands &amp; gravels lie beneath a drape of clayey flow-till.</li> <li>• During the early Holocene, the exposed sands and gravels would have gradually vegetated along serial succession towards a climax community of dense, close-canopied broadleaved woodland. This subsequently gave way, due to human activity, to open oak, hazel and birch forests of variable tree density.</li> <li>• Today, little remains of these former habitats, which have largely been displaced by modern agriculture.</li> </ul>	<ul style="list-style-type: none"> <li>• Evidence of sub surface prehistoric remains and undated field systems and ring ditches were found within and around the sample area.</li> <li>• The sample area is a remnant of a medieval deer park which once formed part of the Royal Forest of Knaresborough.</li> <li>• Gently undulating or flat topography, predominantly rural farmland with mostly arable fields bounded by mature hedgerows.</li> <li>• Limited biodiversity interest primarily associated with mature hedgerows between agricultural fields and small areas of woodland</li> </ul>	<p>The landscape and biodiversity features identified within the sample area are broadly consistent with those for other parts of the ASMRP 3 resources where these overlie the Magnesian Limestone (LCT 6), and are not dissimilar to those for other parts of the resource which fall within LCT 28 and LCT 25. Together, these cover 57% of the ASMRP 3 resource.</p> <p>The low level of archaeological resource identified so far in this ASMRP, despite the large area studied as part of the Yorkshire Henges Mapping Project (NMMP), might be due, in part, to the fact that crop marks do not show well on certain soils, and in part to the high levels of cultivation which have ploughed out many near-surface features.</p>

**Table 2.3: Summary of the comparison of sample area evidence with predictive landscape modelling results for AMRP 3**

### ASMRP 4: Glacial Sand & Gravel Resources

2.78 Glacial sands and gravels are those which were deposited directly at the margins of the former glaciers, following transportation by ice. The resources, as mapped by the BGS, are located primarily within and at the margins of the Vale of York, indicating successive positions of the

former Vale of York glacier, as it retreated back towards the higher ground of the Yorkshire Dales at the end of the last glaciation. Within this area the deposits are preserved as residual patches (following post-glacial erosion) both within the major valleys and across many of the intervening areas.

### **Sample Area**

- 2.79 For ASMRP 4, the selected sample area comprised the outcrop of glacial sand & gravel to the south of Great Crakehall in Harrogate District. In the medieval period both Great and Little Crakehall each had open fields on a three field system, and the sample area lay within the 'East Field' of Great Crakehall (O'Hare, 1993, 19).

### **Comparison of Sample Area with the general character of ASMRP 4 and with wider contexts**

- 2.80 The following sections briefly compare the key characteristics of the sample area with the more general characteristics of ASMRP 4, as set out in the Stage 1 report and with relevant information from other recent local, regional and national studies.

#### Landscape Character:

- 2.81 The sample area falls within LCT 6 (Magnesian Limestone Ridge), though, as noted above for ASMRP 3, the surface features in this area are controlled primarily by the superficial drift deposits (glacial sand & gravel in this case) rather than by the underlying limestone bedrock. In terms of Historic Landscape Characterisation, the site falls entirely within HLC type HNY4358 (18th-19th century partially legible planned enclosure), comprising medium-sized semi-irregular fields defined by erratic hedgerows. From the desk-based assessment we now know that the fields were enclosed earlier than this, in 1598, at the time of Elizabeth I.
- 2.82 The key landscape features observed within the sample area were:
- gently rolling farmland with medium sized fields;
  - mature field boundaries, with evidence of hedge banks and ecologically interesting features;
  - land use within the study area and buffer zone is predominantly agricultural, pasture, arable with some horse grazing. However within the buffer zone the uses included scattered properties, the conservation village of Crakehall and areas of woodland. The built form is mostly made using traditional materials;
  - long views to the east and west.
- 2.83 The wider ASMRP 4 resource distribution and corresponding landscape characteristics are very similar to those for the main parts of ASMRP 3, with important distinctions between the floodplain areas (falling within LCT 24 – River Floodplains) and the adjoining landscapes

(forming parts of LCT 6, LCT 25, LCT28 and LCT 13, respectively). The main difference is that the proportion of ASMRP 4 which falls within LCTs 6, 25 and 28 is significantly higher than in ASMRP 3 (more than 75%). Given the extent to which a number of important characteristics are common to all three of these landscape types (as discussed earlier), it is reasonable to infer that the ASMRP 4 sample area should be very representative of the ASMRP as a whole, at least on landscape grounds. The general character of these areas is low-lying, gently undulating, medium to large scale agricultural landscapes with predominantly arable fields delineated by mature hedgerows, often containing mature hedgerow trees. As with ASMRP 3, the sample area is less likely to be representative of those parts of the resource which fall within LCT 24 or LCT 13, but these account only for 9% each of the total resource, whilst four other LCTs account for just over 6% between them.

2.84 The complex inter-relationship of landscape features resulting from the close juxtaposition of different Quaternary deposits within the Vale of York, as explained earlier in relation to ASMRP 3, applies equally to ASMRP 4.

2.85 The Cheshire Plain (part of NCA 61) provides a national comparison with the landscape of ASMRP 4 in North Yorkshire: The extensive rolling landscape with scattered farmsteads and associated infrastructure such as railways and rural roads are typical of both areas with rising sandstone ridges in Cheshire providing a visual break in the open more low lying landscape as the Magnesian Limestone ridge does in North Yorkshire. The Cheshire Plain LCT type Rolling Farmland, and the North Yorkshire LCT 25, Settled Vale Farmland, are both lowlands are underlain by deposits of both glacial till and glacial sand & gravel. In the Vale of York the deposits are further diversified by the inclusion of glacio-lacustrine clays and glacio-fluvial sediments creating the mosaic of deposits as illustrated in the Stage 2 Predictive Landscape Modelling Report.

#### The Historic Environment:

2.86 The historic environment features associated with the sample area are primarily related to Crakehall village, located immediately to the north and dating from at least medieval times. The buffer zone also includes 25 listed buildings, most of which are either clustered around the village green in Great Crakehall or dispersed throughout Little Crakehall. The earliest evidence of human activity is a single round barrow (Site 3030), located adjacent to the sample area. This would suggest a Bronze Age date, but there are no indications of any other associated sites or field systems from that period.

2.87 Other key features include:

- remnants of early ridge and furrow and lynchets associated with medieval agriculture;
- further evidence of ridge and furrow cultivation and enclosure, dating from the 16<sup>th</sup> century; and



- an historic railway line (Site 3026) which bisects the site.
- 2.88 Ploughing has degraded any other surface features, including tumuli which may once have existed on the tops of low knolls located within and adjacent to the sample area. Few crop marks have been identified from aerial photography, and site visibility within the sample area is generally poor.
- 2.89 The characteristics of the sample area, as outlined above, are broadly consistent with expectations for ASMRP 4 in general, or at least for those parts of the resource which are not immediately adjacent to the historic communications route of the A1/A1(M) corridor. As noted in the Stage 1 report, this largely follows the alignment of the Dere Street Roman road, and is associated with a much higher density of known archaeological evidence than other parts of the resource. Whilst this anomaly is at least partly explained by the greater intensity of archaeological investigations that have been carried out within the A1(M) corridor, it probably also reflects the historic importance of the route itself as a major line of communication and trade, and the resulting increased impetus for farming and settlement within adjoining areas.
- 2.90 The Cheshire Plain, particularly the area to the west, provides a national comparison to the historic environment of ASMRP 4 in North Yorkshire. The majority of Cheshire is characterised as HLC Type Post Medieval Fieldscape (27%) and within this there is overlap with areas of earlier enclosure associated with the development of townships (see ASMRP 4 Landscape section above). The expansion of arable farming in the 19th century was associated with the growth of fodder crops to support livestock raising and resulted in the final major 'deforestation' of the Medieval forests of which Delamere is a remnant. This later enclosure of the wider countryside is reflected in the age of farm houses and farm buildings, the majority of which date from the 19th century. There is poor visibility for archaeology in this ASMRP type, with earlier human activity located on river terraces and communication routes and the sandstone ridge.

The Natural Environment:

- 2.91 The ASMRP 4 sample area and buffer zone consist of arable, improved and neutral, semi-improved grassland. The fields are generally small and divided by hedgerows. As noted above, the sample area is bisected by a railway line which has an associated belt of small trees and scrub. No Biodiversity Action Plan (BAP) priority habitat has been previously identified in the sample area and (other than the species-rich hedgerows) no habitat or habitat features of specific conservation interest were identified during the site inspection.

- 2.92 The key natural environment features observed or previously recorded within the sample area and/or its buffer zone were:
- evidence of European Protected Species (EPS) including bats, otter and great crested newts;
  - evidence of domestically protected species including water vole, white-clawed crayfish, reptiles and badger;
  - evidence of hedgerows qualifying as 'special' under the Hedgerow Regulations 1997.
- 2.93 As with ASMRP 3, the foregoing characteristics of the sample area suggest only limited biodiversity interest. This is associated primarily with mature hedgerows between agricultural fields, small areas of woodland and areas of neutral semi-improved grassland. On the basis of the landscape character observations noted earlier, this may well be characteristic of much wider areas of the ASMRP 4 resources - particularly the 75% of these which fall within LCTs 6, 25 and 28: these all share similar characteristics in terms of agricultural land use and field boundaries. Once again, mature hedgerows throughout these areas are likely to meet the selection criteria for BAP habitats, and where ponds occur, these may also meet selection criteria due to the potential presence of BAP species. The species of principal importance in these areas will include bats (various species) which will utilise the numerous farm buildings for roosting purposes and hedgerows for foraging and commuting. Badgers are likely to occur due to the abundance of improved and semi-improved grassland. The density of species-rich hedgerows is likely to support a wide variety of farmland bird species.
- 2.94 As with ASMRP 3, it is unlikely that the sample area will be representative of those parts of the resource which fall within LCT 13 (moors fringe) and LCT 24 (river floodplain) since these have quite different land use and vegetation characteristics which, in both cases, are likely to support a much richer biodiversity. Only a small fraction of the resource falls within a range of other landscape types, each of which will have its own biodiversity characteristics.
- 2.95 As noted in the Stage 1 report, only 1.2% of the overall ASMRP 4 resource falls within one or more (mostly local) natural environment designations.
- 2.96 These various observations suggest that ASMRP 4, as a whole, may have only limited biodiversity interest at present. It would seem that there is also less potential for this to be enhanced than is the case in the otherwise very similar ASMRP 3. This is reflected in the fact that the resources have a much reduced overlap with identified Biodiversity Landscape Areas (only 7%, compared with almost 30% for ASMRP 3) and with Green Infrastructure Corridors (only 31% in total, compared with almost 58% in ASMRP 3).
- 2.97 In terms of wider contexts, biodiversity comparisons are once again extremely difficult because of the wide range of different habitat types involved, and the fact that none of them is unique to this (or any other) specific mineral resource. The comments made above, in relation to

ASMRP 3, regarding comparisons between National Character Areas, apply equally to ASMRP 4. Readily available data simply do not allow meaningful comparisons to be made, at the level of individual resource types.

**Conclusions for ASMRP 4**

2.98 Table 2.4, below, summarises the key observations resulting from the comparison of desk study (predictive landscape modelling) and limited field observations within sample areas.

Predictive Landscape Modelling - summary profile	Sample Area evidence	Comparison and Key Observations
<ul style="list-style-type: none"> <li>• The ASMRP 4 sand &amp; gravel resources were laid down prior to any known human activity in the area. They are therefore unlikely to contain buried archaeological evidence.</li> <li>• The depositional surfaces are likely to have been attractive sites for occupation by early humans in the immediate post-glacial period, although there would have been little to differentiate these areas from ASMRP 3</li> <li>• They can be expected to contain evidence for all periods of activity from the Mesolithic onwards.</li> <li>• Site visibility is generally poor, reflecting the increased clay content of the sediments and the increased likelihood of flow till at the surface</li> <li>• Vegetation succession and the growth and decline of natural habitats is likely to have been very similar to ASMRP 3.</li> </ul>	<ul style="list-style-type: none"> <li>• Remnants of early ridge and furrow and medieval lynchets were observed in the sample area</li> <li>• Ploughing has degraded other surface features such as tumuli, which may once have been visible as low knolls within the landscape.</li> <li>• Site visibility is generally poor.</li> <li>• The sample area includes fields enclosed in 1598, although much is planned 18th and 19th century enclosure bounded by hedgerows</li> <li>• Land use is predominantly arable cultivation and semi improved grassland. There is limited biodiversity interest - primarily associated with mature hedgerows between agricultural fields and small areas of woodland.</li> </ul>	<p>The sample area accurately reflects the summary profile for ASMRP 4, which seems likely to be typical of the majority of the ASMRP 4 resource 75% of which falls within the same or very similar landscape character types (LCT's 6, 25 and 28) which, despite certain differences, share many of the same broad characteristics</p>

**Table 2.4: Summary of the comparison of sample area evidence with predictive landscape modelling results for AMRP 4**

**ASMRP 5: Undifferentiated Sand & Gravel Resources**

2.99 Undifferentiated sand & gravel resources are mapped within the Vale of Pickering and appear to correspond to (or at least to include) beach deposits formed at the margins of the former ice-dammed glacial lake which occupied the whole of this area during the Devensian glaciation. The deposits extend continuously along the foot of the Chalk escarpment of the Yorkshire Wolds, from Norton-on-Derwent in the west to Muston, near Filey in the east. They also occur along the northern margin of the former lake to the south and west of Seamer, Wykeham and

Brompton, and to the south of Pickering. A further outcrop extends along the western margin of the former lake to the north west of Malton. Further out into the centre of the Vale the sands give way organic silts and clays of the former glacial lake and many open water and marshy areas survived in these areas into historic times (Menuge, 2003).

### **Sample Area**

- 2.100 The selected sample area comprised the outcrop of undifferentiated sand & gravel at Rillington, in Ryedale District.

### **Comparison of Sample Area with the general character of ASMRP 5 and with wider contexts**

- 2.101 The following sections briefly compare the key characteristics of the sample area with the more general characteristics of ASMRP 5, as set out in the Stage 1 report, and with relevant information from other recent local, regional and national studies.

#### Landscape Character:

- 2.102 In terms of Landscape Character, the site falls partly within LCT 22 (Open Carr Vale Farmland) and partly within LCT 30 Sand and Gravel Vale Fringe. All the characteristics of these LCT units are seen within the sample area. In terms of Historic Landscape Character, the site falls within HLC polygon HNY10990 - Planned large scale parliamentary enclosure. This consists of medium sized regular fields defined by straight hedges. The area has significant legibility and the enclosure dates from between 1638 and 1778 (WS Atkins, 2000). The first date is very early for planned enclosure
- 2.103 The sample area is an intensely farmed landscape with most natural features being managed to accommodate arable farming; hedgerows are fragmented and have suffered from part removal. The key landscape features observed within the site were:
- open landscape affording extensive views across the Vale of Pickering;
  - low lying level terrain;
  - planned agricultural strip farming;
  - the boundaries are geometric and regular, defined by land use rather than landform;
  - the area has a strong network of public rights of way.
  - the Malton to Scarborough Railway crosses the north western part of the buffer area and two rows of pylons run parallel to the railway line along the Vale of Pickering.
- 2.104 All of these features are also characteristic of most of the wider ASMRP 5 resource outcrop, which either coincides very closely with the Sand and Gravel Vale Fringe (LCT 30), or extends out into the flatter areas which comprise LCT 22 (Open Carr Vale Farmland), within in the Vale

of Pickering in the east, and LCT 26 (Enclosed Vale Farmland) within the Vale of Rye in the west. The site is especially typical, in landscape terms, of the outcrop which runs along the southern edge of the Vale of Pickering with the chalk escarpment of the Wolds directly to the south. It is slightly less typical of those parts of the outcrop around Wykeham, on the northern side of the vale, where the landscape is partly modified by mineral extraction and plantation woodland, or of the eastern edge of the Vale, between Seamer and Star Carr, where the topography is slightly undulating.

- 2.105 As is the case throughout ASMRP 5, the seemingly bland and managed arable landscape at Rillington provides no surface indication, to the casual observer, of the great archaeological potential which lies beneath the surface, as described in the following section.
- 2.106 In terms of wider comparisons, the Vale of Pickering has a similar geological origin (i.e. as a former ice-dammed proglacial lake) to the Humberhead levels (National Character Area 39), which have developed on the site of the most low-lying parts of the former glacial Lake Humber. This overlaps with the southernmost part of the North Yorkshire study area and extends further south into York, South Yorkshire and North Lincolnshire. Both areas exhibit flat, low-lying topography with a high water table and highly fertile organic soils which have been artificially drained in post-medieval times to facilitate modern, intensive agriculture.

The Historic Environment:

- 2.107 The key historic environment features observed within the sample area were:
- high potential for significant sub-surface archaeological remains associated with the field-systems;
  - high potential for archaeological remains from the Anglo-Saxon period;
  - potential for further prehistoric sub-surface archaeological remains within/beneath the glacio-fluvial sand deposits;
  - HLC Type planned enclosure, the Rillington enclosure is of an early date.
- 2.108 The area surrounding Rillington was included in the aerial photographic interpretation of the Yorkshire Wolds as part of the National Mapping Programme (Stoertz, 1997). The mapping revealed evidence for significant sections of Iron Age/Romano-British field systems, two square barrows and a pit alignment in the buffer zone and sample area. The density of features identified in the buffer zone is comparable to other identified complexes but the visible remains are more significant on the east side of Rillington where there are field-systems and a cemetery of around 25 square barrows (WS Atkins, 2000). Extensive cropmark evidence exists in these areas for Iron Age/Romano-British field-systems and burial sites crossing into the ASMRP sample area (Sites 5017, 5018 and 5024). More generally, aeolian (wind-blown) soil deposits may have covered and preserved features, whereas the visible cropmark sites will

necessarily be truncated by ploughing in order for them to be visible (Powlesland, 2003; MAP Archaeological Consultancy Ltd, 1992, 1993).

- 2.109 As noted in the Stage 2 reports, the Heselton Parish Project has provided a framework of archaeological research in this area over many years (Powlesland *et al.*, 1997; Haughton & Powlesland, 1999; Powlesland, 2000; Powlesland, 2003). This work has revealed both a continuum of activity throughout all periods of history and prehistory from the Mesolithic onwards, and a previously unsuspected density of sites, demonstrating the major archaeological potential of this area. The work has included discoveries of major Iron Age cemeteries at West Heselton and Rillington and an extensively excavated Anglo Saxon cemetery at West Heselton.
- 2.110 Professor Powlesland's work, based on long-term study of aerial photographs, geophysical mapping, and comparisons with other similar sites, has confirmed that the archaeological potential of this area is immense and must be a key factor in consideration of future planning and land management (Powlesland *et al.*, 1997). His work has also demonstrated that crop mark identification does not provide a true indication of the wealth of the buried archaeological resource.
- 2.111 The earliest evidence of human activity dates from the early Mesolithic and is found on the lake margins above the mire which was left as the lake drained and silted up. These observations apply equally to both the sample area and other parts of the Vale of Pickering, including all parts of the ASMRP 5 resource. In terms of archaeological potential, at least, it can therefore be concluded that the sample area is representative of the ASMRP as a whole. Moreover, as noted in the Stage 1 report, extensive survey work by the Landscape Research Centre has found few areas within the Vale of Pickering where archaeology appears to be absent, and it seems wise to treat these apparent areas of absence with suspicion.
- 2.112 Putting these observations into a regional context, an unpublished Statement of Significance produced by Dr Louise Cook of the Landscape Research Centre (Cook, 2011) notes that the Vale of Pickering includes the key archaeological sites at Star Carr, Flixton, West Heselton and Rillington, Malton and Norton, and although designation is limited to specific identified sites, the Landscape Research Project led by Professor Powlesland has revealed a complex cultural landscape.
- 2.113 There is particular potential in many parts of this area for the preservation of buried organic and other remains within waterlogged organic soils underlain by clay. This is exemplified by the well-known designated Mesolithic site of Star Carr, which is a key site in the Vale of Pickering, providing evidence of very early human activity in the area. Investigations here have also demonstrated how artificial land drainage in the past, and continuing today, is damaging this resource and is likely to be damaging others like it that have yet to be discovered. This has significant implications for future land management across the Vale of Pickering, not only

in terms of the need to avoid dewatering in relation to future mineral extraction in the area (as is presently the case), but also in terms of more general agricultural drainage and flood risk.

2.114 The Historic Environment Study by Land Use Consultants (2005), carried out in support of the Regional Spatial Strategy, identified the Vale of Pickering as one of the National Character Areas within Yorkshire and The Humber with regional importance for:

- significant archaeological deposits covered by wind-blown sand;
- distinctive settlement pattern: on the north side the settlements are close to each other just above the old lake margin and at the foot of the lime stone scarp. 'Strip' parishes extended to the north and onto the moorland. There is a similar line of villages to the south extending on to the Wolds;
- elsewhere the landscape is dominated by planned enclosure and settlement is dispersed;
- buildings are brick with pantile roofs, some stone and chalk from adjacent small quarries.

2.115 Roskams and Whyman (2005) note that the Vale of Pickering was a routeway (one of many) from the previously exposed land ("Doggerland") which now lies beneath the North Sea, but which formerly linked Britain to mainland Europe (see para 3.75 of the Stage 2 Predictive Landscape Modelling report and also Coles, 2000). With the onset of global warming during the early to mid-Holocene, the Vale of Pickering would have been one of the areas receiving an influx of immigrants displaced from the areas being flooded by the rising sea.

2.116 In terms of a wider, national context, the lessons being learned from the Vale of Pickering are very relevant to other parts of the country which were formerly at the margin of ice-dammed lakes. In particular, these include the margins of the former 'Lake Humber' which once occupied vast areas of the Southern Vale of York, the Humberhead Levels, the Lower Trent valley and the Fens of East Anglia. Beach deposits within these areas may offer similar potential for archaeological activity to that being found in the Vale of Pickering and have recently been investigated as part of the Vale of York Visibility Study (Howard *et al.*, 2008). The Humberhead Levels and Central Lincolnshire Vale also have great potential for regionally and nationally significant waterlogged and preserved archaeology based on the interpretation of topography, geology and known archaeological sites (Roskams and Whyman 2005).

2.117 Comparisons can also be made, once again, with the Thames Valley. Although the geology of the Vale of Pickering is completely different from the river gravels of the Thames Valley, the archaeology is in many ways comparable, in particular with regard to its density and character. There is a similar spread of Iron Age / Roman settlements with associated co-axial field systems. Each is separated by a relatively uniform interval along the line of the floodplain and compares to the spread of settlements along the northern and southern sides of the ASMRP 5 outcrop. In that case, the settlements are tightly constrained between the Vale of Pickering and the higher ground of the Limestone Foothills and the Yorkshire Wolds, respectively. The

communications are forced down these narrow corridors, hence it is inevitable that the settlements have a linear character, and there is a close correlation between the settlement and the Roman roads. A series of ladder settlements, identified within the geophysical survey data set, are similarly orientated along the line of the Vale of Pickering and reflect the linear spread of the settlements. Notable ladder settlements also occur in other areas of Yorkshire, for example near Castleford, where there is no comparable topographic restriction, but those do not have the same consistency of orientation.

- 2.118 By comparison, the settlements of the Thames Gravels are scattered unimproved settlements each associated with a coaxial field system and are not conjoined into ladders, they are more closely comparable with those of Skipwith in the southern part of the Vale of York.
- 2.119 The geophysics of ASMRP 5 indicates a higher density of settlement activity than that of the Thames Gravels, but on the other hand aerial photography data for ASMRP 5 is more comparable given that it shows only a small proportion of the archaeological resource. The geology of the Thames Valley would be suitable for investigation by geophysical survey but this has not, hitherto, been undertaken on the scale that has been used in the Vale of Pickering (the implication being that if a similar level of geophysics was undertaken on the Thames gravels, a comparable density of settlement remains might be revealed). However, given the greater degree of topographic constraint within ASMRP 5, it is perhaps not surprising that the settlement density of the ASMRP 5 corridor is higher than that of the Thames Gravels.
- 2.120 The enormous density of grain storage pits from Rillington closely compares with those found in abundance across the Thames Gravels however, indicating (perhaps) that, despite the differences in geology and settlement form, there are more similarities than differences between the two areas in the archaeological resource.

The Natural Environment:

- 2.121 As noted above in the landscape section, most natural features within the ASMRP 5 sample area have been intensely managed to accommodate arable farming, with some improved grassland pasture. The fields are generally small and divided by hedgerows but most of these are fragmented. Those which are intact are not substantial. There are also small areas of semi-natural deciduous and mixed woodland. The fields are generally bounded by ditches, some of which are substantial and carry running water. The area offers potential for a range of rare, scarce and protected species, including water voles, otters and perhaps badgers. Features within the adjoining buffer zone may be utilised by foraging, commuting and perhaps roosting bats. No Biodiversity Action Plan (BAP) priority habitat has been previously identified in the sample area and no habitat of specific conservation interest was identified during the site inspection.
- 2.122 The key natural environment features within the sample area may thus be summarised as:



- evidence of European Protected Species (EPS) including bats and otter;
- evidence of domestically protected species including water vole and badger;
- spread of invasive non-native species including Himalayan balsam.

- 2.123 Given the very strong similarity, in landscape terms, between the sample area and the wider ASMRP 5 resource, it would seem likely that the site is also representative from a biodiversity perspective (though this cannot be confirmed without reference to more detailed habitat and species records for the wider area). Subject to this proviso, it would seem likely that the current biodiversity interest across the resource outcrop will be limited, certainly by comparison with the diverse range of habitats which would have existed here prior to the intensification of agriculture in medieval times. That period included clearance of most of the remaining woodland that hadn't already been cleared during the Bronze Age to Romano-British periods, and extensive artificial drainage of soils (see the Stage 2 Predictive Landscape Modelling report, paragraphs 3.76 to 3.83, and also Atherden (2003) and Menuge (2001, 2003)).
- 2.124 The relatively poor biodiversity of the area at present is reflected in the fact that only a very small fraction of the resource (0.53%) has any natural environment designations (notably the River Derwent SAC and the Wintringham Marsh SSSI, near Rillington). There is, however, very considerable scope for increasing biodiversity through habitat creation and management, and almost all, (86%) of the resource falls within one or another of the current Biodiversity Landscape Areas. The predominant area of overlap (almost 77% of the resource) is with BLA 12, the Vale of Pickering, which is home to a number of target wetland and farmland bird species (pers. comm., Dr Louise Cook LRC 2011). More than 60% of the resource also falls within regional, sub-regional or district-level Green Infrastructure Corridors, thus providing further incentive and opportunity for habitat improvement and for re-connecting fragmented wildlife corridors.
- 2.125 Within the central Vale, the watercourses and managed drainage systems regulate the flow of surface water and allow intensive agriculture to take place. As noted earlier, such drainage has been shown to have a detrimental effect on waterlogged archaeological remains. It also restricts the biodiversity which would otherwise be expected if the land were undrained. Particular opportunities therefore exist to reduce these effects by allowing the hydrological regime to return to a more natural condition. In recognition of this, the Cayton and Flixton Carr Wetland Project is designed to restore parts of these areas as grazing marsh, with wet ditches, seasonal pools and pockets of wet woodland and reed bed (Cook, 2011). These and other peat sites, such as Pickering Carrs in the north west, Wykeham Carr and Hutton Buscel Carr in the east and Hertford Carrs in the east may provide important wetland habitats for palaeo-vegetational reconstruction.

2.126 Comparisons can be made with the work by Natural England and the Environment Agency to reverse the decline in the condition of lowland raised bogs (which has resulted from agricultural drainage and/or commercial peat extraction), through the creation of 'hydrogeological buffer zones' around the margins of these degraded conservation sites (Symonds Group 2004; Morgan Jones *et al.*, 2005; Capita Symonds 2005). Such work, which is being implemented through Water Level Management Plans, is designed to allow water levels to be raised within the designated sites, thereby facilitating a return to more favourable conditions for the protected habitats.

**Conclusions for ASMRP 5**

2.127 Table 2.5, below, summarises the key observations resulting from the comparison of desk study (predictive landscape modelling) and limited field observations within sample areas.

<b>Predictive Landscape Modelling - summary profile</b>	<b>Sample Area evidence</b>	<b>Comparison and Key Observations</b>
<ul style="list-style-type: none"> <li>• The ASMRP 5 resources represent beach and deltaic sediments laid down at the margins of the former Lake Pickering (an ice-dammed proglacial lake)</li> <li>• The Vale of Pickering is recognised as having one of the highest concentrations of archaeological activity in Britain, with substantial evidence from all periods of human activity, from the early Mesolithic onwards.</li> <li>• The buried resource is frequently buried beneath wind-blown cover sands and/or has been subject to centuries of intensive cultivation.</li> <li>• Site visibility is therefore low - crop marks are not good predictors of archaeological potential in these areas.</li> <li>• The buried resource includes organic and other waterlogged remains which are at risk from agricultural drainage and (potentially) from quarry dewatering.</li> <li>• Almost all of the rich biodiversity which once would have characterised this area has already been lost, though there is scope for valuable habitat regeneration in many areas.</li> </ul>	<ul style="list-style-type: none"> <li>• The sample area at Rillington is a low lying open landscape offering extensive views across the Vale of Pickering. The field boundaries are geometric and regular, defined by land use rather than land form.</li> <li>• The area had an existing evidence base for sub-surface archaeological remains from the prehistoric and Anglo Saxon periods as well as significant Iron Age and Romano British field systems. The remnant sub surface landscape is not visible on site, however, being either masked by overlying sediment and/or degraded by ploughing.</li> <li>• Intense management of the land for agriculture has fragmented habitats, although there are small areas of semi-natural deciduous and mixed woodland, and the ditches are substantial and carry running water.</li> </ul>	<p>The sample area is typical of the ASMRP 5 landscape at the foot of the Wolds. It matches all the main characteristics of this ASMRP seen in Stage 1 and accurately reflects the summary profile.</p> <p>The area is slightly less typical of the parts of the landscape on the northern side of the Vale near Wykeham where there has been large scale mineral extraction and plantation woodland screens the extraction site, or of the slightly more undulating land to the east between Seamer and Star Carr.</p>

**Table 2.5: Summary of the comparison of sample area evidence with predictive landscape modelling results for AMRP 5**

## **ASMRP 6: Quaternary Brick Clay Resources**

- 2.128 Fine-grained glacio-lacustrine sediments (clays and silts) accumulated on the beds of both large and small glacial lakes at the margins of the Vale of York glacier. Remnants of these deposits are widely preserved throughout this area, notably within the central and southern parts of Hambleton District, the eastern parts of Harrogate District, the south western part of Ryedale District and throughout much of Selby District.

### **Sample Area**

- 2.129 For ASMRP 6, the selected sample area comprised the outcrop Quaternary brick clay resources located directly east of the villages of Monk Fryston and Hillum in Hambleton District.

### **Comparison of Sample Area with the general character of ASMRP 6 and with wider contexts**

- 2.130 The following sections briefly compare the key characteristics of the sample area with the more general characteristics of ASMRP 6, as set out in the Stage 1 report, and with relevant information from other recent local, regional and national studies.

#### Landscape Character:

- 2.131 The sample area and its buffer zone both fall within LCT 23 (Levels Farmland). In terms of Historic Environment Characterisation, the site falls partly within HLC polygon HNY6007 (Planned large scale parliamentary enclosure) and partly within HNY5107 (Modern improved fields). The first of these areas consists of legible parliamentary enclosure of parts of both the Hillum and Monk Fryston awards (dated 1797-1811) with medium sized regular fields defined by straight hedgerows. The second area comprises large prairie fields which have been created by the large scale removal of earlier field boundaries. These modern fields are defined by erratic ditches.
- 2.132 The key landscape features observed within the sample area are:
- very Low lying flat terrain;
  - mixed landscape use and scales of use including farming and large scale industrial development;
  - an open landscape affording extensive views in all directions;
  - small watercourses (Ings) and drainage ditches run adjacent or act as field boundaries;
  - this is a landscape that in many areas has been drained to allow it to be used more intensively for growing crops. The drainage ditches define the pattern of the landscape.

- 2.133 There is evidence of smaller-scale historic field patterns in the linear and rectangular arrangement of boundaries, but these are overlain by modern land uses and large-scale industrial features now dominate the landscape. The buffer zone is similar in character although field sizes are larger and scattered farm buildings give way to the villages of Hillam and Monk Fryston to the west. These villages are typical of many in the North Yorkshire landscape, comprising of nucleated settlements, vernacular building materials and surrounded by agricultural land use.
- 2.134 The LCT 23 classification is the most common landscape type within the wider ASMRP 6 resource, covering almost one third of the total outcrop, almost entirely within the Humberhead Levels. Other parts of the resource occur mainly within LCT 28 (Vale Farmland with Plantation Woodland & Heathland - primarily within the Vale of York) and to lesser extents within LCT 25 (Settled Vale Farmland - mostly within the Vale of Mowbray), LCT 24 (River Floodplains) and LCT 6 (Magnesian Limestone Ridge). To varying degrees, most of these have a number of key landscape features in common with LCT 23, including the predominance of arable agriculture and lowland terrain (the latter being less evident in LCT 6). All of them are also characterised by a predominance of the HLC type Modern Improved Fields. In each of these respects, the sample area may be considered representative of the ASMRP 6 resources as a whole. But there are also some important differences, as outlined below.
- 2.135 In many places, particularly within LCT 23 and parts of LCT 28, the landscape is intensively drained, but this is not the case in LCT 6. In the Vales of York and Mowbray the field boundaries are primarily defined by mature hedgerows, but ditches become predominant in the flatter and wetter Humberhead Levels whilst drystone walls sometimes replace hedges within LCT 6. In the southernmost part of the ASMRP the large cooling towers and electricity pylons that are aligned with the Humber estuary are over-scaled features within the flat landscape but these become progressively irrelevant to the landscape character further north.
- 2.136 In terms of wider comparisons, the landscapes of ASMRP 6 have many similarities to those of the Lancashire and Amounderness Plain (National Character Area 32). This is a low-lying, relatively flat and gently rolling plain characterised by high grade agricultural land. Unlike ASMRP 6, the clay subsoils here are largely of glacial till and marine origin, rather than glacio-lacustrine sediments, but the overall effect on landscape character is very similar. Lowland raised mounds occur within the flattest parts of both areas, and both have been extensively drained, largely during the 18<sup>th</sup> century, to facilitate large scale modern agriculture and horticulture. A key difference within NCA 32 is the lack of hedges and the network of lanes and tracks around rectilinear fields.

The Historic Environment:

- 2.137 Neither the sample area nor the buffer zone has been subject to any previous archaeological excavation and there are no designated archaeological sites or historic buildings. The land was

once owned by Selby Abbey and was enclosed at the end of the 18th/early 19th century. Areas of ridge and furrow and grubbed-out field boundaries have been observed through aerial photography (Vale of York NMP, Kershaw, 2001).

2.138 The key historic environment features observed within the sample area were:

- the extent of sub-surface archaeological features remains unknown. Aerial photography has not revealed cropmarks but the brick clay geology may not be conducive for displaying cropmarks;
- HLC Type – Planned Large Scale Parliamentary Enclosure and Modern Improved Fields reflecting the influence of agricultural improvements over two centuries;
- the ridge and furrow, where identified at the sample area, is typically narrow, and is likely to reflect post-medieval ploughing;
- the setting of the Monk Fryston Conservation Area and the Hillam designated site within the existing very open landscape.

2.139 The archaeological resource identified within the sample area was very limited, both in terms of existing records and new observations, with no evidence of pre-medieval activity. To a large extent this is thought to reflect the low site visibility associated with the heavy clay sub-soils which characterise this resource. However, it is also likely that, prior to large scale drainage of such areas, commencing in the post-medieval period, the poorly drained nature of the land would have deterred human activity. Equally, the lack of evidence might be due to the limited extent of recent development in this rural area, and/or the intensive level of modern agriculture, which in turn has limited the recovery of artefacts.

2.140 The National Mapping Programme, in conjunction with the Vale of York Visibility Project (Howard *et al.*, 2008) has demonstrated more widely that there are very low numbers of cropmark sites associated with the glacio-lacustrine silt and clay components of the '25 foot drift' deposits of the former glacial 'Lake Humber', some of which correspond to ASMRP 6. Indeed, almost all of the cropmarks identified by Howard *et al.* (*ibid*) within the 25ft drift are located in areas of sandier sediments within or at the edges of those deposits. Whilst these observations corroborate the findings of the present study in terms of the correlation between site visibility and geology, they still leave open the question of cause and effect, as discussed above. Whatever the explanation, although clay soils may restrict the ability to recognise sites, this is at least partly a reflection of the site visibility should not be taken to indicate an absence of early human activity.

The Natural Environment:

- 2.141 The natural environment features observed within the sample area were:
- evidence of European Protected Species (EPS) including bats and otter;
  - evidence of domestically protected species including water vole and badger.
- 2.142 As noted above, the ASMRP 6 sample area and buffer zone consists primarily of intensively managed arable land with some improved grassland pasture. The fields are generally large and are mostly bounded by ditches, some of which are substantial and carry running water. Hedgerows are largely fragmented and defunct, but some parts of these remain intact. Mature trees within former hedgerows are often isolated. No Biodiversity Action Plan (BAP) priority habitat has been previously identified in the sample area and no habitat of specific conservation interest was identified during the site inspection.
- 2.143 Given that the sample area is considered to be representative of at least one third of the wider ASMRP in terms of landscape character, and at least partially representative of many other parts of the resource, it may be expected that the same will apply regarding features of the natural environment. As with ASMRP 5, the intensity of agricultural management within ASMRP 6 can be expected to have minimised biodiversity interest, although some important features do remain, including remnants of mature hedgerows, occasional mature trees, isolated farm buildings and, within the Humberhead Levels especially, an extensive network of drainage ditches and ephemeral ponds.
- 2.144 There are also opportunities for these remnant habitats to be extended, improved and reconnected. 37% of the ASMRP 6 resources fall within regional, sub-regional or district level Green Infrastructure Corridors, and 23% of the resources coincide with identified Biodiversity Landscape Areas. These are primarily within the lower Aire and Went valleys but also to some extent within the Magnesian Limestone and elsewhere.
- 2.145 In terms of wider contexts, biodiversity comparisons are once again extremely difficult because of the wide range of different habitat types involved, and the fact that none of them is unique to this (or any other) specific mineral resource. Thus, while comparisons might be made between ASMRP 6 and other areas, such as the Lancashire and Amounderness Plain (National Character Area 32), which have certain topographic and geological similarities, meaningful comparisons cannot be made at the level of individual resource types, because of the lack of readily available resource-specific biodiversity data.

**Conclusions for ASMRP 6**

- 2.146 Table 2.6, below, summarises the key observations resulting from the comparison of desk study (predictive landscape modelling) and limited field observations within sample areas.

Predictive Landscape Modelling - summary profile	Sample Area evidence	Comparison and Key Observations
<ul style="list-style-type: none"> <li>• ASMRP 6 resources form part of a complex mosaic of Quaternary glacial sediments which occupy the low-lying areas of the Vales of York, Mowbray and the Humberhead Levels</li> <li>• As the lakes drained and silted up at the end of the glaciation, they will have gradually been transformed into areas of wetland marsh and mire - unattractive areas for human occupation</li> <li>• The lake margins and intervening areas (including ASMRPs 3 and 4) would probably have been utilised to a much greater extent</li> <li>• Poor site visibility on heavy clay soils, and the limited extent of development-related excavations greatly hinders knowledge of any early historical development that might have taken place</li> <li>• The potential for well-preserved archaeological deposits in these areas therefore still remains.</li> <li>• The modern agricultural landscape developed only after post-medieval drainage, and displaced the former wetland habitats.</li> </ul>	<ul style="list-style-type: none"> <li>• The sample area is an open landscape, flat and low lying with intensively managed arable land use and some improved pasture.</li> <li>• There are extensive views in all directions. There is large scale industrial development and large cooling towers are a dominant feature in views.</li> <li>• There is an area of parliamentary enclosure with medium sized, hedged fields, but elsewhere there are large, prairie style fields where earlier boundaries have been removed.</li> <li>• Biodiversity is limited but there are remnants of mature hedgerows and occasional mature trees. These together with isolated farm buildings and drainage ditches provide opportunities for a number of protected species.</li> <li>• There has been no previous archaeological study recorded of this site. Aerial photography has revealed signs of earlier ridge and furrow cultivation (Kershaw 2001), but no crop marks are evident within the sample area</li> </ul>	<p>The sample area accurately reflects the summary profile for ASMRP 6.</p> <p>The lack of archaeological evidence is consistent with the low site visibility associated with heavy clay soils, but could also be consistent with a lack of early human activity prior to post-medieval drainage of the former wetland.</p>

**Table 2.6: Summary of the comparison of sample area evidence with predictive landscape modelling results for AMRP 6**

## ASMRP 7: Cretaceous Chalk Resources

2.147 Cretaceous Chalk deposits of ASMRP 7 underlie the whole of the Yorkshire Wolds and their geological characteristics are responsible for the overall morphology and elevation of this area. They represent an extensive resource that has been used in the past as a source of both agricultural lime and (in neighbouring East Yorkshire and Humberside) for cement manufacture. The Wolds form a mature limestone plateau (c. 150m above sea level) dissected by a dense network of steep-sided dry valleys (Foster, 1987).

## Sample Area

2.148 The selected sample area for ASMRP 7 comprised the outcrop of Chalk resources to the south of Duggleby, in Ryedale District.

## Comparison of Sample Area with the general character of ASMRP 7 and with wider contexts

2.149 The following sections briefly compare the key characteristics of the sample area with the more general characteristics of ASMRP 7, as set out in the Stage 1 report, and with relevant information from other recent local, regional and national studies.

### Landscape Character:

2.150 The sample area and its surrounding buffer zone both fall within the largest of the Landscape Character Types within ASMRP 7: LCT 18 (Chalk Wolds). They form part of the high plateau surface, with its characteristic broad, rolling landform. In terms of Historic Landscape Characterisation, the site falls within HLC polygon HNY9242 (Large scale private enclosure). This is an area of planned enclosure which is almost certainly part of the Kirby Grindalythe enclosure by agreement and consists of medium sized fields defined by straight hedges. It has significant legibility with less than 10% boundary loss. This aspect of the landscape contrasts with the immediately surrounding areas, which are dominated by modern improved fields with a large degree of boundary loss.

2.151 It is a simple yet attractive landscape with a high skyline and expansive views, interrupted only by low hedgerows and few mature hedgerow trees. The sample area has strong intervisibility with the buffer zone and the surrounding landscape.

2.152 The key landscape features observed within the sample area are:

- expansive, elevated rolling landscape;
- principally arable land use;
- medium-sized fields defined by straight hedgerows
- rural and remote;
- an open landscape affording extensive views in all directions.

2.153 Topographically and in general landscape terms, the character of the sample area is typical of the LCT 18 Chalk Wolds, which covers almost 70% of the whole ASMRP 7 resource outcrop. The principal differences, compared with other parts of LCT 18, are seen in the HLC classification: for most of that landscape unit, the dominant HLC types are Modern Improved Fields (41%) and Planned, Large-scale Parliamentary Enclosure (37%). The sample area is therefore relatively unusual in having only medium sized fields and limited boundary loss.



- 2.154 Most other parts of the Chalk outcrop are also dominated by intensively managed large scale agriculture, but there are important landscape differences, mostly linked to topography. The valley of the Gypsey Race (LCT 20, Broad Chalk Valley) has a similar, very open character but is less exposed than the high plateau surfaces and has a lightly settled landscape with a pattern of linear villages and minor roads, largely contained within the valley floor. The Chalk Foothills of LCT 19 are very different, being mostly characterised by steep, clearly-defined scarp slopes, a general absence of development, swathes of species-rich Chalk grassland, numerous blocks of deciduous woodland and long, open views across adjoining lowland landscapes. The remaining parts of ASMRP 7 fall within other, much smaller landscape types, each of which has its own distinctive character, as described in the Stage 1 report.
- 2.155 It may be concluded that, whilst the sample area may be representative, in all except field size, of the majority of the ASMRP 7 resources, this is not the case for the remaining 30% of the area.
- 2.156 In terms of placing ASMRP 7 within a wider, national context, very similar Cretaceous Chalk resources are found in many parts of southern and eastern England, each with its own distinctive, but broadly similar landscape of lightly settled rolling hills, arable fields, close-cropped grassland on bold scarps, rounded open ridges and sculpted dry valleys. Examples include the South Downs, which now has National Park Status, and the Lincolnshire Wolds, the Chiltern Hills, the North Wessex Downs, Cranborne Chase & West Wiltshire Downs and the Kent Downs, which all have AONB status. In this respect, the Yorkshire Wolds are unusual in not being included within a national landscape designation, though they are not unique in this respect (other examples include Salisbury Plain).

The Historic Environment:

- 2.157 The key historic environment features observed within the sample area were:
- Duggleby Howe Scheduled Monument is a major upstanding earthwork with a wider ritual significance in the landscape;
  - this site has potential for surviving sub-surface remains of further significant prehistoric archaeological sites. Known sub-surface archaeological remains include the Wold Entrenchments (Sites 7014, 7015 and 7019), part of a barrow cemetery (Sites 7002-7004) and a disused chalk pit (Site 7021);
  - HLC Type Large Scale Private Enclosure.
- 2.158 The site survey confirmed that intense agricultural use has resulted in poor site visibility today as many early remains have been ploughed flat. The loss of topsoil means that in many places the chalk is more highly visible than in past centuries. A corollary of this is that, in adjoining lower areas, there is greater potential for buried archaeological deposits from the Mesolithic

period to be found below re-deposited top soil in the valley floors, as noted by Roskams and Whyman (2005).

- 2.159 Despite this, the known archaeological resource is high in comparison to many of the other ASMRP sample areas and more generally, based on data gathered in Stage 1 (Stage 1 report CSL 2011). The exposed chalk geology is particularly conducive to revealing crop mark evidence, and previous findings have highlighted a rich multi-period landscape typified by field-systems, barrows and ladder settlements in the surrounding region. (Stoertz, 1997).
- 2.160 Unstratified prehistoric finds have previously been retrieved from the sample area (Roskams and Whyman 2005). The earliest evidence from within the sample area consists of prehistoric worked flints and a sandstone rubber retrieved during evaluation.
- 2.161 There is cropmark evidence for the 'Wold Entrenchments', a system of large-scale territorial boundaries probably dating to at least the Middle Bronze Age (7015, 7017 and 7019). A probable contemporaneous barrow cemetery was identified on the crest of the plateau on the south edge of the sample area containing cropmarks of at least 11 ring ditches (group 7001), only three of which are in the area (7002-7004) (Stoertz, 1997).
- 2.162 The more general character of the heritage resource across the Wolds is very broadly a combination of the medieval settlement around the margins and prehistory remains across the upland areas, and this is reflected in the sample area which is predominantly prehistoric in character, with some post-medieval chalk extraction pits.
- 2.163 As found within the sample area, present day site visibility is poor, reflecting the fact that most of the Wolds have been subject to intensive cultivation in the twentieth century. The high identified resource reflects that in the past there was much improved site visibility by comparison with the present, and that the former earthwork features show up as crop marks in certain conditions.
- 2.164 The Wolds is an area that has been much excavated and researched for many years, with land owners in the 19<sup>th</sup> century carrying out extensive excavations on a series of round barrows. However, barrows had already been levelled in earlier periods through agricultural activity (Stoertz 1997) and it is only the very large upstanding monuments like Duggleby Howe that continue to have a dominant presence in the landscape. By the 1850s most of the old sheep walks, warrens and unenclosed fields had vanished, and surveyors acting for large estate owners had recorded the destruction of barrows, ancient earthworks and the sites of medieval villages, as the Wykeham, Scampston and Hovingham estates gradually redesigned the landscape (Stoertz 1997).

