SECTION 3

FOUNDATIONS OF THE EAST MIDLANDS LANDSCAPE

River Nene near Woodford, Northamptonshire (© River Nene Regional Park/M Williams)

3.1 INTRODUCTION

The diversity of the region's landscape is a result of the complex interplay of a wide range of physical and cultural influences.

The geological structure of the East Midlands, including the range of geological formations and superficial deposits that are present, and the effects of geomorphological processes are the principal factors in determining the character and diversity of the region. In addition to shaping the physical and hydrological structure of the region, this geodiversity has also had a significant effect in influencing the region's economy, patterns of settlement, industrial and cultural heritage and the way that the land has been used for thousands of years. The distribution of mineral resources has influenced the range and distribution of primary industries, while the built character of the region's towns and villages, as well as the range of wildlife habitats and farming regimes can all be attributed, to varying degrees, to these variations in the underlying geology. Section 3.2 describes the main physical influences on the landscape and presents an overview of the region's main land use types.

There is evidence of millennia of human interventions shaping the character of the region's landscape. The generally open character of the landscape has its origins in the prehistoric clearance of native woodland and the ongoing management of natural resources. The patterns created, for example, by hedges, farmed land, common grazing and woodland were all probably in place by the medieval period, as were the principal settlements and communications routes across the uplands and along the river valleys. Six millennia of changes in social organisation and in the concept of land ownership and control are also etched into the landscape; visible in the patterns created for example by hedges, walls and tracks. To the trained eye it is possible to see evidence of communal, perhaps family or clan based territories of the Neolithic period, private estates surrounding Roman villas, the communally farmed open fields of the early medieval period and the private and parliamentary enclosures of more recent centuries. In many instances ancient boundaries continue to mark territories and different land ownerships.

It is onto this ancient framework that change since the Industrial and Agricultural revolutions of the 18th and 19th centuries has had an increasingly dramatic influence on the character of the region's landscape. The rapid growth of cities and towns such as Derby, Leicester, Lincoln, Nottingham and Northampton, together with the consolidation of transportation routes, such as canals, rivers, roads, railways and airports have all had a major influence on the landscape, as well as wider perceptions of landscape quality, tranquillity and remoteness. In the countryside, two centuries of profound change in agriculture, forestry, recreation and the growth of the rural economy have had an equally significant impact on the character of the rural landscape.

Section 3.3 presents a summary of the main episodes of cultural change in the region, as well as key locations in the region to see this evidence. In recognition that landscape is dynamic and continues to evolve, Section 3.4 presents a brief overview of the main forces for change acting on the landscape.

3.2 PHYSICAL INFLUENCES

The geological structure of the East Midlands region, and the juxtaposition and succession of rocks, is fundamental to the form and structure of the landscape. While the underlying bedrock geology is responsible for the principal pattern and elevation of the landform, the different responses of the various rock strata to the effects of weathering processes and erosion have altered the form of the landscape, influenced drainage and soils, and in turn the subsequent patterns of vegetation, land cover and land use. Many of these impacts are not felt in the short term but may take several generations, if not longer to affect the landscape.

The deposition of superficial material during the most recent Quaternary era, such as sands, and gravels, till (predominantly represented as boulder clay) and alluvium, has also been particularly important in moulding and modifying landform patterns. As a consequence, the underlying bedrock is sometimes entirely obscured by extensive superficial deposits.

Sites recognised for their geological importance are preserved as protected Sites of Special Scientific Interest (SSSI) and as Regionally Important Geological and Geomorphological Sites (RIGS) / Local Geological Sites. Currently, however, the latter have no protection.

3.2.1 GEOLOGY AND LANDFORM

Simplified Bedrock Geology is illustrated on Figure 5. Simplified Superficial Geology is illustrated on Figure 6. Landform is illustrated on Figure 7.

Introduction

The East Midlands region lies within a broad belt of sedimentary rocks that dip gently east and south eastwards from the Pennine axis within Derbyshire towards Lincolnshire and the North Sea basin. Rocks ranging in age from the Precambrian to Cretaceous periods form a series of broadly north south aligned rock formations with progressively younger rocks outcropping towards the east. There are very limited outcrops of rocks from the Tertiary Period. In addition to these sedimentary rocks, more isolated areas of igneous rocks are also present, the most significant occurring in Leicestershire. Finally, this bedrock geology is masked in many areas by a range of superficial deposits laid down in the most recent geological Period, the Quaternary.

Relationship with Landform

The landform and 'topographical grain' of the East Midlands Region is inextricably linked to the underlying geological structure and effects of various past climatic variations, periods of tectonic activity, orogenies and marine transgressions that have occurred during the successive geological eras, as well as the characteristics of the rock formations and their differential responses to erosion. In addition to the effects of the deposition of superficial deposits in the Quaternary Period, the existing landform pattern continues to be modified by the effects of macro and micro geomorphological processes. In view of the close relationship between

geology and landform, the principal landform characteristics of the region are described below in association with the geology.