- 2.165 There is increasing knowledge of the period 1000BC – 1500 AD through excavations at sites such as West Heslerton, Wetwang and Wharram Percy with results that can be interpreted across the region (Fenton-Thomas, 2005).
- 2.166 In terms of placing the sample area and the Yorkshire Wolds in general within a wider context, comparisons can be made with other areas of chalk resources further south. Part of the Lincolnshire Wolds is included within the Yorkshire and The Humber region and provides the nearest comparator. This area has not had the same intensity of research interest as the Yorkshire Wolds (Roskams and Whyman 2005), although it has yielded evidence for some of the oldest human remains in Britain (Land Use Consultants 2005). It does not appear to have had the same intensity of agricultural use as the Yorkshire Wolds either, with greater recorded site visibility of hill top barrows and Iron Age trackways. There is a known Roman route to a coastal salt making site. Today's landscape reflects a transformation brought about by parliamentary enclosure which resulted in miles of new hawthorn hedges and individual farmsteads, interspersed with large Georgian houses, parks, planted shelter belts and coverts in the previously open grassland landscape. This designed aspect of the landscapes echoes the impact of large states such as Sledmere on the landscape and built character of the Yorkshire Wolds in the same period.
- 2.167 Regional-scale comparisons can also be made with other areas. The Vale of Pickering, for example, shows a similar high level of Anglo saxon activity to that on the Yorkshire Wolds (Stoertz 1997). Also, discoveries associated with the Iron Age Arras culture are predominantly from the Wolds (Stoertz 1999) but Arras style cart and live stock burials have been found at Skipwith in the Vale of York and further south at Ferrybridge as well as sites in the Vale of Pickering suggesting a wider spread for the elite Arras culture (Roskam and Whyman 2005).
- 2.168 On a more national scale, comparisons can be made with the Berkshire Downs which is also a chalk landscape. The Berkshire Downs, famed for such sites as the Uffington White Horse, has large territorial earthen boundaries extending across much of the landscape, very similar to the situation on the Wolds. There is also a large predominance of burial monuments, most notably round barrows, but also long barrows, indicative of considerable Neolithic activity. The funerary landscape compares well to that of the Wolds, but significantly there is not much in the way of early settlement remains on the Berkshire Downs.
- 2.169 Like the Wolds, the Berkshire Downs is a landscape that has been subject to recent plough disturbance and there is good survival of crop marks, revealing earlier field systems and funerary remains, as well as settlements from later periods, now deserted. Many of the fields are the rectilinear 'Celtic' field systems that are similar to many of the crop mark field systems of the Wolds.
- 2.170 In the Roman period there were a number of villa sites and examples include the Maddle Farm site (Gaffney and Tingle 1989).

2.171 In the medieval period the villages predominate along the edges of the Berkshire Downs, most notably along the spring line, with the parish boundaries extending up into the area of the Downs. They thus are afforded the upland grazing and the lowland arable from a single location. This closely mimics the character of the medieval nucleated settlement along the northern margins of the Wolds.

The Natural Environment:

2.172 The ASMRP 7 sample area and buffer zone is dominated by arable land on calcareous soils. The fields are medium to large and divided by hedgerows. However, a high proportion of the hedgerows are defunct and fragmented, and some field boundaries have been removed all together. Some very small areas of semi-natural broadleaved and mixed woodland exist primarily in abandoned quarries where the land cannot be farmed.

2.173 A single Site of Special Scientific Interest (SSSI) occurs in the buffer zone. This is known as Stonepit and Nova Slacks and is designated as a small area of chalk grassland with species rich calcareous grassland and scrub. The latest SSSI condition assessment identified 100% of the SSSI as being in unfavourable – recovering condition. Stonepit and Nova Slacks is also a local wildlife site (non-statutory designation).

2.174 The key natural environment features observed within the sample area were:

- evidence of domestically-protected species including badger;
- spread of invasive non-native species including Himalayan balsam;
- management of the Stonepit and Nova Slacks SSSI and of the associated SINC (outwith the SSSI).

2.175 Within such a heavily modified agricultural landscape, the habitats likely to qualify as BAP habitats are those typically associated with agricultural land. Given the underlying geology and thin calcareous soils, there is a good potential for semi-natural Calcareous Grassland to be established in any areas not under intensive agricultural management. Such grassland would be likely to support a diverse invertebrate assemblage, with the potential for BAP species to occur. Brown hare are likely to occur (possibly in high density) in all areas of this ASMRP.

2.176 Broadly similar observations are likely to apply to the majority of the chalk outcrop, i.e. the 82% of it which falls within LCT 18 (Chalk Wolds) and LCT 20 (Broad chalk valley), though this cannot be confirmed in any detail without reference to detailed habitat surveys. Quite different conditions are likely to be found, however, within the narrow chalk valleys (LCT 21) and the chalk foothills (LCT 19), where the steeper slopes have been less favourable for modern intensive farming. As previously noted, these areas include swathes of species-rich chalk grassland and blocks of deciduous woodland. The narrow valleys around Thixendale are

host to the main concentration of biological SSSIs anywhere on the Wolds. Overall, there is potential in these areas for a more diverse flora and fauna, and potential nuclei for managed enhancement of biodiversity across a wider area. This is partly reflected in the distribution of biodiversity opportunity areas, although these also occur within small valleys and scarp slopes within the main upland plateau of LCT 18. Much larger areas of the plateau surface (including the sample area) and most of LCT 20 fall within Biodiversity Landscape Area 15 (the West Wolds). In total, this covers 41% of the ASMRP 7 resources.

- 2.177 In terms of understanding the full biodiversity potential of these areas, consideration needs to be given to the range of vegetation communities and habitats which are likely to have existed here in the past (prior to the introduction and later intensification of arable farming), but also to the changes in climatic conditions which have taken place since those times. Palaeo-environmental evidence is more limited for the Wolds than for many other areas, because of the lack of peat deposits and lake sediments (which elsewhere provide good palynological evidence for changes in vegetation). While it has been shown that dense areas of forest existed in other parts of Yorkshire during the climatic optimum of the mid-Holocene (c. 8,000-5,000 cal BP) it is likely that only a light woodland canopy was established on the Wolds, reflecting the different geology, in combination with altitude and relatively low rainfall, compared with areas further west. Evidence from Willow Garth (Bush and Flenley, 1987) shows that herbaceous plants were important elements during this period. Open grassland habitats appear to have been a continuous landscape element since the Late Glacial period (c. 12,800 to 11,950 cal. BP), at least locally, although the species composition has changed greatly over time (Bush, 1993). The Late Holocene (c. 5,000 cal BP to present) has seen increasing human impact on vegetation and land use. On the Wolds, much of the landscape became a “sheepscape” (Atherden, 1998), taking advantage of the natural grassland but arable farming now dominates in many areas.
- 2.178 Information contained in the Natural Area Profile for the Yorkshire Wolds (English Nature, North East & Yorkshire Team, 1997) notes that conversion to arable farming, improvement by reseeded and chemical treatments and to a lesser extent afforestation have resulted in large-scale losses of chalk grassland in that area in recent decades, with an estimated loss of some 35% of this habitat during the 1980s alone. It also notes that this area as a whole has less than 1,000 ha of high quality (wildlife-rich) chalk grassland remaining.
- 2.179 In terms of wider contexts, biodiversity comparisons are somewhat easier than for other ASMRPs because of the more restricted range of habitat types involved. Particular attention can be given to the survival of lowland calcareous grassland within the Yorkshire Wolds and other areas of chalk landscapes in southern and eastern England. Overall, reference to the UK BAP national archives<sup>2</sup> confirms that this priority habitat has suffered a sharp decline in extent throughout the country over the last 50 years. There are no comprehensive figures but a

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<sup>2</sup> <http://webarchive.nationalarchives.gov.uk/20110303145213/http://ukbap.org.uk/UKPlans.aspx?ID=12#1>

sample of chalk sites in England surveyed in 1966 and 1980 showed a 20% loss in that period and an assessment of chalk grassland in Dorset found that over 50% had been lost between the mid-1950s and the early 1990s. Current estimates put the amount of lowland calcareous grassland remaining in the United Kingdom at around 33,000 to 41,000 ha, with almost all of this in England. The bulk of the resource is found on chalk (25,000 to 32,000 ha), with major concentrations in Wiltshire, Dorset and the South Downs. By comparison with those areas, the Yorkshire Wolds have clearly fared much worse in terms of the survival of this priority habitat.

**Conclusions for ASMRP 7**

2.180 Table 2.7, below, summarises the key observations resulting from the comparison of desk study (predictive landscape modelling) and limited field observations within sample areas.

<b>Predictive Landscape Modelling - summary profile</b>	<b>Sample Area evidence</b>	<b>Comparison and Key Observations</b>
<ul style="list-style-type: none"> <li>• The Yorkshire Wolds were ice free during the last glaciation, but the earliest evidence of human activity in this area is from the Neolithic period</li> <li>• The historic landscape character is a combination of medieval settlement around the margins and prehistory remains across the upland areas</li> <li>• Deserted Medieval Villages testify to the retreat from widespread cultivation during the 'Little Ice Age' of the late 16th to late 19th Centuries</li> <li>• The land is well drained and suited to modern intensive arable cultivation</li> <li>• This has largely displaced the earlier natural habitats, dominated by species-rich calcareous grassland, but areas of these remain as important refugia on the steeper slopes of narrow chalk valleys and chalk foothills</li> <li>• Archaeological features recognised in the 18th and 19th centuries have often been ploughed out on the hill tops and valley sides, but there is potential for archaeological preservation under re-deposited top soil at the base of slopes</li> </ul>	<ul style="list-style-type: none"> <li>• The sample area falls within the main part of the Chalk Wolds (LCT 18), with its characteristic broad rolling plateau land form</li> <li>• It is an area of planned enclosure with medium sized fields bounded by hedgerows</li> <li>• The area has expansive views with low hedges and a few mature trees</li> <li>• A large proportion of the hedges in the sample area are fragmented and defunct. Small areas of semi-natural broad leaved woodland survive, primarily within abandoned chalk pits</li> <li>• The sample area contains part of a barrow cemetery and potential for buried sub surface remains. There is also crop mark evidence for the characteristic 'Wold entrenchments'</li> <li>• The adjacent Duggleby Howe Scheduled Monument is a major upstanding earthwork with a wider ritual significance in the Wolds landscape</li> </ul>	<p>Except for the relatively small size of its fields, compared with immediately surrounding areas, the sample area is typical of the main Chalk Wolds landscape (LCT 18), which covers 70% of the ASMRP 7 resources</p> <p>It accurately reflects the summary profile for ASMRP 7, except for those aspects which relate to the much smaller but very important areas within the narrow chalk valleys and foothills, where agriculture is far less intensive and greater biodiversity is evident</p>

**Table 2.7: Summary of the comparison of sample area evidence with predictive landscape modelling results for AMRP 7**

## ASMRP 8: Jurassic Limestone Resources

2.181 Jurassic Limestones occur within the southern part of the North York Moors, partly within the National Park and partly within North Yorkshire. The latter outcrops are found between Helmsley and Pickering in the west, and to the north of Seamer in the east.

### Sample Area

2.182 The selected sample area for ASMRP 8 comprised the outcrop of Jurassic Limestone resources to the north of Wrelton in Ryedale District.

### Comparison of Sample Area with the general character of ASMRP 8 and with wider contexts

2.183 The following sections briefly compare the key characteristics of the sample area with the more general characteristics of ASMRP 8, as set out in the Stage 1 report and with relevant information from other recent local, regional and national studies.

#### Landscape Character:

2.184 The sample area is an area of arable farmland on the dip slope of the Jurassic Limestone escarpment, bounded to the east and west by narrow, steep-sided, wooded valleys, and to the south by the flat expanse of the Vale of Pickering. Both the site and surrounding buffer zone fall within Landscape Character Type 4 (Limestone Foothills and Valleys).

2.185 In terms of Historical Landscape Characterisation, the site is divided between three different HLC polygons:

- *HNY21612. Piecemeal Enclosure.* This comprises an area of medium-sized fields in a semi-irregular pattern. It has partial legibility with up to 60% boundary loss since 1850, and is defined by regular external and internal hedgerow boundaries;
- *HNY10982 Modern Improved Fields.* This comprises an area of large fields in a semi-irregular pattern. It is defined by regular external and straight internal hedgerow boundaries;
- *HNY11008 - Planned Large scale Parliamentary Enclosure.* This comprises an area of medium-sized fields in a semi-irregular pattern. It is defined by an erratic external and straight internal hedgerow boundaries.

2.186 The key landscape features observed within the sample area were:

- distinctive landform rising to the north with narrow dry valleys;
- rural and remote farming landscape;
- ancient woodlands within the valleys;

- the combination of the landform and the Ancient Woodland provides a linear pattern, in a north-south direction, parallel to the dip-slope of the limestone escarpment.
- 2.187 The sample area sits on the high ground of above a series of finger like valleys, and contains a farm/small holiday complex set within surrounding coniferous and mixed woodland beside a disused quarry. Quarries and limekilns are found across this landscape, and the stone has been used, locally at least, as a building material as well as for agricultural purposes, as a source of lime.
- 2.188 On lower ground to the south lies the village of Wrelton: a picturesque village comprising of properties built largely of local pale limestone with red pantile roofs. Many of the houses are now used as holiday homes. The village is compact and sited at the foot of the limestone escarpment, forming part of the distinctive line of settlements which lie between the limestone and the Vale of Pickering along much of the northern edge of the Vale.
- 2.189 In all of these respects, the sample area and its surroundings appear to be representative of the ASMRP 8 resources as a whole, or at least the majority of these (77%) which fall within LCT 4. These are characterised by arable landscapes on the relatively open, dissected dip slope surfaces, and adjoining valley landscapes with ancient woodlands and predominantly pastoral farming, with clear demarcation between the enclosed fields, farms, settlements and the wooded valley sides.
- 2.190 The sample area is not representative, however, of the remaining 23% of the resource which fall either within LCT 30 (Sand & Gravel Vale Fringe) or, to a much smaller extent, within adjoining areas of LCT 22 (Open Carr Vale Farmland) and LCT 1 (Urban Landscapes). The topography in all of these areas is much more subdued, as the limestone dips beneath the superficial deposits of ASMRP 5, with its characteristically low-angled, low relief landscape, forming a transition zone between the limestone outcrops to the north and the low-lying Vale of Pickering to the south.
- 2.191 In terms of placing the ASMRP 8 landscapes within a wider, national context, comparisons can be made with geological equivalents elsewhere in England. These include the dip-slopes which form the eastern edge of the Lincolnshire Limestone, directly north and south of Lincoln (National Character Areas 45 and 47) and the south-eastern edge of the Cotswolds. In the first of these, the escarpment dips to the east, away from the prominent, west-facing scarp slope known as the 'Lincolnshire Edge' or simply as 'the Cliff'. In marked contrast to the Limestone Foothills and Valleys of LCT 4 in North Yorkshire, the dip slope here is not intricately dissected by steep-sided, wooded valleys. In the Cotswolds example, the landscapes are rolling, open, high plateaux moulded by physical and human influences, with arable land and large blocks of woodland. The incised landscape of the eastern Cotswolds and scattered villages which are unified in design and materials are more comparable with the characteristics of LCT 4 in North Yorkshire.



The Historic Environment:

- 2.192 No systematic archaeological investigations have been undertaken across the area. The fields have been improved and there is no sign of earlier cultivation and no cropmark evidence of sub-surface remains. The geology should be conducive to the survival of crop marks, but only natural geological features were observed. In the sample area all visible archaeology dates to the period of post-medieval enclosure, and almost all is associated with widespread limestone quarrying (one of which is a probable parish quarry). There are limekilns used for the production of lime for land improvement and building products (8032, 8033, 8040-8043). Other sites are associated with farming practices at Crook Farm.
- 2.193 The key historic environment features observed within the sample area were:
- some evidence for earthwork remains, but these are almost all related to post-medieval limestone extraction. Some fragmentary evidence for prehistoric sites in the buffer zone, but the area has not been systematically investigated and thus the sub-surface archaeological resource remains undefined;
  - potential for sub-surface remains associated with the Roman Road (Site 8009);
  - Crook Farm, an (unlisted) eighteenth century farmstead (Site 8023), should be recorded and understood within the context of this landscape;
  - the undesignated putative Roman road (Site 8009);
  - 3 main HLC Types (see Landscape section above) - Of these, the Piecemeal Enclosure is largely of post medieval date, and the Modern Improved Fields to the north show large scale boundary loss since 1850.
- 2.194 Elsewhere within ASMRP 8 there is only a moderate density of historic environment scores. There is a scattering of Bronze Age round cairns located at the interface between the more fertile arable lands of the Vale of Pickering and Vale of Rye to the south and the upland areas of the North York Moors to the north. In the wider region the archaeological resource reflects the built heritage in nucleated medieval villages surrounded by fossilised strip-field cultivation and later piecemeal enclosure with dispersed upland farms. The remnants of the medieval field system reflect the established agricultural nature of the landscape. The manor of Wrelton was recorded in the Domesday Survey and, as noted in the landscape section, the village forms part of the distinctive line of historic settlements along the foot of the limestone outcrop. These settlements also include Helmsley, Beadlam, Kirkbymoorside, Sinnington, Middleton and Pickering. Beadlam is on the site of a Roman villa indicating the antiquity of settlement along this line. There is also evidence of the old Roman road leading to Cawthorne Camp through the sample study area.

- 2.195 In all of these respects, including the use of limestone as a building material, sporadic occurrences of earlier remains, and the quarrying of the stone for agricultural as well as building use, the sample area does appear to be broadly characteristic of the ASMRP as a whole.
- 2.196 The national comparison made earlier with the Jurassic limestone resource in the Cotswolds exhibits a similarity in the use of building stone, but in North Yorkshire, ASMRP 8 is a much smaller resource and, although used for building stone, is found predominantly in smaller vernacular and older buildings.

The Natural Environment:

- 2.197 Within the sample area and buffer zone, the vegetation cover consists of predominantly arable fields with substantial species-rich hedgerows. There are also areas of dense scrub within a small, disused quarry. The tree cover is principally located within the adjoining valleys and includes two areas of ancient woodland (Cass Hagg Wood and Beadale Wood) within the buffer zone. There are a number of hedgerow trees, mainly along the lanes, and various scattered trees (possibly remnants of older hedgerows which have since been removed).
- 2.198 The predominance of substantial species-rich hedgerows and the mix of arable and pasture land in close proximity to mature woodland make this site of high value to a range of bird species. The hedgerows and road verges (where present) are also likely to be of high value to invertebrates and offer some potential for reptiles, specifically slow worm (*Anguise fragilis*). Although no reptile species has been previously recorded in the area, the habitat is suitable.
- 2.199 Cass Hagg Wood and Beadale Wood are both ancient and semi-natural, lowland beech and yew woodlands. This is a Biodiversity Action Plan (BAP) habitat. Beadale Wood is also a Site of Importance for Nature Conservation (SINC) / Local Wildlife Site (non-statutory designation). The Local Wildlife Site report identifies semi-natural broadleaved woodland and dense / continuous scrub as occurring within this SINC. The sample area and much of the adjoining parts of ASMRP 8 which have similar landscape characteristics (i.e. those within LCT 4) have a particular potential for woodlands likely to meet the criteria for BAP habitat status. The small valleys within the escarpment result in areas which do not lend themselves to agricultural modification and most of the associated woodlands are therefore old and contain a high number of mature trees. These habitats offer high potential for bats, birds and badgers. Calcareous soils developed on the limestone outcrops present the potential for Calcareous Grassland on any area that is not subject to agricultural modification. Agricultural land tends to be divided by mature hedges, which are likely to qualify as BAP habitat.
- 2.200 The presence of exposed faces in the numerous small quarries, and perhaps even those within the larger Newbridge Quarry, which continues to produce crushed rock aggregates, offer potential for bats to roost and hibernate as do the drystone walls which occur throughout this

ASMRP. Old hedges, particularly where associated with stone walls, are likely to offer potential for various BAP plant and invertebrate species.

2.201 Comparisons can be made once again with the geologically equivalent landscapes of the Jurassic Lincolnshire Limestone, to the north and south of Lincoln. Here, much of the dip slope is characterised by arable farming and residual habitats associated with field margins and hedgerows are likely to not dissimilar to those in ASMRP 8. However, as noted in the landscape section above, in marked contrast to the Limestone Foothills and Valleys of LCT 4 in North Yorkshire, the dip slope here is not intricately dissected by steep-sided, wooded valleys. There is therefore likely to be much less Ancient Woodland present, in the Lincolnshire example.

**Conclusions for ASMRP 8**

2.202 Table 2.8, below, summarises the key observations resulting from the comparison of desk study (predictive landscape modelling) and limited field observations within sample areas.

Predictive Landscape Modelling - summary profile	Sample Area evidence	Comparison and Key Observations
<ul style="list-style-type: none"> <li>• Slightly undulating well drained landscape, on the dip-slope of the limestone foothills of the North York Moors</li> <li>• Heavily wooded in the past, and ancient woodland remains along steep valley sides which dissect the limestone slopes</li> <li>• Distinctive use of dry stone walling, stone for building and evidence of small scale extraction and lime burning, together with one larger scale, operational aggregates quarry</li> <li>• No systematic archaeological investigations have been undertaken and the area does not show up as a distinctive HLC type</li> <li>• There is a scattering of Bronze Age cairns, but the archaeological resource largely relates to nucleated medieval villages with fossilised remains of medieval open field strips</li> </ul>	<ul style="list-style-type: none"> <li>• The sample site sits on the high ground of above a series of finger like valleys containing Ancient Woodlands</li> <li>• Land use is predominantly arable with some evidence of earlier enclosure, and there are mature, species-rich hedgerows</li> <li>• The area contains a farm/small holiday complex set within surrounding coniferous and mixed woodland beside a disused quarry</li> <li>• The manor of Wrelton was recorded in the Domesday Survey and the village has a large number of older properties constructed of local stone</li> <li>• There has been no previous archaeological survey and no crop mark features were observed. All visible archaeology dates to the post medieval period, although there is potential for sub-surface remains associated with the nearby Roman road</li> </ul>	<p>The sample area appears to be representative of most of the ASMRP 8 Jurassic Limestone resource, and accurately reflects the summary profile.</p>

**Table 2.8: Summary of the comparison of sample area evidence with predictive landscape modelling results for AMRP 8**

## ASMRP 9: Magnesian Limestone Resources

- 2.203 The Magnesian Limestone comprises two geological formations: the Cadeby Formation, which tends to be massively bedded and the most suitable for building stone production (as well as aggregates) and the thinner and more thinly-bedded Brotherton Formation, which occurs higher in the Permian sequence, outcropping further east. The two outcrops run more or less parallel to each other in a narrow and almost unbroken belt which extends throughout North Yorkshire, from the area around Manfield in the north of Richmondshire to the area around Kirk Smeaton in the south of Selby District. The resource continues northwards into County Durham and southwards into South Yorkshire and Nottinghamshire.

### Sample Area

- 2.204 For ASMRP 9, the selected sample area comprised the outcrop of Magnesian Limestone resources located above and sloping down towards the western side of the River Ure to the north of Ripon, in Harrogate District.

### Comparison of Sample Area with the general character of ASMRP 9 and with wider contexts

- 2.205 The following sections briefly compare the key characteristics of the sample area with the more general characteristics of ASMRP 9, as set out in the Stage 1 report and with relevant information from other recent local, regional and national studies.

#### Landscape Character:

- 2.206 Both the site and most of its buffer zone fall within LCT 6 (Magnesian Limestone Ridge), although the normal topography to be expected of that type is modified here by the effects of irregular subsidence caused by the natural dissolution of underlying gypsum deposits. Part of the buffer zone, to the east of the sample area, extends onto LCT 24 (River Floodplain), although most of that area forms part of the sloping valley side rather than actual floodplain.
- 2.207 In terms of Historic Landscape Characterisation, the sample area incorporates two distinctly different HLC polygons:
- *HNY4471 - Modern improved fields*: an area of large modern fields where the boundaries have been completely reorganised and replaced with straight hedgerows. (The previous HLC of piecemeal enclosure is not visible within the current landscape); and
  - *HNY4472 - Golf Course*. This is Ripon golf course which has fragmentary legibility of the earlier HLC of piecemeal enclosure, most of the boundaries of which have been removed. That, in itself, had been established in part of the historic landscape of Ripon Parks

- 2.208 The key landscape features observed within the sample area were:
- long distant views across the Vale of York to the North York Moors;
  - a managed landscape incorporating a variety of land uses;
  - mature tree cover;
  - subsidence hollows associated with gypsum dissolution.
- 2.209 Overall, the landscape here reflects the situation commonly found on the edge of settlements in this ASMRP, where farming and leisure meet.
- 2.210 Within the sample area, the Magnesian Limestone resources are concealed by Quaternary drift deposits (glacial till). However, the underlying limestone still exerts an important influence upon the topography of the site and that of the buffer zone, particularly on the higher ground, furthest away from the river. As noted above, this influence is modified - particularly where the land slopes down towards the river and especially within and to the south of the golf course - by the effects of subsidence associated with underlying gypsum deposits. These effects, though common within the Ripon area and in a few other parts of the Magnesian Limestone outcrop (Thompson *et al.*, 1996, 1998), are not typical of the wider ASMRP 9 resource. It is therefore mainly the higher ground in the north-western part of the site, dominated by gently undulating large arable fields, which reflects the more characteristic landscape of ASMRP 9, although the pockets of woodland and grassland found within the steeper parts of the valley side are also characteristic of other valleys within ASMRP 9. Other features that are often seen within other parts of the resource, such as limestone crags and quarries, are not seen within this area. It must therefore be concluded that, in terms of visible landscape character, the sample area is only partially representative of the ASMRP as a whole.
- 2.211 In terms of placing ASMRP 9 within a wider, regional and national context, the most obvious comparisons are to be found within the continuation of the Magnesian Limestone outcrop into South Yorkshire, Derbyshire and Nottinghamshire. These areas fall largely within National Character Area 48 (Trent and Belvoir Dales) and have many similar characteristics to those ASMRP 9, but also some important differences. NCA 48, overall, comprises open, arable or mixed farmland over a gently undulating landform, with shallow ridges dropping down gently to broad river valleys. The Magnesian Limestone ridge in these areas frequently has a more pronounced scarp face along its western edge, than is the case further north, and this has been utilised as the site of prominent buildings such as Hardwick Hall and Bolsover Castle in Derbyshire, and Laughton-en-le-Morthen church, near Rotherham in South Yorkshire. Another important difference is that the limestone in these areas lies beyond the limits of the Devensian glaciation (as is the case in the southernmost parts of ASMRP 9, but not those further north). This enables the character of the limestone, rather than the superficial drift deposits to have a more prominent influence on the surface topography and landscape characteristics. This includes the characteristic development of steep-sided, wooded

limestone gorges, of which the best known is the Creswell Crags on the Derbyshire/ Nottinghamshire border,

The Historic Environment:

2.212 The sample area of ASMRP 9 is contained within Ripon Parks, an extensive area of parkland held by the Archbishop of York.

2.213 The key historic environment features observed within the sample area were:

- substantial earthwork remains of a medieval moated site (Site 9005) within the north-western extremity of the sample area and remains of a putative park boundary;
- surviving sub-surface remains associated with these sites are considered likely to exist;
- landscaping for the golf course and ploughing of adjoining arable land may have masked other sub-surface archaeological features;
- there is slight evidence for prehistoric archaeological sites in the buffer zone. The sub-surface archaeological resource has not been investigated, however, and therefore remains undefined.

2.214 ASMRP 9 as a whole is a long-settled landscape and, despite the degradation of archaeological remains through centuries of intensive agriculture, there is evidence of human activity from the Mesolithic period onward across the area. The limestone ridge has been an important transport route since pre-Roman times and an attractive one for settlement and agriculture, on account of its slightly elevated and well-drained characteristics (see Stage 1 report and Stage 2 Predictive Landscape Modelling report for further details). Excavations associated with the upgrading of the A1 in North Yorkshire provide an indication that the resource potential is likely to be high across much of this ASMRP. The relatively limited archaeological evidence found to date within the sample area should therefore not be taken to indicate a lack of historical activity. Rather, it may simply reflect that, like many other parts of the Magnesian Limestone outcrop, the area has yet to be intensively studied. Archaeological resources could well be buried, especially with areas where the limestone is overlain by Holocene sediments and/or by accumulated soils at the base of slopes, as a result of intensive ploughing.

2.215 Within a wider, regional context, the Southern Magnesian Limestone ridge extends southwards into West Yorkshire, South Yorkshire, Derbyshire and Nottinghamshire. Throughout these areas, LUC (2005) note that the ridge has significance for:

- limestone quarrying and the use of limestone;
- evidence of Roman routes and Roman occupation;
- evidence of Iron Age Settlement;
- Neolithic monuments along the line of the ridge;

- Norman influence – motte and bailey defences at Tickhill, Pontefract, Kippax, Mexborough, Barwick in Elmet, Spofforth, Knaresborough, West Tanfield and Snape;
- Battlefields – Towton and Boroughbridge;
- Designed parklands including Allerton Park, Brodsworth and Bramham.

- 2.216 Another general characteristic seen within some of these areas is that cropmarks do not show up well in areas where the limestone is overlain by glacial drift. Whilst such deposits restrict site visibility the lack of information is not necessarily an indication of the absence of early activity (Roberts *et al.*, 2011). Despite this there is considerable evidence for Roman activity and the area has evidently attracted settlement. The earliest evidence of human activity within the Magnesian Limestone, at Creswell Crags in Derbyshire, is thought to date from up to 43,000 years ago, and is one of the most northerly places known to have been visited by our ancient ancestors.
- 2.217 In Nottinghamshire, the landscape of the Magnesian Limestone ridge suffered an apparent decline at the end of the Roman period of settlement. As recorded in the Domesday Book (1086), the area was only thinly occupied, with the majority of settlements being along the western margins of the ridge. The medieval Sherwood Forest occupied much of the outcrop and was an area of 'waste' reserved for royal hunting. This emphasises that it was not initially an area favoured for settlement. However, with the increasing demands for cultivatable land in medieval period, coupled with the demands for timber, the woodland of the Magnesian Limestone Ridge came under continual pressure during this period. The settlements upon the ridge do not have the antiquity of those to the west, located on the coal measures, and reflect a later occupation of the ridge. In many respects the landscape of the Yorkshire section is comparable, being an area that was not initially favoured, but which became more intensively occupied.
- 2.218 The 16th and 17th centuries saw the development extensive parkland across the Magnesian Limestone Ridge, which was associated with the transfer of monastic sites and estates into lay hands and the construction of large country houses
- 2.219 The establishment of industry largely formed the modern landscape of the Magnesian Limestone Ridge, particularly in the southern part of Nottinghamshire. There had been industrial activity, small-scale and local, throughout the medieval period and later. Stone quarrying was perhaps the most significant of these, supplying prestige buildings. Also locally important were charcoal and lime burning and corn milling, powered by both wind and water. These characteristics are partially replicated within the North Yorkshire section of the ridge (ASMRP 9) but not to the same extent.

The Natural Environment:

- 2.220 The key natural environment features observed within the sample area were:
- evidence of European Protected Species (EPS) including great crested newts, otter and bats;
  - evidence of domestically protected species including badger;
  - the Ripon Parks SSSI.
- 2.221 As noted above, the ASMRP 9 sample area and buffer zone are dominated by arable land, amenity grassland (golf course) and improved / semi-improved pasture on calcareous soils. In general, the fields are moderately large and divided by hedgerows with occasional mature trees. The species of principal importance in these areas will include bats (various species) which are likely to utilise mature trees and farm buildings for roosting purposes, and hedgerows, ponds and pasture for commuting and foraging. Calcareous grasslands may include BAP plant species are likely to support a good invertebrate assemblage which again may contain BAP species.
- 2.222 The majority of the sample area is a golf course and is therefore intensely managed amenity grassland. Unlike the smaller areas of improved and semi-improved pasture located to the south and east of the golf course, this does not offer potential for badger setts and foraging opportunities are likely to be limited. The arable land also offers only limited potential for badgers. Some areas of semi-natural broadleaved woodland also exist, however, as do areas of mixed, semi-natural and plantation woodland. The hedgerows and woodlands are likely to support a variety of farmland bird species.
- 2.223 A small area of Fens was noted within the eastern-most part of the buffer zone. Fens are a Biodiversity Action Plan (BAP) priority habitat. That area also falls within the Ripon Parks Site of Special Scientific Interest (SSSI). This covers part of the River Ure and adjacent land on the western side of the river, encompassing a range of floodplain habitats including grasslands, bogs and adjoining areas of woodland on the valley side.
- 2.224 Ponds are abundant within both the sample area and buffer zone. They exist primarily within subsidence hollows and are generally small and often ephemeral, varying with seasonal variations in rainfall and fluctuations of the water table. In many cases they also lie in close proximity to one another and, taken together, these characteristics offer high potential for great crested newts. Where ponds occur, these may therefore meet the selection criteria for Biodiversity Action Plan habitats, due to the potential presence of BAP species. The density of ponds in the area and the proximity to the River Ure also make the sample area and buffer zone suitable for otters.



- 2.225 Given the rather atypical nature of the landscape features within this site, compared with most other parts of the ASMRP 9 resources (as discussed earlier), it seems unlikely that the site will be fully representative of the ASMRP in terms of biodiversity. The density of ponds, in particular, is a specific feature relating to the occurrence of gypsum-related subsidence (which creates an unusually high density of topographic hollows), and the presence of glacial drift above the Magnesian Limestone (which impairs the normally free-draining characteristics of the limestone soils). That said, much of the ASMRP 9 outcrop is concealed beneath one type or another of Quaternary drift deposits and the occurrence of ponds and wetlands is therefore likely to be more prevalent than might otherwise be expected within a limestone area (see also the earlier comments on ASMRPs 1, 2, 3 and 4, where these overlie the Magnesian Limestone). Other features seen within the sample area (including the arable fields, hedgerows, fragmented woodlands and areas of improved and semi-improved calcareous grassland) are all seen, in varying proportions, in other parts of the Magnesian Limestone outcrop.
- 2.226 Despite the relatively unusual features included within parts of the sample area, it may therefore be concluded, tentatively, that most of the habitats and species found in this area are likely to be seen throughout ASMRP 9, but with differences in proportions from one area to another. More detailed confirmation of this, however, would require analysis of habitat data for all parts of the ASMRP, which has not been possible within this study.
- 2.227 As discussed in the landscape section above, wider comparisons can be made with the continuation of the Magnesian Limestone outcrop into South Yorkshire, Derbyshire and Nottinghamshire, where the limestone is not overlain by glacial drift deposits and thus has a more direct influence on topography and vegetation. Information for these areas is available from Nottinghamshire County Council's Countryside Appraisal<sup>3</sup> and from the landscape character assessment for Derbyshire<sup>4</sup>. The latter provides the most detailed information regarding biodiversity and habitats. It notes that the rock weathers to form a light, fertile, friable soil which has resulted in arable farming becoming the dominant land use on the main parts of the ridge, as is the case in North Yorkshire, but in some of the lower-lying areas to the east, heavier clay soils are associated with mixed farming. Again, this is comparable to the eastern dip slope of the Magnesian Limestone further north, where it grades down into the lowlands of the Vale of York and the Humberhead levels. In both of these areas, habitats relating to hedgerows, arable field margins and pockets of woodland are the only surviving vestiges of the richer woodland and grassland habitats which would once have thrived here.
- 2.228 The main difference between these areas and the outcrop in North Yorkshire relates to the steep-sided, wooded limestone gorges which appear to be more common in the Derbyshire and Nottinghamshire areas. The relative inaccessibility of these gorges and their steep rocky

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<sup>3</sup> <http://www.nottinghamshire.gov.uk/home/environment/landimprovements/landscapecharacter/countrysideappraisal/countrysideappraisal-chapterfour.htm>

<sup>4</sup> [http://www.derbyshire.gov.uk/images/LCA-Southern\\_tcm44-21121.pdf](http://www.derbyshire.gov.uk/images/LCA-Southern_tcm44-21121.pdf)

sides have minimised agricultural disturbance and allowed many original, or semi-natural habitats to survive in excellent condition. Impeded drainage within the valleys (compared with the free-draining limestone ridge) has enabled grazing meadows, wet grasslands, and nationally-scarce Magnesian Limestone grassland on steeper slopes, to thrive. The gorges also contain widespread small areas of Ancient Woodland, primarily along watercourses. These are made up of a rich mixture of broad-leaved trees, primarily Ash (*Fraxinus excelsior*), Pendunculate Oak (*Quercus robur*) and Lime (*Tilia cordata* and *Tilia platyphyllos*).

**Conclusions for ASMRP 9**

2.229 Table 2.9, below, summarises the key observations resulting from the comparison of desk study (predictive landscape modelling) and limited field observations within sample areas.

Predictive Landscape Modelling - summary profile	Sample Area evidence	Comparison and Key Observations
<ul style="list-style-type: none"> <li>• Extensive, north-south oriented outcrop of limestone, largely elevated above the adjoining lowlands of the Vale of York and Humberhead Levels, to the east</li> <li>• For this reason it has been utilised since pre-Roman times as a major communications route (now the A1(M) corridor), and has long been attractive for settlement and agriculture</li> <li>• Southern part of the ridge was ice-free during the last glaciation, and thus available for early human occupation</li> <li>• Archaeological potential, highlighted by investigations associated with the A1(M) should be high throughout most of the outcrop and across all periods of human activity, from at least the Mesolithic period onwards</li> <li>• The archaeological resource is likely to have been degraded by many centuries of ploughing within the extensive arable fields which characterise much of the area</li> <li>• Arable farming has also greatly reduced the biodiversity which once existed, but areas of semi-natural broad-leaved woodland and calcareous grassland have survived, particularly but not only on valley sides</li> <li>• Evidence of past limestone extraction and extensive use in construction of walls and buildings. Some ongoing extraction for aggregate</li> </ul>	<ul style="list-style-type: none"> <li>• The Magnesian Limestone resource within the sample area is concealed by glacial till and the landscape has been modified by subsidence associated with the dissolution of underlying gypsum deposits</li> <li>• Much of the area is included with Ripon Golf Course (intensely managed amenity grassland) but was formerly within Ripon Parks</li> <li>• Areas outside the golf course are predominantly arable land, but woodlands survive within subsidence hollows and on steep slopes adjacent to the River Ure floodplain which borders the eastern side of the sample area</li> <li>• Substantial subsurface remains of a moated site lie within the north west of the sample area.</li> <li>• The golf course and adjacent arable land may conceal further sub surface remains</li> <li>• Ponds are abundant. Primarily found within subsidence hollows, they are generally small and often ephemeral, providing a range of specialised habitats</li> </ul>	<p>The sample area reflects many but not all of the key points identified in the summary profile for ASMRP 9. It also exhibits a number of atypical features - primarily those associated with gypsum-related subsidence which is localised to this and a limited number of other locations within the resource outcrop.</p> <p>In common with many parts of the broad ASMRP 9 resource, it is located well away from the A1(M) route corridor, but nevertheless has a high archaeological potential because of its proximity to the historically important centre of Ripon. Poor site visibility within the sample area is typical of those parts of the Magnesian Limestone outcrop which are concealed by glacial till deposits, but in this area the effect has been increased by the intensive management of the golf course.</p>

**Table 2.9: Summary of the comparison of sample area evidence with predictive landscape modelling results for AMRP 9**

## **ASMRP 12: Carboniferous Sandstone Resources**

2.230 Certain sandstones within the Carboniferous Millstone Grit series are identified as ‘mineral’ deposits on the BGS resources map and it is these which form ASMRP 12. The identified resources crop out within parts of Craven District, primarily to the south-east of Settle and to the south of Skipton. A separate outcrop occurs directly to the north of Harrogate and Knaresborough.

### **Sample Area**

2.231 For ASMRP 12, the selected sample area comprised the outcrop of Carboniferous sandstone (Millstone Grit) resources to the south east of Skipton, in Craven District. The sandstone resources are partially concealed by Quaternary glacial drift deposits, though these appear to be quite thin, and outcrops of sandstone occur in several parts of the site, both on open ground and within abandoned small quarries within the lower enclosed fields.

### **Comparison of Sample Area with the general character of ASMRP 12 and with wider contexts**

2.232 The following sections briefly compare the key characteristics of the sample area with the more general characteristics of ASMRP 12, as set out in the Stage 1 report, and with relevant information from other recent local, regional and national studies.

#### Landscape Character:

2.233 Despite its predominantly upland setting, on land rising up from the Aire Valley onto Skipton Moor, most of the sample area falls within Landscape Character Type 31 (Settled Industrial Valleys). The north eastern third of the site, located on higher ground on Skipton Moor itself, falls within LCT 35 Gritstone Low Moors & Fells).

2.234 In terms of Historic Landscape Characterisation (captured for Craven District from the Lancashire HER), the site incorporates two HLC types:

- HNY4889 (Lowland meadow) defined as ancient enclosed land, probably for meadow grazing, with some evidence of boundary change to create larger irregular fields. Internal boundaries are dominated by overgrown hedgerows, external boundaries are mainly stone walls;
- HNY4969 (Unknown planned enclosure - post medieval in origin) with internal boundaries of straight stone walls, and external boundaries of curvilinear stone walls. Some loss of boundaries has occurred since the first edition map, with the creation of the reservoir (in the northern part of the buffer zone).

- 2.235 Land use within most of the area is semi-improved pasture with high sandstone stone walls and a few hedgerows. Two residential properties, converted from farm buildings, are sited within the area. The higher parts of the buffer zone are moorland. Trees are present within the landscape and although mature are not large, due to their exposed locations. They are found as small shelterbelts, along the small watercourses/valleys and as possible boundary features.
- 2.236 The key landscape features observed within the sample area were:
- sloping valley side, extending from the edge of open moorland on higher ground to the edge of the heavily industrialised valley floor;
  - extensive views to the north, west and south especially from the higher ground;
  - principally a rural landscape but in close proximity to the town of Skipton;
  - dry stone walls and buildings constructed of local sandstone
  - the landform varies in complexity from unified, balanced and diverse in the uplands to complex, discordant and fragmented, reflecting the varying land use, within the valley bottom.
- 2.237 The ASMRP 12 resources elsewhere in North Yorkshire extend across a much wider range of landscape types - from the drumlin valleys (LCT 32) and rolling upland farmland (LCT 14) near Settle to the siltstone and sandstone moors and fells of the Forest of Bowland (LCT 37) and Elsack Moor (LCT 38). In addition, the smaller resource outcrop to the north of Harrogate straddles the boundary between the Gritstone Valley (LCT 36) and the Magnesian Limestone Ridge (LCT 6). Within each of these areas, the influence of the underlying sandstone on the landscape is dependent largely upon the extent to which it is concealed by Quaternary drift deposits - particularly glacial till and/or peat. Where the drift is thin and patchy, as is the case within most of the sample area and most other areas of steeply sloping ground, the sandstone has a prominent influence, both on the shape of the land and in the use of sandstone in rural walls and buildings. On higher ground, especially where drainage is poor, the sandstone is sometimes overlain by thin glacial tills and/or Holocene peat deposits; whilst on lower ground, it is frequently concealed by thick alluvium and/or glacial sediments, and there are additional landscape differences, in some areas, associated with the density of settlement and urbanisation. It is therefore primarily on the sides of upland valleys and fells, as exemplified by the sample area itself, where the sandstone has a clear influence. It therefore follows that, whilst the sample area is likely to be representative of such areas, it cannot be representative of the lowland parts of the resource (especially the heavily industrialised areas within the Aire valley), or of other areas (including some parts of the upland fells) where the sandstone is concealed beneath thick superficial deposits.

2.238 In terms of potential comparisons of ASMRP 12 with other geographical areas, the most obvious comparators (geologically) include the Millstone Grit moorlands within parts of West Yorkshire, Lancashire, Northumberland and the Dark Peak area within the Peak District National Park. Within the Dark Peak (NCA 51), the landscape is similar but more dramatic than that of the same ASMRP within North Yorkshire as it is characterised by having sharply defined, elevated and vast plateaux with gritstone ridges and long uninterrupted views. Architectural style includes dispersed buildings and settlements constructed from local gritstone with typical blackened appearance, similar to the settled valleys within North Yorkshire, such as the Skipton area. In another comparison, with NCA 36, (Southern Pennines), similarities include the populated valley bottoms with stone buildings extending along valley sides, set against the backdrop of the moorland; gritstone towns centred around key features of industrial heritage such as textile mills and other industrial development mainly in the valleys but with settlements on the moorland fringe; main road, rail and canal routes located along the valley bottoms. These areas also afford extensive views from elevated locations in all directions. Another characteristic, which has been identified as a sensitivity of the landscape, is the presence (and threat) of visually intrusive features including windfarms, transmission masts, overhead powerlines and sandstone, gritstone and clay quarries, mainly on the fringe of the area.

The Historic Environment:

2.239 The key historic environment features observed within the sample area were:

- the presence of four Scheduled Monuments, all prehistoric rock, (Sites 12001, 12002, 12005 and 12007);
- a further five Scheduled Monuments, rock art panels (Sites 12003, 12004, 12006 and 12008) and the enclosed settlement (Site 12009) included in the buffer zone;
- the presence of extensive, albeit mostly small-scale, quarrying within the sample area and buffer zone;
- extensive surface remains of archaeological features of a broad range of periods but with high proportions of prehistoric sites and post-medieval quarrying. There is a potential for sub-surface remains across other parts of the sample area, despite thin soil coverage, but there is a higher potential for survival in the rough-grazed northern field. There is Potential for further sub-surface archaeological remains beneath peat deposits on the adjacent Skipton Moor;
- expansive views between the sample area and the town of Skipton and Skipton Castle.

2.240 The character of the topography within the sample area is in some respects representative of much of the remaining ASMRP. It is an upland area, with undulating ground, and as such has had a relatively limited soil build up; as a consequence, much of the archaeological resource is evident on the surface as earthworks or as upstanding monuments. Because of the sloping

and undulating ground, the land would have had lower levels of anthropogenic activity, by comparison with the adjacent lowlands. However, although the activity is likely to have been reduced overall, because of the surface exposure of the remains, the site visibility is higher than on the lowlands, providing a somewhat exaggerated impression of the amount of past occupation and activity.

- 2.241 There is occasional outcropping Carboniferous sandstone across the sample area, as seen elsewhere within the ASMRP. The stone has probably been used for local construction, as evidenced by the numerous small quarries. The same stone has also been used for prehistoric rock art and there are numerous examples across this area and in other parts of the ASMRP.
- 2.242 The archaeological resource within the area or buffer zone is exceptional, including scheduled rock art and an Iron Age enclosure within the buffer zone. This is a much higher level of resource than is found elsewhere within the ASMRP, but the character of the remains is comparable.
- 2.243 In terms of wider, regional and national perspectives, the sample area can be compared with other central and south Pennine sites where carved rock art is found within upland sandstone and gritstone landscapes. Relatively local examples include other sites above the Aire and Wharfe Valleys, on the moors above towns such as Keighley, Bingley and Ilkley (LUC, 2005). Ilkley Moor, for example, is a very comparable area of undulating moorland, which is characterised by a significant concentration of rock art, including cup and ring marked stones, but also a variety of more complex motifs, and has been studied over an extended period (Boughey and Vickerman 2003; Raistrick, 1934; Ilkley Archaeology Group 1986). Both here and in the sample area, the rock art reflects the fact that the rock was able to be worked by prehistoric peoples with basic tools but was also sufficiently hard to have survived up to 5,000 years of weathering.
- 2.244 Anglezarke Moor, a western outlier of the Pennines in Lancashire, also has considerable similarities with some of the ASMRP 12 landscapes although here, a coarser-grained part of the Carboniferous Millstone Grit sequence has been worked, in the past, to produce traditional millstones. Adjacent to the large disused building stone quarry at Stronstrey Bank, many blank millstone wasters extend across the area from this industry. The flat-surfaced millstone blanks are often set up perched at an angle against other rocks, and as a consequence, many who have looked at the area in the past omitted to notice that one of these stones had not been worked, and was in fact the capping stone of a Neolithic chambered round cairn (Howard Davis 1996). The area has extensive peat cover but this has been degraded by a series of massive fires which have exposed the underlying archaeology (OA North, 2009a). On nearby Turton Moor (Cheetham Close) is a stone circle that used rocks of Carboniferous sandstone, and is one of the few stone circles in Lancashire (LUAU, 2000; Fletcher, 1987).

2.245 The Forest of Bowland, also in Lancashire, has underlying Carboniferous Sandstone geology, but has extensive peat cover and it is anticipated that a significant archaeological resource in this area may be obscured. However, there is a substantial Bronze Age cairn field at Nicky Nook, on the western margins of the upland massif (OA North, 2009a) and also a scattering of burial round cairns. In general the site visibility of prehistoric remains in this area is low by comparison with other comparable upland regions, and in part the peat has obscured the resource, but there was also an early onset of peat formation extending down from the rounded summits which would have inhibited the development of early settlement (OA North, 2009a, *ibid*).

The Natural Environment:

2.246 The ASMRP 12 sample area and buffer zone are dominated by improved grassland, semi-improved acid grassland and un-improved acid grassland. Small areas of semi-natural broadleaved woodland exist in the valleys and a small area of semi-natural mixed woodland exists within the buffer zone. Small watercourses flow along the eastern edge of the sample area towards the Leeds and Liverpool Canal which runs through the southern part of the buffer zone. No Biodiversity Action Plan (BAP) priority habitat has been previously identified in the sample area and no habitat of specific conservation interest was identified during the site inspection.

2.247 The key natural environment features observed or previously recorded within the sample area were:

- evidence of European Protected Species (EPS) including otter and bats;
- evidence of domestically protected species including reptiles and water vole.

2.248 Although no BAP priority habitats were identified within the sample area, ASMRP 12 more generally is known to exhibit a range of such habitats, many (but not all) of which are represented within the six SSSIs in this area. These include upland heathland, blanket bog, upland flushes, marsh and swamp, upland birch woodland, lowland, lowland fen, lowland meadows, rivers and others. Additional priority habitats, as well as a mosaic of other habitats important to wildlife, exist in other areas, beyond the designated sites.

2.249 ASMRP 12 also offers potential, at least, for other upland BAP habitats such as Upland Mixed Ash woods and, where steep slopes exist which make intensive agricultural improvement difficult, there is also some potential for Upland Hay Meadows.

2.250 The presence of drystone walls offers potential for bat species to roost, hibernate and commute through the area. Woodland in the small valleys similarly offers potential for bat species. The more remote upland areas within this ASMRP offer increased potential for BAP

bird species including Ring Ouzel and Red Grouse. Reptile species are also likely to occur in this ASMRP, particularly on south facing slopes.

2.251 Wider comparisons could be made with other areas of similar topography and geology, such as the sandstone and gritstone outcrops within the Yorkshire Dales National Park, the Forest of Bowland AONB, Pendle Hill, and the Dark Peak within the Peak District National Park. Once again, however, such comparisons are extremely difficult to make in any detail because of the wide range of different habitat types involved, and the fact that none of them is unique to this (or any other) specific mineral resource. The comments earlier, in relation to ASMRP 3, regarding comparisons between National Character Areas, apply equally to ASMRP 12. Readily available data simply do not allow meaningful comparisons to be made, at the level of individual resource types.

**Conclusions for ASMRP 12**

2.252 Table 2.10, below, summarises the key observations resulting from the comparison of desk study (predictive landscape modelling) and limited field observations within sample areas.

<b>Predictive Landscape Modelling - summary profile</b>	<b>Sample Area evidence</b>	<b>Comparison and Key Observations</b>
<ul style="list-style-type: none"> <li>• ASMRP 12 sandstone resources are primarily exposed in moorland areas where Quaternary superficial deposits are either thin or absent</li> <li>• Natural and man-made outcrops of sandstone exert a strong influence on the present day landscape</li> <li>• Archaeological evidence is limited to the exposed surfaces, except in areas where it may be concealed by Holocene blanket bog</li> <li>• Early human activity evidenced by ring cairns and rock art</li> <li>• Rough grazing predominates, with little or no arable cultivation</li> <li>• Evidence of small-scale past extraction – disused quarries, walls and buildings.</li> </ul>	<ul style="list-style-type: none"> <li>• The sample area near Skipton falls within LCT 35 (Gritstone Low Moor and Fells)</li> <li>• The sloping valley side includes an area of lowland meadow with evidence of ancient enclosure, and on the higher fell, post medieval enclosure with drystone boundary walls built of the local sandstone</li> <li>• Land use comprises improved pasture on the lower-slopes, with semi-improved acid grassland on higher ground, and with trees found in small shelter belts and along small valleys. Adjoining summit areas on Skipton Moor are largely unimproved acid grass moorland.</li> <li>• Site visibility is high and the archaeological resource in this area is exceptional. The sample area and buffer zone included eight scheduled rock art panels and an enclosed settlement.</li> <li>• There were numerous outcroppings of sandstone which had been used as small quarries in the past</li> </ul>	<p>The sample area is fairly typical of the summary profile, but not of all parts of the ASMRP 12 resources.</p> <p>The influence of the underlying sandstone on the landscape is dependent upon the extent to which it is concealed by Quaternary drift deposits - particularly glacial till and/or peat.</p> <p>This also directly affects the visibility of ancient rock art. Both the sandstone and the associated archaeology is most likely to be seen on valley sides or low fells. In higher summit areas, they are more likely to be concealed by superficial deposits; whilst in industrialised valleys both will be hidden or modified by modern development.</p>

**Table 2.10: Summary of the comparison of sample area evidence with predictive landscape modelling results for AMRP 12**



## **ASMRP 14: Carboniferous Limestone Resources**

- 2.253 Carboniferous Limestone occurs within the central part of Craven District, between and to the south of Settle and Skipton, and more extensively within Richmondshire District, primarily to the south and west of Leyburn and to the north and west of Brompton on Swale and Richmond. Smaller outcrops occur to the south west and north-west of Pateley Bridge in Harrogate District.

### **Sample Area**

- 2.254 For ASMRP 14, the selected sample area comprised the outcrop of Carboniferous Limestone resources at Holgate Moor, in the north-west of Richmondshire District.

### **Comparison of Sample Area with the general character of ASMRP 14 and with wider contexts**

- 2.255 The following sections briefly compare the key characteristics of the sample area with the more general characteristics of ASMRP 14, as set out in the Stage 1 report, and with relevant information from other recent local, regional and national studies.

#### Landscape Character:

- 2.256 The sample area falls within Landscape Character Type 33 (Gritstone High Plateau) - a category which applies to all of the upland areas above Swaledale, irrespective of the underlying geology. The sample area is underlain by limestone, but this forms part of an alternating succession of rock types including sandstones and occasional chert, which crop out within the buffer zone, to the east and west of the sample area, respectively.
- 2.257 In terms of Historic Landscape Characterisation, the sample area falls within HLC type HNY1662 (Reverted Moorland). This land was mainly enclosed at the time of the first edition OS with large enclosures, some of which are still visible on site, but by the time of the 2nd edition this seems to have reverted to back to moorland.
- 2.258 Today, this is an area of managed upland moorland, principally heather and moorland grass, with no tree cover within the study area. The land is used principally for rough grazing and as a managed grouse moor. Within the buffer zone there is tree cover within the valley bottoms and shelterbelts around the farmsteads. There are areas of standing water, retained by thin peat deposits above the limestone, and small watercourses run through the area in a south easterly direction, towards Rake Beck. Other natural features within the area are 'shake holes' (subsidence features developed above solution cavities within the limestone). The site is also dotted with former mine shafts, which are similar in appearance to the shake holes and often in close proximity.

- 2.259 The key landscape features observed within the sample area were:
- upland moor;
  - rolling landform interspersed with sharp features such as steep valleys;
  - extensive views to the south and south east.
- 2.260 The sample area is characteristic of those parts of ASMRP 14 which occur on the upland plateau of LCT 33, but such areas account for only 18% of the overall resource. More commonly, the limestone resources crop out within valley sides, where they typically form steep or vertical crags (not seen within the sample area); or beneath valley floors, where they are generally concealed by superficial drift deposits (not present within the sample area, except for thin peat deposits). Overall, the resources are associated with no less than sixteen different Landscape Character Types, with LCTs 13 (Moors Fringe) and 32 (Drumlin Valleys) being more common than LCT 33. In landscape terms, the sample area cannot therefore be taken as being representative of ASMRP 14 as a whole.
- 2.261 In terms of comparison with other areas, there are strong similarities between ASMRP 14 and the continuation of the same resource into the adjoining landscapes of the Yorkshire Dales National Park. Those areas include outcrops of Carboniferous Limestone, between sandstones and other lithologies, on moorland plateaux, on valley side scars, and beneath glacial drift deposits on the valley floors. In both areas there are common features such as open moorlands with limited tree cover, relicts of historical mining activity and remote agricultural stone buildings within a landscape of little or slow change. But there are also important differences, primarily in the sparser degree of settlement and the greater degree of relief within the National Park, between the higher peaks and the valley floors and in the presence within the Park of well-developed limestone pavements and other karstic features (including sinks and resurgences along the course of many upland streams). These and other aspects of natural beauty are ultimately reflected in the designation of this landscape as a National Park.
- 2.262 Comparison can also be made with the White Peak area of the Peak District in Derbyshire where the geology is somewhat different, with much thicker sequences of limestone and little or no interbedded sandstone. This, together with the very limited occurrence of Quaternary glacial drift deposits is reflected in a quite different landscape character, compared with both ASMRP 14 and the Yorkshire Dales. In particular, although the elevated limestone plateau of the White Peak is incised by steeply cut dales and gorges, with numerous limestone scars, crags and cave systems on the valley sides, there are very few limestone pavements, open moorland on the plateau is replaced by calcareous grassland, and drystone walls comprised almost exclusively of limestone tend to dominate the landscape. Overall, the various characteristics of the landscape and its importance for outdoor recreation combine to justify its designation as a National Park.

The Historic Environment:

- 2.263 The historic environment features observed within the sample area were:
- complex earthwork features of extractive industries in the sample area and buffer zone;
  - archaeological potential - Newly discovered prehistoric funerary cairn. There is some evidence for disparate prehistoric sites across the moorland;
  - there is the potential for significant sub-surface remains both within and below peat deposits, including potential for the survival of organic archaeological remains. As there have been no intrusive investigations, the sub-surface archaeological resource remains undefined in the area;
  - HLC Type is entirely Reverted Moorland that was formerly enclosed at the time of the first edition OS mapping. Some of the large enclosures dating back to the 19<sup>th</sup> and early 20<sup>th</sup> Centuries are still just visible.
- 2.264 The sample area is characterised by prehistoric round cairns, which reflect limited early activity, though not necessarily settlement in this exposed upland terrain. This also demonstrates the survival of early monuments as surface evidence and is a typical indicator of upland landscapes. There is relatively little peat covering over the landscape, allowing site visibility of the prehistoric monuments. However, the area is covered with heather, reflecting its use as a grouse moor and that does severely affect site visibility. In general this level and character of heritage resource is fairly typical for much of the uplands on the margins of Yorkshire, and while this includes the wider upland landscapes of ASMRP 14, it is certainly not unique to it.
- 2.265 The HLC type is 'dominant dispersed industry', a reflection of past mineral extraction and its influence (NYCC and EH 2010) and there are numerous sites relating to mineral extraction across the extent of the sample area and its buffer zone. These comprise mine shafts, dams, leats and hushing channels. Such industrial landscapes are not uncommon within the wider area and relate directly to the mineral potential of the locality. This is common to some areas of the ASMRP. As noted above with respect to landscape character, however, the sample area is not representative of the lower lying and improved areas of ASMRP 14.
- 2.266 National comparisons for areas of upland Carboniferous limestone include the eastern margins of the Lake District, such as Askham; the Crosby Ravensworth western margins of the Eden Valley; substantial areas of the Yorkshire Dales National Park and the Alston area of Northern Pennines. These areas have a distinctive archaeological character that is in many respects determined by the geology, for example a preponderance of lime kilns and associated quarries. These include small kilns associated with the production of lime for agriculture, but also larger scale industrial working such as the large Hoffman lime kilns of Langcliffe and Mealbank on the

southern margins of the Yorkshire Dales (Johnson 2002; Trueman & Quartermaine 1993). Such monuments are a common feature within many (but not all) parts of ASMRP 14.

- 2.267 Minerals such as lead occur in veins embedded within limestone strata, and there are substantial lead workings, within the Alston / Nenthead areas of the Northern Pennines. These accord with the ASMRP 14 sample area which was also characterised by mine shafts associated with mineral extraction (Gill 1993; LUAU 1997; Raistrick and Jennings 1965; Roe 2003).
- 2.268 One of the most notable characteristics of limestone is that it is water soluble and results in a landscape pockmarked by shake holes, often with underground caverns beneath. While these are inherently natural features they have been exploited by man and many caverns contain stratified deposits relating to occupation, or quite often ritual deposition. Significant ritual deposits from the Romano-British period have been found in a number of caves in the Yorkshire Dales, such as Victoria Cave, near Settle, which also contains significant Neolithic deposits (Brannigan and Dearne 1991; Quartermaine 1995). Anthropogenic workings of caves are typically associated with certain areas of the Yorkshire Dales and the Peak District and are not necessarily a characteristic of all limestone seams. No significant cave deposits have been identified within the limestones of ASMRP 14.
- 2.269 A characteristic feature of limestone areas within the Yorkshire Dales and further west is outcropping in the form of limestone pavement (sub-horizontal surfaces where bedding planes within the limestone have been exposed by glacial erosion and affected by intensive subsequent dissolution by rainwater) and continuous limestone crags along valley sides. These are often associated with settlement and field system remains, which have a distinctive visual character that typically exploits lines of outcropping and pavement blocks. Little Asby, on the south-western margins of the Eden Valley, has a rich diversity of settlements and field system remains that include Iron Age / Bronze Age type co-axial field systems and pastoral enclosures as well as field systems and settlements of medieval and early medieval origin (OA North 2009b). Limestone pavements are not developed within ASMRP 14 but valley-side crags are common within Swaledale and Wensleydale and the general form of the settlements and field systems in these areas is comparable to that seen in the landscapes further west.
- 2.270 Complex enclosed settlements, dating from the Iron Age and Romano-British periods, are sometimes found in other limestone areas, often located around and within areas of limestone pavement. Two examples built into pavement are found from Askham Fell, above Ullswater, and there is a line of them on the southern margins of the Yorkshire Dales, of which one at Broadwood, Ingleton, has been excavated and found to have been founded in the later Iron Age (Johnson, 2004). Given the absence of limestone pavement within ASMRP 14, such settlements are not found in that area.
- 2.271 The limestone uplands are also associated with archaeological resources that are more associated with upland areas in general, rather than being specific to limestone. These include

Bronze Age round cairns and similar funerary monuments. Round cairns have been found within the ASMRP 14 sample area and in many other uplands associated with ASMRP 14.

The Natural Environment:

- 2.272 The vast majority of the ASMRP 14 sample area and buffer zone is upland heath, which is a Biodiversity Action Plan (BAP) habitat. Fell gripping (i.e. open drainage channels) to improve grazing conditions, together with moorland management practices associated with grouse moors mean that drier heather and acid grassland predominate in these areas. The moorlands seen within both the sample area and buffer zone are of high value to bird species. Various BAP species are likely to breed in this area and it is likely to be of significance for species such as Lapwing, Red Grouse, Skylark and Curlew.
- 2.273 The natural environment features observed within the sample area were:
- evidence of European Protected Species (EPS) including bats;
  - evidence of domestically protected species including reptiles and water vole;
  - management of upland heath BAP habitat.
- 2.274 This and other similar areas of ASMRP 14 offer high potential for Upland Heathland, Upland Flushes, Fens and Swamps and Blanket Bog. The presence of dry-stone walls and open mine shafts offer potential for hibernating bats. Reptiles are highly likely to occur, although periodic burning of the heather as part of the grouse moorland management regime probably excludes the possibility of large populations.
- 2.275 Whilst the characteristics of the sample area and buffer zone are likely to be typical of those parts of ASMRP 14 which fall within LCT 33, they are unlikely to be representative of other parts of the resource which fall within other landscape types (i.e. the majority of ASMRP 14). The immense variety of topography, aspect and land use in other parts of ASMRP 14 mean that there is likely to be a wide range of both priority and other habitats represented including blanket bog, upland heathland, upland mixed ashwoods, upland calcareous grasslands, lowland meadows and rivers.
- 2.276 Wider comparisons could be made with other areas of similar topography and geology, such as the Carboniferous Limestone outcrops within the Yorkshire Dales National Park, the White Peak within the Peak District National Park, and the very different Mendip Hills in Somerset. Once again, however, such comparisons are extremely difficult to make in any detail because of the wide range of different habitat types involved, and the fact that none of them is unique to this (or any other) specific mineral resource. The comments earlier, in relation to ASMRP 3, regarding comparisons between National Character Areas, apply equally to ASMRP 14. Readily available data simply do not allow meaningful comparisons to be made, at the level of individual resource types.

**Conclusions for ASMRP 14**

2.277 Table 2.11, below, summarises the key observations resulting from the comparison of desk study (predictive landscape modelling) and limited field observations within sample areas.

Predictive Landscape Modelling - summary profile	Sample Area evidence	Comparison and Key Observations
<ul style="list-style-type: none"> <li>• ASMRP 14 limestone resources occur within the upland moors and intervening dales in the westernmost part of the study area, linked directly to more extensive outcrops in the Yorkshire Dales National Park.</li> <li>• The limestone underlies extensive upland plateau surfaces but is more commonly exposed in the dale sides where it forms distinctive scars, often modified by historic quarrying activity</li> <li>• Blanket bogs in the moorland areas replaced formerly extensive upland forests - both testifying to and (in some cases) concealing evidence of early human activity in these areas.</li> <li>• Despite this, site visibility is generally good and early human activity is evidenced by the survival of prehistoric round cairns</li> <li>• Drainage of upland areas for sheep grazing has led to a mosaic of acidic grassland and dry heath, with isolated woodlands on the steep valley sides</li> <li>• Shake holes created by natural dissolution of the limestone occur on upland surfaces as do the extensive remains of former lead mining activity including disused shafts, buildings, chimneys and flues.</li> <li>• Large scale extraction of crushed rock aggregates continues in several areas.</li> </ul>	<ul style="list-style-type: none"> <li>• The sample area falls within LCT 33 (Gritstone high plateau). It is underlain by limestone but forms part of an alternating succession of rock types including sandstone and chert.</li> <li>• The area has a rolling upland landform with sharply-defined steep valleys. There are extensive views to the south and south east.</li> <li>• The sample area included evidence of both limestone dissolution (shake holes) and former lead mining ( mine shafts, leats etc.).</li> <li>• There is evidence of Prehistoric activity on the moor and potential for sub surface archaeological remains, including the survival of organic remains beneath the peat</li> <li>• The landscape is characterised as reverted moorland (HLC 2011), having previously been enclosed in the 19th century.</li> <li>• Today it is managed upland moorland used for rough grazing and a managed grouse moor.</li> <li>• The upland heath is a BAP habitat and is of high value to bird species, including Lapwing, Red Grouse, Skylark and Curlew</li> </ul>	<p>The sample site is typical of the Gritstone high plateau, but this accounts for only 18% of the ASMRP resource. Although many of the summary profile features are represented, many others are not (particularly the steep limestone scars, associated hanging woodlands and areas of modern limestone extraction).</p> <p>The sample area cannot therefore be taken as being representative of the whole resource.</p>

**Table 2.11: Summary of the comparison of sample area evidence with predictive landscape modelling results for AMRP 14**

## 3. Review of Methodologies Used in Stages 1 and 2

### Introduction

- 3.1 This chapter of the report provides a review and discussion of the success (or otherwise) of the methodologies used in this project to date to gather and analyse environmental information about the mineral resources of North Yorkshire. This is intended to inform any future, similar projects that may be commissioned by English Heritage and/or North Yorkshire County Council.
- 3.2 In our response to the Invitation to Tender, Capita Symonds (CSL) and Oxford Archaeology North (OAN) proposed method statements for each of the tasks required to complete the project. The tasks were already specified in some detail by NYCC, including the number and overall size of the sampling areas, leaving little scope to modify the overall approach but many of the finer details were proposed by the project team.

### Summary of Approach

- 3.3 Stages 1 and 2 involved gathering, mapping and analysing spatial relationships between various environmental datasets for the different Areas of Surface Mineral Resource Potential (ASMRPs) identified in North Yorkshire. The tasks set out in Stages 1 & 2 were as follows:

#### Stage 1: Environmental Mapping and Characterisation

- Task 1i: Mapping of spatial extent of Areas of Surface Mineral Resource Potential (ASMRP)
- Task 1ii: Historic environment data concordance
- Task 1iii: Strategic environmental mapping
- Task 1iv: Define key environmental characteristics of each ASMRP.
- Task 1v: Identify and describe relationships and interactions between key characteristics of each ASMRP at a strategic level.
- Task 1vi: Identify, map the spatial extent of, and describe/justify up to 12 sample areas within each ASMRP for further detailed study.
- Task 1vii: Production of updated project design
- Task 1viii: Production of Stage 1 Highlight Report

## **Stage 2: Detailed Environmental Evidence Gathering and Assessment of Sample Areas within each ASMRP**

- Task 2i: Desk-based assessment and literature review.
- Task 2ii: Site visits/Walk over survey
- Task 2iii: Landform element classification
- Task 2iv: Land-use mapping
- Task 2v: Detailed Landscape Character Assessment
- Task 2vi: Topographic modelling
- Task 2vii: Predictive landscape models
- Task 2viii: Production of a Stage 2 Highlight Report

3.4 The main objective of Stage 1 was to gather landscape, environmental and historic environment data about the ASMRPs and to apply an agreed methodology to identify 12 sample sites for detailed assessment in Stage 2. In order to achieve an objective and representative selection of sites across as many different ASMRPs as possible, an objective, GIS-based scoring system was developed which combined readily available digital (GIS) landscape, environmental and historic environment data. This is described fully in Chapter 7 of the Stage 1 report and summarised briefly in Table 3.1, below, under methodology.

3.5 The main objectives of Stage 2 were to carry out detailed assessments of each of the selected sample areas, and to develop digital terrain models of the topography, in order to combine with both the sample area findings and the Stage 1 information to produce Predictive Landscape Models (PLMs) for each of the ASMRPs. These are merely ‘conceptual models’ based on limited available data, and are expressed simply as ‘profiles’ for each ASMRP within the Stage 2 PLM report. The models attempt to bring together an understanding of the long term evolution of the landscape, biodiversity and human activity within each of the mineral resources.

3.6 Table 3.1, below, describes the objectives of both Stage 1 and Stage 2 of the project; the methodologies used to meet those objectives; the positive and negative outcomes of using the methodologies, and suggestions regarding improvements which would benefit this type of work in the future.



Stage (objectives)	Methodology	Positive Outcomes	Negative Outcomes	Improvements suggested
<p><b>Stage 1: Environmental Mapping and Characterisation</b></p> <p>The Project Specification set out 6 tasks within Stage 1 to collect data about the Areas of Surface Mineral Resource Potential and identify 12 sample areas for further study</p>	<p>Datasets and sources of information required for data gathering were agreed with the Steering Group and then captured and incorporated into GIS.</p> <p>Individual mineral resource polygons (shape files) for each ASMRP were overlaid with datasets covering landscape designations, landscape character, AHEIP (Areas of Historic Environment Interest and Potential) density scores (based on date, period and number of HER/NMR monuments within each polygon), and natural environment designations.</p> <p>The characteristics of each ASMRP, in terms of landscape, historic environment and natural environment, were described in the Stage 1 report, based on interrogation of the available GIS data.</p> <p>An objective, quantitative selection procedure was developed, based on available GIS datasets (as explained in Chapter 7 of the Stage 1 report), and was applied to the data polygons in order to select representative sample areas of the requisite size for each ASMRP.</p>	<p>The methodology allowed for an holistic approach which encompassed, landscape, historic and natural environmental data.</p> <p>The North Yorkshire County landscape assessment report provided a very useful, GIS-based source of information on landscape character which was able to be combined with ASMRP polygons to derive landscape descriptions for each one.</p> <p>HLC type enabled useful descriptions of each ASMRP and each sample area to be developed, based on present and past land use.</p> <p>Internal workshops allowed for integration of ideas between specialists within the project team, but more opportunities for shared workshops and site visits would have been useful, if timescale and budgets had allowed, to ensure a more comprehensive, multi-disciplinary approach.</p> <p>Objective methodology for selecting representative sample areas, based on available data, resulted in useful, selections, agreed by the Steering Group and subsequently proved (in Stage 3) to be broadly representative, in most cases.</p>	<p>Characterisation of the ASMRPs from readily available GIS data sources allowed for only a partial understanding to be gained of each one. Although meant to be only a high-level, strategic assessment, and although this was able to be supplemented by existing local knowledge by some members of the project team, it resulted in a less comprehensive understanding than that already held by individual members of the Steering Group, within their individual areas of specialism. Whilst many of these gaps were able to be filled later in the project, much more time in Stage 1 would have enabled a fuller understanding to be gained through the review of additional, non-GIS, data (including spatial data held by NYCC in printed form).</p> <p>Inevitably, more detailed information is known about some areas than others and, for areas where there has been extensive previous research (such as the Vale of Pickering), more time is needed to assimilate and do justice to the available results than was allowed for within the Specification.</p> <p>More generally, results can only be based on what is known: some areas may have value which, as yet, is not reflected in designations or other readily accessible, GIS-based, data sources.</p> <p>Not all areas of mineral resource are the same size so some distortion of AHEIP density scores occurred e.g. ASMRP 13 is a small area and scores were particularly high, whilst polygons in other resources (notably ASMRP 9) were often very large, disguising important variations within them.</p> <p>Although the scoring system worked well as a basis for selecting sample areas, it was less useful for gaining a more detailed overview of the historic environment character in each ASMRP because of the variety of historic environment data covering many periods.</p> <p>With regard to HLC, the data provides a limited perspective on historic land use as it only provides present land use and its origins and not specific archaeological or built environment features.</p>	<p>Clearer definition of the expectations required of the Stage 1 analysis, in terms of dealing with more detailed, non-GIS based information, would allow prospective tenderers to have gained a much better appreciation of the timescale and costs which needed to be assigned to Stage 1.</p> <p>This would have avoided the need for extensive revision of the Stage 1 report, and consequential impacts on the overall programme.</p> <p>Greater availability of GIS-based data would greatly enhance the outcomes of this kind of work.</p> <p>More time and budget should be allowed in order to assimilate the vast array of data; to allow testing of alternative methods of assessing the data; and to allow the various disciplines within the project team more time to be able to combine their knowledge and understanding, before moving on to Stage 2.</p> <p style="text-align: right;"><i>(table continues on next page)</i></p>

			<p>With regard to the natural environment, very little GIS data was readily available to inform either the sample selection or the summary of characteristics. Information on designations was available but this accounted for only a small fraction of each ASMRP and descriptions based on this data failed to provide a good understanding of the wider biodiversity characteristics of each ASMRP. Data on other biodiversity assets, such as the overall distribution of broad habitats or even BAP priority habitats within the study area was not available in GIS format so could not be used in this study.</p> <p>GIS-based data on biodiversity opportunities, Biodiversity Landscape Areas and Green Infrastructure Corridors was available but with minimal explanatory information, which again limited its use in characterising the ASMRPs. On their own, these data indicate areas of potential for biodiversity enhancement but say nothing about the existing conditions.</p>	
<p><b>Stage 2: Detailed Environmental Evidence Gathering and Assessment of Sample Areas within each ASMRP</b></p> <p>The Project Specification set out 7 tasks within Stage 2 to gather more detailed information on the sample areas within 12 of the ASMRPs.</p>	<p>More detailed information was gathered for the 12 sample areas.</p> <p>Site surveys were carried out jointly by specialists in landscape assessment, geology, ecology and archaeology.</p> <p>Detailed descriptions of the characteristics of each sample area were produced, including maps of landform units within each of the sample areas.</p> <p>HLC data provided a description of present day landscape character at sample area level, informed by its historical development e.g. Parliamentary Enclosure</p>	<p>The project Specification identified the number and total size of the sample areas. This was essential in terms of being able to estimate costs and programme implications.</p> <p>The desk studies which preceded the site visits allowed for a much greater depth of knowledge to be developed for the individual sample areas and (to some extent) for other parts of the respective ASMRPs.</p> <p>The fieldwork provided good opportunities to investigate the character of each ASMRP in much greater detail on the ground, and vital opportunities for the various specialists within the project team to combine their understanding and knowledge in the field.</p>	<p>The number of sample areas (as defined in the Project Specification) was too small and not statistically representative. At least three sample areas per ASMRP would have provided some indication of variability within each ASMRP, and thereby allowed greater confidence in the findings. This would also have helped to strengthen any conclusions regarding differences between the ASMRPs.</p> <p>The size of the sample areas was also too small to allow for landform elements or other factors which extend over larger areas to be mapped, and it increased the likelihood of incorporating what were unrepresentative features (this applies equally to the natural environment, the historic environment and to landscape in general).</p> <p>Both of these factors have made it difficult to extrapolate the results obtained from the sample areas to the rest of the corresponding ASMRPs. This, in turn, has necessitated a higher-level strategic approach, as explained in Chapter 4 of this report.</p>	<p>In order to allow for a greater number of larger sample areas to be included, the budget would need to be significantly increased and there would also be implications for the project timescale.</p>

**Table 3.1: summary of observations relating to the methodologies used in Stages 1 and 2**

## Alternative Approaches

- 3.7 The suggestions outlined in the right-hand column of Table 3.1, above, point to some aspects of an alternative approach to this kind of work. Whilst many of these suggestions simply relate to the need for more time and budget in order to fulfil the expectations of the Client team, they also point to a need for better **preparation** in terms of the availability of consistent quality GIS-based data across all three specialist areas: landscape, historic environment and natural environment. The lack of digital data for the distribution of habitats, in particular, was found to be a major drawback.
- 3.8 Further benefits could be gained from strengthening the cooperation between the consultant and Client teams into a more comprehensive **partnership approach**. Whilst formal meetings and informal 'workshops' with the Steering Group have been extremely valuable, and whilst there has been a very clear 'open door' from NYCC regarding access to data, there may be benefits from widening this partnership to include other key stakeholder groups, including (in particular) representatives of the minerals industry, in order to share information, knowledge and perspectives throughout the life of the project. This would greatly enhance the mutual understanding of available and workable resources (taking account of economic and practical as well as environmental criteria), and - looking ahead to the requirements of Stage 3 - it would also assist with the mutual understanding of current best practice in terms of both avoiding and/or mitigating adverse environmental effects and creating environmental improvements. In the current project, these issues have been able to be covered by the consultant team, and by independent discussions with industry but much better outcomes would be possible through wider cooperation from the outset.

## General Observations

- 3.9 **Communication:** throughout the project a number of workshops have taken place, as well as the scheduled Project Review meetings at the end of each stage. Although these were initially planned for CSL/AON to discuss project issues, invitations to attend were extended to all members of the Steering Group as it was felt this would help establish a common understanding of the processes and approach as the project developed. During Stages 1 to 3 of the project, there have been 4 CSL/AON team workshops and members of NYCC have attended 3 of these. Attendance of both the client and consultants at these workshops has provided additional opportunities to discuss the project and to review and refine methodologies. The main benefit has been 'face to face' discussion on expectations in relation to content and delivery of the various stages. Where these haven't totally aligned, a way forward has been agreed and both parties have left with a greater understanding of what to expect, a reduced sense of frustration and improved communication.

- 3.10 A sensible and proportionate level of communication needs to be maintained throughout the life of the project in order to maintain momentum re project delivery; too many or too few interventions from either party can impact on programme and cause confusion as to what is the ultimate outcome.
- 3.11 **Multi-disciplinary approach:** This has clearly been essential throughout the project, as envisaged in the Specification. In delivering this project, the specialist knowledge of archaeologists, a historic environment specialist, geologists (minerals and geomorphology), landscape architects, ecologists and GIS specialists have been brought together. The team has discussed the findings of the respective data sources, surveys, assessments and analysis with each other and, as a result, has developed a much clearer understanding of the overall relationships between the characteristics of their respective fields with regard to surface mineral resources in the North Yorkshire landscape. It has been particularly useful to have corresponding specialists representing the client team as this has facilitated more detailed discussion across all environmental topics.

## 4. Potential to Generalise for the Whole of each ASMRP

### Introduction

- 4.1 The extent to which generalisations can be made from the limited number of small sample areas to the full extent of each ASMRP depends upon the extent to which each sample area is representative of the wider area. This, in turn, depends upon the size, number and location of each sample area and the diversity of the ASMRP. As explained in the Stage 1 report, the size and number of the sample areas was fixed by the research specification for this project. Sample areas were consequently selected for only eleven out of the fourteen ASMRPs (1, 2, 3, 4, 5, 6, 7, 8, 9, 12 and 14) and, with the sole exception of ASMRP 1, only one sample area was able to be selected for each of these.
- 4.2 Shortlists for the location of each sample area were determined through an objective, automated, GIS procedure, as explained in Chapter 7 of the Stage 1 report, with the final selection of each area (from four shortlisted candidate areas) being made more subjectively by the project Steering Group. The procedure was designed to ensure that each sample area was as representative as possible of the ASMRP concerned, based on available GIS data. The process was clearly subject, in this respect, to the limitations of the available datasets, but nevertheless produced a reasonable selection which was agreed by the Steering Group.
- 4.3 Detailed reports on the desk study and field observations for each of the selected areas are presented in the Stage 2 sample areas report, and a comparison of these observations with the more general characteristics of each ASMRP, including the Predictive Landscape Modelling profiles, also developed in Stage 2, has been presented in Chapter 2 of this report. The key observations relating to these comparisons, as summarised in the tables at the end of each ASMRP section in Chapter 2, are brought together in Table 4.1, below. Also shown in the right hand column of this table are some additional observations relating to the extent to which the influence of major landscape designations (National Parks and Areas of Outstanding Natural Beauty) should also be taken into account, as a major indicator of landscape sensitivity.

### Findings

- 4.4 On the basis of the information summarised in Table 4.1, below, it can be concluded that most of the sample areas seem to have proved to be reasonably representative of their ASMRPs, but (not surprisingly) that there are a number of exceptions to this, relating primarily to the inherent diversity of the landscapes and other features involved. This diversity is reflected, to at least some degree, in the summary profiles developed from the Stage 2 Predictive Landscape Modelling exercise, but not always in the more limited sample areas.

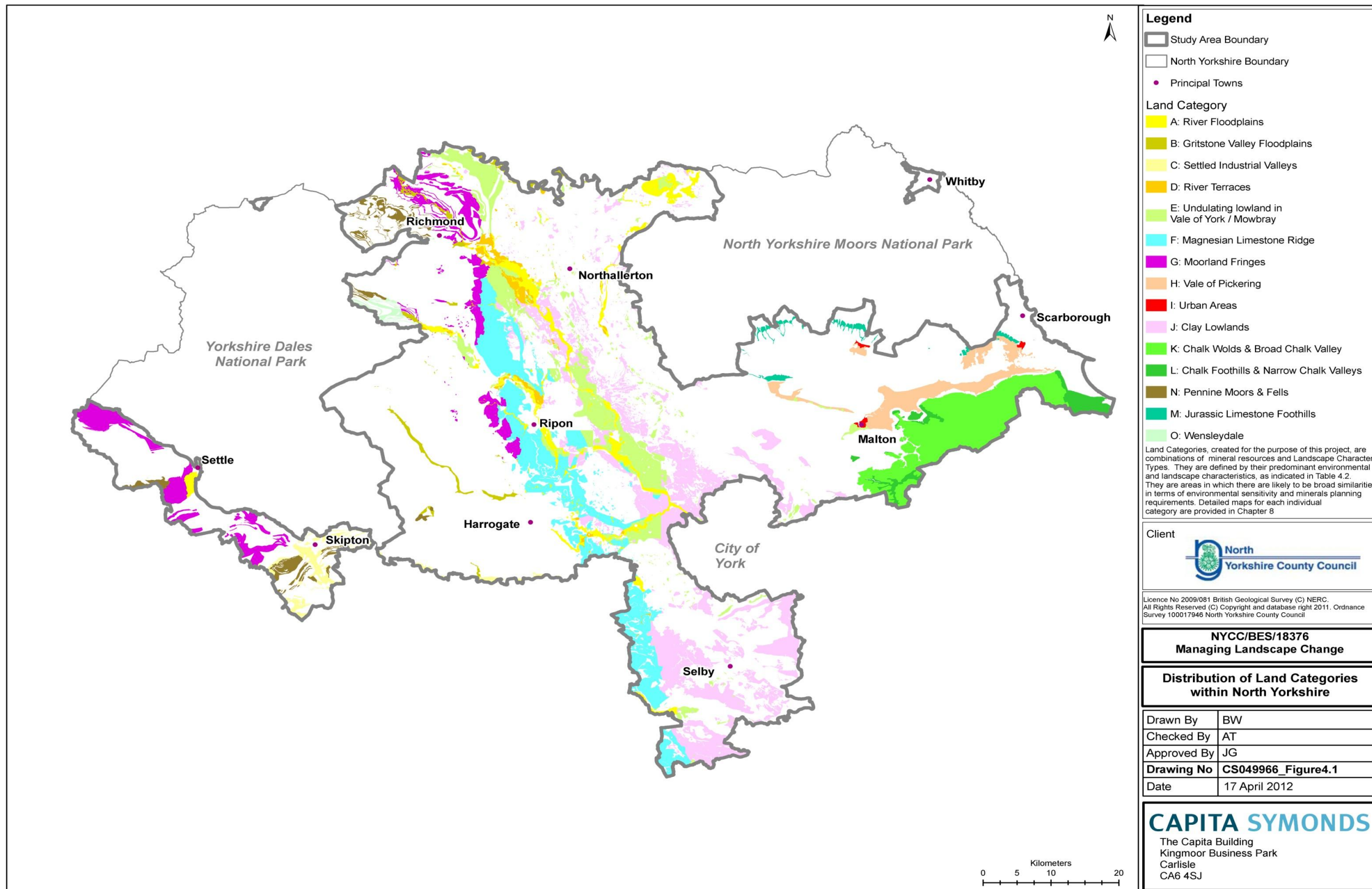
- 4.5 The implications of this are that it would be unwise to generalise about whole ASMRPs from the information obtained within the sample areas alone. This is not at all surprising, given the small size of the sample areas and the statistically invalid number of these which were available for investigation.
- 4.6 Greater confidence can be had in generalisations based on the summary profiles from the Predictive Landscape Modelling report, since these are based on a much wider range of knowledge, combining the sample area findings with wider desk-top analysis and with local knowledge available to the project team. Even this is far from perfect and (as noted in Chapter 3) could be greatly improved if more time and budget were available, but it provides a more substantive basis for generalisation than the sample sites alone, and a more justified basis for future planning, as addressed in Stage 4 of this project.
- 4.7 It must also be remembered that any kind of model is merely a simplification of reality, designed to provide a starting point for understanding and further investigation. Users of this report should therefore refer to the detailed information which contributed to the Predictive Landscape Modelling work, rather than relying purely on the summary profiles. This is especially important for those who may be developing proposals for future mineral extraction within North Yorkshire, and those responsible for assessing such proposals. Further guidance on the sources of information which potential applicants should make use of is presented in Chapter 9 of this report.

## **Environmental Categorisation**

- 4.8 Taking account of the varying degrees of similarity, in terms of environmental characteristics, within *and between* different ASMRPs, certain geographical groupings begin to emerge which may provide a more useful basis for future planning than the ASMRP boundaries themselves. Although some of the ASMRPs, such as the Vale of Pickering (ASMRP 5) and the Yorkshire Wolds (ASMRP 7), have strong internal homogeneity, there are also differences, as reflected in their component LCTs. For other ASMRPs, where there is a more complex interplay of different landscape types, this is not the case. Equally, however, there is not always consistency within individual LCTs, which occur across many different types of resource. Even in the Vale of York, where many similarities exist across the areas of ASMRP 3 and ASMRP 4 resources, there are important differences associated with the ASMRP 6 clay resources and the ASMRP 1 floodplains within the same general areas. Table 4.2, below identifies a total of 15 categories, each of which is considered to have a greater degree of homogeneity than either the ASMRPs or the LCTs, and thus provides a potential basis for developing planning recommendations. The categories are utilised in Chapters 7 and 8 of this report and their geographical distribution is illustrated in Figure 4.1.

ASMRP	Comparison and key observations (from summary tables in Chapter 2)	Additional observations
ASMRP 1 Sample Areas 1.1 and 1.2	The sample areas accurately reflect the summary profile for ASMRP 1, which seems likely to be typical of much of resource, except for those areas within the settled industrial valleys of the Aire and Wharfe, where much greater urbanisation is evident.	Representative of the majority of ASMRP 1, except for those areas (mostly in Nidderdale) which fall within an AONB and those in upper Swaledale, Wensleydale and Craven which are visible from within parts of the Yorkshire Dales National Park
ASMRP 2	The sample area broadly reflects the summary profile for ASMRP 2, which seems likely to be typical of much of resource, except for those areas within the settled industrial valleys of the Aire and Wharfe, where much greater urbanisation is evident.	Representative of the majority of ASMRP 2, except for very small areas of resource which fall within an AONB and those which are visible from within parts of the Yorkshire Dales or North York Moors National Parks
ASMRP 3	The landscape and biodiversity features identified within the sample area are broadly consistent with those for other parts of the ASMRP 3 resources where these overlie the Magnesian Limestone (LCT 6), and are not dissimilar to those for other parts of the resource which fall within LCT 28 and LCT 25. Together, these cover 57% of the ASMRP 3 resource. The low level of archaeological resource identified so far in this ASMRP, might be due, in part, to the fact that crop marks do not show well on certain soils, and in part to the high levels of cultivation which have ploughed out many near-surface features.	Representative of the majority of ASMRP 3, except for very small areas of resource which fall within an AONB or which are visible from within parts of the Yorkshire Dales or North York Moors National Parks.
ASMRP 4	The sample area accurately reflects the summary profile for ASMRP 4, which seems likely to be typical of the majority of the ASMRP 4 resource 75% of which falls within the same or very similar landscape character types (LCTs 6, 25 and 28) which, despite certain differences, share many of the same broad characteristics.	Representative of most of ASMRP 4, except for the resources around Galphay which fall within parts of the Nidderdale AONB
ASMRP 5	The sample area is typical of the ASMRP 5 landscape at the foot of the Wolds. It matches all the main characteristics of this ASMRP seen in Stage 1 and accurately reflects the summary profile. The area is slightly less typical of the parts of the landscape on the northern side of the Vale near Wykeham where there has been large scale mineral extraction and plantation woodland screens the extraction site, or of the slightly more undulating land to the east between Seamer and Star Carr.	Representative of most of ASMRP 5, except for the small area of resource which falls within the Howardian Hills AONB. Most areas are visible at a distance from within parts of the North York Moors National Park
ASMRP 6	The sample area accurately reflects the summary profile for ASMRP 6. The lack of archaeological evidence is consistent with the low site visibility associated with heavy clay soils, but could also be consistent with a lack of early human activity prior to post-medieval drainage of the former wetland.	Representative of most of ASMRP 6, except for the very small areas of resource which fall within the Howardian Hills AONB. Some areas are visible at a distance from within parts of the North York Moors National Park.
ASMRP 7	Except for the relatively small size of its fields, compared with immediately surrounding areas, the sample area is typical of the main Chalk Wolds landscape (LCT 18), which covers 70% of the ASMRP 7 resources. It accurately reflects the summary profile for ASMRP 7, except for those aspects which relate to the much smaller but very important areas within the narrow chalk valleys and foothills, where agriculture is far less intensive and greater biodiversity is evident.	Mostly representative: none of the resource falls within an AONB, but the northern edge is visible at a distance from within parts of the North York Moors National Park
ASMRP 8	The sample area appears to be representative of most of the ASMRP 8 Jurassic Limestone resource, and accurately reflects the summary profile.	Representative of most of ASMRP 8, except for the western-most area of resource which falls within the Howardian Hills AONB. Most of the resource is visible from within parts of the North York Moors National Park
ASMRP 9	The sample area reflects many but not all of the key points identified in the summary profile for ASMRP 9. It also exhibits a number of atypical features - primarily those associated with gypsum-related subsidence which is localised to this and a limited number of other locations within the resource outcrop. In common with many parts of the broad ASMRP 9 resource, it is located well away from the A1(M) route corridor, but nevertheless has a high archaeological potential because of its proximity to the historically important centre of Ripon.	Representative of most of ASMRP 9, except for the small areas of resource which fall within the Nidderdale AONB
ASMRP 12	The sample area is fairly typical of the summary profile, but not of all parts of the ASMRP 12 resources. The influence of the underlying sandstone on the landscape is dependent upon the extent to which it is concealed by Quaternary drift deposits - particularly glacial till and/or peat. This also directly affects the visibility of ancient rock art. Both the sandstone and the associated archaeology is most likely to be seen on valley sides or low fells. In higher summit areas, they are more likely to be concealed by superficial deposits; whilst in industrialised valleys both will be hidden or modified by modern development.	Representative of most of ASMRP 12, except for the small areas of resource which fall within the Forest of Bowland AONB. Much of the resource is visible from within the Yorkshire Dales National Park
ASMRP 14	The sample site is typical of the Gritstone high plateau, but this accounts for only 18% of the ASMRP resource. Although many of the summary profile features are represented, many others are not (particularly the steep limestone scars, associated hanging woodlands and areas of modern limestone extraction). The sample area cannot therefore be taken as being representative of the whole resource.	Representative of most of ASMRP 14, except for the small areas of resource which fall within the Nidderdale AONB. Much of the resource is visible from within the Yorkshire Dales National Park

Table 4.1: Summary of the observations for each ASMRP regarding the potential to generalise

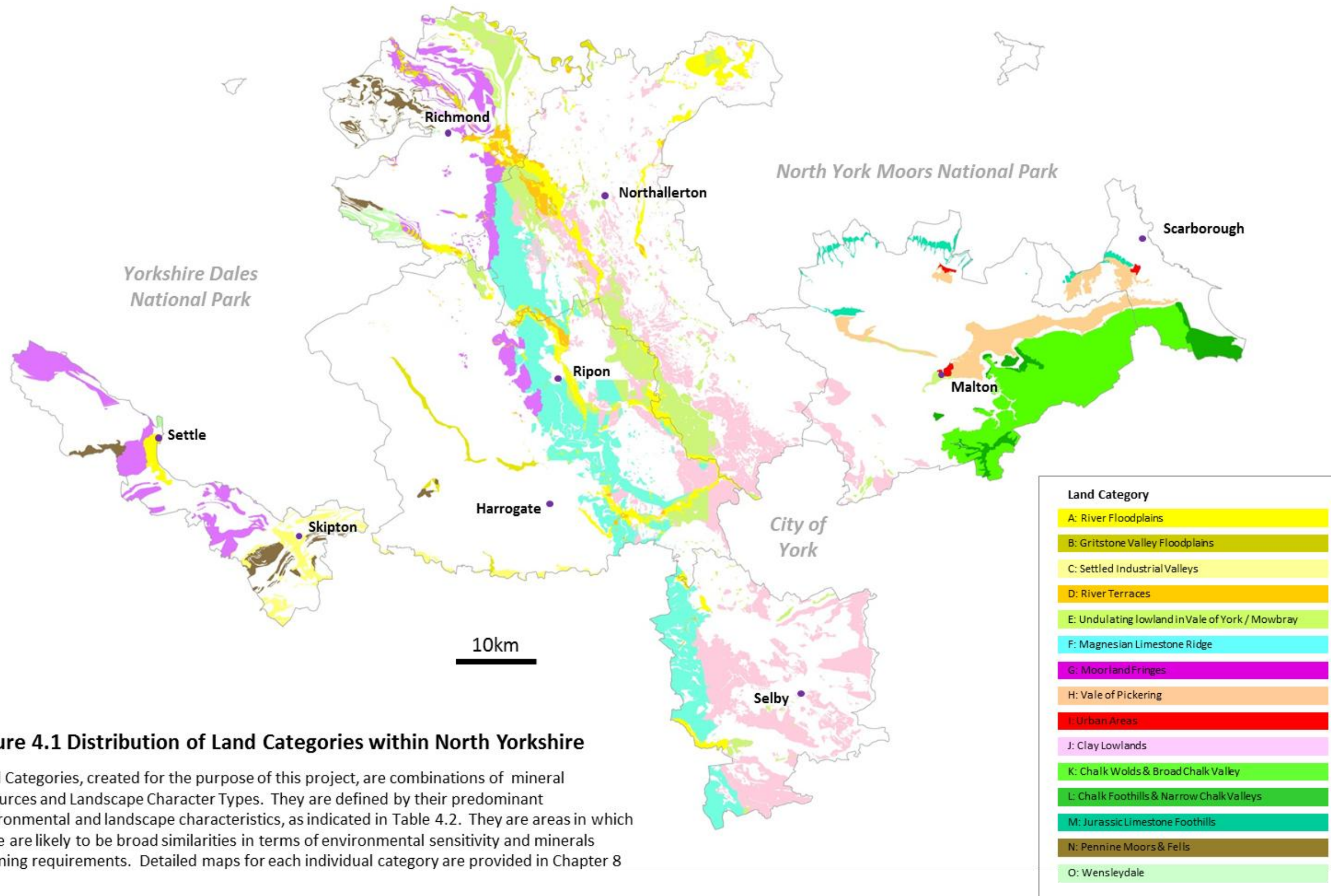


Land Categories, created for the purpose of this project, are combinations of mineral resources and Landscape mineral types. They are defined by their predominant environmental and landscape characteristics, as indicated in table 4.2. They are areas in which are likely to be broad similarities in terms of environmental sensitivity and minerals planning requirements. Detailed maps for each individual category are provided in chapter 8.



Table 4.2: Summary of Land Categories for all ASMRPs			
Category	ASMRPs	LCT Subdivisions (in order of decreasing area within each ASMRP)	Dominant feature(s) in terms of environmental characteristics
Category A	ASMRP 1 (including areas superimposed on ASMRPs 9, 10, 11)	LCTs 24, 27, 6 & 25 plus Tees Valley part of LCT 36	ASMRP 1 - Modern River Floodplains
	ASMRP 12	LCT 11	Floodplain of the River Ribble
Category B	ASMRP 1, 2 & 13	LCT 36 except Tees Valley & LCT 13	Gritstone Valley Floodplains
Category C	ASMRPs 1, 2, 12 & 14	LCT 31	Settled Industrial Valleys
Category D	ASMRP 2	LCTs 24, 25, 27, 13, 6	ASMRP 2 - River Terraces
Category E	ASMRP 3	LCTs 28, 24, 25, 23	Mixed features within general lowland topography, predominantly within the Vale of York & Vale of Mowbray - all dominated by modern agriculture
	ASMRP 4	LCTs 25, 28, 24, 27	
	ASMRP 5	LCT 5	
	ASMRP 9	LCTs 27, 25	
	ASMRP 14	LCT 27	
Category F	ASMRPs 3, 4 & 9 (including areas superimposed on ASMRPs 10 & 11, but excluding areas overlain by ASMRP 1)	LCT 6	Magnesian Limestone ridge, including areas overlain by glacial and glaciofluvial sediments
Category G	ASMRPs 3, 4 & 9	LCT 13	Moors Fringe or Drumlin Valleys or Rolling Upland Farmland
	ASMRPs 10 & 12	LCT 32	
	ASMRP 12	LCT 14	
	ASMRP 14	LCTs 13, 14 & 32	
Category H	ASMRP 5	LCTs 30 & 26	ASMRP 5 - sand & gravel outcrops at the margins of the Vale of Pickering
	ASMRP 5	LCT 22	Open Carr Vale Farmland within the Vale of Pickering
Category I	ASMRP 5	LCT 1	Urban Landscapes
Category J	ASMRP 6	LCTs 23, 28, 25, 24, 6, 27	ASMRP 6 - low-lying, flat agricultural landscape with poor visibility
	ASMRP 9	LCT 23	levels farmland
Category K	ASMRP 7	LCTs 18 & 20	Chalk Wolds & Broad Chalk Valley
Category L	ASMRP 7	LCTs 19 & 21	Chalk Foothills & Narrow Chalk Valleys
	ASMRP 13	LCT 19	
Category M	ASMRP 8	LCTs 4 & 30	Limestone Foothills
Category N	ASMRP 12	LCTs 38, 37, 35	Siltstone, Sandstone & Gritstone Moors and Fells
	ASMRP 13	LCTs 34 & 35	

	ASMRP 14	LCT 33	
Category O	ASMRP 14	LCT 9	Farmed Dale



**Figure 4.1 Distribution of Land Categories within North Yorkshire**

Land Categories, created for the purpose of this project, are combinations of mineral resources and Landscape Character Types. They are defined by their predominant environmental and landscape characteristics, as indicated in Table 4.2. They are areas in which there are likely to be broad similarities in terms of environmental sensitivity and minerals planning requirements. Detailed maps for each individual category are provided in Chapter 8

## 5. Options for Sensitivity and Capacity Analysis

### Introduction

- 5.9 In order to progress the subsequent parts of Stage 3, consideration was given to a range of potential options regarding the overall approach to be taken in the assessment of environmental sensitivity and capacity for future mineral development within North Yorkshire. This Chapter outlines the options available, noting examples from previous recent studies, and identifies the relative pros and cons of each one, as a rationale for selecting the preferred approach to be used in this study. It then describes in more detail the methodology for implementing the preferred approach.

### Options Available

- 5.10 For the purposes of this project, Section 2.3.5 of the project specification notes that 'sensitivity' shall be defined as "the degree to which a particular key environmental characteristic (using Stage 1 and Stage 3: 2.3.1) outputs) of an ASMRP is vulnerable to harm and/or change with potentially adverse effects upon its character".
- 5.11 Section 2.3.6 of the Specification further defines 'capacity' as "a consideration of the sensitivity information (from Stage 3: 2.3.5 output) and judgement about the relative value of each key environmental characteristic, to guide minerals development to less sensitive or vulnerable areas. This judgement will be an interpretation of the significance of the key environmental characteristics; a subjective opinion, based upon professional, specialist synthesis and interpretation of relative importance".
- 5.12 Sensitivity, as used in this study, is therefore required to deal with the intrinsic vulnerability of the natural and historic environments to potential impacts, irrespective of any mitigation measures that may be put in place through planning conditions to reduce or eliminate adverse impacts, or even to create positive long term environmental improvements through the eventual restoration and reclamation of surface mineral workings. The potential for long term improvement differs markedly between the natural and historic environments. In the former case, although biodiversity can be harmed in various ways by mineral extraction, in the longer term it can also be markedly enhanced through high quality restoration and aftercare. By comparison, damage to the historic environment is permanent (though it can be compensated to some degree by investigation, recording, analysis and dissemination/outreach activities). The focus required here, however, is very clearly on intrinsic vulnerability.
- 5.13 As noted by English Heritage (draft, 2011), techniques of assessing sensitivity to change are fast developing and the standard guidance on the subject, Topic Paper 6 of the Landscape

Character Assessment (LCA) suite, published in 2002 by Scottish Natural Heritage and the former Countryside Agency (now Natural England) is currently under review. Despite the subsequent and rapid development of ideas in this area, however, the 2002 guidance made an important distinction between overall landscape sensitivity, and sensitivity to a particular type of change.

5.14 For the purposes of the present study, three broad approaches to the assessment of sensitivity may be considered:

- 1) **A quantitative approach based on assigning scores to various environmental features** (ancient monuments, cropmarks, historic parks, SSSIs, SINCs etc.), to reflect their intrinsic vulnerability, leading to the production of a map illustrating spatial variations in sensitivity (i.e. a 'traffic lights' map identifying three or more categories of sensitivity);
- 2) **A quantitative or partly qualitative approach based on the varying types of sensitivity exhibited by individual receptors** (e.g. different types of heritage resource, different facets of landscape character or different habitats) to various types of impact. This would take account of the fact that any individual receptor will be sensitive, in varying degrees, to a range of different potential impacts. If it could be done this would again lead to some kind of spatial mapping of sensitivity.
- 3) **A purely qualitative, scenario-based approach**, in which the generalised key characteristics of each ASMRP (or perhaps broad subdivisions of each ASMRP) are considered in terms of their sensitivity to the specific range of impacts likely to be associated with the kinds of mineral extraction that would be likely to take place in that ASMRP. This would lead directly to the development of policies or guidance applicable to each of these broad areas (e.g. guiding applicants to the particular types of sensitivity which they would need to address within their applications), and the differences between the ASMRPs (or parts thereof) could be illustrated on a map.

5.15 In order to decide on which overall approach should be used in this project, consideration was given to the overall, generic pros and cons of each one, in relation to what this project needs to achieve. There are two fundamental aspects of this. Firstly, the outcome of the project needs to provide 'robust and credible evidence' to support future planning policy, and must therefore be able to withstand scrutiny by the public and other stakeholders during consultation and by the planning inspector at the EIP stage. Secondly, the chosen methodology had to be achievable within the timescale and budget allocated to this task.

#### Option 1) quantitative (scoring-based) approaches

5.16 This option would entail using numerical scoring to create a matrix of scores for different designations or types of asset associated with different natural and historic environment

assets or types of landscapes. A scientific approach such as this can be seen as a consistent and unbiased way of combining scores from very different assets in to a matrix or GIS layers to compare very different things. Such approaches have been carried out, at County level, with complex studies of landscape sensitivity, and in more recent years, such studies have increasingly incorporated spatial and other electronic data generated through Historic Landscape Character (HLC) and the digitised Historic Environment Records (Hers).

- 5.17 One specific example which can be used to illustrate the numerical scoring approach is that undertaken by Chris Blandford Associates (2004) as part of their overview of the historic environment of the large Thames Gateway Regeneration area (for English Heritage, Kent County Council and Essex County Council). The study used desk based sources to define the historic environment character of the project area and developed a sensitivity model to 'assess the sensitivity of fabric, integrity and historic significance of the three key components of the historic environment (historic landscape, built heritage and archaeology) to major physical change resulting from modern development' (CBA 2004). The methodology varied for each of the 3 elements, but all included a GIS-based numerical approach to defining the sensitivity of individual assets and creating a cumulative model of that sensitivity. The numeric values were not comparable between the key elements, and were only relevant within each element. Only when the scores had been assigned was a common scale of sensitivity used to allow a matrix of sensitivity covering the three elements to be produced.
- 5.18 The difference in data availability and data sources, point data for listed buildings polygons for archaeological sites and large scale designations such as the Greenwich World Heritage Site and conservation areas. Crucially professional judgement was used to assign numerical values for sensitivity to change, with a common scale created to allow a broad cross comparison between the identified 'themes'. Buffers were also defined around some resources to take account of setting and associated features. A scheduled monument was assigned a sensitivity value of 30, a listed building a value of 20, whilst Greenwich World Heritage Site with a 300metre buffer was given a score of 50.
- 5.19 The project report states that 'as in many studies it was decided it was not possible to produce one map showing relative sensitivity of every heritage asset to every type of change' (CBA 2004) Three tables of sensitivity scores were developed, that for Built Heritage/Urban Areas ranged from Extremely Sensitive (for a score of 70+) where major physical change was unlikely to be accommodated, through Highly Sensitive (20-69) where physical change is likely to have significant impacts on the historic environment, through to Little Known Sensitivity(score of 1-4) and no data. In contrast the table for Historic Landscape Sensitivity ranged from Extremely Sensitive (a score of 24+), to Little Known Sensitivity (1-4), and Archaeological Sensitivity with Extremely Sensitive given to areas with scores of 300+, which were known to have a high concentration of archaeological sites and Limited Known Sensitivity at the bottom of the scale with a score of 1-9.

- 5.20 The sensitivity analysis raised a number of issues for concern in relation to consistency of data across the area and the availability of additional data. The Thames Gateway study concluded that the three sensitivity analyses presented key messages about broad patterns and sensitivity of areas and sites and could inform strategic decision making when combined with local knowledge and professional judgement but was not suitable for use for detailed site allocation decisions.
- 5.21 A rather different and more simplistic GIS-based approach was developed by the British Geological Survey in connection with the 'Phase 1' assessment of sand & gravel resources for the Yorkshire and Humber Region (McEvoy et al., 2004). This approach simply entailed overlaying all known environmental constraints within the GIS to produce a composite map showing spatial variations in the 'density' of constraints. No weighting was assigned to the different types of constraint, and no recognition at all was given to factors (such as unscheduled archaeological features and un-designated habitats or landscapes) which were not able to be represented as GIS layers. The authors note that 'Higher sensitivity does not mean an area will be unsuitable for development, just that there may be more to consider and more stakeholders to consult'. Whilst this represents an interesting starting point, it does not deal with issues in any depth and provides only a partial (very incomplete) view of issues that need to be considered by decision-makers.
- 5.22 Taking account of these examples, and of more general expectations relating to the practicalities of assigning scores to individual assets, the pros and cons of this approach can be summarised as follows:
- PROS: If it could be achieved in a way which was acceptable to all, a map showing categories of sensitivity would be a perfect solution, as it would provide very clear guidance as to where future mineral development should be directed (i.e. where proposals would be likely to receive a favourable planning response and where they would not). This would reduce uncertainties for mineral operators and others and would help to minimise environmental impacts by avoidance of the most sensitive locations.
  - CONS: Any scoring system is likely to prove controversial because different experts will disagree on the particular scores assigned to particular features. Notwithstanding this, whilst scoring might be achievable (to some extent) for the historic environment (for example through the density method used in Stage 1 for identifying 'average' sample areas, or through the more sophisticated use of HLC data), it would not be achievable in terms of landscape quality or the natural environment and would be difficult to use for unknown buried archaeology or hitherto unrecorded surface features such as ridge and furrow. This is simply because existing digital data on these topics is too limited to provide an adequate representation of sensitivity. In the case of landscape it would rely on the presence or absence of a single designation (AONBs) and would not allow for differentiation within either of these

two categories. In the case of the natural environment it would allow only for scores to be assigned to existing designations (international, national and local) which, as demonstrated in Stage 1, apply only to very small percentages of each ASMRP. In both cases, an approach which relied exclusively on designated sites would contravene the principles of the European Landscape Convention, which is being embraced by Natural England with regard to landscape, biodiversity and geodiversity. Whilst additional biodiversity and limited geodiversity data is available, this is not in a suitable (GIS) or consistent format for analysis within the timescale and budget available. For landscape, there is County-wide coverage of landscape character types (as reviewed in Stage 1), and some more detailed District assessments, but all of these deal with character, not quality, and thus do not provide a basis for scoring or quantitative analysis. Similarly, for biodiversity, ecological surveys are highly localised and again would not provide a basis for consistent scoring across the whole of the study area.

- CONS (continued): Another fundamental issue is that sensitivity is so dependent upon the nature of the imposed change: a particular feature (e.g. a peat bog containing waterlogged artefacts) may be highly sensitive to one factor (e.g. dewatering of a nearby excavation) whilst being completely unaffected by other potential impacts, such as noise or dust associated with the extraction.

5.23 In addition to the practical concerns outlined above, restricting the areas considered acceptable for mineral applications on environmental grounds would effectively short circuit the normal planning process. It would prejudge the outcome of individual applications rather than allowing proposals to be considered on their individual merits, and in the light of mitigation strategies that may be offered to deal with environmental concerns. It may also result in applications being restricted to areas in which the mineral is more costly to recover and/or to transport to market areas, with consequential adverse impacts on the economy and on Carbon emissions. For all of these reasons, the minerals industry would offer very robust challenges to this approach which would be extremely difficult (if not impossible) to rebut at an Inquiry, given the inadequacy of the data on which scores could be based. This difficulty might be reduced if the sensitivity map was issued simply for guidance purposes, and if the scores were not relied upon when judging applications ... but that would defeat the objective.

5.24 One further problem is that any map which delineates categories of acceptability for future development (of any kind) runs the risk of causing planning blight to property and land use values. Such risk is diminished if the spatial boundaries between categories are based on clear and robust evidence – such as the presence or absence of mineral resources – but it would be heightened if the categories are based on more spurious or inadequate data.



Option 2) approaches based on the varying types of sensitivity of individual receptors

- 5.25 One of the main difficulties in implementing option 1 is that individual receptors are sensitive to different things, and that different receptors within the same area will therefore give rise to different scores for any given type of impact. One potential solution to this would be to consider each individual receptor separately and then somehow to integrate the results to derive an overall indicator of sensitivity for a particular area - as in the second part of the Thames Gateway sensitivity assessment of Historic Environment character, as outlined above (CBA 2004).
- 5.26 Within the natural environment sector, research driven by the requirements of both the Water Framework Directive and the earlier Habitats Directive has attempted to identify the critical 'tolerance ranges' in terms of both water quality and hydrological regime, for different habitats and plant communities within lowland wetland environments (Wheeler & Shaw, 2000; Wheeler et al., 2004). That work has highlighted the fact that, whilst the requirements of wetlands have historically been focused on variations in water levels, these cannot be separated from water quality issues and that hydrochemical conditions will often be the main critical factors influencing the component vegetation communities. Wheeler et al. (ibid) also note that research in this area is ongoing and that only generic guidance as to the tolerance range of different wetland plant communities has so far been able to be given. This is not least because of the complexity of ecosystems and the differences in tolerance between individual species.
- 5.27 Such difficulties can only be compounded when attempts are made to consider a wider range of receptors. This, however, has been attempted by the Heritage and Environment Service of Bedfordshire County Council, in a study which brought together landscape, historic environment and biodiversity designations and other sensitivity indicators to assess vulnerability to the impacts likely to be associated with proposed areas of town and village development (Bedfordshire County Council, December 2008). The assessment was informed by desk based study and field work, but drew extensively on the knowledge and experience of the County Councils own Heritage and Environment Service. The themes were seen as inter related and equally important with no hierarchy of interest – all themes were seen as having an equal contribution to the special character of the area. A sensitivity scale of 1-4 based on the significance of the environmental resource, (derived from designation and professional judgement) with 4 being the least sensitive, was used within the study areas, to map spatial variations of acceptability. A second stage was completed looking at areas of level 2 and 3 sensitivity to see if mitigation to was possible to integrate development areas into the countryside. In this case and others (e.g. Worcestershire County Council, 2003 and Land Use Consultants & GOSW, 2003), sensitivity based on scoring known attributes has been used as a starting point for understanding the sensitivity and vulnerability of the natural and historic

environments. The approach is seen as successful at a general level but requiring more detailed assessment, particularly where there is likely to be extensive mitigation requirements.

5.28 At a regional level, recent work in the East of England explores sensitivity to a given type of change, and places emphasis on sensitivity, rather than capacity, as a basis to positively focus future landscape change (Landscape East and Land Use Consultants June 2011). In 2004, Hampshire County Council worked with West Berkshire Council to develop a methodology for determining landscape sensitivity, based on comprehensive assessments of landscape character and historic landscape character, using indicators based on condition, significance and robustness:

- **Condition** - how well has the condition been preserved, is it intact? (professional judgement);
- **Significance** – designations, rarity, does it represent or dominate the landscape character or contribute to its setting;
- **Robustness** – looking at particular attributes and their vulnerability, and in addition adding professional judgement on its reparability or replacement.

5.29 Hampshire County Council subsequently hosted a peer review workshop, bringing together those from across a number of disciplines to discuss the methodology and usefulness of the results generated (see Hampshire County Council, 2005). The paper makes interesting reading in terms of our similar thoughts on methodologies and data. Does a feature or a landscape have ‘inherent’ or ‘overall’ sensitivity? Hampshire County Council has come to the view that there had to be some sort of stimulus or a threat for change to occur, using examples of the difference in condition of heathland areas depending on the size of the adjacent population. It was agreed amongst those attending that a multi-disciplinary and holistic approach was important, that scoring was a useful way of combining data but the resultant mapping could be misinterpreted, that there will be an increasing role for HLC, with the opportunity to combine data sets, and finally a discussion about the use of the term sensitivity being viewed widely as a constraint and the possibility of other descriptions or terms being utilised in future studies.

5.30 Taking account of these examples and of more general expectations relating to the likely availability of adequate and complete data, the pros and cons of this approach can be summarised as follows:

- **PROS:** This approach would, theoretically, offer much greater sophistication than Option 1, as it would take account of multiple individual sensitivities for each receptor, and would thus be underpinned, theoretically, by more robust scientific data;
- **CONS:** The fundamental difficulty is the lack of data. Without being assured of complete and comprehensive data, and without having a thorough knowledge of the area concerned, it is

not possible to have sufficient certainty in terms of many important receptors, such as species and habitats, buried archaeology and long term visual impacts. Previous attempts to assess sensitivity in this way, for example Natural England's work on the tolerance of individual types of plant communities to external factors such as rainfall, water quality and groundwater levels, have tended to stall because of insufficient detailed knowledge of, and ability to quantify, the variables involved. Whilst this approach might be possible at individual sites, given adequate long term baseline modelling to properly understand and quantify the processes and responses involved, it would simply be impossible to attempt on a County-wide scale.

### Option 3) qualitative, scenario-based approach

- 5.31 The difficulties associated with the lack of adequate quantitative data, and those relating to the multiplicity of potential impacts, depending on the nature of the proposed development, may be able to be overcome by utilising qualitative data and by focusing on specific development scenarios, such as mineral extraction, reservoir construction, wind farms or built development.
- 5.32 English Heritage is currently developing new guidance along these lines, incorporating the use of Historic Landscape Characterisation (HLC) to assess sensitivity to change (English Heritage, (draft) 2011).
- 5.33 Two recent studies published by Cornwall County Council (2010a and 2010b) used this emerging approach as the basis for sensitivity mapping in relation to the specific issue of informing future decisions on wind turbine and solar farm installations. In this case, the scenarios incorporated four stages to understanding the vulnerability of the historic environment to the known or predicted effects of the proposed change:
- 1) Assess the negative and positive effects of the scenario
  - 2) Assess the vulnerability or openness of a place to those effects
  - 3) Assess the degree to which the places significance will influence consequent decisions
  - 4) Draw conclusions and make decisions
- 5.34 Any assessment carried out in relation to a particular type of development is likely to bear some resemblance to an EIA approach, the main difference being that, in this case, the assessment would be applied more strategically, to a range of resource areas, rather than to an individual, specified location.
- 5.35 Landscape sensitivity and capacity have been considered at a strategic level in relation to Regional Spatial Strategies and other strategic planning frameworks, for example as part of the Strategic Environmental Assessment (SEA) or Sustainability Appraisal (SA) procedures which may apply. One example is the East Midlands Regional Landscapes Scoping Study Final Report

(Porter et. al., 2008). That particular study identified two different types of environmental resource: - the wider environment where there is a need to maintain overall character and resource but where there might be scope for change or development; and key natural and cultural resources which can be identified within the wider environment and which are considered irreplaceable, such that loss or damage would be extremely serious. In any scenario-based approach it will be important to separately identify features of this type and to consider their sensitivities to the specific impacts likely to be involved.

5.36 Taking account of these examples, and of more general expectations relating to the use of qualitative data, the pros and cons of this approach can be summarised as follows:

- PROS: A qualitative, scenario-led approach would avoid the need to rely on comprehensive, quantitative data and thus would have the benefits of simplicity and achievability which are lacking in Options 1 and 2. It would be a natural extension of the existing project requirements for Predictive Landscape Modelling, in Stage 2, and the assessments of key environmental characteristics and mineral extraction methods, in Stage 3. These would provide the necessary information on sensitivities and potential impacts, respectively. Such an approach would also be focused more directly on the development of policies and guidance that will help mineral operators to give adequate consideration to the key environmental issues associated with different types of quarrying in different types of deposit. This is a key requirement of the project, and the main focus of Stage 4;
- Whilst some operators already have a good knowledge of key environmental issues, many others do not. This is evidenced by applications which are not supported by adequate information on mitigation strategies etc. Once applicants have given adequate consideration to the key issues involved, they are more likely to either submit applications which adequately address these issues (e.g. supported by adequate baseline monitoring, research, consultation and mitigation strategies) or decide for themselves to look elsewhere if the costs involved in doing these things seem likely to be prohibitive. In effect, this allows for a valid 'monetisation' of environmental sensitivities by encouraging mineral operators to make site-by-site assessments of the balance between complying with environmental requirements/expectations at a given site and working elsewhere. (The validity of this is likely to be far greater than the generic 'contingent valuation' of environmental assets, which is increasingly being promoted by Defra, but which generally relies upon broad estimates of value rather than site-specific details);
- The concept of comparing alternatives in this way could potentially be enhanced if the operators were invited to make use of a comparative Ecosystem Services assessment, along the lines of the methodology developed by Thompson *et al.*, (2010), based on work on hard rock aggregate quarrying in the Mendips. This avoids the need for spurious valuation and provides a much easier basis for the qualitative or partly quantitative comparison of

alternative development proposals. This could not be a mandatory requirement but it may be a helpful supplement to the statutory EIA process;

- **CONS:** The main weakness of this approach is that it would rely on the validity of the predictive landscape modelling and qualitative assessment of key environmental sensitivities, as carried out in this project, to provide an adequate characterisation of the features that are typically associated with each of the ASMRPs. This validity is likely to vary from one ASMRP to another, leaving significant uncertainties in some areas. However, given that this information would be used only to provide an indication of the key issues, and not to provide a definitive statement of the only issues, in each ASMRP, this is likely to be much less of a problem than the lack of quantitative, GIS-based data which affects Options 1 and 2.

5.37 On the basis of the foregoing observations and discussion with the Project Steering Group, it was agreed that Option 3 should be used in this project. Further details of the methodology for implementing this approach are set out below.

### **Methodology for implementing a scenario-based approach**

5.38 In order to implement a qualitative, scenario-based approach for the assessment of the sensitivity to future mineral extraction in North Yorkshire, the following sequential steps were carried out, enabling information relating to landscape, the historic environment and the natural environment to be taken into account.

5.39 **Step 1 (Scenario development):** Identify the types of impact associated with each type of surface mineral working within each ASMRP (e.g. wet worked sand & gravel, dewatered dry working of sand & gravel, large scale aggregates extraction of Carboniferous and Magnesian limestone, small scale and potentially large scale block stone working of Carboniferous sandstone and of Magnesian and Jurassic Limestone for use as building stone, opencast coal working, brick clay extraction etc.). This information is presented as part of the evaluation of the key characteristics of mineral development in Chapter 6 of this report.

5.40 **Step 2 (Identification of key environmental sensitivities):** Identify, in broad, qualitative terms, the main environmental characteristics of each ASMRP that would give rise to sensitivities in relation to the potential impacts for that ASMRP identified in Step 1. This is a natural extension of the Predictive Landscape Modelling work carried out in Stage 2 of the project and of the identification key environmental characteristics, as dealt with in Chapter 2 of this report. This has included consideration of multiple types of sensitivity for different types of landscape, historic environment and natural environment 'asset', as explained more fully in chapter 7 of this report, but has not attempted to quantify these. The assessment, which incorporates professional judgement and logical expectations derived from the key characteristics, is presented in the form of tables for each ASMRP in Chapter 7. In all cases the sensitivities take

account of the range of potential impacts associated with the type of mineral extraction likely to be involved for the ASMRP concerned, as detailed in Step 1. Insofar as possible, differences in sensitivity have been identified for several subdivisions of each ASMRP, based on differences in Landscape Character Type. In some cases, significant variations were able to be identified between the different LCTs, whilst in others there were more similarities than differences, at least from a practical, qualitative point of view.

- 5.41 **Step 3 (Consider capacity for future mineral development):** Capacity is generally regarded as the inverse of sensitivity: the greater the sensitivity of a particular area to a specific type of development, the lower the capacity of that area will be to accommodate such impacts. However, whilst sensitivity has been considered in terms of the intrinsic vulnerability of an area or feature to potential impacts, irrespective of mitigation, it would be unrealistic for capacity to be judged on the same basis. A key tenet of the planning system is that conditions can be used to control development in such a way that it can be allowed to proceed, if it is needed, in situations where this might not otherwise be acceptable. For the purposes of this study, therefore, the assessment of capacity has been based on a consideration of both the intrinsic sensitivities, identified in Step 3 (see Chapter 7), and the potential for mitigation and enhancement (as covered within Chapter 6 of this report).
- 5.42 **Step 4 (Develop generic guidance on addressing the sensitivities):** Without being too prescriptive, it should be possible to identify the approaches that applicants should be advised to take in order to deal with specific combinations of working method and environmental sensitivity. Although there are likely to be more similarities than differences between the different areas, there will be certain factors which require differences in approach. This exercise, to be carried out in Stage 4 of the project, will develop generic recommendations for planning but will also focus on these differences, taking particular account of the findings from Step 3 above, which will highlight the need for particular forms of mitigation in different circumstances.

## 6. Key Characteristics of Mineral Development

### Introduction

- 6.1 This Chapter explains the types of mineral development typically associated with each of the ASMRPs. It then provides a generic overview of the environmental impacts associated with mineral working in general, together with a summary of the intrinsic variations in types of impact associated with each type of working and consideration of both cumulative and combined effects. Whilst the emphasis is necessarily on potential impacts, because it is these which influence the intrinsic sensitivities of the landscape, as discussed in Chapter 7 of this report, consideration is also given to the corresponding opportunities which exist for environmental mitigation and enhancement. This is because an understanding of these factors plays such a crucial role in determining the capacity of a given area to accommodate future mineral extraction, as discussed in Chapter 8 and is likely to inform future decision-making.
- 6.2 This analysis forms the basis for identifying the scenarios for each ASMRP, on which the subsequent assessments of sensitivity and capacity are focused.

### Types of surface mineral working

- 6.3 The principal types of surface mineral working encountered within North Yorkshire fall into the following categories:
- **Sand & gravel extraction above the water table** (applicable to ASMRPs 2, 3, 4 and perhaps 5). This involves simple mechanical excavation and screening (sometimes with washing to remove fines);
  - **Sand & gravel extraction below the water table** (applicable to ASMRPs 1 and 5, and to some parts of ASMRPs 2, 3 and 4). Important distinctions can be made between sites which are 'wet worked', by means of mechanical or suction dredging from beneath the water surface either using floating pontoons or long-reach excavators at the side of the pit; and those which utilise dewatering methods to lower the water table in order to allow dry excavation. The latter allows for more efficient excavation of separate geological horizons, but also gives rise to additional potential impacts associated with the drawdown if the water table in adjoining areas;
  - **Shallow brick clay extraction** (applicable only to ASMRP 6) either above or below the water table, usually by means of long-reach excavators from the sides of the pit. Note: the extraction of deeper clays from the Carboniferous deposits of ASMRP 11 would take place only in conjunction with opencast coal extraction - see below);

- **Chalk extraction** (applicable only to ASMRP 7). In North Yorkshire this has hitherto involved only dry excavation above the water table, usually by means of mechanical ‘ripping’ of the relatively weak rock. Elsewhere, larger-scale extraction for cement production often involves wet working below the water table, but this is considered an unlikely scenario for ASMRP 7;
- **Building Stone extraction** (applicable to ASMRPs 8, 9 and 12). This is effectively restricted to resources which lie above the water table and involves mechanical extraction of individual blocks of sandstone or limestone, sometimes facilitated by the use of low explosives (black powder). Although dewatering could theoretically be used to access deeper resources, in practice this would be impractical for most building stone quarries because of the very slow rate of extraction involved - it would simply not be economic, or environmentally acceptable, to maintain continuous dewatering for small scale and usually intermittent operations. Exceptions to this may occur, however, in larger scale operations;
- **Crushed Rock Aggregate Extraction above the water table** (applicable primarily to ASMRPs 9 and 14). This entails high explosive blasting to fragment the rock, and crushing to reduce the size of the fragments, prior to screening to separate out the size fractions and sometimes washing to remove excess fines. Such quarries are usually geared to high levels of production and will often include additional facilities such as asphalt coating plants and concrete batching;
- **Crushed Rock Aggregate extraction below the water table** (Again applicable primarily to ASMRPs 9 and 14). This involves a continuation of the same operations at greater depth, facilitated by dewatering. The drawdown of water levels and the depth of excavation tend to be much deeper than is the case for dewatered sand & gravel excavations;
- **Opencast Coal extraction** (Applicable only to ASMRP 10). Potentially, this may involve very large scale and rapid excavation of overburden, often to considerable depths, followed by careful, mechanical excavation of individual coal seams and interbedded brick clay horizons. In practice, no such operations have taken place in North Yorkshire and are unlikely in future.

## The environmental impacts of surface mineral working

- 6.4 Mineral extraction inevitably gives rise to localised environmental impacts and often to other impacts over the wider landscape, particularly where the impacts are cumulative and/or on a large scale. The excavation and removal of mineral unavoidably changes the shape of the land and removes existing landscape features, habitats and archaeological material. In doing so, it



also creates noise, dust, traffic and carbon emissions which otherwise would not exist. Quarrying may also disrupt the natural flows of groundwater and surface water, both physically and in terms of water quality, and this, in turn, may have impacts on water-dependent habitats and ecosystems in the areas which surround the quarry. This section outlines the range of generic impacts which need to be considered, before focusing on the variations between different types of extraction.

6.5 As noted in the introduction, however, it must be recognised that most potential adverse effects can be mitigated, in one way or another, and managed within acceptable limits through the use of good practice techniques (enforced, where necessary, through the use of planning conditions and/or environmental permits). Other effects may be more difficult to mitigate and in such cases a balance needs to be struck between the need for the mineral and the acceptability or otherwise of the residual impacts (i.e. those which would still be likely to occur after mitigation). Equally, however, it is increasingly being demonstrated that certain impacts can be managed in such a way as to create positive environmental benefits in the longer term. This includes impacts on biodiversity and geodiversity, where quarrying often provides opportunities for substantial enhancement, compared with existing, 'baseline' conditions, including the reconnection rather than fragmentation of existing habitats. Quarrying frequently provides opportunities for large scale changes to the physical form of the landscape. Whilst this can be damaging where the existing landscape is highly valued, in other cases, through sympathetic landform design, it can lead to the creation of interesting and imaginative new landscape features which, in turn, may become highly valued in their own right.

6.6 Most responsible mineral operators are keen to ensure that such benefits are built in to their quarry and restoration designs from the outset, and to minimise or avoid any adverse effects through the implementation of good practice in design, monitoring and mitigation. Nevertheless, it is important to understand what the potential impacts are, so that policies can be developed which help to guide mineral operators as to the need for these to be addressed in their planning applications and ROMP5 reviews of existing planning conditions.

#### Landscape and Visual Impacts

6.7 These impacts arise where a development results in change to the physical landscape. Changes or removal of elements in the landscape (e.g. tree, slope and field boundary vegetation) may give rise to changes in the character of the landscape and how it is experienced. Visual effects arise where a development causes changes in the composition and extent of available views, as a result of physical changes to the landscape, and will be influenced by the detailed nature and scale of the extraction works proposed.

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<sup>5</sup> Reviews of Old Mineral Permissions, as carried out at periods of not more than 15 years by the Mineral Planning Authority

- 6.8 The visual impact of quarrying is commonly regarded as one of the most important concerns to local communities, particularly (but not only) in the case of hard rock (limestone and sandstone) aggregate quarries, chalk pits and opencast coal extraction, since these tend to be the largest and most visually prominent types of extraction. By virtue of their geological nature, limestone, sandstone and chalk tend to form areas of upstanding relief, within which large scale excavations are difficult to hide and are often exposed to distant views over wide areas of countryside – especially where the quarries cut into existing hillside exposures of rock.
- 6.9 By contrast, sand & gravel pits and clay pits tend to be much shallower and located on lower ground, but even here, such quarries can introduce strongly discordant and unwelcome elements into the landscape, including open water bodies where mineral is extracted from beneath the water table. Modern sand & gravel pits can also sometimes extend over much wider areas than many crushed rock quarries. Not only does this directly transform the landscape over larger surface areas, it also opens up views into the working and restored areas from surrounding landscapes - particularly those on higher ground. This occurs, for example, within the Vale of Pickering, where mineral extraction is generally well-screened within the Vale itself but visible from the crest of the Yorkshire Wolds and from the limestone foothills of the North York Moors.
- 6.10 Progressive landscape change over a period of time from successive mineral workings in particular areas can result in significant cumulative impacts, both in terms of visual intrusion and more fundamental landscape change. This can be especially noticeable in the case of open water restoration: whilst such restoration schemes, if well-designed, can offer biodiversity, aesthetic and recreational benefits, they inevitably represent a significant change to the pre-existing landscape which may, or may not, be desirable. This situation is compounded where successive phases of extraction and restoration transform large areas of former floodplain into a network of lakes and wetlands, as is beginning to be seen in parts of the Swale and Ure valleys, for example. Notwithstanding the fact that this may revert the floodplain to something more akin to the type of environment which existed during early Holocene times, and in doing so may greatly enhance biodiversity (provided that a mix of connected terrestrial, marginal and aquatic habitats is provided, rather than just open water), the impact of such change on the landscape will be dramatic. Further discussion of this and other cumulative effects is provided at the end of this chapter.
- 6.11 Landscape impacts, other than those associated with visual intrusion, can often be more subtle but no less important, and very significant effects can arise in areas where the landscape is considered to be of high value or particularly sensitive - for example within Areas of Outstanding Natural Beauty, areas of Great Landscape Value, and areas which provide important settings for listed buildings, historic parks and gardens, or other designed and natural landscapes. Studies of the historic landscape character may reveal old boundaries and

land management features that are of interest in understanding the evolution of landscape character in the area concerned.

- 6.12 Both excavations and the construction of screening bunds can disrupt the general landscape character of a particular location, as can restoration schemes which involve the plantation of forestry or woodland and/or the creation of large water bodies. At the simplest level, the excavation of an existing landscape will inevitably transform its character, both in terms of its surface topography and its existing pattern of land use, including field patterns, trees, hedgerows, and other field boundaries. Whilst all of these things can, potentially, be restored following mineral extraction (even mature hedgerows can be translocated, with care) it is always difficult and often impossible to re-create the original landscape. Whether or not this is acceptable will depend on the significance of the impacts, the importance of the original landscape, the nature and quality of the proposed restoration and the views of the local communities affected.
- 6.13 In some cases, the diversion of watercourses or access routes (roads, bridleways, and footpaths) in order to permit extraction can extend the direct landscape impacts into adjoining areas. Equally, the presence of features such as crushing and screening plant, asphalt coating and concrete batching plant can introduce significant industrial elements into the existing landscape unless they are well screened or contained within the quarry void. Such features are only temporary, however, and may be seen as acceptable if the long term restoration scheme allows for the landscape character to be either returned to its original condition or enhanced, provided that special features and monuments are protected in the interim. This highlights the importance of separating temporary from long-term and permanent landscape impacts, and of incorporating appropriate mitigation measures into the design of the proposed workings from the outset.
- 6.14 Table 6.1, below, outlines the type of potential landscape and visual impacts associated with the operational phase of different types of mineral operations and whether the impacts are likely to be direct or indirect. The table does not include the effects of quarry restoration.

Mineral Operation	Type of Impact	Direct or Indirect Impact
Hard Rock Extraction	Loss of hill or prominent landscape feature – change in views and character	Direct
	Loss of field pattern - change in landscape character	Direct
	Change to existing infrastructure (new roads and associated signs)	Direct
	Introduction of plant machinery	Indirect
	Loss of vegetation cover	Indirect
	Light pollution	Indirect
Sand and Gravel extraction	Introduction of new landscape features such as stockpiled materials, pre-operation planting (screens)	Indirect
	Loss of habitats resulting in change to landscape character	Indirect
	Change in landscape character – loss of field pattern	Direct
	Change to existing infrastructure (new roads and associated signs)	Direct

**Table 6.1: Direct and indirect landscape and visual impacts associated with different types of mineral extraction**

- 6.15 Although landscape impacts can sometimes be mitigated through good design, the inevitability of at least some form of landscape change as a consequence of mineral extraction means that it is vital to fully understand the character and perceived value of the existing landscape before proposals for extraction are developed. Such proposals then need to take this into account in developing a well-founded vision for the creation of new, sustainable landscapes which are likely to become valued in their own right, both by local communities and by visitors.
- 6.16 The benefits of developing a 'strategy' and/or landscape plan for mineral extraction which takes into account the multi-faceted effects on the environment: visual, landscape, ecological, hydrological, heritage over a large scale are evident in areas such as The Lee Valley Regional Park and Cotswold Water Park. Both areas are mineral rich and have been designed to meet planning and community objectives post extraction: the Lee Valley is now part of the 2012 Olympics and the Cotswold Water Park, after recognition that the cumulative impacts were fragmenting the landscape character, has become a diverse wildlife habitat as well as an area of economic stimulus due to waterside residential development.

6.17 In areas where there is an agreed need for continued mineral extraction which outweighs the importance of the existing landscape, the necessity for extraction can be harnessed for the deliberate creation of new landscapes which are designed, from the outset, to provide optimum long term benefits. This concept has been discussed for many years between operators and mineral planning officers within one of the UK's most intensively quarried areas - the Mendip Hills in Somerset - and recent studies in that area (Thompson & Birch, 2009; Thompson et al., 2010) have examined how the Ecosystems Approach could be used, within that concept, to optimise the overall delivery of 'ecosystem services'. Such services include several aspects of landscape, including aesthetic value, spiritual value, sense of place and various different elements of tranquillity.

### Archaeological Impacts

6.18 As emphasised in the Practice Guide on Mineral Extraction and Archaeology (Minerals Historic Environment Forum, 2008), the impacts of mineral extraction on the historic environment in general, and on archaeology in particular, are distinguished from most other impacts because they are irreversible. Once such features have been removed through excavation or demolition they can never be reinstated into their original location and context, and much if not all of their original authenticity and value will have been permanently destroyed.

6.19 The Monuments at Risk Survey of England, 1995 (Darvill & Fulton 1998) demonstrated that, between 1945 and 1995, largely before the introduction of planning guidance on the historic environment, mineral extraction had a significant impact on archaeological monuments, with 12 per cent of observed cases of wholesale loss and 3 per cent of piecemeal loss of sites attributable to the extractive industries. As noted by English Heritage (2008a), although modern mineral extraction is a highly regulated industry, many earlier workings were very extensive and led to the loss of archaeological sites on a landscape scale, especially as a result of sand and gravel quarrying in the river valleys of central, southern and eastern England.

6.20 Even where such features are not removed but are simply close to a mineral extraction site, they can still be adversely affected, even by modern workings. Examples, including those given by English Heritage (2008a) and others include:

- the quarrying and/or inappropriate restoration of adjoining land which can disfigure the historic character of the landscape and compromise the setting of important monuments;
- the effects of noise, dust and vibrations associated with blasting and/or quarry traffic, which may damage the fabric of sensitive historic buildings, monuments or areas, and reduce opportunities for their enjoyment and appreciation;

- the deposition of overburden or other mineral waste in areas which obscure or reduce the appreciation of historic sites; and
- the effects of quarry dewatering (temporary lowering of the water table to permit dry excavation). This can potentially be a very serious issue in areas where there are waterlogged archaeological remains: lowering of the water table and/or changes in groundwater quality brought about by dewatering can instigate changes which rapidly influence the rate of decay of previously saturated buried artefacts (Thompson *et al.*, 2008).

- 6.21 The significance of potential adverse effects on the historic environment will be determined, in part, by the nature of any heritage designations which apply to the features concerned. These include World Heritage Sites, Scheduled Ancient Monuments, Listed Buildings, Registered Parks and Gardens and Registered Battlefields. However, English Heritage's Policy on Mineral Extraction (English Heritage 2008a) is that this "should not normally take place if it would result in the loss of or damage to a nationally important historic or archaeological site (whether designated or not) or listed building, or where it would have a significant adverse effect on its setting" (our emphasis). In other cases, any unavoidable adverse impacts are required to be reduced to a minimum by mitigation.
- 6.22 PPS5 Planning for the Historic Environment (CLG 2010) refers throughout to designated and non-designated heritage assets - 'those parts of the historic environment that have significance because of their historic, archaeological, architectural or historic interest'. The PPS makes it clear that this 'covers heritage assets that are not designated but which are of historic interest and are thus a material planning consideration'.
- 6.23 There is a variety of ways in which at least some of the potential effects associated with quarrying can be mitigated, or even avoided, through the use of good practice. The effects of dewatering, for example, can be controlled through a variety of mitigation methods linked in to effective monitoring systems (Thompson *et al.*, *ibid*). It is also possible to repair historic buildings and structures, where these have been previously damaged or left to decay. However, buried artefacts, buildings and historic landscapes, once removed by quarrying, can never truly be reinstated, although it may be possible to replicate their appearance and to recreate their setting.
- 6.24 Set against these adverse impacts is the fact that quarrying itself, and the investigations which are obliged by PPS5 to precede it (and in many cases to continue in parallel with it) are frequently able to enhance our knowledge of the historic environment, compared with that which existed prior to extraction. Detailed guidance on the practicalities of carrying out the necessary investigations is set out in the Practice Guide (Minerals Historic Environment Forum, 2008), and the most recent national planning policies relating to such work are set out in PPS5.

As emphasised by English Heritage (2008a), however, more effective approaches to the investigation of historic sites and landscapes are continuously being developed and, for this reason as much as any other, Government policy has always advocated a presumption in favour of the preservation in situ of nationally important remains and their settings. The same logic can be extended to sites of less than national importance where preliminary desk-based research identifies features of potentially high significance, though this becomes a matter of balance for the Mineral Planning Authority, taking account of all relevant advice and information.

6.25 Where extraction is permitted, the benefits of associated archaeological investigations can be considerable, as evidenced by the many research and 'outreach' projects in recent years (including many that were supported by the now defunct Aggregates Levy Sustainability Fund).

6.26 In conclusion, the direct physical impacts of mineral extraction on the historic environment will frequently result in the destruction of that resource. Even this can to some extent be mitigated by ensuring that an understanding of the resource informs the identification of extraction sites and where a site becomes vulnerable to damage, or is threatened with unavoidable loss, it is fully recorded. Although there is a presumption against the loss of any heritage asset which has high significance, the benefits associated with a development proposal may sometimes outweigh its retention. This is discussed further in Chapter 8 of this report

### Biodiversity

6.27 Biodiversity, i.e. the variety of life in all its forms, can be adversely affected by quarrying activity. Impacts may include the physical removal of existing land and associated habitats through mineral excavation, including the disruption or severance of wildlife corridors; and disturbance of wildlife in surrounding areas, through the effects of noise, dust, traffic and lighting, or (in the case of water-dependent ecosystems) through the impacts on groundwater and surface water. Further details of these individual impacts are given later in this section.

### *Habitats*

6.28 Although existing habitats are removed by quarrying, new ones are created, sometimes with more varied conditions and greater biodiversity than that which existed before extraction began. This applies especially where quarries are located in areas which previously were intensively farmed arable landscapes with limited biodiversity interest (though even here, arable field margins, ditches and species-rich hedgerows often provide important localised habitats which, along with individual mature trees, isolated farm buildings and other features may support a range of wildlife including rare or endangered species). In other areas, such as open moorlands, grasslands, traditional meadows, ancient woodlands, lakes, rivers and those parts of river floodplains which are most frequently inundated, the existing biodiversity will

generally be far richer than that which could be recreated by quarry restoration (at least within the short to medium term), and its loss would therefore represent a serious environmental impact.

- 6.29 The UK Biodiversity Action Plan (UK BAP) identifies 17 broad habitat types within terrestrial and freshwater environments, and a total of 40 priority habitats within these, where conservation action is primarily focused. Conservation includes enhancement and expansion of important habitats, as well as their protection, and here again there is considerable scope for quarry restoration to contribute to this by creating priority habitats, as is being demonstrated by the ongoing RSPB/Natural England “Nature After Minerals” initiative. Whilst such work is commendable, and whilst it may sometimes be used in partial mitigation of adverse impacts associated with the operational phase of quarrying, the nature and significance of those impacts needs to be fully understood.
- 6.30 Significance, in this sense, relates not only to the quality and rarity of the habitats and species involved, and the scale of impact on these, but also to whether or not the connectivity within or between particular habitats is being affected. As clearly illustrated in Chapter 2 of this report, and in Chapter 3 of the Stage 2 Predictive Landscape Modelling report, much of the present-day landscape within areas of mineral resource potential has only fragmented remains of habitats which were once far more extensive. Further fragmentation, whether by agriculture, mineral extraction or other forms of development, needs to be avoided and, wherever possible, reversed. A wide range of biodiversity initiatives are ongoing throughout North Yorkshire, often with a view to extending and reconnecting habitats that have previously been reduced or fragmented. Once again, quarry restoration can play an important role in this, but consideration must also be given to the potential effects of quarrying itself in severing existing connections.
- 6.31 All potential impacts also need to be considered in terms of ecosystems, i.e. the interactions which take place between all living and non-living components of the landscape. Impacts on certain parts of an ecosystem can often have unexpected consequences on other parts of the system and on the ecosystem services which the system provides. These are the functions which many different aspects of the natural environment have in providing benefits to humans. They include provisioning services, such as the supply of food, water, minerals and genetic diversity; regulatory services, such as natural water purification and the regulation of flooding, air quality and climate change; and cultural services, such as landscape aesthetics, spiritual values and sense of place.

### *Designations*

- 6.32 The significance of biodiversity impacts is, however, also related to the quality of the habitats involved. To some extent, this is reflected in statutory and non-statutory designations, ranging from those imposed in connection with European Directives to local sites identified by



individual local authorities. In this respect, it needs to be understood that designations - especially those at national and international levels - are frequently identified as examples of a particular type of habitat, and do not necessarily cover all areas of that particular type. Other areas (e.g. smaller fragments) may be protected only by local designations. That said, as noted in PPS 9 (Biodiversity and Geological Conservation), the most important sites for biodiversity are those identified through international conventions and European Directives, i.e. those which have been designated as:

- Special Areas of Conservation (SACs) under the European Habitats Directive;
- Special Protection Areas (SPAs) under the European Wild Birds Directive;
- protected wetlands under the international Ramsar convention; or
- areas which are important (e.g. as foraging areas) to the survival of individual European protected species.

6.33 In the first three of these cases, at least (collectively referred to as ‘European’ or ‘Natura 2000’ sites), the highest levels of protection are afforded: proposals for development must either prove that there will be no adverse impact on the integrity of the site or that there is an overriding public interest and no alternatives. In the fourth case, the geographical areas of protection are not generally defined, but the issue still represents a major constraint to any form of development which would be likely to affect significantly the local distribution or abundance of the species concerned (Section 41 of the Conservation of Habitats and Species Regulations 2010).

6.34 National designations, including National Nature Reserves (NNRs) and Areas or Sites of Special Scientific Interest (ASSIs/SSSIs) also provide statutory protection and thus signify a high degree of importance. However, by comparison with potential impacts on European sites, there is greater scope here for mitigation and/or compensatory measures to be taken into account (see below).

#### ***Types of Impact***

6.35 The effects of mineral extraction on fauna and flora within a given area can be direct (e.g. through the physical removal of existing land and associated habitats, and through the effects of noise, dust, traffic and lighting in disturbing wildlife in adjoining areas), or they can be indirect (e.g. through the knock-on effects on habitats of impacts on groundwater and surface water, or those associated with fugitive dust).

6.36 Direct impacts within the area of quarrying operations (including the formation of overburden mounds, spoil tips, lagoons and stockpiles, as well as the excavation itself) need little explanation: any pre-existing biodiversity in these areas is largely destroyed or relocated (in the case of habitats and vegetation) or displaced (in the case of wildlife). Displacement may or

may not be a problem, depending on the extent and suitability of comparable habitats for the wildlife to move into within the surrounding area, but particular requirements apply to European protected species (i.e. those listed in Annex IV of the Habitats Directive, including bats, otter, great crested newt, natterjack toad, white clawed crayfish and many others), and to nationally protected species including barn owl, water vole, badger, all breeding birds, grass snake, adder and slow worm. The latter are protected under the Wildlife and Countryside Act 1981 (as amended).

- 6.37 Whilst every care is needed to minimise and manage these impacts, it is worth noting that, even whilst a quarry is operational, species such as peregrine falcons, buzzards, sand martins, foxes, common frogs, great crested newts and a wide range of invertebrates are widely reported to thrive within the quarry itself. Additional species such as herons, great crested grebes, swans, redshanks and a variety of wildfowl are commonly seen within lagoons and settlement ponds adjacent to the active workings, and a much greater range of wildlife is generally attracted to areas which are either restored specifically for nature conservation once quarrying ceases, or which are simply allowed to regenerate naturally.
- 6.38 Direct impacts on wildlife and vegetation communities can also extend beyond the boundaries of quarrying operations. Certain plants may be intolerant of airborne dust, whilst animals and birds may be sensitive to noise, traffic and/or the effects of artificial lighting (particularly in remote rural areas which would otherwise be characterised by very dark night skies).
- 6.39 Indirect effects can occur where damage to a habitat (e.g. through the effects of dust or through changes to one or more aspects of the water environment) results in adverse consequences for particular plants within that habitat or the fauna which the habitat supports. Further details of air quality impacts (including dust) and of the many different types of impact on groundwater and surface water are discussed separately below.
- 6.40 A further aspect which needs to be considered is the indirect consequence which any biodiversity impact may have on ecosystem services: as noted earlier, these are the functions which various different aspects of the natural environment have in providing benefits to humans. Services associated with biodiversity features include the maintenance of genetic, and species diversity, and maintenance of ecosystem composition, structure and processes.

#### ***Mitigation and Compensation***

- 6.41 In addressing the need to conserve and enhance biodiversity, the key principles of PPS9 promote a sequential approach of: avoiding impacts, mitigating impacts and compensating for any remaining impacts. Where none of these can adequately be achieved, the normal expectation is that planning permission should be refused.

- 6.42 Impacts from mineral extraction can be avoided by locating new sites away from important habitats, and this should always be considered as a first choice. In practice, however, this may not always be possible, since minerals can only be worked where they are found and many other constraints also need to be taken into account.
- 6.43 Where avoidance is not possible, mitigation measures need to be considered. These should form part of a clear mitigation and monitoring strategy, underpinned by a comprehensive understanding of the habitats and ecosystems involved. This requires baseline monitoring surveys to be carried out during the appropriate seasons, together with an agreed system for monitoring the condition of vulnerable receptors throughout the life of the proposed workings.
- 6.44 Where impacts are likely to entail the physical removal of existing habitats, reliance will need to be placed largely on compensatory measures (see below), such as the creation of new habitats or the translocation of existing ones, where this is feasible. Some degree of mitigation can also be achieved, however, by carefully timing the initial vegetation clearance and soil stripping, so as to minimise disturbance to breeding populations within the habitats concerned.
- 6.45 Where potential impacts are identified on sensitive habitats or species beyond the immediate site of extraction, mitigation measures range from those which control the impact at source (e.g. by limiting the drawdown of groundwater levels within particular areas, or by limiting noise and dust emissions) to those which control the proximity of the excavation to the sensitive sites. This may simply be a matter of limiting the extent of excavation or, in some cases, it may be feasible to create alternative new habitats which replicate, extend or improve the condition of the existing habitats, either in advance of or in parallel with mineral extraction.
- 6.46 Consideration must be given, however, to the timescales involved. It takes a very short time for existing habitats to be destroyed as part of the process of preparing a site for mineral extraction (i.e. removal of existing vegetation and topsoil), but much longer for the same (or improved) habitats to be fully re-established, following the cessation of extraction and the completion of restoration works to create a new land form. For this reason, where European sites are concerned, and where it is established that there is an overriding need for mineral extraction and no alternatives, there is a requirement for compensatory (replacement) habitats to be established before the existing habitats are lost. In other cases, the length of time and other factors involved in establishing new or replacement habitats will usually be a material consideration for the Minerals Planning Authority in determining the acceptability, or otherwise, of an applicant's proposals.
- 6.47 Compensation may be considered as a last resort where adequate mitigation and avoidance cannot be achieved. Options can include the creation of substitute habitats, either within the

development site or elsewhere; and/or the provision of financial or other resources to support off-site compensation and management by others. A common expectation - for example as noted in Doncaster Council's Supplementary Planning Document on 'Planning for Nature' (Doncaster Council 2008) - is that compensation "needs to achieve net gain and be bigger, better and more protected than the original site, and also must be established prior to the destruction of the original habitat". That document also notes, however, that "for ancient features such as hedgerows, veteran trees, mature woodland and species-rich grassland, development is unlikely to be permitted, as such habitats cannot be recreated."

- 6.48 In conclusion, mineral extraction can potentially have severe environmental impacts on fauna, flora and natural or semi-natural habitats and wider ecosystems, especially (but not only) during the operational phase of quarrying. However, with careful planning, and by avoiding impacts on existing European designations, by avoiding or minimising and mitigating impacts on national and local designations, and by avoiding the severance and fragmentation of existing habitats, it is possible for mineral operations to be compatible with the over-arching objective of sustainable development. Moreover, by creating new areas of priority habitat, and by helping to reconnect previously fragmented habitats and wildlife corridors through well-designed restoration schemes, quarrying also has the potential to create net biodiversity gains overall. This potential will usually be maximised where the quarry operator has developed an effective company Biodiversity Action Plan (cBAP), especially where this is integrated with Local Biodiversity Action Plans (LBAPs) for the areas concerned and with regional and national BAP targets.

### ***Geodiversity***

- 6.49 In the case of geodiversity, mineral extraction is often able to create clear benefits rather than adverse impacts, though this depends on the type of geological designation involved. Designations comprise geological SSSIs, Regionally Important Geological and geomorphological Sites (RIGS) and Local Geological Sites (LGS). Each of these can be categorised into one or more of a number of classes such as 'finite' or 'extensive' exposures, or 'active process' sites, which help to define their resilience to external threats<sup>6</sup>.
- 6.50 Geodiversity benefits may be achieved simply by virtue of the opportunities which quarrying provides to reveal geological features which otherwise would never be seen, and through the provision of controlled and safe access to these for research and educational purposes. This can apply both during the working life of the quarry and afterwards, if geo-conservation exposures are retained within the final restoration design.
- 6.51 Adverse impacts still need to be considered, however, particularly 'finite' or 'integrity' sites, where these would be threatened by proposed extraction. Such threats may include the

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<sup>6</sup> See Prosser, C., Murphy, M. and Larwood, J. 2006. *Geological Conservation: a Guide to Good Practice*. Natural England.

removal of or damage to landforms or exposures which are important for geo-conservation purposes, or the obscuring of these by the placement of overburden or restoration materials or the growth of excessive vegetation.

- 6.52 In the case of 'extensive' geological sites, exposures (including those created by quarrying itself) can usually be replaced by new quarry faces revealing comparable features as the excavation proceeds, and it is only occasionally that these will be sufficiently important represent a constraint to continued working. That might occur, for example, where existing classic exposures that are important for the historical development of geology are under threat, or where exceptionally rare mineralisation or other features are revealed in a quarry face. Such examples will normally be classed as 'finite' rather than 'extensive'.
- 6.53 Other threats include the disruption or disturbance of active geomorphological processes within 'integrity' sites, as might be the case where a river has to be diverted or where an active cave system would be intercepted.
- 6.54 Adverse impacts can be avoided, and geodiversity benefits greatly enhanced, where a quarry operator has developed a company Geodiversity Action Plan (cGAP), especially where this is tied in to Local Geodiversity Action Plans (LGAPs) for the areas concerned.

#### *Air Quality*

- 6.55 Quarrying can have impacts on air quality in two main ways: through the generation of dust and through the emission of pollutants associated with quarry plant, mineral processing activities and emissions from vehicles.
- 6.56 Dust is primarily a localised issue within and surrounding the quarry itself. Existing national policy, as set out in Minerals Policy Statement 2 (Annex 1: Dust) notes that the effects may be experienced up to 1km from the source, but are most likely to give rise to concerns within 100m, depending on site characteristics and in the absence of mitigation.
- 6.57 Dust may be generated from a wide range of quarrying activities including soil stripping, overburden removal and associated earthworks, drilling, blasting, loading, tipping, crushing, screening, trafficking by quarry vehicles, and wind transportation of dust from stockpiles and other exposed surfaces within the quarry. Outside the quarry, dust can also be generated from lorries or rail waggons leaving the site, especially if these are un-sheeted. Dust from any of these sources can, unless adequately controlled, lead to a deterioration of local air quality and can be a nuisance to local residents and businesses, as well as having a potentially damaging effect on human health – especially but not only to those who work within the quarries. Health impacts within adjoining areas have been of particular concern in relation to opencast coal extraction, because of the relatively high levels of airborne shale particles.

However, research (as reported in MPS2, Annex 1) has indicated that, even here, the health impacts appear to be limited.

- 6.58 In some circumstances, fugitive (wind-blown) dust can be damaging to sensitive industries and to agriculture, vegetation and wildlife in adjoining areas. The latter impacts result from the chemical and/or physical effects of dust on leaf surfaces (including the shading or blocking of stomata which reduces a plant's ability to photosynthesise), and also changes in soil chemistry – notably where the dust is highly alkaline or highly acidic.
- 6.59 Modern quarrying and opencast operations adopt a wide range of techniques to limit the generation of dust within the quarries and processing operations, and to limit the exposure of adjoining areas to fugitive dust. The latter may include the use of enclosed processing and conveyor systems, dust suppression from haul roads using water sprays, the use of trees to screen the quarry and intercept blowing dust, the use of wheel washes and sheeted lorries to limit the extent of mud trafficking and dust from vehicles leaving the site. Dust monitoring systems are frequently installed in the areas surrounding a quarry to check the effectiveness of these measures.
- 6.60 Other forms of air pollution from mineral operations include sulphur, carbon and particulate emissions from the combustion of fossil fuels within quarry plant and machinery; emissions from vehicles both within the quarry and those used for transportation off site; emissions of acid gases and heavy metals from the burning of recovered oils; the products of combustion from asphalt and sand drying plants; and odours from asphalt production, in the form of bitumen fumes. Some of these emissions can be reduced, on site, through the use of electric rather than diesel or fuel oil-powered machinery (although emissions associated with the fuel used in power stations then has to be considered). Those associated with offsite transportation can be reduced by the use of more fuel-efficient lorries and driving techniques and/or by the use of rail or water-based transportation, where this is feasible.

#### ***Environmental Noise and Vibration***

- 6.61 Environmental noise and vibration impacts are those which are felt outside the quarry or processing plant, as distinct from the impact on employees within the workplace, which are covered by various health & safety regulations.

#### ***Noise***

- 6.62 Environmental noise is that which affects people living, working or engaged in leisure activities within the vicinity of a quarry, or which affects wildlife in adjoining areas, especially certain types of breeding birds. The effects are usually experienced during the normal working day, although in some cases they may also include night-time working. The degree of impact is dependent primarily on the loudness and nature of the noise at source; the effectiveness of

mitigation measures in limiting, absorbing or restricting the transmission of the noise; the level of other background noise within the area and the sensitivity of the receptors.

- 6.63 Sources of noise within surface mineral workings and associated processing units include periodic blasting in hard rock quarries and the use of warning sirens; mechanical extraction of mineral and overburden, including soil stripping and the construction of screening bunds; engines used to power fixed and mobile plant; tipping, crushing and screening operations; loading of mineral; and vehicle movements within and outside the quarry, including the use of audible reversing alarms.
- 6.64 Existing national policy as set out in Minerals Policy Statement 2 (Annex 2: Noise) notes that it is not practicable to stop all noise emissions from surface mineral working but that a variety of mitigation measures can be used to reduce noise generation and its impact upon the surrounding area and properties. Such measures are generally imposed by planning conditions and/or by other environmental regulations. They include details relating to the site location and layout, including the use of appropriate buffer zones; the choice of equipment; maintenance of equipment; careful design of site operations; appropriate sequencing of activities; and the use of acoustic screening, both at source (e.g. enclosure of fixed plant) and to restrict the transmission beyond the quarry limits (e.g. using baffle mounds, vegetation and acoustic fencing).

#### ***Vibration***

- 6.65 Ground-borne vibration associated with mineral processing is rarely a significant impact – being likely to occur only where there is a much more evident noise problem. Given the comprehensive controls on noise emissions which usually exist, the associated vibrations are generally of little consequence.
- 6.66 Ground vibration associated with production blasting in hard rock quarries, however, is a quite different matter and one which is very difficult to mitigate other than by maintaining a suitable distance between blasting operations and nearby receptors. A distinction needs to be made between blasting for crushed rock aggregate production, where high explosives are used to fragment the rock; and low explosive (gunpowder) blasting which may be used in some building stone quarries to gently separate large blocks of stone along natural joints and bedding planes. In the latter case, the objective is to minimise any fracturing of the rock itself, and the transmitted vibrations are therefore very much lower and far more localised than in aggregate quarries.
- 6.67 In the case of hard rock aggregate quarries, mineral operators will always try to minimise the extent of extraneous ground vibration, not least because this represents ‘wasted’ energy and therefore reduced efficiency for the intended purpose of the blast, which is to fragment the rock, allowing it to be removed from the quarry face, and subsequently fed into the primary

crusher. Nevertheless, some degree of ground vibration is always generated from production blasting and will radiate away from the blast location, attenuating with distance.

- 6.68 Damage to buildings and other structures can occur if the dynamic stresses induced by ground vibration exceed the allowable design stress for the building materials involved. Such damage may range from very fine 'cosmetic' cracking of plaster, in the case of minor vibrations, to major cracking of structural elements, in the case of much greater levels of vibration, such as those which might be experienced very close to the blast itself. Human perception of vibration begins at levels well below those associated with the onset of cosmetic damage, and research for the former DETR (1998) has shown that fear, rather than actual damage, is the source of most complaints relating to blasting vibrations. Very few allegations were found of actual damage and there were no proven claims at all.

### *Traffic*

- 6.69 The environmental effects of traffic associated with mineral working relates primarily to the transportation of mineral products by road, rail and in some cases by inland waterways and sea, together with the return journeys made by empty vehicles and trains, and deliveries of products such as oil, bitumen and cement for on-site processing works (asphalt plants, concrete batching plants, concrete block manufacturing etc.). Additional impacts are associated with cars and vans used by employees and contractors but these are relatively minor compared with those associated with heavy goods vehicles.
- 6.70 The impacts involved potentially include the effects of traffic in causing congestion, severance, collisions, noise, vibration, dust, air pollution from exhaust gases, mud on the road and danger to pedestrians, particularly on minor roads and villages, together with the more general impact of Carbon emissions from the combustion of fossil fuels.
- 6.71 All of these impacts tend to be higher for road haulage than for other modes of transport, especially in the case of quarries which are located a long way from the primary route network (i.e. trunk roads, dual carriageways and motorways), thus necessitating long journeys on minor roads through relatively quiet rural areas. In such areas, the effects are increased, not only by the relative tranquillity which otherwise may exist, but also by virtue of the narrowness of the roads, the closer proximity of residential and other buildings, the increased likelihood of pedestrians and cyclists on the roads, and the fact that quarry traffic is likely to represent a higher proportion of vehicles on the road than would be the case on the primary route network.
- 6.72 In most cases, however, road haulage is the only feasible mode of transport available. None of the existing mineral operations in North Yorkshire (excluding the National Parks) has direct access to a rail connection, and it would be prohibitively expensive, in relation to the low price of most if not all mineral products, to construct new links. It would also generally be too



expensive and inefficient to consider transporting material by road to a railhead and then transferring the goods onto trains. Not only would this involve costly double-handling of the material it would still involve road haulage through rural areas and would generate additional impacts (primarily noise and dust) associated with transferring the material from lorry to train.

- 6.73 In practice, the economics of bulk transportation of minerals are such that there is a natural imperative for quarries to be located as close as possible to primary routes (subject to the fixed distribution of mineral resources), so that the products can be transported more efficiently (and cheaply) to the main markets, which tend to be located within or close to major towns and cities. It is rare for modern quarries to be located in more remote areas, except where the mineral involved has a very limited geographical distribution (as is the case, for example, with the High Specification Aggregates extracted within upper Ribblesdale, in the Yorkshire Dales National Park).
- 6.74 Where road haulage through rural areas cannot be avoided, the traffic impacts can be mitigated to a significant degree by a variety of good practice measures which are increasingly being adopted by responsible operators, whether or not they are stipulated in planning conditions. Depending on local circumstances and concerns, these may include: road improvements and provision of improved (safe) site access for lorries; limiting the number of lorry movements and/or hours of working; restricting HGV traffic to specified routes; ensuring that lorries are sheeted to limit dust and that they pass through wheel washes to limit the trafficking of mud onto public roads; using modern, well-maintained vehicles with optimum fuel efficiency and relatively low Carbon emissions; and the use of driver training to help increase health and safety, efficient driving and courtesy.

#### *Water Environment*

- 6.75 Surface mineral workings can potentially have a wide range of both positive and negative impacts on many different aspects of the water environment. As explained more fully in the recently updated Guide to Good Practice on Controlling the Effects of Surface Mineral Workings on the Water Environment (Thompson et al., 2008), the effects involved are both varied and complex.
- 6.76 In order to understand the various impacts it is important to appreciate what is meant by the water environment. This is defined by Thompson et al. (ibid) as comprising: “groundwater and surface water bodies and the water resources within them, together with the ecosystems, habitats, species, water users, existing land use and development, and archaeological features that are either dependent on those resources or sensitive to changes in their conditions”. Consideration thus needs to be given to a very wide range of potential receptors, as well as to the sources of impact and the physical processes involved in connecting the two.
- 6.77 The sources of impact include:

- Mineral exploration (impacts on groundwater resources associated with boreholes and trial pits);
- The physical presence of excavations and stockpiles (disturbance of surface water features, increase or decrease in flood risk, removal of the unsaturated zone leading to loss of temporary storage and increased vulnerability of the aquifer to contamination, and working below the water table, including loss of groundwater resources, readjustment of hydraulic gradients and contamination risks);
- Quarry dewatering (loss of local groundwater resources, derogation of other groundwater abstractions, impacts on surface water features; impacts on water-dependent ecosystems, habitats and species, degradation of buried archaeological features, contamination caused by changes in groundwater flow paths, subsidence or settlement, and the various impacts of post-dewatering water table rebound);
- Site processes and management (on-site water losses; suspended sediment in site run-off, risks associated with natural contamination, including acid rock drainage, other contamination risks including excavation of contaminated land, accidental spillages and industrial processes within the site);
- Quarry reclamation (risks associated with open water, backfilling with overburden or imported fill, engineered landfill, and low level restoration); and
- After-use (water-based after-uses, land-based 'countryside' after-uses, and residential, commercial and industrial after-uses).

6.78 Full details of the potential impacts associated with each of these aspects of quarrying are set out in the above-mentioned Guide to Good Practice, which also provides comprehensive information on the mitigation measures available to deal with each one.

6.79 In most cases, the adverse effects can either be anticipated and prevented, or at least reduced to an acceptable level by means of careful assessment, planning and monitoring, and through the timely implementation of appropriate mitigation measures. Similarly, potential benefits on the water environment can be optimised if the opportunities are foreseen and planned for from the outset.

6.80 In all cases, the ideal solution is to avoid specific impacts through careful planning, location and detailed design. It is rarely possible to avoid all potential impacts in this way, however, and reliance must therefore also be placed on other forms of mitigation. Such measures may sometimes be preferable when all aspects of sustainability are taken into account. For example, providing that it is adequately controlled, mineral extraction within an environmentally sensitive area may prove to be more sustainable, overall, than if carried out in less sensitive locations at greater distance from the areas of demand, once such things as traffic impacts, including Carbon emissions and increased costs of transportation are taken into

account. The use of established mitigation measures, linked to appropriate monitoring schemes, can thus enable mineral extraction and associated operations to be granted planning permission in situations where this might otherwise be precluded by the perceived level of risk.

- 6.81 Mitigation measures may, in some cases, need to be deployed from the outset, as precautionary or preventative measures, or simply as standard working methods to control such things as surface runoff and contamination risks. In other cases, particularly in relation to progressively developed impacts such as those induced by dewatering, they may only need to be brought into play if and when agreed thresholds of impact are detected through routine operational monitoring, as part of a staged mitigation strategy.
- 6.82 Uncertainties regarding potential impacts and the need for (and likely effectiveness of) mitigation should always be reduced as far as practicable before planning permission is granted. From an operator's point of view, proposals should therefore be developed on the basis of a sound conceptual model of the local hydrogeological system and of the operational water balances likely to be associated with each phase of development, including the use of mitigation measures as appropriate.

### **Differences relating to type of mineral and type of extraction**

- 6.83 Most of the foregoing types of impact will need to be at least considered in relation to all types of surface mineral working. Differences between them are largely a matter of scale, duration and location. For the most part, such differences need to be considered on a site-specific basis but there are some generalisations which can be made regarding the intrinsic characteristics of different types of extraction, irrespective of location and environmental setting.
- 6.84 At this level, differences can be considered in terms of:
- the typical size and location of the quarry void (crushed rock and opencast coal operations generally being larger and more visible than other types of working, although some large sand & gravel workings can also cover large areas - although this usually relates to the cumulative impacts of successive extensions and new permissions within a given area - which need to be considered as a separate issue);
  - whether or not the quarry extends beneath the water table and, if so, whether dewatering is required or whether the mineral can be worked under water (which is possible for sand & gravel, where necessary, although dry working is generally preferred for optimum efficiency);

- whether or not the mineral deposits are likely to contain important water resources (especially likely for limestone and chalk quarries and for sand & gravel pits, but may also be true for sandstone);
- the method of working, including whether or not high explosive blasting is required (generally applies only to crushed rock quarries but may also be required to some extent in opencast coal and in some chalk quarries);
- the nature of any mineral processing carried out, including whether or not crushing and screening is required (again, crushing is generally applicable only in hard rock quarries, but screening is required in all types of aggregate production. Saw mills may be present at building stone quarries, to produce sawn blocks, slabs, paving stones and other products, but more commonly these facilities are sited elsewhere and already exist);
- the likely presence or absence of ancillary manufacturing processes within the site, such as asphalt coating plant, concrete batching plant and concrete block production (any or all of these are commonly found at the site of crushed rock quarries but may sometimes also be present at large sand & gravel sites); and
- the typical rate of production and output, since these will influence the magnitude of certain impacts (e.g. noise, blasting vibration, traffic impacts) and the duration and frequency with which they are experienced (once again, crushed rock and opencast coal units are likely to be the most prominent, on account of their high volume production).
- the likely nature of quarry restoration, including opportunities for 'rolling' restoration which help to limit the area of active workings at any given time, and whether or not the restoration is likely to result in a substantial change of landscape character (as will usually be the case where part or all of the site is restored to open water).

6.85 Some generic distinctions can therefore be made, particularly between major crushed rock quarries (which tend to have high levels of potential impact); sand & gravel quarries (which tend to have more modest potential impacts, except when working below the water table, and excluding cumulative impacts); and building stone quarries (which, because of their small size, lack of blasting and very limited output tend to have low levels of impact in most categories). Shallow clay pits are likely to have low levels of impact in some categories but medium levels in others. Chalk pits are also likely to be associated with different levels of impact in different categories, depending on methods of working. Many modern chalk pits which are used for cement manufacture are wet-worked below the water table, but those in North Yorkshire are generally on higher ground, above the water table, and would be more likely to be worked dry. Such quarries may or may not require the occasional use of blasting. Opencast coal extraction has much in common with hard rock quarries, except that blasting is only required, if at all, to

loosen the bands of rock between the coal seams and not to induce complete fragmentation of the rock face. The environmental impacts of reclamation and after-use may also be less for coal extraction because of the relatively poor baseline conditions that are sometimes found in coalfield areas. Further south, within the main part of the Yorkshire, Derbyshire and Nottinghamshire coalfield (and in similar industrialised coalfields elsewhere), modern opencast extraction has often been seen as a mechanism for improving the derelict and contaminated landscapes left behind by former industrial activity.

### *Categories of Impact*

- 6.86 All types of impact are a function of both the intrinsic features of the operation (e.g. the level of noise, the amount of traffic, the depth of the void etc.) and the nature and sensitivity of the receptors within and around the location involved. 'Receptors' in this sense range from people, fauna and flora to habitats, water resources, landscapes and various facets of the historic environment. For certain types of impact, which are directly related to the intrinsic type and amount of activity within the quarry (e.g. dust, noise, vibration, traffic), it is easier to identify generic distinctions between different types of working. For other types of impact, however, (e.g. on landscape, archaeology, habitats and species), it is the receptors which actually define the impact, and which are therefore far more important in determining the likely scale of potential adverse effects. For example, the effects of a large sand & gravel pit with open water restoration, located within an area of highly valued historic landscape, may have greater impacts than a crushed rock quarry located in an area which has little in the way of landscape, historic environment or biodiversity interest. In such cases it becomes virtually impossible to generalise regarding the 'typical' levels of impact associated with particular types of working. In between these two groups are the various types of impact on the water environment, where both the nature of the operations and the characteristics of existing groundwater and surface water features (including their links to habitats and ecosystems) are more closely balanced in terms of their importance in determining the scale of impact.
- 6.87 Environmental sensitivity influences the significance of actual impacts in all cases and is considered separately in Chapter 7 of this report.

### **Cumulative and Combined Effects**

- 6.88 Cumulative effects can be a major issue where two or more quarries are located in close proximity to each other, either simultaneously, during the operational phase, or sequentially.
- 6.89 In the first case, problems may arise from the compound effects of such things as noise, dust, traffic and the drawdown of water tables associated with dewatering from multiple locations. The effects are both increased in overall magnitude and spread out over a wider area. Whilst the effects from any one of the sites may be considered acceptable (subject to mitigation

and/or compensatory measures), the cumulative effects of two or more sites within the same area might not.

- 6.90 In the second case, where adjoining sites are developed sequentially, as is often the case with sand & gravel extraction within wide floodplains or river terraces, the operational impacts will generally be capable of adequate mitigation and management, but the consequences of final restoration might not be. This is especially likely where restoration is partly or wholly to open water: the original landscape becomes transformed into a disjointed pattern of isolated, water-filled holes, resulting in a complete change of character. Whether or not this is acceptable will depend on the sensitivity (see Chapter 7) of the original landscape, including its historic and natural environment components. In some cases, the progressive creation of a new, water and wetland-dominated landscape may have biodiversity, amenity and visual benefits which outweigh any losses to other features. But in other cases the changes will be more finely balanced or, in some cases, completely unacceptable.
- 6.91 In-combination effects relate to situations where different types of impact combine to create much greater problems than might otherwise be expected, based on the assessment of individual issues. In the case of large, crushed rock aggregates extraction on open hillsides, for example, high levels of visual intrusion are likely to combine with high levels of noise and dust, potentially giving rise to more complaints than small-scale sand or clay pits on lower ground.
- 6.92 Understanding these various combinations highlights a key part of the rationale behind this project i.e. taking an integrated look at landscape, biodiversity and heritage issues.

## 7. Assessment of Sensitivity

### Introduction

- 7.93 As explained in the final part of Chapter 5, above, the selected approach to the assessment of environmental and landscape sensitivity within this project is based on qualitative analysis, and focuses on the specific scenario of future mineral extraction.
- 7.94 The starting point for this assessment is to recognise that most forms of potential impact associated with surface mineral working will apply to all geographical areas and environmental settings, and that policies relating to the control of these impacts will therefore largely be generic across all areas.
- 7.95 The analysis presented below therefore attempts to identify the ‘special’ sensitivities (whether higher or lower than ‘normal’) that may be associated with particular areas, either because of the intrinsic characteristics of the landscape, historic environment or natural environment in those areas (as summarised in Chapter 2 of this report), and/or because of the type of mineral extraction likely to be involved, and its associated potential impacts (as detailed in Chapter 6).
- 7.96 In order to do this, some initial concept is needed of what is ‘normal’ and how this can be differentiated from what is ‘special’. This would be extremely difficult and controversial to establish in any quantitative way, even for individual issues, but an attempt can be made to provide more general, qualitative definitions that can be used to guide professional judgement. Across all three of the topic areas under consideration, we suggest that this would need to encompass the concepts of **quality, uniqueness, significance and vulnerability**.

### Components of sensitivity

- 7.97 Features of exceptional **quality** (such as nationally or internationally important designations) would clearly fall into the ‘special’ rather than ‘normal’ category. However, in this respect it must be remembered that, for historic and natural environment features, such designations only attempt to deal with a representative sample of special features and that other features of equal ‘national’ importance may also be present.
- 7.98 Consideration also needs to be given to the concept of **uniqueness**: a feature which is the only one of its kind and which adds to our understanding of the landscape, past cultures or the changing natural environment over time can be regarded as ‘special’ whether or not it has any kind of designation. Equally, where there are multiple examples of a particular feature in a given area, not all of these may need to be preserved, even if they are all of a similar quality. In the field of archaeology, for example, if there are multiple tumuli within a given area, the

loss of some of these, in exchange for a greater understanding of what they contain, may be seen as an acceptable outcome - though this may not apply to the loss of individual elements from a larger group of connected features (such as an alignment of henges). In the field of biodiversity, the preservation of European-designated sites which are refugia for rare or endangered species is of paramount importance, and is backed by European Law. This applies whether or not the sites concerned are unique. More generally, care needs to be taken with uniqueness since (to a specialist, in particular) no two things are exactly alike: this applies equally to particular landforms, rock outcrops, habitats, vegetation communities and to individual historic monuments. To qualify as 'special' in this sense, the uniqueness must be important in some way, at a level which is relevant to planning policy.

- 7.99 Significance is therefore the third vital component in distinguishing between what is normal and what is special, and is perhaps the most difficult for specialists to agree upon. English Heritage (2008b) has noted that "significance is a word used to summarise what is important about a building or place or any type of historic asset. It can be defined as the sum of the heritage values of a place". More generally, a feature may have special significance to a local community, for example in providing or contributing to a 'sense of place'. In other circumstances a feature may have national or international significance, for example because of its importance to scientific or cultural knowledge (including sites that are important for the historical development of scientific ideas). In between, there are features which are significant at a regional or sub-regional level including, for example, wildlife corridors which connect similar habitats and thereby help to protect species and to maintain a healthy natural environment. The severance of such corridors by mineral workings (or other forms of development) can be of much greater significance than might otherwise be expected from the loss of a small area of habitat. It must also be recognised that well-designed mineral operations can be used to re-establish habitat connections that have previously been lost (e.g. through the spread and intensification of agriculture). This, however, will be considered in the following Chapter on capacity, rather than here.
- 7.100 The fourth and final aspect of whether or not something has 'normal' or 'special' sensitivity relates to its **vulnerability** to change. Certain features, such as non-finite geological exposures, which can be replaced with similar (or better) new exposures as a result of mineral extraction can be regarded as fairly robust and therefore non-sensitive. By comparison, the habitat of a species which depends for its survival on the integrity and continuity of that habitat over a given area or distance would be highly vulnerable to its partial removal or severance. Similarly, certain landscapes may be vulnerable to development which disrupted the continuity of a given landform or field pattern.



## Implementation

- 7.101 Bringing all four of these concepts together is not an exact science and, in the case of this project, can only be done on the basis of limited information. It is necessarily a strategic-level exercise informed by a broad-brush desk study and GIS-based analysis (Stage 1 report); more detailed investigations of very small sample areas (Stage 2 sample areas report); and an attempt to create a wider synthesis of understanding (as expressed in the Stage 2 Predictive Landscape Modelling report and in Chapter 2 of this report). Nevertheless, the general concepts outlined above have informed the views of the project team in identifying 'special' sensitivities.
- 7.102 These considerations have been applied to subdivisions of each ASMRP, based on Landscape Character Type (LCT), as defined in the North Yorkshire County Landscape Assessment (Chris Blandford Associates, 2011). These subdivisions were used because the landscape character assessment process, on which they are based, incorporated the consideration of landscape, historic environment and natural environment issues and thus provided a sound basis for differentiation.
- 7.103 Table 7.1, below, shows the issues that have been taken into consideration within each of the environmental categories: landscape, the historic environment and the natural environment.
- 7.104 It must be emphasised, however, that it is only the issues which are considered by the project team to give rise to 'special sensitivities' which are noted in the body of the subsequent tables. It is also important to reiterate that the absence of a special sensitivity does not mean that it does not exist, just that it is not publicly known about (at least to the project team), or that it awaits discovery. Any proposed minerals development will still require a specific site-based data search and watching brief as part of a basic investigation, in accordance with current policy.

<b>Landscape</b>	<b>Historic Environment</b>	<b>Natural Environment</b>
Landscape Quality (AONB)	Predominant HLC Categories	Environmental designations
Geology	Archaeological Deposits	Existing Habitats
Topography & Drainage	Earthworks	Semi-Natural Vegetation
Land Cover	Historic Buildings	Protected species
Enclosure / Field Pattern	Other Historic Structures	Water Environment
Settlement Pattern	Groups of Monuments (including historic settlements, field patterns etc.)	Biodiversity Opportunities
Visible Historic Features		Green Infrastructure
Built Environment & Materials	Designed Landscapes including Registered Parks & Gardens	Geodiversity features (landforms, exposures, active geomorphological processes - all linked to landscape)
Tranquillity	Registered Battlefields	Other Features
Access	Other Features	
Views		
Other Features		

**Table 7.1: key issues taken into account in the assessment of sensitivities to mineral extraction in each environmental category**

## Results

- 7.105 The results are presented below, for each individual ASMRP, in Tables 7.2 to 7.15. Within each table, the component LCT subdivisions are presented in order of their percentage cover within the ASMRP. This is in order to give some indication of ‘weighting’ for the sensitivities involved (those associated with larger areas being likely to have a much greater influence on the development of area-specific policies).
- 7.106 In each table the LCT subdivisions are colour-coded to reflect the broad Land Categories identified in Table 4.2 and Figure 4.1, above.
- 7.107 Although differences in sensitivity have been identified in these tables, between at least some of the LCT subdivisions, these often relate to localised features rather than to the whole subdivision. Moreover, areas which have high sensitivity with respect to the historic environment do not necessarily have high sensitivities in other categories, and vice-versa. This is not surprising, given that the issues involved are very different, but it does mean that variations in overall sensitivity cannot easily be mapped: to do so would create a misleading impression and would not provide a sound basis for the future development of policy.

<b>LCT Subdivisions:</b> (in order of decreasing percentage area)	<b>LCT 24</b> River Floodplain	<b>LCT 27</b> Vale Farmland and Dispersed Settlements	<b>LCT 36</b> Gritstone Valley	<b>LCT 31</b> Settled Industrial Valleys	<b>LCT 6</b> Magnesian Limestone ridge	<b>LCT 13</b> Moors Fringe	<b>LCT 25</b> Settled Vale Farmland	<b>LCTs 1, 3, 4, 9, 11, 26, 28, 29, 32</b>
<b>Percentage of ASMRP within each subdivision:</b>	38.97%	13.01%	9.51% <i>(note, the descriptions below exclude the areas of floodplain within the Tees Valley which are more akin to LCT 24)</i>	8.84%	7.20%	6.06%	5.18%	<5% each
<p>Key Sensitivities, with respect to potential mineral extraction, that may be associated with:</p> <ul style="list-style-type: none"> <li>landscape,</li> <li>the historic environment and</li> <li>the natural environment</li> </ul>	<p>Watercourses are the most distinctive feature of the landscape, presenting special sensitivities in terms of landscape character, active geomorphological processes, water resources and both aquatic and riparian habitats and ecosystems</p> <p>The open, generally flat landform which provides the setting for traditional, nucleated villages, is sensitive to the visual effects of mineral operations</p> <p>The SSSI Hell's Kettles is the only site in the county where open water fed by calcareous springs occurs and is sensitive to water level change caused by extraction</p> <p>The present day land use is predominantly modern and has a low sensitivity.</p> <p>Potential for deeply buried prehistoric deposits from earlier human activity concealed beneath more recent fluvial deposits. There is therefore poor site visibility of early archaeology, which gives a precautionary higher sensitivity to these areas</p> <p>High ecological sensitivity as a result of the patchwork of fen, flood meadows, floodplain mires, marsh and swamp, as well as the river channels and riparian vegetation which form vital wildlife corridors. These wetland environments and ecosystems are especially vulnerable to the effects of watercourse diversions, floodplain excavations and dewatering.</p>	<p>Watercourses again are a distinctive feature of these areas, presenting the same special sensitivities as in LCT 24.</p> <p>Dispersed settlement pattern and pockets of historic parkland are sensitive to visual effects of mineral extraction</p> <p>The present day land use is predominantly modern and has a low sensitivity.</p> <p>However, historic parklands occur in this open rolling landscape.</p> <p>High sensitivity within true floodplain areas, as noted for LCT 24. Elsewhere, away from the rivers, moderate ecological sensitivity in areas of improved agricultural land, including bat roosts in mature trees and built structures and foraging / commuting habitat along hedges / woodland edge.</p>	<p>Watercourses again are a distinctive feature of these areas, presenting the same special sensitivities as in LCT 24.</p> <p>Largely within the Nidderdale AONB which is a long, majestic dale along the River Nidd; internationally important for wildlife and a popular recreational area for walkers to admire the natural beauty.</p> <p>Recreational use, as a gateway to Nidderdale AONB, is sensitive to impacts of mineral operations, such as new roads and change to landscape character through removal of field boundaries.</p> <p>High visual sensitivity as a result of strong visual connectivity with adjacent Moors and Fells.</p> <p>Strong historic landscape/land use pattern that could be diluted by mineral extraction and inappropriate restoration.</p> <p>The heritage value score is high which reflects a large amount of lead mining related features in the valley, and includes communication features and water powered lead processing sites which used to exploit the river.</p> <p>High sensitivity within true floodplain areas, as noted for LCT 24. Elsewhere, away from the rivers, moderate ecological sensitivity in areas of improved agricultural land - as for LCT 27 areas</p>	<p>Watercourses again are a distinctive feature of these areas, presenting similar sensitivities to those in LCT 24 but with increased scope for environmental enhancement.</p> <p>A very small part of this area falls within the Howardian Hills AONB; soft rolling hills with historic parklands which are sensitive to the visual effects of mineral operations.</p> <p>Major communication routes and influence of the West Yorkshire conurbation have resulted in greater urbanisation and industrial activity.</p> <p>The heritage value scoring defines a typically low level of resource. To an extent this reflects the fact that older heritage resources are likely to be buried beneath the alluvium, but also reflects that the area has not been subject to targeted archaeological investigation</p> <p>Relatively low ecological sensitivity, but heightened need/opportunities for biodiversity enhancement in areas of degraded industrial watercourses</p>	<p>Watercourses again are a distinctive feature of these areas, where major valleys cut through the limestone ridge.</p> <p>The setting of historic country houses and designated landscapes on adjoining higher ground may be sensitive to mineral extraction within this LCT.</p> <p>Proximity to A1 M corridor may heighten the sensitivities associated with cumulative impacts (from multiple extraction sites and from HGV traffic)</p> <p>The present day land use is predominantly modern arable agriculture and has a low sensitivity.</p> <p>Historically, these parts of ASMRP 1 have been within an important communications corridor - that of the present-day - A1/M1 giving a locally heightened heritage value and thus greater sensitivity. but otherwise these areas have a low Heritage Value Score.</p> <p>High sensitivity within true floodplain areas, as noted for LCT 24.</p> <p>Heightened sensitivities for groundwater resources may occur where gravel is in hydraulic contact with the limestone aquifer</p>	<p>A small part of this area falls within the Nidderdale AONB ; a popular recreational area for walkers to admire the natural beauty of the landscape and hence sensitive to visual effects of mineral operations</p> <p>Predominantly rural landscape with associated sense of tranquillity; sensitive to noise and disturbance caused by minerals operations.</p> <p>Strong historic landscape/land use pattern, reflecting that it is on the moorland fringe. The historic landscape could be diluted by mineral extraction and inappropriate restoration</p> <p>High sensitivity within true floodplain areas, as noted for LCT 24.</p>	<p>Watercourses again are a distinctive feature of these areas, presenting the same special sensitivities as in LCT 24.</p> <p>In places, modern development has fragmented historic landscape patterns and hedgerows are gappy. Remaining parkland landscapes are more sensitive to mineral operations.</p> <p>No particular features of special historic sensitivity</p> <p>High sensitivity within true floodplain areas, as noted for LCT 24. Other features of high ecological sensitivity may result from the patchwork of habitat types and the abundance of features such as mature parkland trees.</p>	

<b>LCT Subdivisions:</b> (in order of decreasing percentage area)	LCT 24 River Floodplain	LCT 25 Settled Vale Farmland	LCT 36 Gritstone Valley <small>(Note: most of this subdivision of ASMRP 2 falls within the Tees Valley where the landscape is more akin to LCT 24. The descriptions below relate only to the Nidd Valley)</small>	LCT 31 Settled Industrial Valleys	LCT 27 Vale Farmland with Dispersed Settlements	LCT 13 Moors Fringe	LCT 6 Magnesian Limestone Ridge	LCTs 9, 32, 1, 11, 28, 12, and nine others
<b>Percentage of ASMRP within each subdivision:</b>	28.70%	20.65%	10.02%	8.76%	6.60%	3.79%	3.65%	<3.60% each
<p><b>Key Sensitivities, with respect to potential mineral extraction, that may be associated with:</b></p> <ul style="list-style-type: none"> <li>landscape,</li> <li>the historic environment and</li> <li>the natural environment</li> </ul>	<p>High visual sensitivity as a result of the predominantly open and flat landform, facilitating long distance open views and visual connectivity between landscape character areas.</p> <p>Historic sites, listed buildings, designed landscapes and views, and the settings of all of these would have a high degree of landscape sensitivity to all but very small scale mineral operations</p> <p>Strong historic landscape/land use pattern that could be diluted by mineral extraction and inappropriate restoration</p> <p>Association with Roman road (now A1) and well drained means a strong association with older settlement – particularly Roman (Roman fort and vicus at Catterick are in this ASMRP). This makes these areas potentially of greater sensitivity with respect to mineral extraction.</p> <p>Henges at Nunwick and Catterick are on ASMRP 2, and are part of wider ritual landscape associated with adjacent ASMRP 3 at Thornborough. These associations provide a prehistoric context which may increase the sensitivity of other parts of these deposits nearby</p> <p>Locally high ecological sensitivity where terrace deposits adjoin semi-natural riparian habitats along river banks. These form important wildlife corridors and are host to a wide range of both aquatic and terrestrial species.</p> <p>Locally high ecological sensitivity also associated with the wider patchwork of fen, flood meadows, floodplain mires, marsh and swamp, inland bare ground and calcareous grassland habitats, where these occur. Several of these habitats are designated as SSSI and Ramsar sites.</p>	<p>Some historic landscape patterns are evident and these may be sensitive to disturbance and damage from mineral operations. Former WWI airfields are of interest but relatively low sensitivity to minerals development</p> <p>Significant historic landscapes, including ancient piecemeal enclosure and historic parkland. The survival of historic boundaries and features associated with past activity makes this LCT/ASMRP sensitive to extraction damage and need appropriate mitigation/landscape restoration measures to be considered</p> <p>Locally high sensitivity associated with parkland trees where these are used by roosting bats, and with associated hedgerows and other foraging areas.</p> <p>Ancient and semi-natural mixed woodland is also of high ecological importance and therefore sensitive to removal and indirect impacts.</p>	<p>Setting of historic parkland and designed view is sensitive to mineral operations.</p> <p>Significant survival of old landscapes where considerations are similar to LCT 24 and 25.</p> <p>Designated sites with high sensitivity include the Roman bridge and fort at Piercebridge</p> <p>Otherwise there is low level of historic environment (designated and undesignated) resource.</p> <p>Locally high sensitivity associated with parkland trees where these are used by roosting bats, and with associated hedgerows and other foraging areas.</p>	<p>Remnant drystone walls are a special landscape feature and would be sensitive to removal as a result of mineral operations</p> <p>No special sensitivities with regard to impacts of extraction on the historic environment.</p> <p>There is generally a low level established and potential historic environment resource, although the proportion of ornamental parkland is higher than usual</p> <p>Locally high sensitivity associated with parkland trees where these are used by roosting bats, and with associated hedgerows and other foraging areas.</p>	<p>Remnant drystone walls are a special landscape feature and would be sensitive to removal as a result of mineral operations</p> <p>High visual sensitivity as a result of open landscape; strong intervisibility with adjacent landscape types</p> <p>There is a good survival of historic villages within this landscape, and therefore associated potential for archaeological sites. Sensitivity is therefore moderate to high</p> <p>Locally high sensitivity associated with built structures within villages, where these are used by roosting bats.</p> <p>Sensitive BAP habitats may include Traditional Orchards.</p>	<p>Vernacular features which contribute to the landscape character, such as drystone walls, would be sensitive to removal as a result of mineral operations</p> <p>High visual sensitivity as a result of strong intervisibility with adjacent landscape types</p> <p>High sensitivity associated with the site of Anglian cemetery and earlier Roman fort at Baines near Catterick</p> <p>Potential for reptiles and breeding birds on less intensively managed land may present local sensitivities.</p>	<p>The setting of historic country houses (such as Nunwick House) and designed landscapes such as Norton Conyers would be sensitive to mineral operations</p> <p>Parts of this area, around Nosterfield, have a high archaeological resource and high sensitivity because of their location close to the Thornborough Henges and associated ritual landscape</p> <p>Calcareous grassland BAP habitat, 'Special' hedgerows and BAP Hedgerows may present local sensitivities.</p>	

<b>LCT Subdivisions:</b> (in order of decreasing percentage area)	LCT 6 Magnesian Limestone ridge	LCT 28 Vale Farmland with Plantation Woodland & Heathland	LCT 24 River Floodplain	LCT 25 Settled Vale Farmland	LCT 13 Moors Fringe	LCT 23 Levels Farmland	LCTs 1, 12, 32, 27, 11, 19, 9, and sixteen others
<b>Percentage of ASMRP within each subdivision:</b>	24.08%	18.67%	18.60%	15.87%	8.10%	2.57%	<2% each
<p>Key Sensitivities, with respect to potential mineral extraction, that may be associated with:</p> <ul style="list-style-type: none"> <li>landscape,</li> <li>the historic environment and</li> <li>the natural environment</li> </ul>	<p>Special sensitivities in this area include scattered mature veteran trees which are a strong element in this landscape and are reminiscent of past, associated designed landscapes. The agricultural landscape is predominantly intact with a comprehensive, mature hedgerow network, pockets of deciduous woodland and several estates.</p> <p>Gently undulating landscape allowing views between farmsteads and historic estates is a special characteristic of this landscape, such as views between Castle Farm and Alterton Park Mansion.</p> <p>The present day land use is predominantly modern, which would suggest a low historic environment sensitivity.</p> <p>However, the area has a high Heritage Value Score, and notably includes the area of Thornborough where there is a very significant prehistoric resource, including round barrows, a cursus and pit alignments.</p> <p>In the area around Snape, there are Roman buildings, field systems and Snape Castle</p> <p>Generally moderate ecological sensitivity due to intact hedgerows and mature trees.</p> <p>Great crested newts are likely to be abundant throughout due to presence of subsidence hollows and ponds. Meta-populations of GCN are highly sensitive to severance of dispersal routes, e.g. removal of hedgerows etc. Calcareous grassland BAP habitat is likely to occur on unmanaged or lightly grazed land.</p>	<p>There are no areas of high landscape sensitivity in these areas: patches of plantations disrupt views to adjoining landscapes so visual sensitivity is reduced; some historic landscape patterns have been compromised by modern developments and infrastructure; and hedgerows are gappy.</p> <p>The cumulative effects of additional development, including mineral operations could, however, reduce the quality of the landscape</p> <p>The present day land use is predominantly modern and has a low sensitivity.</p> <p>Low ecological sensitivity due to prevalence of improved grassland and plantation woodland.</p>	<p>Open views to adjoining areas may be sensitive to disruption associated with mineral development</p> <p>A generally flat, low-lying landscape which is fairly tranquil and sensitive to the cumulative effects of further mineral extraction, including increased noise and visual effects of additional structures in the landscape</p> <p>Setting of nucleated villages is sensitive to large scale mineral operations where the surrounding landscape is flat, open and visually connects one landscape type to another</p> <p>The present day land use is predominantly modern and has a low sensitivity.</p> <p>High ecological sensitivity due to semi-natural riparian habitats which form important wildlife corridors and are host to a wide range of both aquatic and terrestrial species.</p> <p>Particularly sensitive species include water-vole and otter.</p>	<p>Some historic landscape patterns are evident and these may be sensitive to disturbance caused by mineral operations</p> <p>The present day land use is predominantly modern and has a low sensitivity.</p> <p>The area has a generally low Heritage Value Score, but there are localised areas to the south of Northallerton where there is a high score and therefore higher sensitivity to change. These include the Money Hill Motte and bailey castle at Pickhill.</p> <p>Low ecological sensitivity due to prevalence of improved grassland and plantation woodland. Built structures offer potential for roosting bats.</p>	<p>Partly within the Nidderdale AONB, this area forms a transition between the high moors and fells to the west and the lower Magnesian Limestone ridge to the east. Strong intervisibility with adjacent LCTs and high sensitivity to change</p> <p>Predominantly intact historic features within the landscape, such as walls and hedgerows are sensitive to change</p> <p>Relatively strong historic land use pattern reflecting the survival of old fields on elevated land and on the edge of moors.</p> <p>Some areas have a low Heritage Value Score, but an area to the east of Richmond is crossed by Scots Dyke and includes Easby Abbey. At Ravensworth is a Motte and Bailey fortification. These areas will have a higher sensitivity to change.</p> <p>High ecological sensitivity in higher areas due to non-intensive agricultural management of heath and moorland.</p> <p>Transition between the high moors and fells to the west and the lower magnesium limestone ridge to the east is likely to be occupied by reptiles and of significance to breeding birds.</p>	<p>High visual sensitivity as a result of the predominantly open character and flat landform, which facilitates long distance open views across the landscape and promotes strong intervisibility with adjacent landscape types</p> <p>Moderate landscape and cultural sensitivity as a result of the presence of a patchworks of historic drainage features (ditches and dykes), moated sites and grange sites</p> <p>No special sensitivities with regard to impacts of extraction on the historic environment. For the most part this area has a Heritage Value Score that is low, and there are no scheduled monuments in association.</p> <p>Low ecological sensitivity, resulting from the fact that much of this LCT encompasses improved agricultural land.</p>	

<b>LCT Subdivisions:</b> (in order of decreasing percentage area)	LCT 6 Magnesian Limestone ridge	LCT 25 Settled Vale Farmland	LCT 28 Vale Farmland with Plantation Woodland & Heathland	LCT 13 Moors Fringe	LCT 24 River Floodplain	LCT 27 Vale Farmland with Dispersed Settlements	LCTs 36, 1, 31
<b>Percentage of ASMRP within each subdivision:</b>	36.50%	28.28%	10.81%	9.04%	9.00%	3.99%	<2% each
<p>Key Sensitivities, with respect to potential mineral extraction, that may be associated with:</p> <ul style="list-style-type: none"> <li>landscape,</li> <li>the historic environment and</li> <li>the natural environment</li> </ul>	<p>Part of the outcrop of ASMRP 4 within this LCT falls within the Nidderdale AONB and thus has heightened landscape sensitivities.</p> <p>Elsewhere, special landscape sensitivities include historical features such as the Wensleydale railway line (carrying steam trains) and examples of mature hedgerows.</p> <p>The gently undulating topography within historic estates and scattered mature trees are special features of this area which are sensitive to development.</p> <p>The tranquility of this landscape type is sensitive also to change</p> <p>Strong historic land use pattern that could be diluted by mineral extraction.</p> <p>The Heritage Value Score is generally low but includes a localised area centred on Boroughbridge that is associated with the A1 historic communication route and the Aldborough Roman town and has a locally high Heritage Value Score.</p> <p>Moderately high ecological sensitivity where there are well-established wildlife corridors such as railway lines and hedgerows. These features specifically are likely to be used by reptiles and breeding birds.</p>	<p>The settings of nucleated villages, such as Crakehall would be sensitive to the introduction of mineral operations</p> <p>The present day land use is predominantly modern and has a low sensitivity.</p> <p>Mixed Heritage Value Score across the area, but higher sensitivities occur in an area just north of Boroughbridge and in the environs of Aldborough Roman town. To the south-east of Topcliffe is the historically important Maiden Bower motte and bailey, formerly domiciled by the Earls of Northumberland.</p> <p>Generally low ecological sensitivity due to high prevalence of improved grassland.</p> <p>Higher sensitivities may be associated with hedgerows, many of which are species-rich and old, are abundant as fields are generally small.</p>	<p>The landscape is generally open and flat with no obvious special landscape sensitivities</p> <p>The present day land use is predominantly modern and has a low sensitivity</p> <p>Generally low ecological sensitivity due to high prevalence of improved grassland.</p> <p>Higher sensitivities may be associated with hedgerows, many of which are species-rich and old, are abundant as fields are generally small.</p>	<p>The main outcrop of ASMRP 4 within this LCT falls within the Nidderdale AONB and thus has heightened landscape sensitivities.</p> <p>More generally, there is high visual sensitivity as a result of strong intervisibility with adjacent higher and lower landscapes.</p> <p>Strong historic land use pattern that reflects that it is on the margins of Nidderdale uplands.</p> <p>The Heritage Value Score is generally moderate, and includes the Mowbray Motte and Bailey Castle.</p> <p>High ecological sensitivity due to the amount of non-intensively managed land likely to be of high significance to breeding birds and reptiles</p>	<p>Open views to adjoining areas are sensitive to disruption by new development</p> <p>Mature vegetated river banks are special features within this landscape</p> <p>Because of the focus of past and ongoing gravel extraction within valley floors, these areas are especially sensitive to the cumulative effects of mineral extraction</p> <p>The present day land use is predominantly modern and has a low sensitivity.</p> <p>High ecological sensitivity due to semi-natural riparian habitats which form important wildlife corridors and are host to a wide range of both aquatic and terrestrial species.</p> <p>Particularly sensitive species include water-vole and otter.</p>	<p>Strong vegetation pattern adjacent to rivers which meander through farmed landscape</p> <p>Scattered trees and hedgerows create a mature, unified landscape pattern which would be sensitive to disturbance by mineral extraction</p> <p>The present day land use is predominantly modern and has a low sensitivity.</p> <p>High ecological sensitivity in areas of riparian habitat.</p>	

<b>LCT Subdivisions:</b> (in order of decreasing percentage area)	LCT 30 Sand and Gravel Vale Fringe	LCT 22 Open Carr Vale Farmland	LCT 26 Enclosed Vale Farmland	LCT 5 Limestone Ridge	LCT 1 Urban Landscapes	LCTs 19, 4, 12 and 18
<b>Percentage of ASMRP within each subdivision:</b>	43.88%	36.12%	8.89%	3.79%	3.48%	<2.5% each
<p>Key Sensitivities, with respect to potential mineral extraction, that may be associated with:</p> <ul style="list-style-type: none"> <li>landscape,</li> <li>the historic environment and</li> <li>the natural environment</li> </ul>	<p>High landscape sensitivity as a result of the striking settlement pattern of villages located along the spring line, and designed landscapes</p> <p>Special sensitivities include traditional buildings constructed using vernacular materials including chalk.</p> <p>Field patterns are striking: regular strip patterns are a special feature and sensitive to removal.</p> <p>Very high sensitivity relating to the known or potential richness of the concealed archaeological resource, with evidence of all periods of human activity from the Mesolithic onwards, and the survival of an older landscape which had isolated villages and associated historic field systems.</p> <p>Generally low ecological sensitivity resulting from the fact that this landscape predominantly consists of improved agricultural fields</p>	<p>Linear ditches and small watercourses are a special feature of this landscape and are sensitive to extraction practices</p> <p>Surviving hedgerows associated with strip farming are sensitive to removal as so many have already been removed.</p> <p>Some landscape features, including historic landmarks and vertical elements such as Wykeham Abbey provide which focal points in the flat landscape have higher sensitivity to change</p> <p>Potentially high sensitivities associated with buried archaeology but this land is lower lying and less well drained than LCT 30, and would not have been attractive for human occupation during early periods of history.</p> <p>There is a large amount of parliamentary enclosure, reflecting the fact that a large proportion of this area was previously waste land, enclosed late.</p> <p>Locally high ecological sensitivity associated with the prevalence of deep ditches and streams. These create an important network of wildlife corridors with increasing connections to biodiversity enhancement schemes in peatland areas.</p>	<p>Partly within the Howardian Hills AONB: soft rolling hills with historic parklands which are sensitive to the visual effects of mineral operations</p> <p>High sensitivity likely to be associated with concealed archaeological resources along this narrow strip of better-drained land which extends across the southern edge of the Vale of Rye. The strip formed an historic communication route between Malton and Slingsby and was occupied by villages spread out along the route. Around the villages are the fossilised remains of former open fields (Strip Fields). The area includes Iron Age cemeteries.</p> <p>Generally low ecological sensitivity resulting from the fact that this landscape predominantly consists of improved agricultural fields</p>	<p>ASMRP 5 resources overlap only with the low ground at the northern edge of this LCT, so the high sensitivities which apply to the more elevated parts of the ridge do not apply here</p> <p>The proportion of Unknown planned enclosure reflects a degree of survival of old agricultural systems. The area has a high sensitivity associated with the underlying resource and with Slingsby Castle.</p> <p>Moderately high ecological sensitivity as a result of the patchwork of high quality limestone grassland (mainly linked to grass banks), mature parkland, woodland trees and species-rich grass road verges</p>	<p>Most of the ASMRP 5 resource within this LCT is sterilised by existing built development, including housing estates, industrial estates and the historic core of Malton.</p> <p>Locally high sensitivity associated with the historically significant medieval core of Malton and its Roman fort.</p> <p>Low ecological sensitivity.</p>	

<b>LCT Subdivisions:</b> (in order of decreasing percentage area)	LCT 23 Levels Farmland	LCT 28 Vale Farmland with Plantation Woodland & Heathland	LCT 25 Settled Vale Farmland	LCT 24 River Floodplain	LCT 6 Magnesian Limestone ridge	LCT 27 Vale Farmland with Dispersed Settlements	LCTs 12, 33, 1, 3, 29, 36, 19 and 13
<b>Percentage of ASMRP within each subdivision:</b>	32.68%	30.83%	14.47%	9.62%	8.01%	2.48%	<1% each
<p><b>Key Sensitivities, with respect to potential mineral extraction, that may be associated with:</b></p> <ul style="list-style-type: none"> <li>• landscape,</li> <li>• the historic environment and</li> <li>• the natural environment</li> </ul>	<p>High visual sensitivity due to flat, openness of the landscape allowing long distance views to adjoining areas</p> <p>Hedgerows have been removed to increase field sizes; making remaining hedgerows sensitive to further change</p> <p>The present day land use is predominantly modern and has a low sensitivity.</p> <p>The Heritage Value Score is general low, but higher sensitivities are associated with isolated pockets of high scores, and includes Drax Augustinian Priory, and Castle Hill moated site.</p> <p>Possibility exists of unknown buried archaeology with poor visibility on heavy clay soils</p> <p>Low ecological sensitivity due to most of the landscape being improved farmland.</p>	<p>Whilst most of the landscape is open and flat, patches of woodland are a feature and can provide screening and/or break continuous views to adjoining areas. Visual sensitivity is therefore low</p> <p>The present day land use is predominantly modern and has a low sensitivity.</p> <p>Possibility exists of unknown buried archaeology with poor visibility on heavy clay soils</p> <p>Low ecological sensitivity due to most of the landscape being improved farmland.</p>	<p>Large field sizes and modern farming practices make this area sensitive to further removal of hedgerows</p> <p>Large structures such as power stations, pylons in the low-lying landscape detract from the otherwise rural landscape, thereby reducing the sensitivity to new elements associated with mineral development</p> <p>The present day land use is predominantly modern and has a low sensitivity.</p> <p>Possibility exists of unknown buried archaeology with poor visibility on heavy clay soils</p> <p>Low ecological sensitivity due to most of the landscape being improved farmland.</p>	<p>Open views to adjoining areas are sensitive to disruption by development</p> <p>The present day land use is predominantly modern, but includes the survival of some historic fields which have a higher sensitivity.</p> <p>Generally the Heritage Value Score is moderate, but within this LCT is a small part of the Aldborough Roman town, which has a locally high score and higher sensitivity.</p> <p>Possibility exists of unknown buried archaeology with poor visibility on heavy clay soils</p> <p>Generally low ecological sensitivity due to most of the landscape being improved farmland, but riparian habitats offer significant wildlife corridors and these would be sensitive to any severance.</p>	<p>Views across gently undulating agricultural land are sensitive to the introduction of tall, vertical elements on higher ground (skyline)</p> <p>These are relatively undeveloped areas, characterised by established farm buildings made of local materials; sensitive to the introduction of modern development</p> <p>Scattered mature trees within fields are vulnerable to change</p> <p>The present day land use is predominantly modern, but includes the survival of some historic fields which have a higher sensitivity</p> <p>Possibility exists of unknown buried archaeology with poor visibility on heavy clay soils</p> <p>Low ecological sensitivity due to most of the landscape being improved farmland.</p>	<p>Pockets of historic parkland would be sensitive to the effects of minerals operations</p> <p>The present day land use is predominantly modern, but includes the survival of some historic fields which have a higher sensitivity</p> <p>The Heritage Value Score is low, but higher sensitivities are associated with isolated pockets of high scores, that include South Cowton DMV and Little Smeaton medieval village.</p> <p>Possibility exists of unknown buried archaeology with poor visibility on heavy clay soils</p> <p>Generally low ecological sensitivity overall. Much of this landscape type comprises improved agricultural fields or improved grassland, however there are patches of deciduous woodland and pockets of species rich floodplain meadows which provide key habitats and locally higher sensitivities</p>	



<b>LCT Subdivisions:</b> (in order of decreasing percentage area)	LCT 18 Chalk Wolds	LCT 20 Broad Chalk Valley	LCT 19 Chalk Foothills	LCT 21 Narrow Chalk Valley	LCTs 30, 22 and 17
<b>Percentage of ASMRP within each subdivision:</b>	69.99%	11.88%	11.11%	3.14%	<3% each
<p>Key Sensitivities, with respect to potential mineral extraction, that may be associated with:</p> <ul style="list-style-type: none"> <li>• landscape,</li> <li>• the historic environment and</li> <li>• the natural environment</li> </ul>	<p>The Wolds are currently not within any AONB but the area has special landscape sensitivities due to its distinctive topography and its connectivity to adjacent landscapes</p> <p>The exceptionally tranquil landscape has a sense of remoteness due to its relatively high elevation above the Vale of Pickering, its lack of modern development and scattered shelterbelts of trees. These characteristics represent high sensitivities to the physical effects of mineral operations. The open landscape would also have particular visual sensitivity to the creation of new, large exposures of chalk and to the introduction of new vertical elements associated with mineral workings</p> <p>Further cultural sensitivities associated with the predominantly intact pattern of parkland landscapes, and particular settlement pattern of historic villages in lower valleys with associated management of grazing on higher slopes.</p> <p>Land use is largely modern fields and intensive agriculture; however this ASMRP subdivision has the largest density of scheduled monuments, predominantly prehistoric burial monuments, and for this reason the historic environment sensitivity will generally be high.</p> <p>Locally high ecological sensitivity in some areas, associated with surviving areas of species-rich chalk grassland which are a key habitat.</p> <p>There is also localised geodiversity interest associated with a number of small disused chalk quarries, several of which are designated SSSIs.</p>	<p>High visual connectivity with the Chalk Wolds and Chalk Foothills. As a continuous landscape, this area is sensitive to fragmentation caused by the introduction of man-made, vertical elements</p> <p>The valley sides connecting the foothills to the Wolds serve to enclose views of the valleys</p> <p>Especially tranquil area sensitive to the effects of mineral operations</p> <p>This area also has a large density of scheduled monuments, predominantly settlements of all periods, together with potential archaeological evidence of human activity concealed beneath redeposited top soil. For this reason the historic environment sensitivity will generally be high.</p> <p>Locally high ecological sensitivity in some areas, associated with surviving areas of species-rich chalk grassland which are a key habitat.</p> <p>There is also localised geodiversity interest associated with a number of small disused chalk quarries, several of which are designated SSSIs.</p>	<p>High visual sensitivity as a result of the long views that can be gained from the escarpment and strong intervisibility with the Chalk Wolds, Broad and Narrow Chalk Valleys.</p> <p>High landscape and cultural sensitivity as a result of the striking landscape pattern of the chalk escarpment/foothills and the scattered settlement coupled with pockets of parkland around country houses at Birdsall, Settrington and Place Newton (Scragglethorpe)</p> <p>This area also has a large density of scheduled monuments, including round barrows, settlement sites and the Hunmanby Motte and Bailey, and for this reason the historic environment sensitivity will generally be high.</p> <p>High ecological sensitivity in many areas, associated with swathes of species-rich chalk grassland which are a key habitat.</p> <p>There are also numerous small patches of semi-natural woodland</p>	<p>Forms an integral part of the Chalk Wolds landscape and as such is sensitive to noise, traffic and fragmentation caused by the introduction of development</p> <p>The Heritage Value Score in this area is generally high and the scheduled monuments comprise early cross dykes and round barrows. Sensitivity is therefore generally high</p> <p>High ecological sensitivity in many areas, associated with swathes of species-rich chalk grassland which are a key habitat.</p> <p>There is also localised geodiversity interest associated with a number of small disused chalk quarries, several of which are designated SSSIs.</p>	

<b>Table 7.9: ASMRP 8 (Jurassic Limestone) : Summary of special environmental sensitivities within LCT subdivisions</b>			
<b>LCT Subdivisions:</b> (in order of decreasing percentage area)	LCT 4 Limestone Foothills and Valleys	LCT 30 Sand and Gravel Vale Fringe	LCTs 1, 22 and 26
<b>Percentage of ASMRP within each subdivision:</b>	77.14%	15.67%	<5% each
Key Sensitivities, with respect to potential mineral extraction, that may be associated with: <ul style="list-style-type: none"> <li>• landscape,</li> <li>• the historic environment and</li> <li>• the natural environment</li> </ul>	<p>The southern part of this resource falls within the Howardian Hills AONB: soft rolling hills with historic parklands which are sensitive to visual effects of mineral operations, particularly on the higher ground.</p> <p>More generally there is high landscape sensitivity due to strong landscape and settlement pattern which could be disturbed by mineral operations</p> <p>The Heritage Value is varied and incorporates very low, to high scores, representing opposite extremes of sensitivity</p> <p>High ecological sensitivity within the numerous linear belts of ancient woodland lining the dale sides, many of which have national or local designations for their ecological interest</p> <p>Intervening areas encompass a patchwork of ecological habitats with varying sensitivity to change</p>	<p>High landscape sensitivity as a result of the striking settlement pattern of villages located along the spring line, and designed landscapes</p> <p>High landscape sensitivity due to strong visual connectivity with adjacent LCT</p> <p>There are no known areas of special historic environment sensitivity in this part of the ASMRP</p> <p>Locally high ecological sensitivity associated with old hedgerows and small agricultural fields with a prevalence of ancient woodland and mature trees.</p>	

<b>LCT Subdivisions:</b> (in order of decreasing percentage area)	<b>LCT 6 Magnesian Limestone Ridge</b>	<b>LCT 27 Vale Farmland with Dispersed Settlements</b>	<b>LCT 13 Moors Fringe</b>	<b>LCT 24 River Floodplain</b>	<b>LCT 23 Levels Farmland</b>	<b>LCT 25 Settled Vale Farmland</b>	<b>LCTs 36, 1, 29, 28 and 31</b>
<b>Percentage of ASMRP within each subdivision:</b>	64.73%	8.35%	8.03%	5.74%	4.37%	3.41%	<3% each
<p>Key Sensitivities, with respect to potential mineral extraction, that may be associated with:</p> <ul style="list-style-type: none"> <li>landscape,</li> <li>the historic environment and</li> <li>the natural environment</li> </ul>	<p>Long distance and open views are a special consideration within this area, and these would be sensitive to the visual impacts of quarry development (although older limestone quarries are a feature of the landscape)</p> <p>Mixed land use in some areas (such as the outskirts of Ripon) has put pressure on the retention of hedgerows and scattered mature trees; remnant features would be sensitive to removal, if necessitated by mineral operations</p> <p>The Heritage value score is varied but includes localised areas of higher sensitivity, notably the Thornborough Henges, where ASMRP 9 resources underlie the superficial sands &amp; gravels currently being exploited. More generally, the highest scoring areas are in the vicinity of Ripon, Bedale and Wetherby.</p> <p>Locally high ecological sensitivity, particularly in areas of nationally important, species-rich limestone grassland, and in several pockets of semi-natural ancient woodland scattered along the ridge. There are also a number of SSSIs relating to various ecological habitats that are sensitive to changes in land management.</p>	<p>Strong presence of scattered trees and hedgerows create a mature, unified landscape pattern. The area would be sensitive to the removal of these features, if necessitated by mineral operations</p> <p>The Heritage Value Scores are generally low, but locally high scores occur near Piercebridge Roman fort, and Manfield settlement and field system, which have relatively large numbers of designated monuments. These areas are likely to have higher historic environment sensitivities.</p> <p>High ecological sensitivity in areas of riparian habitat wildlife corridors, and in ponds that are known to support meta-populations of great crested newts.</p>	<p>High visual sensitivity as a result of strong visual connectivity with adjacent areas</p> <p>Strong historic land use patterns that could be diluted by (and are therefore sensitive to) mineral extraction.</p> <p>The area includes high Heritage Value Scores near to Ripon and includes Fountains Abbey and a substantial number of designated monuments. These areas will have high sensitivity with respect to the historic environment</p>	<p>Open views to adjoining areas of limestone outcrop would be sensitive to disruption and fragmentation caused by indirect impacts of mineral operations in those areas</p> <p>Some of these areas have been subject to previous and/or ongoing sand and gravel extraction and would therefore be sensitive to the cumulative effects of mineral extraction</p> <p>Strong vegetation pattern adjacent to rivers which meander through this landscape is a special feature which would be sensitive to the effects of mineral operations</p> <p>The present land use pattern is predominantly modern and has a low sensitivity</p> <p>These areas include high Heritage Value Scores (and thus higher sensitivities) near to Ripon (including Nunwick Henge), near to Thornborough Henges, and around Knaresborough. They also include the Tanfield DMV, and a Roman villa near Tadcaster.</p> <p>High ecological sensitivity in areas of riparian habitat wildlife corridors, and in ponds that are known to support meta-populations of great crested newts.</p>	<p>High visual sensitivity due to flat, openness of the landscape allowing long distance views to adjoining areas</p> <p>Hedgerows have been removed to increase field sizes; and those which survive are therefore sensitive to further change</p> <p>The mixture of land uses, coupled with poor pasture management fragments the existing field pattern; and the landscape is therefore sensitive to further fragmentation</p> <p>The present land use pattern includes substantial areas of parliamentary enclosure and older relict field systems which may be particularly vulnerable to erosion if not considered as part of HLC analysis</p> <p>The Heritage Value Scores are generally low, but there is a small number of scheduled monuments with higher sensitivity, including the Norton Manor House and associated features.</p> <p>Low ecological sensitivity due to prevalence of improved grassland.</p>	<p>Visually sensitive to new development due to strong sense of openness within much of the farmland areas</p> <p>Hedgerows are often gappy and sensitive to change in farming practices and removal for development</p> <p>No known aspects of special sensitivity with regard to the historic environment</p> <p>Species-rich hedgerows are likely to be of some significance and may therefore be of high sensitivity. Similarly, mature trees are likely to be sensitive if used by roosting bats.</p>	

<b>Table 7.11: ASMRP 10 (Carboniferous Shallow Coal): Summary of special environmental sensitivities within LCT subdivisions</b>				
<b>LCT Subdivisions:</b> (in order of decreasing percentage area)	LCT 32 Drumlin Valleys	LCT 6 Magnesian Limestone Ridge	LCT 24 River Floodplain	LCTs 8 and 31
<b>Percentage of ASMRP within each subdivision:</b>	56.73%	39.15%	3.62%	<1% each
<p>Key Sensitivities, with respect to potential mineral extraction, that may be associated with:</p> <ul style="list-style-type: none"> <li>• landscape,</li> <li>• the historic environment and</li> <li>• the natural environment</li> </ul>	<p>The easternmost part of this area, to the south of Clapham, falls within the Forest of Bowland AONB, and thus has heightened landscape sensitivities.</p> <p>More generally, the characteristic 'basket of eggs' (drumlin) topography is a special feature of this area and would be sensitive to disruption by surface mineral extraction</p> <p>Additional sensitivities relate to the presence of other special landscape features, including stone walls and archaeological sites on the drumlins which are vulnerable to disturbance</p> <p>This area has a strong historic land use pattern that could be diluted by surface mineral extraction.</p> <p>The area generally has a low heritage value score, but this reflects a lack of investigation rather than a confirmed absence of heritage.</p> <p>Two areas of higher score (and therefore known higher sensitivity) are centred on Clapham and Burton in Lonsdale, which has a motte and bailey fortification.</p> <p>Locally high ecological sensitivity, associated with pockets of species-rich grassland and remnant mires, developed on the overlying superficial deposits. Some of these are designated as SSSIs for the key habitats that they provide.</p>	<p>The tranquillity in some parts of these areas, afforded on the higher ground away from the A1 (M) where there is little development, is sensitive to change. (Although, more generally, the close proximity of the A1 (M) already negates the tranquillity found in other parts of LCT 6).</p> <p>This area has a strong historic land use pattern, which includes relict parkland, associated with high sensitivity; The historic landscape could be diluted by surface mineral extraction.</p> <p>More generally, the area has a mixture of low and high heritage scores, and therefore both low and high sensitivities, in different areas. Higher sensitivities include the Aberford Dyke System and a Roman road. A significant number of Iron Age / Roman crop mark sites have also been identified from aerial photography.</p> <p>Locally high ecological sensitivity, particularly in areas of nationally important, species-rich limestone grassland, and in areas of semi-natural ancient woodland (both developed on the overlying Magnesian Limestone of ASMRP 9)</p>	<p>Almost all of the ASMRP 10 resources within this area lie beneath the Fairburn and Newton Ings lakes, formed by subsidence associated with former deep coal mining and now protected as an ecological SSSI (see below). The resulting landscape would be highly sensitive to any opencast mining of shallower coal, since this would require the removal of these lakes.</p> <p>As noted above, almost all of this area is occupied by the Fairburn and Newton Ings lakes. The area therefore has some post-industrial heritage significance but only a low historic environment sensitivity.</p> <p>High ecological sensitivity associated directly with the SSSI status of the Fairburn and Newton Ings lakes.</p>	

**Table 7.12: ASMRP 11 (Carboniferous Brick Clay): Summary of special environmental sensitivities within LCT subdivisions**

LCT Subdivisions: (in order of decreasing percentage area)	LCT 6 Magnesian Limestone Ridge	LCT 24 River Floodplain
<b>Percentage of ASMRP within each subdivision:</b>	92.42%	7.58%
<p>Key Sensitivities, with respect to potential mineral extraction, that may be associated with:</p> <ul style="list-style-type: none"> <li>• landscape,</li> <li>• the historic environment and</li> <li>• the natural environment</li> </ul>	<p>The tranquillity in some parts of these areas, afforded on the higher ground away from the A1 (M) where there is little development, is sensitive to change. (Although, more generally, the close proximity of the A1 (M) already negates the tranquillity found in other parts of LCT 6).</p> <p>This area has a strong historic land use pattern, which includes relict parkland, associated with high sensitivity; The historic landscape could be diluted by surface mineral extraction.</p> <p>More generally, the area has a mixture of low and high heritage scores, and therefore both low and high sensitivities, in different areas. Higher sensitivities include the Aberford Dyke System and a Roman road. A significant number of Iron Age / Roman crop mark sites have also been identified from aerial photography.</p> <p>Locally high ecological sensitivity, particularly in areas of nationally important, species-rich limestone grassland, and in areas of semi-natural ancient woodland (both developed on the overlying Magnesian Limestone of ASMRP 9)</p>	<p>Part of the ASMRP 11 resources within this area lie beneath the Fairburn and Newton Ings lakes, formed by subsidence associated with former deep coal mining and now protected as an ecological SSSI (see below). The resulting landscape would be highly sensitive to any opencast mining of shallower coal, since this would require the removal of these lakes.</p> <p>As noted above, almost all of this area is occupied by the Fairburn and Newton Ings lakes. The area therefore has some post-industrial heritage significance but only a low historic environment sensitivity</p> <p>High ecological sensitivity associated directly with the SSSI status of the Fairburn and Newton Ings lakes.</p>

<b>LCT Subdivisions:</b> (in order of decreasing percentage area)	LCT 31 Settled Industrial Valleys	LCT 38 Siltstone and Sandstone Low Moors and Fells	LCT 32 Drumlin Valleys	LCT 37 Siltstone and Sandstone High Moors and Fells	LCT 11 Broad Valleys	LCT 14 Rolling Upland Farmland	LTC 35 Gritstone Low Moors and Fells	LTCs 1, 36, 6, 13 and 8
<b>Percentage of ASMRP within each subdivision:</b>	23.78%	20.8%	17.81%	9.25%	8.90%	8.84%	4.68%	<3% each
<b>Key Sensitivities, with respect to potential mineral extraction, that may be associated with:</b>	<ul style="list-style-type: none"> <li>landscape,</li> <li>the historic environment and</li> <li>the natural environment</li> </ul>							
	<p>Strong pattern of industrial buildings and associated infrastructure, such as canals and factories made from local sandstone. Where these occur there is strong historic integrity within industrial-related development and the remnants of industrial revolution era workings are special features in the landscape. These are increasingly compromised by more recent development and are therefore sensitive to any new development (including large scale mineral extraction) which would add to the fragmentation of this landscape.</p> <p>As in LCT 37, there would be much less sensitivity to small scale building stone extraction</p> <p>Strong historic land use pattern, reflecting an upland terrain; the historic landscape could be diluted by mineral extraction.</p> <p>The heritage value score is relatively high in the area of Airedale, and includes a substantial number of designated examples of rock art.</p> <p>Low ecological sensitivity as a result of heavily modified habitats.</p>	<p>High visual sensitivity as a result of the open skylines and extensive panoramic views across surrounding lower landscapes from higher locations and strong intervisibility with adjacent Landscape Character Types.</p> <p>High landscape and cultural sensitivity, resulting from the predominantly intact landscape pattern of moorland summits, small plantations and scattered, isolated stone barns and farmsteads.</p> <p>The area would, however, be less sensitive to small scale extraction of building stone associated with the repair of existing buildings or the construction of new buildings in the local, vernacular, style.</p> <p>This is predominantly moorland which has seen little modern improvement, and has a significant relict character with high sensitivity to change. The historic landscape could be diluted by mineral extraction.</p> <p>High ecological sensitivity, particularly in the unimproved moorland areas, as a result of the patchwork of key ecological habitats, including blanket bog, dwarf shrub habitats and semi-natural gill woodlands. Many of these habitats are designated as SSSI, SPA and SAC</p>	<p>Parts of this area falls within the Forest of Bowland AONB and thus has heightened landscape sensitivities</p> <p>High visual sensitivity as a result of the predominantly open character and strong intervisibility with adjacent landscape character types including long distance views to the three peaks of Ingleborough, Whernside and Pen-y-ghent</p> <p>Strong pattern of landscape features, including stone walls, hedgerows and pockets of woodland, coupled with the presence of archaeological sites on the drumlins are special landscape sensitivities</p> <p>Strong historic land use pattern, reflecting an upland terrain; the historic landscape could be diluted by extraction.</p> <p>The LCT has a low heritage value score, but this reflects a lack of investigation rather than an absence of heritage, so sensitivity could be higher.</p> <p>Locally high ecological sensitivity, associated with pockets of species-rich grassland and remnant mires, developed on the overlying superficial deposits. Some of these are designated as SSSIs for the key habitats that they provide.</p>	<p>All of this subdivision falls within the Forest of Bowland AONB and thus has heightened landscape sensitivities</p> <p>High level, relatively undisturbed, tranquil and exposed moorland with expansive views across hilltops. This is a 'remote' and rugged landscape which is highly sensitive to development due to the intact pattern of moorland summits, small plantations and scattered, isolated stone barns and farmsteads.</p> <p>The area would, however, be less sensitive to small scale extraction of building stone associated with the repair of existing buildings or the construction of new buildings in the local, vernacular, style.</p> <p>Strong historic land use pattern, reflecting an upland terrain on the edge of the Forest of Bowland; the historic landscape could be diluted by extraction.</p> <p>The LCT has a low heritage value score, but this probably reflects a lack of investigation rather than an absence of heritage, so sensitivity could be higher</p> <p>High ecological sensitivity as a result of the patchwork of key ecological habitats, including blanket bog, dwarf shrub habitats and semi-natural gill woodlands. Many of these habitats are designated as SSSI, SPA and SAC</p>	<p>The Ribble Valley in this area forms a striking flat, open floodplain which is overlooked by adjoining LCTs. The area thus has high visual sensitivity as a result of the predominantly open character and strong intervisibility with adjacent landscape character types</p> <p>The heritage value scores are low in this area, but to a great extent this reflects an absence of investigation, rather than an absence of heritage, so sensitivity could be higher.</p> <p>Recent LiDAR surveys have revealed significant medieval field systems around Rathmell</p> <p>Locally high ecological sensitivity associated with riparian vegetation and wetland areas adjacent to the River Ribble (some of which form part of the Long Preston Deepes SSSI) and the patchwork of interconnected semi-natural ancient woodlands and areas of grassland</p>	<p>All of the ASMRP 12 resources in this area fall within the Forest of Bowland AONB and thus have heightened landscape sensitivities</p> <p>Features, such as drystone walls constructed of local sandstone are a strong visual element of this landscape and help to create a coherent landscape pattern: these are sensitive to change</p> <p>Strong historic land use pattern, reflecting an upland terrain; the historic landscape could be diluted by extraction.</p> <p>Its heritage value scores are low, but to a great extent this reflects an absence of investigation, rather than an absence of heritage, so sensitivity could be higher.</p> <p>No specific features of high ecological sensitivity</p>	<p>High visual sensitivity due to the elevation of this area above the adjoining valleys and visual connectivity with adjacent areas</p> <p>This is predominantly moorland which has seen little modern improvement, and has a significant relict character with high sensitivity to change. The historic landscape could be diluted by extraction.</p> <p>The upland unimproved character has allowed the preservation of monuments and the Heritage Value Score is locally high. These include designated rock art and round and long cairns on Black Hill.</p> <p>High ecological sensitivity as a result of the distinctive patchwork of blanket bogs and heather moorland which provide key habitats for plants and birds and are designated as part of the North Pennine Moors SPA, SSSI and SAC</p>	<p>Most of the small area of LCT 13 in this ASMRP falls within the Forest of Bowland AONB</p>

**Table 7.14: ASMRP 13 (Carboniferous and Jurassic Silica Sand): Summary of special environmental sensitivities within LCT subdivisions**

LCT Subdivisions: (in order of decreasing percentage area)	LCT 34 Gritstone High Moors and Fells (Blubberhouses outcrop only)	LCT 36 Gritstone Valley (Blubberhouses outcrop only)	LCT 19 Chalk Foothills (Burythorpe outcrop only)	LCT 35 Gritstone Low Moors and Fells (Blubberhouses outcrop only)
<b>Percentage of ASMRP within each subdivision:</b>	37.66%	31.29%	23.06%	7.98%
<p>Key Sensitivities, with respect to potential mineral extraction, that may be associated with:</p> <ul style="list-style-type: none"> <li>landscape,</li> <li>the historic environment and</li> <li>the natural environment</li> </ul>	<p>High visual sensitivity as a result of elevated, open nature of this landscape, which facilitates panoramic views across adjacent landscapes. There is strong intervisibility with surrounding areas</p> <p>High landscape and cultural sensitivity, resulting from the predominantly intact landscape pattern of blocky gritstone outcrops, predominantly rural character and strong sense of remoteness and tranquillity throughout, with associated dark night skies</p> <p>This is predominantly moorland which has seen little modern improvement, and has a significant relict character which represents high sensitivity to change. The historic landscape could be diluted by extraction.</p> <p>The area has a high heritage value score reflecting large numbers of rock art features across the Summerscales area. Although there are no designated monuments within the LCT, the sensitivity is nevertheless high.</p> <p>High ecological sensitivity as a result of the distinctive patchwork of blanket bogs and heather moorland which provide key habitats for plants and birds and are designated as part of the North Pennine Moors SPA, SSSI and SAC</p>	<p>High visual sensitivity as a result of strong intervisibility with adjacent moors and fells</p> <p>High landscape and cultural sensitivity as a result of the pattern of narrow valleys, each with their own strongly recognisable landscape pattern and sense of place, coupled with strong historic integrity, numerous historic features and overall sense of tranquillity within this predominantly rural landscape</p> <p>This is predominantly moorland and has a significant relict character. The historic landscape could be diluted by extraction.</p> <p>The area has a high heritage value score reflecting large numbers of rock art features across the Summerscales area. Although there are no designated monuments within the LCT, the sensitivity is nevertheless high.</p> <p>Moderate ecological sensitivity associated with the patchwork of deciduous woodland which provide key habitats</p>	<p>High visual sensitivity as a result of the long views that can be gained from the escarpment and strong intervisibility with the Chalk Wolds, Broad and Narrow Chalk Valleys</p> <p>High landscape and cultural sensitivity as a result of the striking landscape pattern of the chalk escarpment/foothills and the scattered settlement coupled with pockets of parkland around country houses at Birdsall, Settrington and Place Newton</p> <p>The present land use pattern is predominantly modern and in this respect has a low sensitivity</p> <p>However, the area has a high heritage resource and includes the designated Roman site of Kennythorpe (in Burythorpe Parish), which represents locally heightened sensitivity to change</p> <p>Mount Ferrant - the earthwork remains of a timber Motte and Bailey Castle - is close to this ASMRP, in Burythorpe, and the setting would be visually sensitive to mineral operations</p> <p>High ecological sensitivity as a result of the swathes of species rich chalk grassland which are a key habitat and numerous small patches of semi-natural ancient woodland</p>	<p>High visual sensitivity as a result of elevated, open nature of this landscape, which facilitates panoramic views across adjacent landscapes. There is associated strong intervisibility with surrounding areas</p> <p>High landscape and cultural sensitivity, resulting from the predominantly intact landscape pattern of blocky gritstone outcrops, predominantly rural character and strong sense of remoteness and tranquillity throughout, with associated dark night skies</p> <p>This is moorland, which has seen little modern improvement, and has a significant relict character which represents high sensitivity to change. The historic landscape could be diluted by extraction.</p> <p>The area has a high heritage value score reflecting large numbers of rock art features across the Summerscales area. Although there are no designated monuments within the LCT, the sensitivity is nevertheless high.</p> <p>High ecological sensitivity as a result of the distinctive patchwork of blanket bogs and heather moorland which provide key habitats for plants and birds and are designated as part of the North Pennine Moors SPA, SSSI and SAC</p>

<b>LCT Subdivisions:</b> (in order of decreasing percentage area)	LCT 13 Moors Fringe	LCT 32 Drumlin Valleys	LCT 33 Gritstone High Plateau	LCT 9 Farmed Dale	LCT 31 Settled Industrial Valleys	LCT 27 Vale Farmland with Dispersed Settlements	LCT 14 Rolling Upland Farmland	LCTs 36, 1, 34, 11, 29, 38, 24, 8, & 7
<b>Percentage of ASMRP within each subdivision:</b>	29.98%	20.87%	18.35%	9.43%	5.65%	4.86%	3.84%	<2% each
<p><b>Key Sensitivities, with respect to potential mineral extraction, that may be associated with:</b></p> <ul style="list-style-type: none"> <li>landscape,</li> <li>the historic environment and</li> <li>the natural environment</li> </ul>	<p>Strong pattern of hedgerows and drystone walls as field boundaries, which are predominantly intact and which represent a high sensitivity to change.</p> <p>Patchwork of historic designed landscapes, predominantly rural character and relatively strong sense of tranquillity are all further special sensitivities</p> <p>Strong seasonal colour provided by heather moorland is a special feature of this landscape</p> <p>Strong historic land use pattern which could be diluted by mineral extraction.</p> <p>The Heritage Value Score is low to moderate, but includes the Iron Age hill fort of Stanwick Camp, and part of Scots Dyke, which represent areas of higher sensitivity.</p> <p>Locally high ecological sensitivity associated with numerous small woodlands, hedgerows and open moors, which provide key habitats. These have, however, been depleted in many places by agricultural improvement</p>	<p>the characteristic, undulating 'basket of eggs' (drumlin) topography with clumps of trees is a special feature in parts of this area and would be sensitive to disruption by surface mineral extraction</p> <p>Additional sensitivities relate to the strong intervisibility with adjacent areas including long distance views to the three peaks of Ingleborough, Whenside and Pen-y-ghent</p> <p>Strong historic land use pattern which could be diluted by mineral extraction.</p> <p>Locally high ecological sensitivity associated with pockets of species-rich grassland and remnant mires, some of which are designated SSSI for the key habitats they provide.</p>	<p>High visual sensitivity as a result of elevated, open nature of this landscape, which facilitates panoramic views across adjacent landscapes.</p> <p>High landscape and cultural sensitivity, resulting from the predominantly intact landscape pattern of blocky gritstone outcrops, predominantly rural character and strong sense of remoteness and tranquillity throughout, with associated dark night skies</p> <p>Strong seasonal colour provided by heather moorland is a special feature of this landscape</p> <p>Strong historic land use pattern, which includes large areas of parliamentary enclosure and could be diluted by extraction.</p> <p>The Heritage Value Score is high, and includes designated rock art and prehistoric round cairns, in the area of Kirkby Hill / Gayles. These features represent high sensitivities, as do the relicts of former lead mining in this area.</p> <p>High ecological sensitivity as a result of the distinctive patchwork of blanket bogs and heather moorland which provide key habitats for plants and birds and are designated as part of the North Pennine Moors SPA, SSSI and SAC</p>	<p>High visual sensitivity as a result of strong intervisibility with adjacent moors and fells, and key views to the three peaks of Ingleborough, Whenside and Pen-y-ghent</p> <p>High landscape and cultural sensitivity as a result of the diverse pattern of dales, each with their own strongly recognisable landscape pattern and sense of place, coupled with strong historic integrity, numerous historic features (including drystone walls, field barns, hedgerows and prehistoric monuments) and overall sense of tranquillity within this predominantly rural landscape</p> <p>Strong historic land use pattern which could be diluted by mineral extraction.</p> <p>The Heritage Value Score is moderate to high, including designated round cairns, the Roman fort at Wensley, the Keld Heads lead smelt mill and Middleham castle. All of these represent localised areas of heightened sensitivity to change.</p> <p>High ecological sensitivity as a result of the patchwork of species rich meadows and pastures, mosaics of rushy and managed pastures on hill sides and swathes of calcareous grassland on limestone, many of which are of national importance for their landscape and biodiversity value</p>	<p>High visual sensitivity associated with strong intervisibility with adjacent higher landscapes</p> <p>Strong historic land use pattern which could be diluted by mineral extraction.</p> <p>Low ecological sensitivity overall, resulting from the predominance of urban development and improved agricultural fields</p>	<p>Strong vegetation pattern adjacent to rivers which meander through farmed landscape</p> <p>Scattered trees and hedgerows create a mature, unified landscape pattern. The area is sensitive to the removal of these features.</p> <p>The present land use pattern is predominantly modern and has a low sensitivity</p> <p>The LCT includes some areas of very high Heritage Value scores and therefore higher sensitivities. These include the area centred upon Middleton Tyas, near Scotch Corner, and designated monuments here which include an eighteenth century copper mine and an area of medieval cultivation.</p> <p>Generally low ecological sensitivity overall. Much of this landscape type comprises improved agricultural fields or improved grassland, however there are patches of deciduous woodland and pockets of species rich floodplain meadows which provide key habitats with higher sensitivities</p>	<p>High visual sensitivity as a result of strong intervisibility with adjacent higher and lower landscapes</p> <p>High landscape and cultural sensitivity as a result of the intact network of limestone drystone walls which contribute to coherent pattern; and predominantly rural character, strong sense of remoteness, tranquillity and dark night skies</p> <p>Strong historic land use pattern which could be diluted by mineral extraction.</p> <p>Localised ecological sensitivity associated with trees and pockets of ancient woodland which provide local habitat and wildlife corridors</p>	



## 8. Assessment of Capacity for future Mineral Extraction

### Introduction

- 8.1 As noted in Chapter 5 of this report, environmental capacity is generally regarded as the inverse of sensitivity: the greater the sensitivity of a particular area to a specific type of development then, other things being equal, the lower the capacity of that area will be to accommodate such impacts.
- 8.2 However, capacity is also affected by a number of other factors: the scale and nature of the sensitivities relative to the scale and nature of development: the potential to mitigate effects of mineral extraction and the cumulative effects of additional extraction sites within an area. The potential complexity of interactions between these factors makes it difficult to define capacity with a high degree of confidence in any particular case, particularly within the context of a strategic level study such as this. The approach set out in this Chapter is therefore intended to represent a starting point for the consideration of capacity and the discussion here is a generalisation. Pre-application discussions with the planning authority are an important factor in gathering information which will help to determine capacity.
- 8.3 As explained in Chapter 4, the mineral resources within North Yorkshire have been assigned to a number of 'Land Categories' based on common types of topography and environmental characteristics, each of which has particular environmental sensitivities as indicated in the ASMRP Tables 7.2- 7.15 above. These categories form the basis for the following assessment of capacity for further mineral extraction and are illustrated in a plan showing distribution of all the land categories (figure 4.1) and also at the beginning of each section below describing land categories A to O.
- 8.4 In assessing capacity it has been assumed that, other things being equal, a Category covering a large area is more likely to provide greater scope to identify locations of lower sensitivity where future mineral working can take place, than one which covers a small area. Likewise Categories, or parts thereof, which have already experienced mineral extraction, will have reduced capacity for further extraction, compared with areas of unworked resources elsewhere. However in many cases, the extension of existing sites may be preferable to opening up new ones. The location for future minerals working is a matter which requires detailed, site-specific consideration, and cannot be fully addressed in a broad-scale assessment such as this. **For this and other reasons of site-specific detail, the findings identified below can only be regarded as very general indications.**
- 8.5 Consideration of mitigation is also a factor in determining capacity Mitigation can allow a proposal which is initially environmentally sensitive to go ahead after detailed consideration of the impacts and collaborative agreement on reclamation, management and monitoring proposals being reached. Similarly, in certain situations it may be applicable to consider and enter into a (Section 106) legal agreement with an operator to ensure the long term management of a site to an appropriate standard and beneficial

after-use over a period of time which exceeds that provided through normal planning conditions (ref Stage 4 report, Chapter 8).

- 8.6 The following assessments, which result in low/medium/high, or a combination of 2 levels being applied to each category, are qualitative judgements based upon our interpretation of the sensitivities and character of the areas and developed from our knowledge of the extensive evidence based created for this project. These judgements are **relative** to the other categories. Some objective information has been used to develop the qualitative judgements: various datasets have been created in order to inform the spatial capacity of each category and to provide details on the extent of each mineral resource and Landscape Character Type (LCT) present within each of the categories (these are included here as Tables 8.1, 8.2 and 8.3). **The following assessments are a generalisation and applicable across the whole area of each Category and should not be applied to any specific location within a Category.** The results are summarised at the end of this chapter by table 8.4 which provides an overview of the general capacity assessments.
- 8.7 *It should be noted that the data on the extent of existing and former minerals development used in this assessment is sourced from records held by North Yorkshire County Council as mineral planning authority and reflects the position up to 2008. It indicates the total area covered by applications for minerals extraction and therefore does not necessarily reflect the total extent of areas permitted or actually worked, which will be less. Whilst this represents a significant limitation in the quality of the data it is considered to be adequate to inform the general strategic-level judgements about relative capacity provided in this study.*

Land Category	Total Area (hectares)	Approx. Area of Mineral applications (hectares)	% of mineral applications in relation to size of area
A	13079.15	378	2.89%
B	2099.86	26.96	1.28%
C	3669.59	60.47	1.65%
D	3305.45	456.73	13.82%
E	19694.87	161.53	0.82%
F	27157.20	730.38	2.69%
G	15223.43	199.32	1.31%
H	8084.07	26.67	0.33%
I	316.80	0	0%
J	40887.62	27.04	0.07%
K	19949.44	11.86	0.06%
L	3550.26	7.68	0.22%
M	1776.65	12.99	0.73%
N	4371.41	241.31	5.52%
O	1073.90	27.75	2.58%

Table 8.1 showing the area of each category in relation to area of mineral applications

Land Category	ASMRP	Approx. Area of ASMRP within Category (hectares)	% of ASMRP in relation to size of area
A	1	10536.73	80.56%
A	12	545.37	4.17%
A	10	146.09	1.12%
A	11	2150.85	16.44%
B	1	1778.43	84.69%
B	13	105.65	5.03%
B	2	215.78	10.28%
C	1	1378.78	37.57%
C	12	1456.50	39.69%
C	14	644.10	17.55%
C	2	419.92	11.44%
D	2	3305.45	100%
E	14	553.25	2.81%
E	3	8402.97	42.67%
E	4	7127.84	36.19%
E	5	344.53	1.75%
E	9	3974.43	20.18%
F	3	3631.76	13.37%
F	4	4995	18.39%
F	9	21884.04	80.58%
G	10	2496.73	16.40%
G	12	1632.03	10.72%
G	14	6230.85	40.93%
G	3	1221.31	8.02%
G	4	1237.63	8.13%
G	9	2713.56	17.82%
H	5	8084.07	100%
I	5	316.80	100%
J	6	40124.58	98.13%
J	9	1476.78	3.61%
K	7	19949.44	100%
L	13	77.87	2.19%
L	7	3472.39	97.81%
M	8	1776.65	100%
N	12	2127.51	48.67%
N	13	154.09	3.52%
N	14	2089.80	47.81%
O	14	1073.90	100%

Table 8.2 showing the area of each Mineral resource within each of the Categories

Land Category	LCT	Approx. Area of LCT within Category (hectares)	% of LCT in relation to size of area
A	11	545.37	4.17%
A	24	6088.28	46.47%
A	25	808.57	6.18%
A	27	2029.14	15.51%
A	6	3110.55	23.78%
A	36	497.23	3.80%
B	13	977.94	46.57%
B	36	1121.92	53.43%
C	31	3669.59	100%
D	24	1376.37	41.64%
D	25	990.60	29.97%
D	27	316.70	9.58%
D	6	175.02	5.29%
D	36	446.66	13.51%
E	23	388.25	1.97%
E	24	4036.34	20.49%
E	25	6725.87	34.15%
E	27	3904.17	19.82%
E	28	4295.70	21.81%
E	5	344.53	1.75%
F	6	27157.20	100%
G	13	8279.30	54.39%
G	14	978.95	6.43%
G	32	5965.18	39.18%
H	22	3284.64	40.63%
H	26	808.84	10.01%
H	30	3990.59	49.36%
I	1	316.80	100%
J	23	14129.66	34.56%
J	24	3936	9.63%
J	25	5920.78	14.48%
J	27	1013.33	2.48%
J	28	12611.97	30.85%
J	6	3275.88	8.01%
K	18	17053.87	85.49%
K	20	2895.57	14.51%
L	19	2785.73	78.47%
L	21	764.53	21.53%
M	30	299.97	16.88%
M	4	1476.68	83.12%
N	33	2089.80	47.81%
N	34	127.16	2.91%
N	35	313.61	7.17%
N	37	566.44	12.96%
N	38	1274.40	29.15%
O	9	1073.90	100%

Table 8.3 showing the area of Landscape Character Type within each Category

## Land Category A: River Floodplains

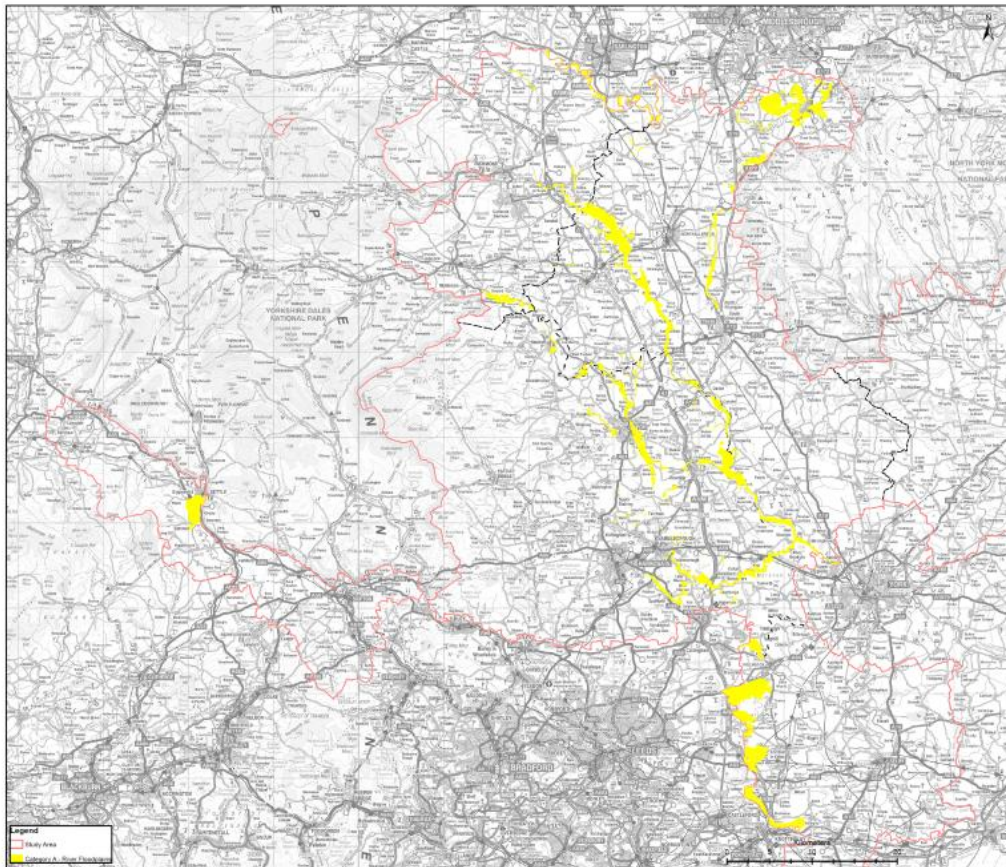


Figure 8.1 Geographical coverage of Category A

- 8.8 Category A comprises modern river floodplains and includes most of the ASMRP 1 sub-alluvial sand & gravel resources, other than those which occur within Categories B or C. It covers a fairly large area of 13,079 hectares of which almost 3% is or has been covered by applications for mineral working.
- 8.9 Mineral workings within Category A occur or have occurred in just three main areas: in the Tees Valley to the south west of Darlington, in the Swale Valley around Ellerton and in the Ure Valley around Ripon. Elsewhere, the deposits are largely unworked. However, between Catterick and Scorton in the Swale Valley, there are extensive gravel workings associated with the immediately adjoining river terrace deposits of Category D.
- 8.10 The typical shared characteristics within Category A include: an open, flat floodplain with distinctive watercourses running through wide valleys and the dominant Landscape Character Type is 24, River Floodplain, which covers 46.47% of the Category.
- 8.11 This Category is further characterised by some particular environmental sensitivities (refer to chapter 7 of this report, table 7.2 and 7.13) including: the presence of historic parks and gardens on adjoining higher ground; where the river floodplain contributes to the setting of such places, and also within this context is the notable Jervaulx Abbey. As noted in Chapter 2, the aggregate deposits within ASMRP 1 are generally of relatively recent origin

(and thus have limited potential for surface archaeological features) but may overlie deeply buried archaeological remains of greater antiquity. The archaeological resource within this category may therefore be categorised as having a low site visibility, and this reduces the confidence of any definition of capacity. The present day land use of the floodplains is generally modern agriculture but within this the ecological value of the watercourses and associated riparian habitats is high.

- 8.12 It is judged that there is likely to be a medium level of relative capacity, overall, for further mineral working within this Category. However, in order to limit the potential for adverse cumulative effects (particularly associated with open water restoration), this capacity is likely to be greater in areas that are not adjacent to existing workings. More specific impacts are dependent upon detailed consideration of the location of proposed workings and subsequent design, mitigation and management proposals.

### Land Category B: Gritstone Valley Floodplains

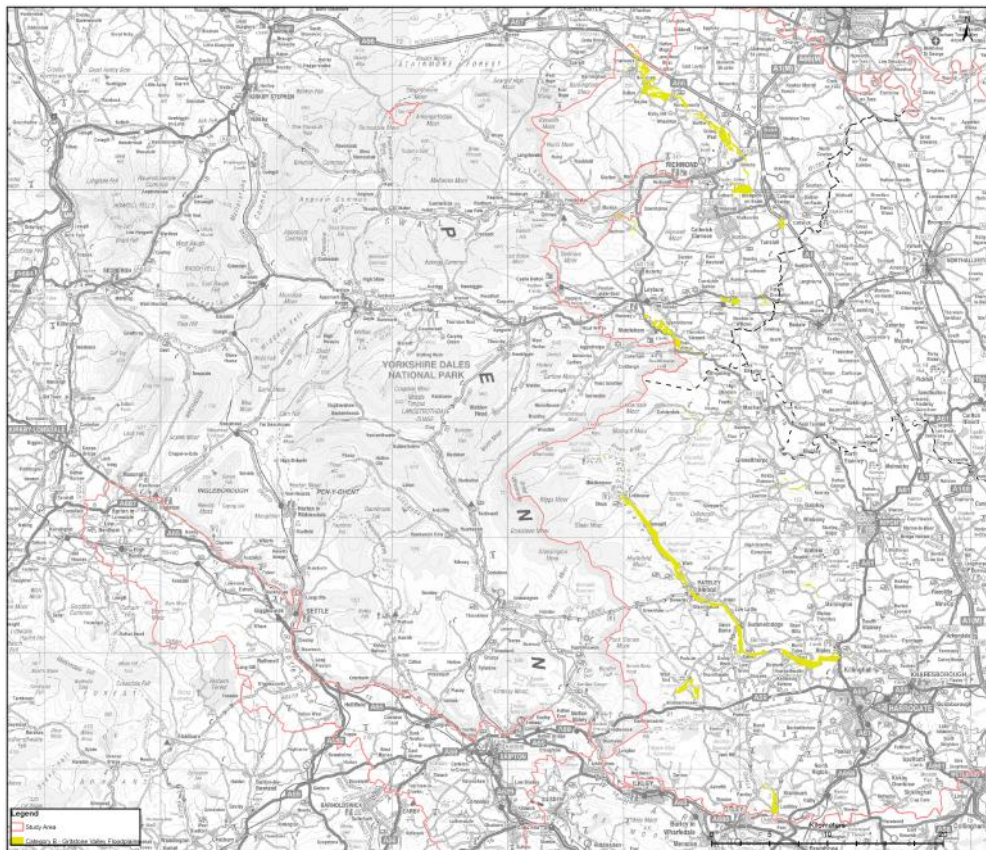


Figure 8.2 Geographical extent of Category B

- 8.13 Category B comprises those areas of ASMRP's 1, 2 and 13 which occur within the Gritstone Valley landscapes of Nidderdale and the Washburn Valley, together with parts of the Ure Valley, south of Leyburn, the Gilling Valley north of Richmond and small parts of the Newton Beck valley, west of Scotch Corner (ref Figure 8.2). It covers a small area of 2,100 hectares of which 1.28% is covered by applications for mineral workings (ref Table 8.1).

- 8.14 The typical landform characteristics which have resulted in grouping these mineral resource types in this category include: a series of relatively narrow valleys; species rich grasslands which support diverse habitats; nucleated villages and associated minor roads within a largely rural landscape with associated sense of tranquillity. These characteristics are typical of LCT 36, Gritstone Valley which covers 53.43% of this Category (ref Table 8.3).
- 8.15 Category B is further characterised by some particular environmental sensitivities (refer to table 7.2, 7.3 and 7.14) including: the presence of watercourses and associated riparian habitats and distinct landscape character; a high heritage value due to the presence of former lead mining related features in the Nidd valley.
- 8.16 It is judged that the nature and extent of these sensitivities is such that Category B landscapes have a low relative capacity to accommodate future mineral working. Specific impacts are however, dependent upon detailed considerations of location of proposed workings and subsequent design, mitigation and management proposals.

### Land Category C: Settled Industrial Valleys

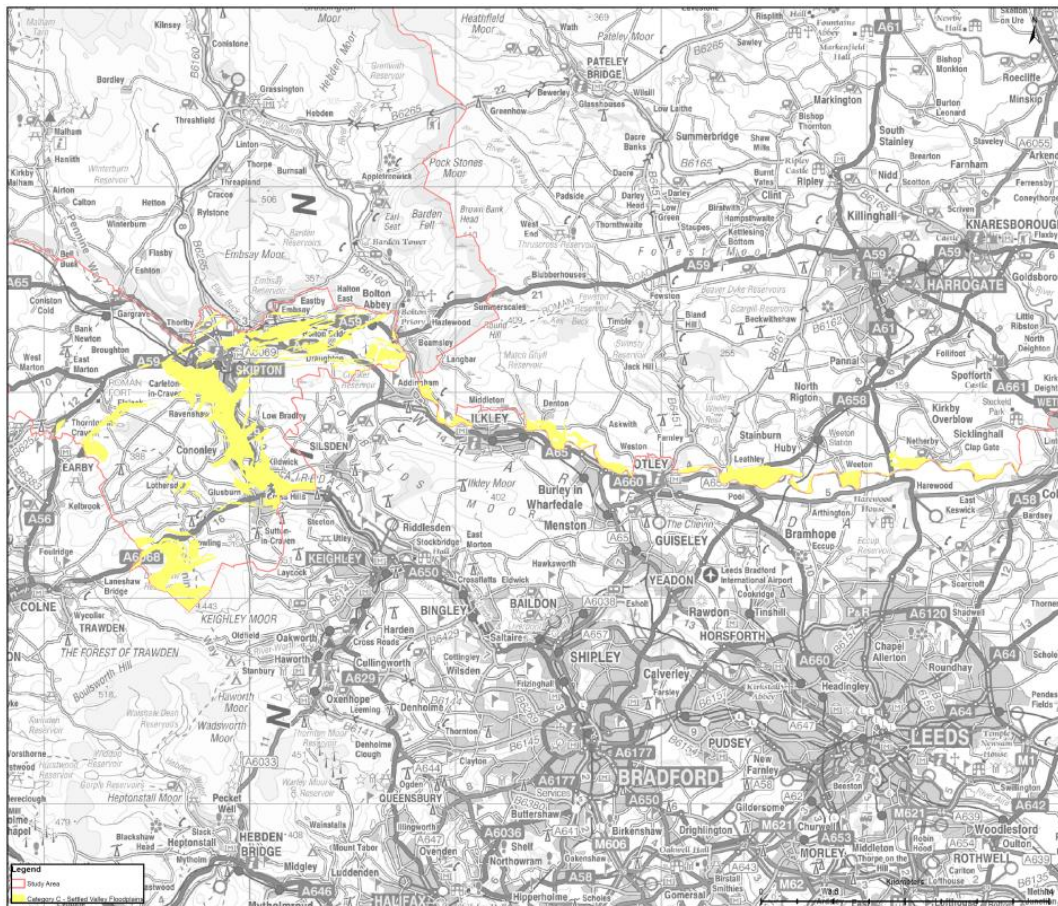


Figure 8.3 Geographical coverage of Category C

- 8.17 Category C comprises those parts of various mineral resources which fall within the settled industrial valley landscapes of LCT 31. It covers 3,700 hectares of which 1.65% is covered by applications for minerals working. (ref Table 8.1), these comprise various permissions



relating to the Skipton Rock limestone quarry. This Category is concentrated around Skipton, where it includes parts of the Aire Valley and adjoining hillsides and extends along the industrialised parts of the Wharfe Valley towards Wetherby further east (ref Figure 8.3). It includes parts of 4 different mineral resources (ref Table 8.2) which are:

- Sub Alluvial sand and gravel (ASMRP 1)
- River terrace sand and gravel (ASMRP 2)
- Carboniferous sandstone (ASMRP 12)
- Carboniferous Limestone Resources (ASMRP 14)

- 8.18 The typical landform characteristics which have resulted in grouping these mineral resource types in this category include: relatively broad valleys which are settled with villages and towns; industrial heritage features; river flowing through valleys which are often crossed by road bridges; historic parkland; fields with associated drystone walls; main roads which disturb the sense of tranquillity and views which often include buildings. These characteristics are typical of LCT 31, Settled, Industrial Valley which covers 100% of this Category (ref Table 8.3).
- 8.19 Category C is further characterised by some particular environmental sensitivities (refer to chapter 7 of this report, table 7.2, 7.3, 7.13 and 7.15) including: remnant drystone walls; bat roosts and foraging areas in woodlands and strong historic land use pattern in parts.
- 8.20 It is considered that new mineral workings may be accommodated within parts of this landscape which are not already developed. Specific impacts are however, dependent upon detailed considerations of location of proposed workings and subsequent design, mitigation and management proposals.
- 8.21 The sensitivities identified within this Category suggest that Category C has medium relative capacity to accommodate further minerals development.

## Land Category: D River Terraces



Figure 8.4 Geographical coverage of Category D

- 8.22 Category D comprises most parts of the ASMRP 2 river terrace sand & gravel resources. It covers an area of 3305.45 hectares, of which a substantial proportion (457 hectares, almost 14%) either is being or has been covered by applications for mineral working.
- 8.23 This Category is concentrated within the Swale Valley between Scorton and Leeming, on the east side of the A1, in the Tees Valley, upstream and downstream of Darlington and in the Ure Valley upstream of Ripon, (ref Figure 8.4). Areas of existing or former mineral permissions are heavily concentrated in the Tees Valley to the southeast of Darlington, in the Swale Valley around Scorton and Catterick, and in the Ure Valley, upstream of Ripon.
- 8.24 The typical landform characteristics of this mineral resource type include: a series of open, flat, low lying river terraces, often adjacent to the floodplain of major rivers (refer to Stage 3 Chapter 2 of this report, section 2.32 to 2.51 and table 2.2).
- 8.25 This category is further characterised by some particular environmental sensitivities (Table 7.3 above) including: evidence of historic land use, parklands and association with older settlements, particularly Roman at Catterick; high visual connectivity with adjacent landscapes; locally high ecological sensitivity where terrace deposits adjoin semi-natural riparian habitats along river banks. These characteristics are typical of LCT's 24, 25, 27

River Terraces which cover 48.15%, 34.65% and 11.08% of this Category respectively (ref Table 8.3).

- 8.26 Due to the high percentage of existing mineral workings within this Category and the cumulative effects of mineral operations, it would suggest that there is less capacity for further extraction in those particular areas. However, there are other undeveloped parts of the resource - for example to the north of Leeming - where this concern would not apply.
- 8.27 It is judged that the nature and extent of these sensitivities is such that there is likely to be a limited capacity for further mineral working within this Category, particularly in the vicinity of existing workings. More specific impacts are dependent upon detailed consideration of the location of proposed workings and subsequent design, mitigation and management proposals.
- 8.28 The range of natural and historic sensitivities and concerns about cumulative impacts have identified that Category D has a low relative capacity to absorb further mineral working.

### Land Category E: Undulating Lowland in the Vales of York & Mowbray

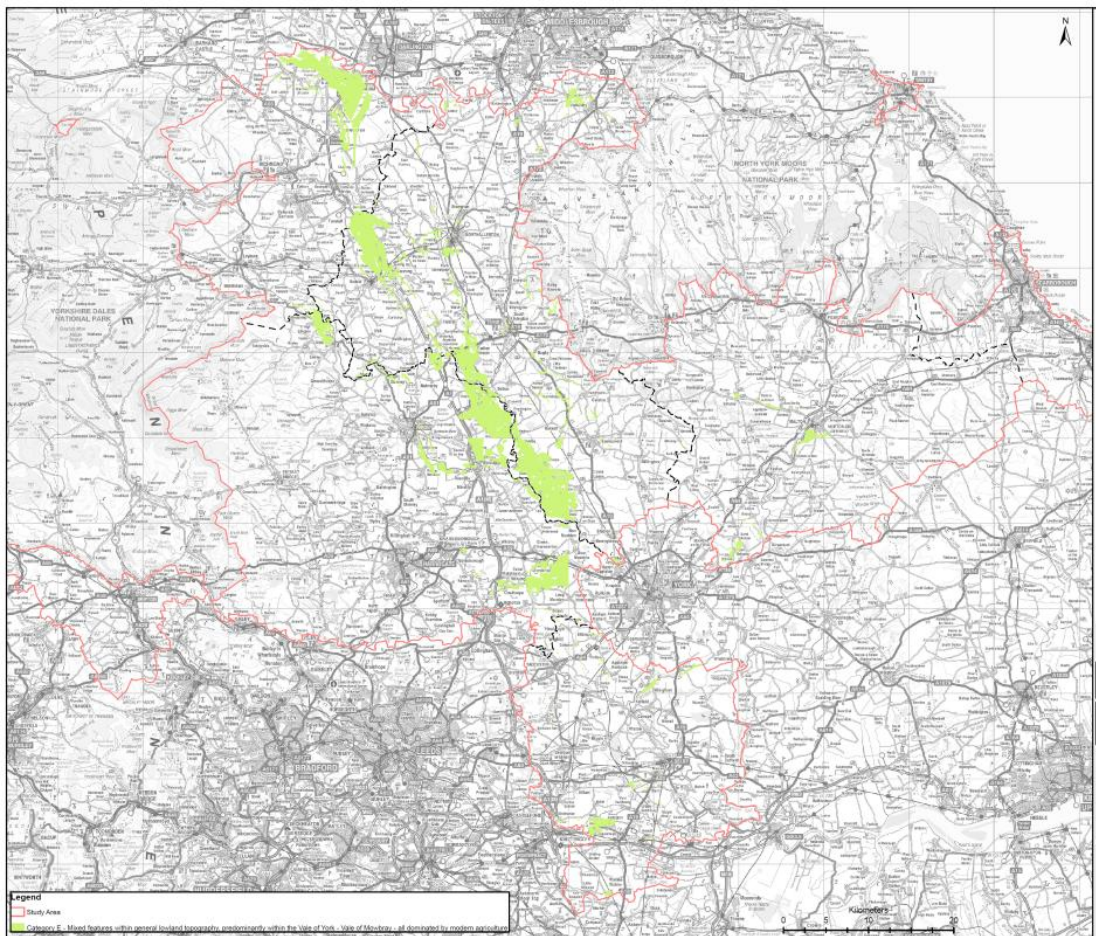


Figure 8.5 Geographical coverage of Category E

- 8.29 Category E comprises a mixed assemblage of lowland topography, mostly within the Vale of York and Vale of Mowbray, and underlain largely by glacial or glacio-fluvial sand & gravel resources. It covers a large area of 19,695 hectares and is relatively undeveloped, from a minerals perspective, with a relatively low proportion (approximately 1%) being covered by applications for mineral working - mostly at Marfield in the Ure Valley.
- 8.30 This Category is predominantly located within a broad belt of land, parallel to the A1 between York and Catterick, with smaller areas around Malton to the east and Knottingley to the south west of Selby (ref Figure 8.5). Although dominated by the glacio-fluvial deposits of ASMRP 3 and the glacial sands & gravels of ASMRP 4, the Category also includes part of the Magnesian Limestone resources (ASMRP 9) the easternmost part of the Carboniferous Limestone (ASMRP 14) and small parts of the undifferentiated sand & gravel resources (ASMRP 5).
- 8.31 The typical characteristics which have resulted in grouping these mineral resource types include: undulating lowland topography and land use dominated by modern agriculture. These characteristics are typical of several landscape character types, including LCT 25, Settled Vale Farmland, which covers 34.15% of this category (ref table 8.3).
- 8.32 The category is further characterised by some particular environmental sensitivities (See Table 7.4, 7.5, 7.6, 7.10 and 7.15 and CBA 2011) including: the potential effects of mineral workings on the setting of traditional villages; habitat diversity associated with riparian vegetation adjacent to watercourses; potential loss of mature, scattered trees and hedgerow fragmentation; some relatively small areas of very high heritage value within the category overall. A small part of the category includes the rich Iron Age and Romano-British landscape at Aldborough near Boroughbridge, but this is a localised area by comparison with the much larger extent of the category elsewhere. Therefore despite the substantial number of existing and previous minerals permissions there is likely to be some relative capacity within the extensive area covered by the resource.
- 8.33 Based on information available to this study, it is judged that the nature and extent of these sensitivities and the limited extent of existing workings is such that it is likely that further mineral workings are capable of being accommodated within this geographical area. Specific impacts are dependent upon detailed considerations of location of proposed workings and subsequent design, mitigation and management proposals. In particular, the cumulative effects of numerous workings in the same area should be considered as a sensitivity which could affect capacity for extraction.
- 8.34 The range of sensitivities identified in relation to the extent of the area covered suggests that Category E has medium to high relative capacity of absorbing further mineral workings.

## Land Category F: Magnesian Limestone Ridge

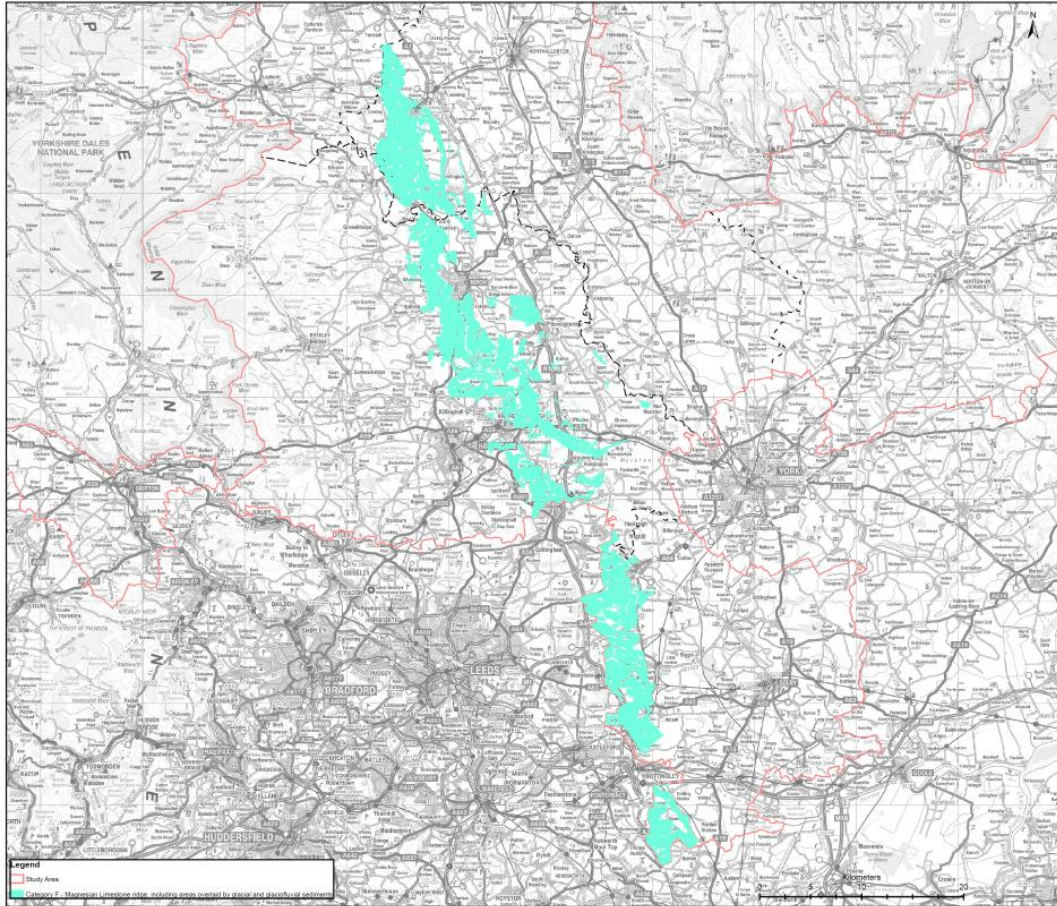


Figure 8.6 Geographical coverage of Category F

- 8.35 Category F comprises almost all of LCT 6 - the Magnesian Limestone Ridge. It includes most of the ASMRP 14 Magnesian Limestone resources (but not those which fall into other landscape character types), and it also includes some parts of ASMRPs 3 and 4 where the underlying limestone still exerts a dominant influence on the landscape.
- 8.36 It is one of the largest Categories, covering 27,157 hectares, of which approximately 730 hectares (2.69%) are covered by applications for mineral working. It occupies a wide band of land from just northwest of Leeming, following the A1 southwards to Wetherby and crossing to the eastern side of the A1 to just south of Knottingley (ref Figure 8.6). Mineral extraction sites occurring within Category F include both hard rock quarries where the limestone is exposed, and sand & gravel pits, such as those around Nosterfield, which exploit the overlying superficial deposits.
- 8.37 The landscape is characteristics of LCT 6, Magnesian Limestone Ridge which covers 100% of this Category (ref table 8.3).
- 8.38 The category is further characterised by some particular environmental sensitivities (refer Table 7.4, 7.5 and 7.10 above and to CBA 2011): significant concentration of Neolithic and Bronze Age monuments and related archaeological deposits in the North of England and includes a number of very substantial round burial cairns extending between Masham and

Bedale; historic country houses and associated designed landscapes, including part of the Fountains Abbey landscape; protected species are likely to be abundant throughout the area; scattered, mature trees and hedgerows are a special landscape feature and the gently undulating form allows views between farmsteads and historic estates, creating a sense of tranquillity in many parts of this Category.

- 8.39 Based on information available to this study, it is judged that whilst the nature of these sensitivities is high, the extensive area covered by Category F and the limited extent of existing and former mineral workings means that it is likely that further mineral workings are capable of being accommodated within this geographical area. Specific impacts are dependent upon detailed considerations of location of proposed workings and subsequent design, mitigation and management proposals.
- 8.40 The range of sensitivities identified in relation to the extent of the area covered suggests that Category F has medium relative capacity of absorbing further mineral workings.

### Land Category G: Moorland Fringes

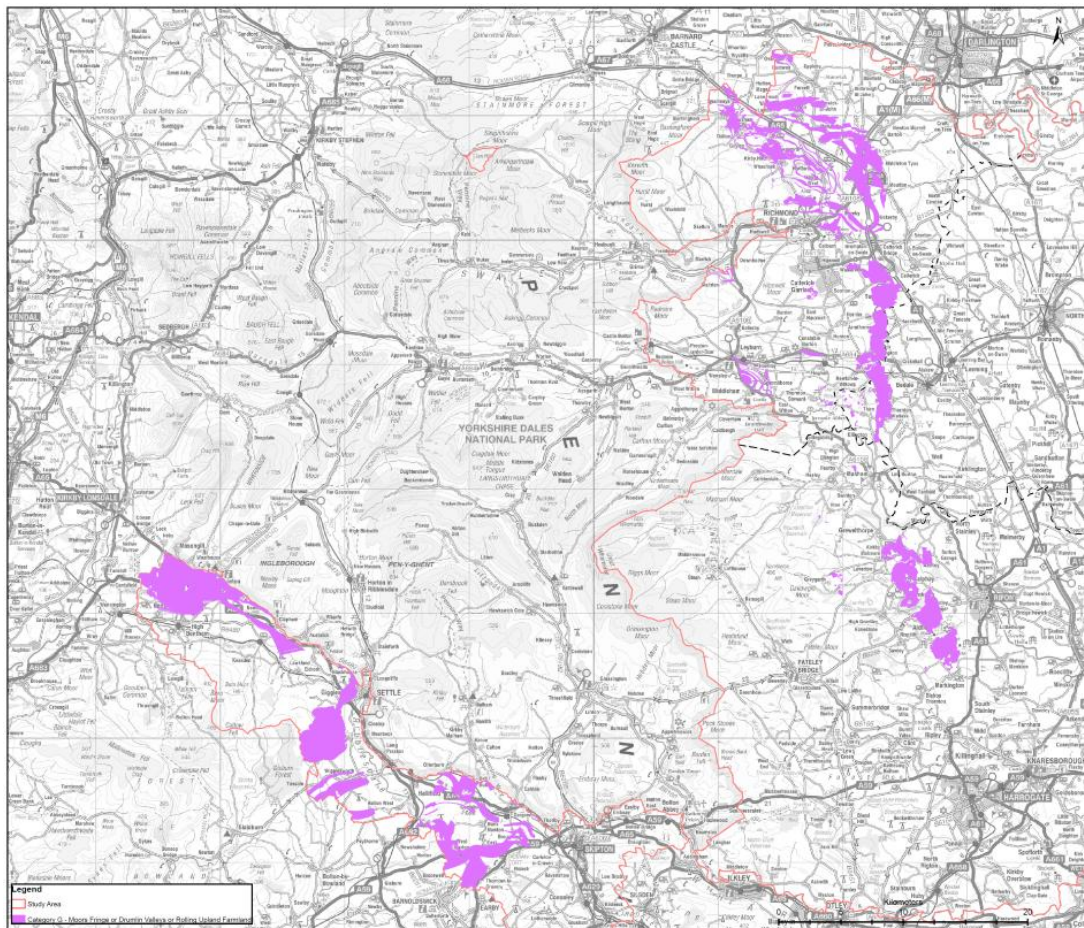


Figure 8.7 Geographical coverage of Category G

- 8.41 Category G comprises a range of different resource types which share the feature of being located in areas of moderately elevated land at the fringes of the Pennine hills. Taken together, these areas cover 15,223 hectares, of which only approximately 199 hectares

(1.31%) are covered by applications for mineral working. The Category is found within two distinct areas; in Craven District, between Kirby Lonsdale and Skipton; and on the eastern edge of the Pennines between Barnard Castle and Ripon (ref Figure 8.7). It includes parts of six different mineral resources (ref Table 8.2) which are:

- Glacio-Fluvial Sand & Gravel Resources (ASMRP 3)
- Glacial Sand & Gravel Resources (ASMRP 4)
- Magnesian Limestone Resources (ASMRP 9)
- Carboniferous Shallow Coal (ASMRP 10)
- Carboniferous sandstone (ASMRP 12)
- Carboniferous Limestone Resources (ASMRP 14)

8.42 Existing or former mineral workings occur only in that part of Category G which lies around and to the north of Richmond, including small areas of sand & gravel extraction within the Swale Valley, and larger limestone quarries between the A1 and A66 around Melsonby.

8.43 The category is further characterised by some particular environmental sensitivities (refer to Table 7.4, 7.5, 7.10, 7.11, 7.13 and 7.15 and to CBA 2011) and includes the World Heritage Site of Fountains Abbey /Studley Royal to the west of Ripon; predominantly intact historic farmland features such as drystone walls and mature hedgerows; areas of high ecological value due to the non-intensive agricultural management of heath and moorland; some areas of high archaeological value where Iron Age/Roman crop mark sites have been identified and there is a sense of tranquillity in higher parts of the landscape.

8.44 It is judged that the nature and extent of these sensitivities and the limited extent of existing workings is such that some further mineral workings are likely to be capable of being accommodated within this geographical area.

8.45 The range of sensitivities identified in relation to the extent of the area covered suggests that Category G has low to medium relative capacity of absorbing further mineral workings. This assessment is a generalisation and specific impacts are dependent upon detailed considerations of location of proposed workings and subsequent design, mitigation and management proposals.





- 8.50 The range of sensitivities identified, in particular those associated with archaeology, suggests that generally Category H has low relative capacity of absorbing further mineral workings.

### Land Category I: Urban Areas

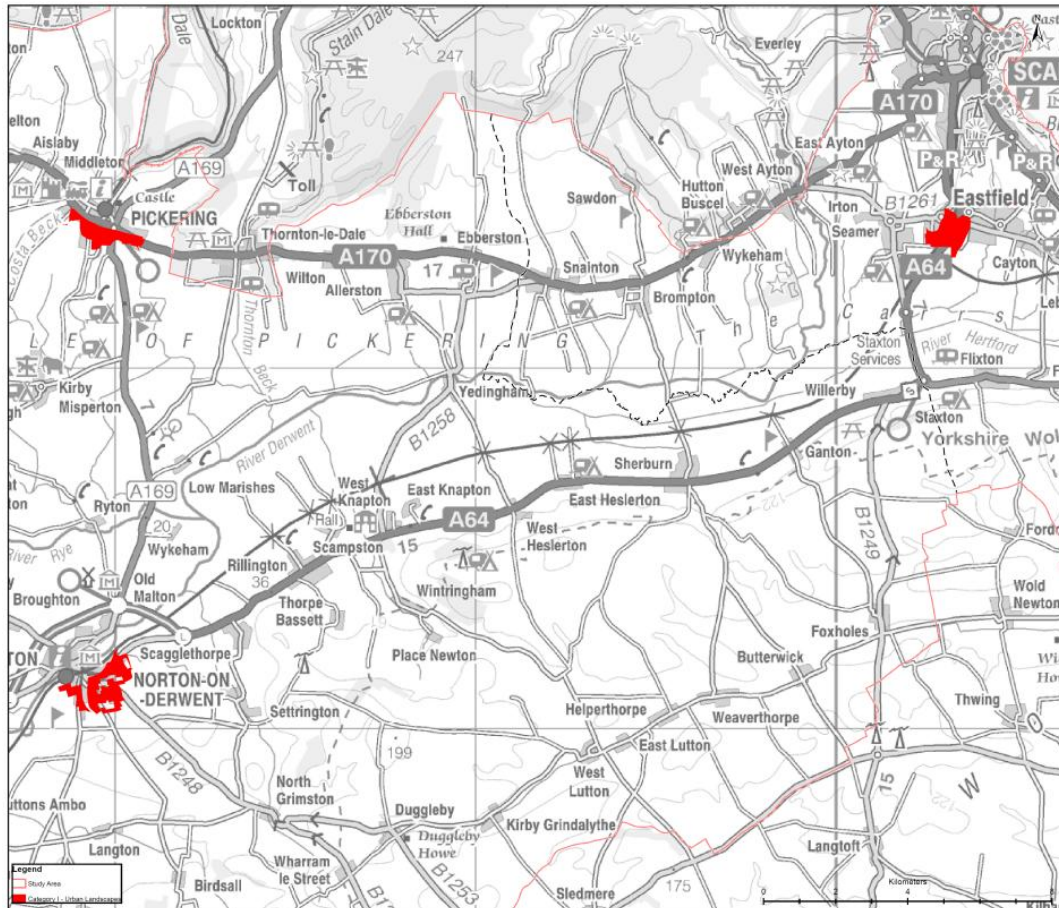


Figure 8.9 Geographical coverage of Category I

- 8.51 Category I comprises areas of existing built development within ASMRP 5, around Pickering, Eastfield (nr Scarborough) and Malton/Norton-on-Derwent (ref Figure 8.9). It covers just 316 hectares, and contains no mineral applications.
- 8.52 Category I is extremely unlikely to have any capacity for minerals extraction in the future because of proximity to existing areas of residential development, urban parks and popular countryside parks.

## Land Category J: Clay lowlands

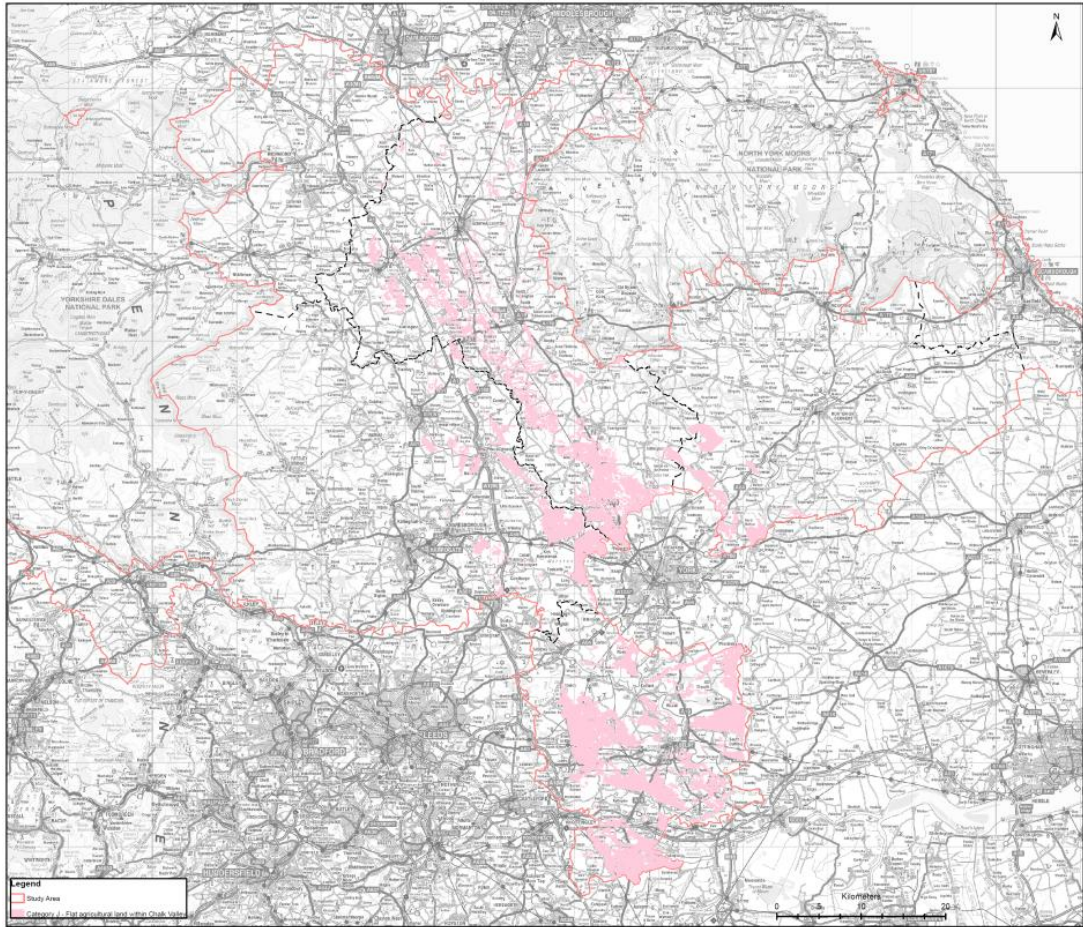


Figure 8.10 Geographical coverage of Category J

- 8.53 Category J comprises all of the Quaternary brick clay resources of ASMRP 6, scattered throughout the Humberhead Levels, the Vale of York and the Vale of Mowbray, together with a small adjoining area of the Magnesian Limestone resources (ASMRP 9), where these extend onto lower ground and exhibit a similar landscape character. Taken together, the innumerable individual outcrops which make up this Category form the largest area of all the categories covering 40,888 hectares, of which only 27 hectares (0.07%) are covered by applications for mineral working (this being a single site at Alne, to the south of Easingwold).
- 8.54 Category J has few particular environmental sensitivities (refer to Table 7.7 and 7.10 and to CBA 2011). The landscape has been substantially changed over the years through settlement and modern day activities, which has fragmented the landscape character. There are only limited numbers of documented heritage assets within the extent of the category; however, the clay soils limit the ability to reveal underlying archaeological sites as crop marks and site visibility is generally low. The documented record may therefore be an unrepresentative indicator of the heritage resource. The major sensitivity within this category is to further overall fragmentation caused by a diverse range of land use.

- 8.55 Therefore it is likely that further mineral workings are capable of being accommodated within this geographical area.
- 8.56 The range of sensitivities identified in relation to the extent of the area covered suggests that Category J has high relative capacity of absorbing further mineral workings. This assessment is a generalisation and specific impacts are dependent upon detailed considerations of location of proposed workings and subsequent design, mitigation and management proposals.

### Land Category K: Chalk Wolds & Broad Chalk Valley

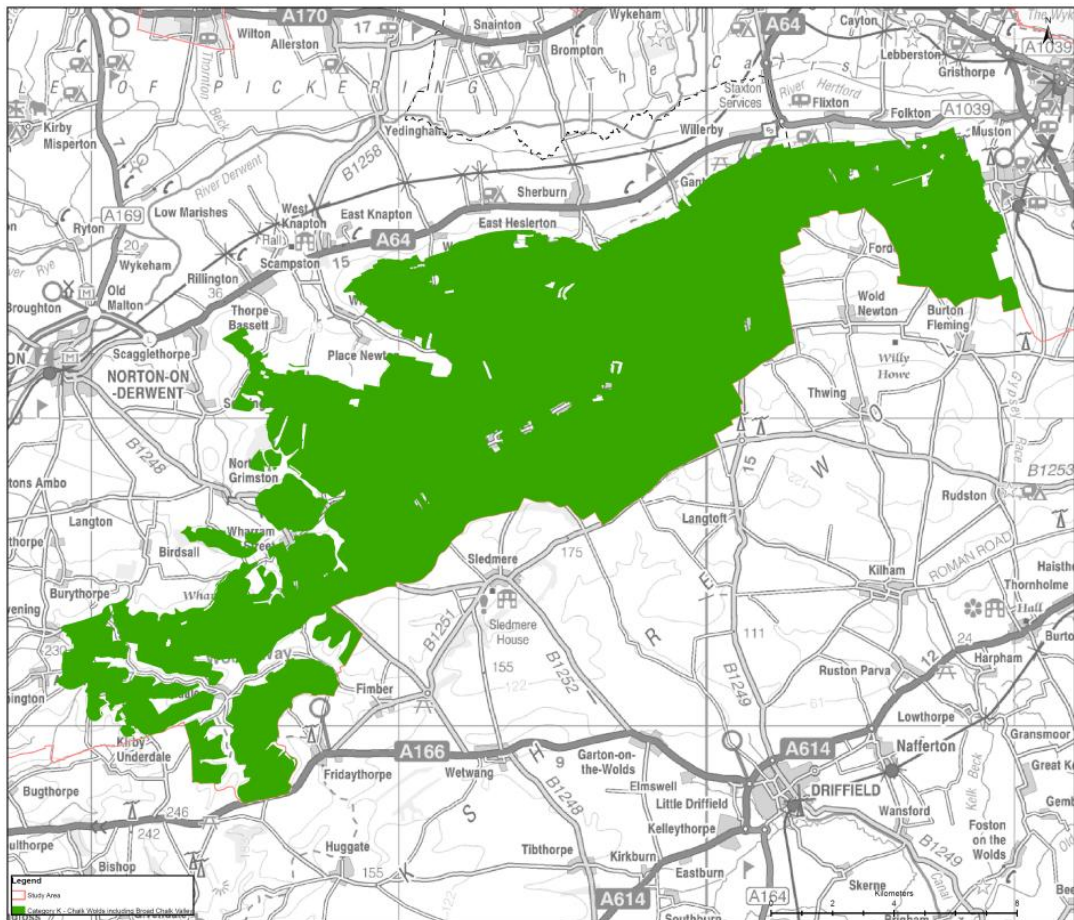


Figure 8.11 Geographical coverage of Category K

- 8.57 Category K comprises the largest part of the ASMRP 7 Chalk resources within the Yorkshire Wolds, incorporating the main part of the Chalk Wolds (LCT 18) together with the Broad Chalk Valley (LCT 19). This is a large area covering 19,949 hectares, of which only 11.86 hectares (0.06%) are covered by applications for mineral working (Flixton quarry near Hunmanby and a small area around a mineral exploration borehole near Duggleby).
- 8.58 It is characterised by particular archaeological and historic sensitivities (refer to Table 7.8), with evidence of early human activity such as barrows and linear earthworks, and deserted/contracted villages that resulted from the creation of large sheep farming enterprises from the Medieval period onward. High visual sensitivity due to this areas open

character and intervisibility from the higher points. Remnant areas of chalk grassland have high natural value for flora and fauna.

- 8.59 It is judged that the nature and extent of these sensitivities is such that it is unlikely that further mineral workings are capable of being accommodated within this geographical area without extensive consideration of location and mitigation measures to manage adverse archaeological and visual impacts as described in the key characteristics of the chalk resource.
- 8.60 Therefore the range of sensitivities identified in relation to the extent of the area covered suggests that Category K has an overall low relative capacity to absorb future mineral working.

### Land Category L: Chalk Foothills and Narrow Chalk Valleys

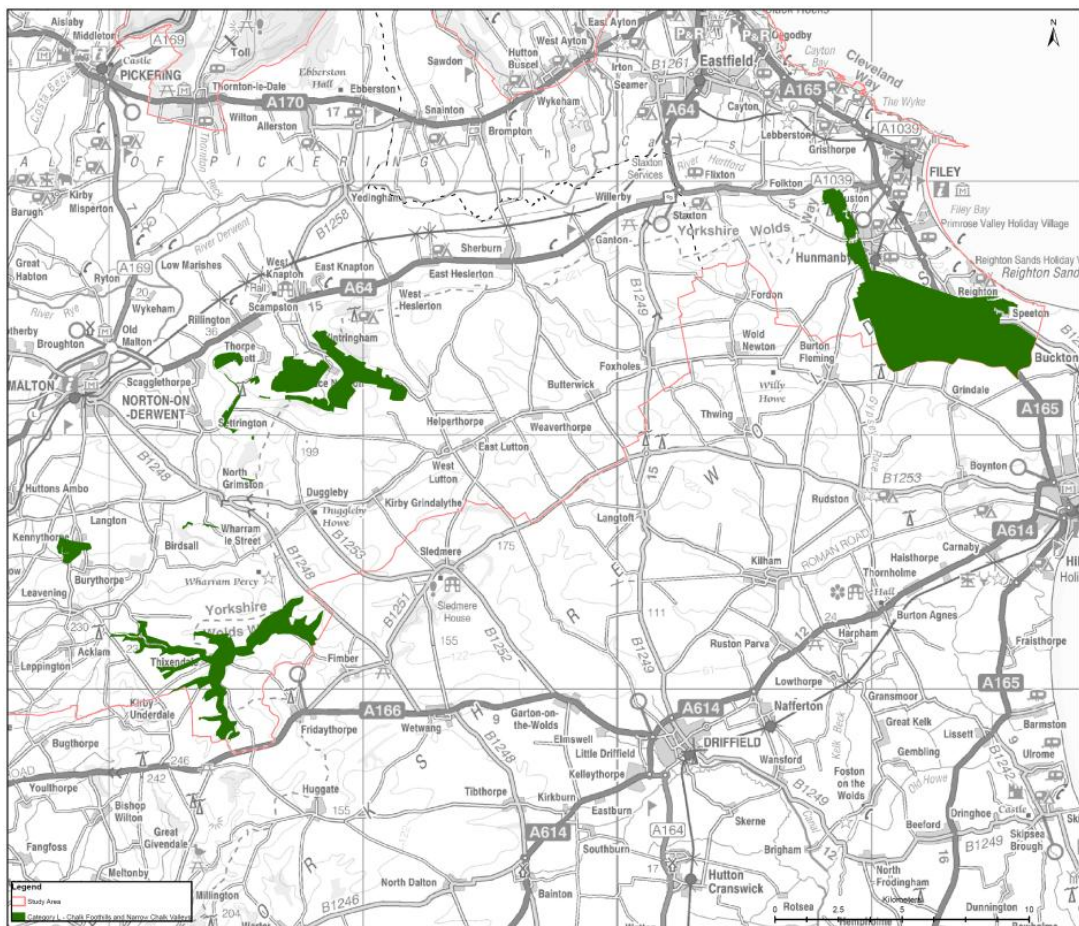


Figure 8.12 Geographical coverage of Category L

- 8.61 Category L comprises the remaining parts of the ASMRP 7 Chalk resources - those which fall within LCTs 19 and 21 (Chalk Foothills and Narrow Chalk Valleys, respectively). It also includes the small outcrop of silica sand (ASMRP 13) at Burythorpe. Overall, this is a relatively small area covering 3,550 hectares, of which approximately only 8 hectares (0.22%) are covered by applications for mineral working.

- 8.62 LCT 19 covers over 78% of Category L, Chalk Foothills (ref Table 8.3).
- 8.63 The category is further characterised by some particular environmental sensitivities (refer to Table 7.8 and 7.14 and to CBA 2011) and includes; high visual sensitivity due to elevation and openness of rolling hills, high ecological sensitivity due to species rich chalk grassland and semi-natural ancient woodlands; high landscape and cultural sensitivity due to significant archaeological and built landscape, past historic landscape character of parkland, hedges and piecemeal enclosure.
- 8.64 It is judged that the nature and extent of these sensitivities is such that it is unlikely that further mineral workings are capable of being accommodated within this geographical area. Specific impacts are dependent upon detailed considerations of location of proposed workings and subsequent design, mitigation and management proposals.
- 8.65 The range of sensitivities identified in relation to the extent of the area covered suggests that Category L has low relative capacity of absorbing further mineral workings.

### Land Category M: Jurassic Limestone Foothills

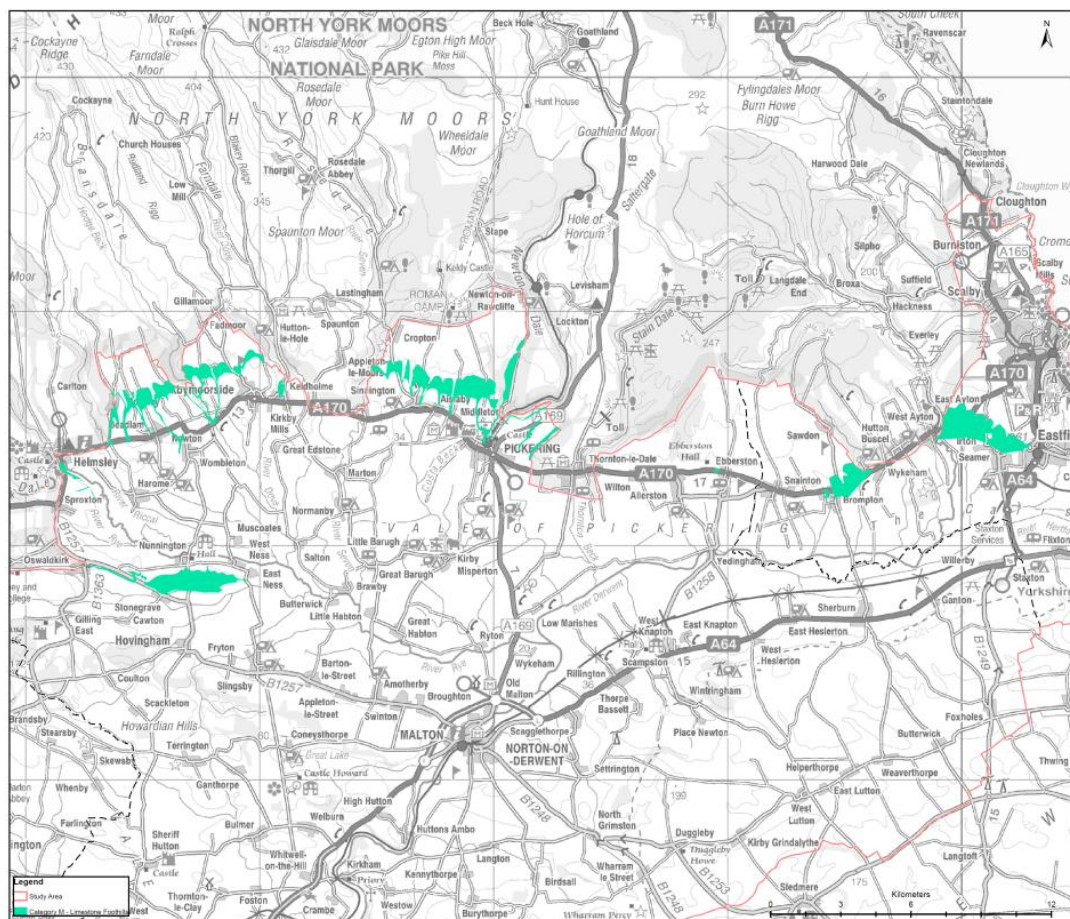


Figure 8.13 Geographical coverage of Category M

- 8.66 Category M comprises the outcrop of ASMRP 8 Jurassic Limestone resources within the foothills of the North York Moors - largely to the north of the A170 from Helmsley to Eastfield with a small area at Nunnington (ref Figure 8.13). This is a small area covering

1,777 hectares, of which only 13 hectares (0.73%) are covered by applications for mineral working, near Pickering. The main existing working area, Newbridge Quarry, also extends beyond the ASMRP 8 outcrop to include limestone resources which lie beneath younger strata.

- 8.67 Landscape The typical characteristics of this Category includes: ancient woodlands which occupy valley sides; prehistoric mounds and burial sites preserved within moorland or woodland; strong visual connectivity with surrounding landscape; traditional farm buildings made from vernacular material; contrast between the very narrow wooded valleys and open arable hilltops. This is typical of LCT4 Limestone Foothills and Valleys which covers over 83% of Category M (ref Table 8.3).
- 8.68 The Category is further characterised by some particular environmental sensitivities (refer to Table 7.9 and to CBA 2011) and includes: high landscape quality due to strong landscape and settlement patterns; some areas of significant heritage value; areas of diverse ecology along the numerous linear belts of ancient woodland lining the dale sides.
- 8.69 It is judged that the nature and extent of these sensitivities is such that it is unlikely that further mineral workings are capable of being accommodated within this geographical area. Specific impacts are dependent upon detailed considerations of location of proposed workings and subsequent design, mitigation and management proposals.
- 8.70 The range of sensitivities identified in relation to the extent of the area covered suggests that Category M has low relative capacity of absorbing further mineral workings.

## Land Category N: Pennine Moors and Fells

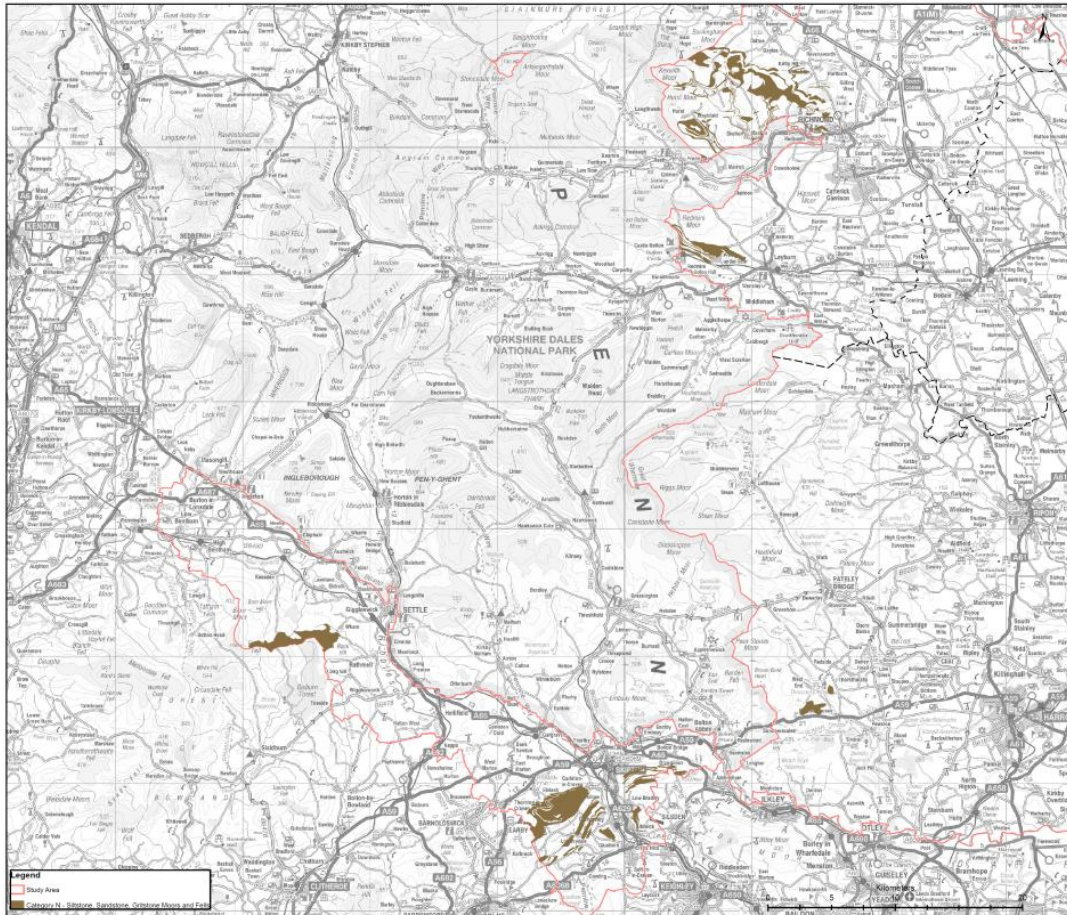


Figure 8.14 Geographical coverage of Category N

- 8.71 Category N comprises those parts of ASMRPs 12, 13 and 14 (Carboniferous sandstone, silica sand and limestone) which occur within the siltstone, sandstone and Gritstone moors and fells of LCTs 33, 34, 35, 37 and 38. Taken together, these areas cover 4,371 hectares, of which approximately 241 hectares (5.52%) are covered by applications for mineral working. The outcrops are located around Richmond, to the west of Settle and to the southwest and east of Skipton (ref Figure 8.14).
- 8.72 Landscape characteristics are typical of LCT 33, Gritstone High Plateau, which covers almost 48 % of Category N (ref Table 8.3).
- 8.73 The Category is further characterised by some particular environmental sensitivities (refer to Table 7.13, 7.14 and 7.15 and to CBA 2011). This includes: strong intervisibility with adjacent and distant landscapes due to elevation and openness; predominantly intact landscape pattern of blocky Gritstone outcrops; strong seasonal colour is a special feature of this landscape; examples of rock art and prehistoric cairns are a special heritage feature and reflect the survival of important prehistoric landscapes in the predominantly upland landscape; high ecological sensitivity as a result of the distinctive patchwork of blanket bogs and heather moorland providing key habitats for plants and birds.

- 8.74 It is judged that the nature and extent of these sensitivities is such that it is unlikely that further mineral workings are capable of being accommodated within this geographical area. Specific impacts are dependent upon detailed considerations of location of proposed workings and subsequent design, mitigation and management proposals.
- 8.75 The range of sensitivities identified in relation to the extent of the area covered suggests that Category N has low relative capacity of absorbing further mineral workings.

### Land Category O: Wensleydale

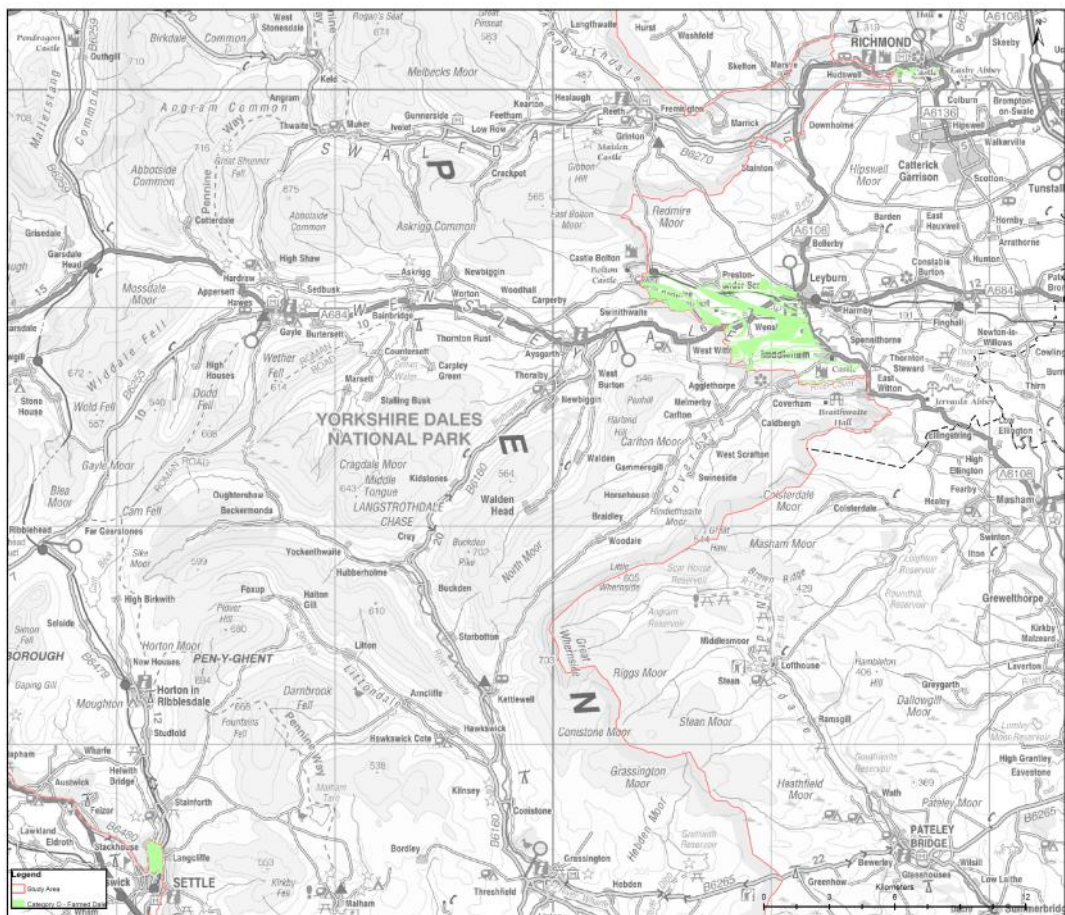


Figure 8.15 Geographical coverage of Category O

- 8.76 Category O comprises that part of the Carboniferous Limestone resource which occurs within the valley floor of Wensleydale, to the south and west of Leyburn, and in a smaller area on the northern outskirts of Settle (ref Figure 8.15). Together, these areas cover 1074 hectares, of which approximately 28 hectares (2.58%) are covered by applications for mineral working, to the west of Leyburn.
- 8.77 Landscape characteristics are typical of LCT 9 Farmed Dale which comprises 100% of Category O (ref table 8.3).
- 8.78 The Category is further characterised by some particular environmental sensitivities (refer to Table 7.15 and to CBA 2011) and includes: numerous features constructed from



vernacular materials including walls and barns; there is a strong sense of tranquillity and of unity within the landscape due to the use of locally sourced building materials and vernacular designs; high visual connectivity with adjacent moors and fells, with key views of the three peaks of Ingleborough, Wharfedale and Pen-y-gent and patchworks of species rich meadows and pastures of national importance. Localised significant archaeological landscapes reflect the mainly pastoral usage of the upland area that has allowed the survival of upstanding and buried remains.

8.79 It is judged that the nature and extent of these sensitivities is such that it is unlikely that further mineral workings are capable of being accommodated within this geographical area. Specific impacts are dependent upon detailed considerations of location of proposed workings and subsequent design, mitigation and management proposals.

8.80 The range of sensitivities identified in relation to the extent of the area covered suggests that Category O has low relative capacity of absorbing further mineral workings.

## Summary

8.81 The following table summarises the general relative capacity ratings based on a qualitative approach to assessment but also identifies considerations for specific sites. This reinforces the point made at the beginning of this chapter which explains that these assessments are applicable to the area of each Category generally but that, with further research and detailed investigation, there are specific areas within each Category where landscape, ecology, archaeology or geology are more significant than others.

Land Category	Capacity Assessment rating	Comment re considerations for specific sites
A	Medium	Particular issues: green infrastructure - riparian habitats, deep buried archaeology
B	Low	Industrial archaeology and high amenity value of the Nidderdale AONB
C	Medium	Settled nature of valleys and existing land use limits mineral development options
D	Low	High ecological value and history of human activity. Cumulative impact of further minerals development
E	Medium to High	Identified areas of high value but likely mineral opportunities

		within large area of mineral resource currently unexploited
F	Medium	Mature landscape, evidence of long history of human activity will limit opportunities
G	Low to Medium	Tranquil historic landscape and ecological value. Good crop mark visibility
H	Low	Significant known archaeological resource, potential for extraction linked to management of the archaeological landscape
I	Low	Urban/suburban fringes of towns.
J	High	Opportunities for landscape restoration, but low archaeological site visibility means may conceal potential sites
K	Low	Open landscape and high archaeological sensitivity across this category
L	Low	High ecological and landscape sensitivity
M	Low	High archaeological and ecological value within this limestone landscape
N	Low	Open and remote moorland – an archaeological landscape of great antiquity with high ecological value
O	Low	High landscape value

Table 8.4 summary showing relative capacity of each Category for mineral extraction

## 9. Conclusions

- 9.1 The Stage 3 work has brought together information gathered in Stages 1 and 2 of the project in a way which has allowed sensitivities to and broad capacities for, future mineral extraction in North Yorkshire to be assessed.
- 9.2 In developing the methodology for this work, it was recognised that the depth of information available across different aspects of the environment would make it impossible to produce a detailed assessment of either sensitivity or capacity, and a much broader, strategic, scenario-based approach has therefore had to be taken. This has focused on the intrinsic vulnerability of the environment to the impacts likely to be associated with mineral extraction, and has concentrated on the 'special sensitivities' of different areas, as indicated by known aspects of their landscape character, historic environment and natural environment features. This is in recognition of the fact that most sensitivities will require site-specific detail in order to be properly assessed and that, for a strategic study such as this, it is only the 'special' or outstanding aspects of sensitivity which can be distinguished, as a basis for guiding future planning recommendations.
- 9.3 The sensitivity assessments have been applied to subdivisions of each Area of Surface Mineral Resource Potential (ASMRP), divided on the basis of Landscape Character Type. They have also been applied to groupings of areas (referred to here as Land Categories) which have similar, predominant environmental characteristics, and to which common planning approaches might be able to be developed. These categories, which sometimes incorporate two or more different mineral types within a particular topographic or environmental setting, have been used as the basis for the broad assessment of capacity.
- 9.4 Environmental capacity is generally regarded as the inverse of sensitivity: the greater the sensitivity of a particular area to a specific type of development then, other things being equal, the lower the capacity of that area will be to accommodate further impacts from such development.
- 9.5 However, capacity is also affected by a number of other factors: the specific nature of the sensitivities compared with the likely impacts of the proposed development; the size of the area compared with the scale of potential impacts; the extent to which the area has already been affected by previous extraction and associated reclamation schemes; and the potential to mitigate the likely effects of future mineral extraction, including cumulative effects within a given area. The potential complexity of interactions between these factors makes it difficult to define capacity with any degree of confidence in any particular case, particularly within the context of a strategic level study such as this. The approach used in this report

is therefore intended to represent only a starting point for the consideration of capacity and the findings are, of necessity, very generalised.

- 9.6 Various assumptions were made as part of the capacity assessment, as summarised below. A Land Category covering a large area is more likely to provide greater scope to identify locations of lower sensitivity where future mineral working can take place, than one which covers a small area. Likewise, Land Categories, or parts thereof, which have already experienced mineral extraction, will have reduced capacity for further extraction, compared with areas of unworked resources elsewhere.
- 9.7 The assessment has produced relative capacity ratings for each Land Category. Whilst these qualitative judgements provide a very broad indication of areas which may be more capable than others of accommodating future mineral extraction, they are not definitive and should be used only as a general guide. It is also important to emphasise that the judgements are *relative* to the other categories, rather than being absolute. Moreover, a high, medium or low rating for any given category does not imply that all areas within that category are assessed at that level of capacity: there will always be significant variations from one location to another. High capacity overall does not mean there would be no sensitivities to address, either within the category as a whole or at any individual site. Equally, low capacity does not mean that there are no prospects for future extraction. In all cases there is an overriding need for site-specific assessment in much more detail than has been possible in this high-level, strategic study.
- 9.8 Originally Stage 3 also included the development of an Environmental Research Framework for each ASMRP. It was concluded through various workshops that this will now be included in Stage 4 as it informs recommendations for planning.

## 10. References Cited

Archaeological Planning Consultancy website (listing numerous individual reports):

<http://www.archaeologicalplanningconsultancy.co.uk/thornborough/reports.php>

Archaeoscope (2008): ***Nosterfield Environs Report***,

Atherden M, (1998): ***The vegetation history of Yorkshire: A bog-trotter's guide to God's own county***. Naturalist, 124 1999 137-158

Atherden M, (2003): ***Vegetation History***, in Butlin R A (ed) *Historical Atlas of North Yorkshire* 26-27

Atkinson, R J C, Piggott, C M, and Sandars, N K, (1951): ***Excavations at Dorchester, Oxon***. Oxford

Barclay, A J, Gray, M and Lambrick, G, (1995): ***Excavations at the Devil's Quoits, Stanton Harcourt, Oxfordshire, 1972-3 and 1988***. Thames Valley Landscapes: the Windrush Valley 3, Oxford

Bedfordshire County Council (December 2008): ***Environmental Sensitivity Assessment, South Bedfordshire Growth Area, Final Report***

Bridgland, D.R. (1985): ***The Pleistocene History of the Middle Thames Valley***, Cambridge University Press. 155pp

Bridgland, D.R. (1994): ***Quaternary of the Thames***, Geological Conservation Review Series, No. 7, Chapman and Hall, London, 441pp

Bridgland D, R, Horton B P, and Innes J, B, (1999) ***The Quaternary of North-East England Field Guide***. Quaternary Research Association.

Bridgland, D. R., Innes, J., Long, A. and Mitchell, W. (editors) (2011): ***Late Quaternary Landscape Evolution of the Swale-Ure Washlands, North Yorkshire***. Oxbow Books, Oxford.

BRIG (ed. Maddock, A.) (2008): ***UK Biodiversity Action Plan; Priority Habitat Descriptions (updated July 2010)***. [http://jncc.defra.gov.uk/PDF/UKBAP\\_PriorityHabitatDesc-Rev2010.pdf](http://jncc.defra.gov.uk/PDF/UKBAP_PriorityHabitatDesc-Rev2010.pdf) (Updated July 2010)

Brightman, J and Waddington, C (2010) ***Aggregates and Archaeology in Derbyshire and the Peak District*** Bakewell, Archaeological Research Services Ltd

Bouhey, KJS, and Vickerman, EA, (2003): ***Prehistoric rock art of the West Riding***, Yorkshire Archaeology, 9, 177

Brannigan, K. & Dearne, M.J. (1991): ***A Gazetteer of Romano-British Cave Sites and their Finds***. Department of Archaeology and Prehistory, University of Sheffield

Brown, F, Howard-Davis, C, Brennand, M, Boyle, A, Evans, T, O'Connor, S, Spence, A, Heawood, R, and Lupton, A, (2007): ***The archaeology of the A1(M) Darrington to Dishforth DBFO road scheme***, Lancaster

Bush M, B, (1993): **An 11,400 year palaeoecological history of a British chalk grassland**. Journal of Vegetation Sciences **4** 47-66

Bush M, B, and Flenley J, R, (1987) **The age of the British chalk grassland**. Nature, **329** 434-436

Butlin, RA (2003) **Historical Atlas of North Yorkshire**

Capita Symonds (2005) **UK Biodiversity Action Plan: Lowland Raised Bogs – Identification of Sites for Remediation in England and Options for their Restoration**, Capita Symonds Ltd, East Grinstead (38 pp)

Cheshire County Council Historic Environment Team (2007): **The Cheshire Historic Landscape Characterisation** Cheshire County Council and English Heritage

Chris Blandford Associates (2004): **Thames Gateway Historic Environment Characterisation Project** English Heritage, Kent County Council and Essex County Council

Chris Blandford Associates (2011): **North Yorkshire and York Landscape Characterisation Project**. Final Report to North Yorkshire County Council (May 2011) 244pp.

Cooke, L. (2011): **Vale of Pickering: Statement of Significance** Landscape Research Centre, Yeddingham (unpublished document, August 2011).

Cornwall Council (2010a): **Historic Landscape Character and Sensitivity Mapping for photo voltaic (solar farms) installations in Cornwall**.

Cornwall Council (2010b): **Historic Landscape Character and sensitivity for wind farm Installations in Cornwall**.

Darvill, T. and Fulton, A. (1998): **The Monuments at Risk Survey of England 1995**. London: Bournemouth University and English Heritage.

Dickson, A & Hopkinson, G, (2011): **Holes in the landscape: seventeen years of archaeological investigations at Nosterfield Quarry, North Yorkshire**, <http://www.archaeologicalplanningconsultancy.co.uk/thornborough/nos.php>

English Heritage (2006a): **Historic Farmsteads Preliminary Character Statement: Yorkshire & The Humber Region**

English Heritage (2006b): **The Humber Wetland Survey: Vale of York Region project**

English Heritage (2008a): **Mineral Extraction and the Historic Environment** (19pp)

English Heritage (2008b): **Conservation Principles: Policies and Guidance for the Sustainable Management of the Historic Environment** English Heritage April 2008

English Heritage (2011): **Seeing the History in the View: a method for assessing heritage significance within views**. English Heritage May 2011

- English Heritage (draft, 2011): ***Using Historic Landscape Characterisation (HLC) to Assess Sensitivity to Change.***
- English Nature (2004): ***Action for Floodplain Diversity.*** English Nature, Peterborough (10pp)
- Fenton-Thomas, C., (2005): ***The Forgotten Landscapes of the Yorkshire Wolds.***
- Fletcher, M, (1987): ***Cheetham Close: A Bronze Age Complex in Bolton,*** Greater Manchester Archaeol J, **3**, 19-25.
- Foster, S. W. (1987): **The dry drainage system on the northern Yorkshire Wolds.** In: Ellis, S (ed) *East Yorkshire Field Guide.* Quaternary Research Association 36-38
- Fuller, R.M. (1987): ***The changing extent and conservation interest of lowland grasslands in England and Wales: a review of grassland surveys 1930-84.*** Biological Conservation, 40, 281-300.
- Gibbard, P. L. (1985): ***The Pleistocene history of the Middle Thames Valley.*** Cambridge University Press. (155pp)
- Gill, A. (1993): ***The Grassington Mines,*** Northern Mines Research Society, **46**, Keighley
- Grant, A. in association with Clarke, P. and Lynch, S.(2010): ***Landscape capacity studies in Scotland – a review and guide to good practice.*** Scottish Natural Heritage Commissioned Report No.385
- Hampshire County Council (2004) ***Assessing Landscape Sensitivity at a Strategic Level: A Description of Methodology.*** Hampshire County Council
- Houghton, C., and Powlesland, D.J. (1999): ***West Heselton - The Anglian Cemetery. Volume 1: The Excavation and Discussion of Evidence.*** English Heritage (197pp)
- Herefordshire Council (2002): ***Landscape Character Assessment.*** Supplementary Planning Guidance.
- Hey, G, (2004): ***Yarnton: Saxon and medieval settlement and landscape,*** Thames Valley Landscapes Monograph **20**, Oxford
- Hey, G, (ed) (in prep) ***Yarnton: Neolithic and Bronze Age settlement and landscape,*** Thames Valley Landscapes Monograph, Oxford
- Hey, G, Booth, P and Timby, J. (2011): ***Yarnton: Iron Age and Roman settlement and landscape,*** Thames Valley Landscapes Monograph **35**, Oxford
- Hey, G, Garwood, P, Robinson, M, Barclay, A, and Bradley, P. (2011): ***The Thames through time: the archaeology of the gravel terraces of the upper and middle Thames. Volume 1:2: the Mesolithic, Neolithic and early Bronze Age,*** Thames Valley Landscapes Monograph **32**, Oxford
- Hibbert F, A and Switsur V, R, (1976): ***Radiocarbon dating of Flandrian pollen zones in northern England.*** New Phytologist, **77**, pp793-807

- Howard, A.J., Whyman, M., Challis, K. and McManus, K.B. (2008): ***Recent work on the geomorphological and archaeological landscape of the Vale of York***. In Atherden, M. and Milsom, T. (eds) *Yorkshire Landscapes Past and Present*. PLACE, York. pp. 69-76.
- Howard A J, Macklin M G, Black S, and Hudson-Edwards K (2000): ***Holocene river development and environmental change in upper Wharfedale, Yorkshire Dales, England***. *Journal of Quaternary Science* 15 239-252
- Howard-Davis, C, (1996): ***Seeing the sites: Survey and excavation on the Anglezarke Uplands, Lancashire***, *Proc Prehist Soc*, **61**, 133-66
- Ilkley Archaeology Group (1986): ***The carved rocks on Rombalds Moor***. Wakefield
- Innes J, B, Blackford J, J and Simmons I, G, (in press, 2012) ***Mesolithic environments at Star Carr, the eastern Vale of Pickering and environs: local and regional contents***.
- Johnson, D. (2002): ***Limestone industries of the Yorkshire Dales***, Stroud
- Johnson, D. (2004): ***Excavation of Broadwood Enclosure, Thornton in Lonsdale, North Yorkshire: report on the excavation of a Romano-British enclosure and 17th-century lime kiln***. Ingleton
- Joint Officer Working Group (2005): ***Strategic Landscape Sensitivity- summary of discussion at Peer Group Workshop, Reading, 20<sup>th</sup> July 2005***. Hampshire County Council (22pp)
- Kershaw, A. (2001): ***Vale of York National Mapping Programme Project Review***. English Heritage.
- Lambrick, G, (2009): ***The Thames through time, the archaeology of the gravel terraces of the Upper and Middle Thames: the Thames Valley in late prehistory: 1500 BC-AD 50***, Thames Valley Landscapes Monograph **29**, Oxford
- Lambrick, G, and Allen, T, (2004): ***Gravelly Guy, Stanton Harcourt, Oxfordshire: the development of a prehistoric and Romano-British community***, Thames Valley Landscapes **21**, Oxford
- Land Use Consultants (2003): ***South West Renewable Energy Strategy: Using Landscape Sensitivity to set Draft Targets for Wind Energy***. Unpublished report to the Government Office for the South West.
- Land Use Consultants (2005): ***Yorkshire and The Humber Regional Spatial Strategy: Historic Environment Study***, Prepared for English Heritage, Yorkshire and the Humber Historic Environment Forum and Yorkshire and the Humber Regional Assembly.
- Land Use Consultants (2007): ***Phase 2 Sand And Gravel Study for Yorkshire and Humber: Appraisal of Apportionment Options***.
- Land Use Consultants (2011): ***An Assessment of the Landscape Sensitivity to On-shore Wind Energy and Large Scale Photovoltaic Development in Cornwall*** (Land Use Consultants and Cornwall Council)



Landscape East and Land Use Consultants (June 2011): ***Guidance on Assessing Sensitivity of the Landscapes of East England***

Lee, G, and Vyner, B, (1995): ***Managing the archaeology of the North York Moors National Park***, CBA, York.

LUAU (1997): ***Nenthead Lead Mines, Cumbria: Report on Archaeological Recording***, unpubl rep

LUAU (2000): ***Cheetham Close, Turton, Lancashire: Archaeological Survey***, unpubl rep

McEvoy, et al., (draft, 2004): ***Yorkshire and Humber Regional Aggregates Working Party: Sand and Gravel Study. British Geological Survey Commissioned Report***, XX/00/00. (31pp).

Manby TG, Moorhouse S & Ottaway, P (2003) ***The Archaeology of Yorkshire: An Assessment at the Beginning of the 21st Century***. YAS Occasional Paper 3.

MAP Archaeological Consultancy Ltd. (1992): ***Proposed Malton to Rillington Pumping Main***, unpubl rep

MAP Archaeological Consultancy Ltd. (1993): ***Excavations along the Malton to Rillington Pumping Main***, unpubl rep

Menuge N, (2001): ***A Guide to the Wetland Heritage of the Vale of Pickering***

Menuge N, (2003): ***Drainage and wetland sites in the Vale of Pickering*** in Butlin R A (ed) *Historical Atlas of North Yorkshire* 157-158

Minerals Historic Environment Forum, (2008): ***Mineral Extraction and Archaeology: A Practice Guide***. (30pp)

Morgan Jones, W. J., Poole, J. S. & Goodall, R. (2005): ***Characterisation of Hydrological Protection Zones at the Margins of Designated Lowland Raised Peat Bogs***. JNCC Report 365 (87pp).

Natural England (2009): ***Green Infrastructure Guidance***. (97pp)

Oxford Archaeology North (2009a): ***Upland Peats Managerial Assessment - Final Report***, unpubl rep

Oxford Archaeology North (2009b): ***Little Asby Scar and Sunbiggin Tarn Common, Eden District, Cumbria***, unpubl rep

Peacock, C. (2003): ***Rivers, Floodplains and Wetlands - Connectivity and Dynamics*** (RSPB, Sandy, Bedfordshire (64pp)

Phillips, A.D.M. and Phillips, C.B. (eds.) (2002): ***A New Historical Atlas of Cheshire***. Cheshire County Council.

Porter, j, Swanwick, C, Simpson J. (2008): ***East Midlands Regional Landscapes Scoping Study Final Report***. East Midlands Regional Assembly/Natural England.

- Powlesland, D., Lyall, J. and Donoghue, D., (1997): ***Enhancing the record through remote sensing: the application and integration of multi-sensor, non-invasive remote sensing techniques for the enhancement of the Sites and Monuments Record. Heslerton Parish Project, N. Yorkshire, England.*** Internet Archaeology 2  
(<http://intarch.ac.uk/journal/issue2/pld/index.html>)
- Powlesland, D.J. (2000): **West Heslerton: Aspects of Settlement Mobility**, Oxbow Books, Oxford.
- Powlesland, D.J. (2003): **25 years of archaeological research on the sands and gravels of Heslerton.** Landscape Research Centre, Yedingham (48pp).
- Powlesland, D., Lyall, J., Hopkinson, G., Donoghue, D., Beck, M., Harte, A. and Stott, D. (2006): ***Beneath the sand—remote sensing, archaeology, aggregates and sustainability: a case study from Heslerton, the Vale of Pickering, North Yorkshire, UK.*** Archaeological Prospection. Vol 13 No. 4 pp 291-299.
- Powlesland, D.J. (2011): ***Identifying the Unimaginable - Managing the Unmanageable.*** In Cowley, D.C. (Ed): *Remote Sensing for Archaeological Heritage Management*. EAC Occasional Paper No. 5. (Proceedings of the 11th EAC Heritage Management Symposium, Reykjavik, Iceland, 25-27 March 2010).
- Quartermaine, J. (1995): ***Victoria and Albert Caves, North Yorkshire, Archaeological Survey***, unpubl rep
- Raistrick, A. (1934): ***Cup and Ring marked rock of West Yorkshire.*** Yorkshire Arch J, 32
- Raistrick, A. & Jennings, B. (1965) (repr 1989): ***A History of Lead Mining in the Pennines***, Littleborough
- Richards, C, (1996): ***Henges and Water, Towards an Elemental Understanding of Monumentality and Landscape in Late Neolithic Britain***, J Material Culture, 1.3, pp. 313-36
- Roberts, I, Deegan, A. & Berg, D, (2010): ***Understanding the cropmark landscapes of the Magnesian Limestone: the archaeology of the Magnesian Limestone and its margins in South and West Yorkshire and parts of North Yorkshire and north Nottinghamshire***, English Heritage/Archaeological Services WYAS
- Roe, M. (2003): ***Lead Mining Archaeology in the Yorkshire Dales.*** Landscapes, 4.1, 65-78
- Roskams, S and Whyman, M (2005) ***Yorkshire Archaeological Research Framework – draft resource assessment report*** (unpublished)
- Scottish Natural Heritage and the Countryside Agency (2002): ***Landscape Character Assessment - Guidance for England & Scotland. Topic Paper 6: Techniques and Criteria for Judging Capacity and Sensitivity*** (19pp).
- Spratt, DA, (ed) (1982): ***Prehistoric and Roman archaeology of North-East Yorkshire***, BAR, Oxford

Staffordshire County Council (1999): **Planning for Landscape Change**. Supplementary Planning Guidance to the Stoke on Trent and Staffordshire Structure Plan.

Stoertz, C (1997): **Ancient Landscapes of the Yorkshire Wolds** (Royal Commission on the Historical Monuments of England)

Strickland, TJ (2001) **Roman Middlewich: A story of Roman and Britain in Mid Cheshire**

Symonds Group (2004) **Humberhead Peatlands Restoration: Hydrological Review and Assessment of Drainage Capacity at Thorne Moors**, Symonds Group Ltd, East Grinstead (34 pp).

Thames Landscape Strategy: Riverside Wildlife (<http://thames-landscape-strategy.org.uk/biodiversity>)

Thompson, A., Hine, P., Greig, J.R., and Peach, D.W., (1996): **Assessment of Subsidence Arising from Gypsum Dissolution, with particular reference to Ripon, North Yorkshire**. Department of the Environment. Symonds Travers Morgan, East Grinstead. (288pp).

Thompson, A., Hine, P., Peach, D.W., Frost, L. and Brook, D., (1998): **Subsidence Hazard Assessment as a Basis for Planning Guidance in Ripon**. In Maund, J.G. & Eddleston, M. (eds) **Geohazards in Engineering Geology**. Geological Society, London, Engineering Geology Special Publications, **15**, pp 415-426.

Thompson, A.; Howarth, C.L.; Goodwin, A.; Buckley, C; and Harris, K. (2008): **Good Practice Guidance on Controlling the Effects of Surface Mineral Working on the Water Environment**. Report to the Department of Communities and Local Government, and the Mineral Industry Research Organisation. Capita Symonds Ltd, East Grinstead. (207 pp plus Appendices).

Thompson, A., Knapman, D., Harris, K., Birch, J. and Jarvis, D. (2010): **An Ecosystems Approach to Long Term Minerals Planning in the Mendip Hills. Phase II Final Report**. Report to Defra and the Minerals Industry Research Organisation. Published by Capita Symonds Ltd., East Grinstead. (40pp + appendices)

Trueman, D. & Quartermaine, J. (1993): **Mealbank quarry and Hoffman kiln, Ingleton, North Yorkshire**, Unpubl rep

Wheeler, B.D. & Shaw, S.C., (2000): **A Wetland Framework for Impact Assessment at Statutory Sites in Eastern England**. Environment Agency R&D Technical Report W6-068/TR1.

Wheeler, B.D., Gowing, D.J.G., Shaw, S.C., Mountford, I.O., & Money, R.P. (2004): **Eco-hydrological Guidelines for Lowland Wetland Plant Communities** (Eds. Brooks, A.W., Jose, P.V. and Whiteman, M.I.). Environment Agency (Anglian Region).

Whittle, A, Atkinson, R J C, Chambers, R, and Thomas, N, (1992): **Excavations in the Neolithic and Bronze Age complex at Dorchester-on-Thames, Oxfordshire, 1947-1952 and 1981**, Proc Prehist Soc **58**, 143-201

Whyman, M & Howard, AJ (2005) ***Archaeology and Landscape in the Vale of York***  
<http://www.yorkarchaeology.co.uk/resources/voy-web.pdf>

Wightman W, R, (1968) ***The pattern of vegetation in the Vale of Pickering area c. 1300 AD.***  
Transactions of the Institute of British Geographers, **45** 125-142

Worcestershire County Council (2003): ***County Wide Assessment of Landscape Sensitivity***  
(unpublished paper).

WS/Atkins (2000): ***A64 Improvements: - Rillington Bypass Stage 2 Scheme Assessment Report,***  
unpubl rep

WS Atkins (2006): ***Saltaire World Heritage Site Environmental Capacity Study (Summary).*** Atkins  
and CBMDC

Yorkshire & Humber Biodiversity Forum (1999): ***A Biodiversity Audit of Yorkshire and the Humber.***

Yorkshire & Humber Biodiversity Forum (2009): ***Yorkshire and Humber Regional Biodiversity  
Strategy*** (63pp)

Younger P, L, and McHugh M, (1995) ***Peat development, sand cones and palaeohydrogeology of a  
spring-fed mire in East Yorkshire.*** The Holocene, **5**: 59

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