Geological Periods and Rock Successions

Precambrian (600-543 million years ago [Ma]

The Precambrian period commenced with the formation of the earth but rocks local to the East Midlands date from around 600 to 543 million years ago. These are not only the oldest rocks in the regionbut also some of the oldest in England and Wales. Most of the Charnian rocks are volcaniclastic sedimentary rocks, composed of igneous material – volcanic ash and lava blocks. They were deposited in seas surrounding the volcanoes, a good modern analogy being the island of Montserrat in the Caribbean. Precambrian geology, which only occurs within Charnwood Forest, gained international fame when, in 1957, a schoolboy discovered a primitive fossil in the ancient volcanic rocks. Named *Charnia masonii*, and of a still obscure biological affinity, the fossil was the first evidence found in the world that primitive life forms existed in Precambrian times, and marks a major benchmark in palaeontological and evolutionary thought. The rocks of Charnwood Forest have long been quarried for aggregates and used as building stones.

Cambrian (543-495 Ma)

The youngest rocks in Charnwood Forest are now thought to be of Cambrian age, following the discovery of fossil burrows on gravestones. They comprise mainly marine mudstones that have been cleaved and metamorphosed to slate. These Swithland Slates once formed a major industry in the area, producing roofing slates and grave stones that can be seen on many buildings and in churchyards in and around Charnwood Forest.

Ordovician (495-443 Ma)

During the Ordovician, a new subduction zone formed where England lay, and large magma chambers formed at depth. The molten magma cooled slowly to form coarse grained igneous rocks called granodiorites, now seen at the surface at Mountsorrel and Croft in south Leicestershire.

No rocks from the succeeding Silurian and Devonian periods are now preserved within the region but a major episode of mountain building occurred, the Arcadian orogeny. This raised up the Precambrian rocks into a mountain range, metamorphosing the rocks and producing the cleavage well seen in the Swithland Slate.

Limestone outcrop at Breedon on the Hill (© English Heritage/J Humble)

Carboniferous (355-290 Ma)

By the start of the Carboniferous, England was joined with Scotland for the first time. In the west and north of the region, within Derbyshire, the outcrop of the massive Peak Limestone Group (Carboniferous Limestone Supergroup) forms a broad structural dome with the prominent limestone plateau of the White Peak at the core of this upland area. Differing depositional conditions in the sub-tropical sea in which the limestone was laid down in have resulted in two distinct limestones. The main limestone is a pale grey and thickly bedded shelf limestone that forms the elevated plateau to the south of Castleton. The landform in this area comprises a pastoral upland

plateau dissected by steep-sided limestone valleys (dales), with cave systems locally developed. In contrast, a darker grey basin limestone occurs around the Manifold Valley in the south west of the outcrop. Barrier reefs also developed on the margins of the shelf and these are represented as a hard and fine grained limestone that is particularly resistant to weathering and evident as conical hills known as reef knolls. Notable examples of isolated reefs occur in the Dove Valley such as the hills of Thorpe Cloud and Parkhouse Hill.

Currently, there are 29 working quarries in the limestones of Derbyshire, mainly working aggregate but some working for building stone or lime.

In the Derby area, the youngest rocks of early Carboniferous age (Widmerpool Formation) consist predominantly of mudstones with thin limestones and sandstones. They were deposited in a deep basin, the Widmerpool half-graben. Very limited outcrops of Carboniferous Limestone also occur in Leicestershire and South Derbyshire such as at Breedon Hill, Cloud Hill and Ticknall. These areas have been extensively quarried for their limestone. Surrounding this core of limestone in a horseshoe shape is the younger Millstone Grit Group. These rocks were deposited in a coastal environment with large river deltas building out into the shallow marine waters and forming massive coarse sandstones interbedded with mudstones. The alternating layers of mudstone and sandstone can be observed in the face of Mam Tor where sands had cascaded down the front of the delta. Like the Peak Limestone, the Millstone Grit sandstones are also resistant to erosion and form the upland 'gritstone' moors area of the Dark Peak, as in the Kinder Plateau. They also form distinctive escarpments such as Stanage Edge, Curber Edge and Froggat Edge along the eastern fringe of the Peak District. A small inlier of Millstone Grit occurs around Melbourne in South Derbyshire.

The Millstone Grit is succeeded by the Upper Carboniferous Pennine Coal Measures Group, laid down in low lying swampy deltas with rain forests, when England was on the equator, these comprise a succession of coal seams, formed from the compressed remains of the rich forest and swamp vegetation, interbedded with mudstones, sandstones, seat earths and ironstones. The principal outcrop in the region forms a broad swathe of undulating land with a recurring pattern of hills, ridges and shallow valleys that extends northwards from Derby and Nottingham to the northern perimeter of the region. A smaller outcrop is present in the vicinity of Swadlincote, Ashby de la Zouch and Coalville forming the Leicestershire and South Derbyshire Coalfields. There are small outliers of Pennine Coal Measures around Melbourne. As well as coal mining, pottery formed a major industry in parts of the region.

Mam Tor near Castleton, Derbyshire (© English Heritage/J Humble)

Escarpment at Froggat Edge near Calver, Derbyshire (© English Heritage/J Humble)

Permian (290 - 250 Ma) and Triassic (250 - 205 Ma)

The succeeding Permian period is mainly represented in the eastern side of Derbyshire and also extending into Nottinghamshire, with small areas of rocks of presumed Permian age in parts of north west Leicestershire. Laid down in the shallow and extensive landlocked Zechstein Sea, a magnesium rich limestone (dolostone) was deposited that now forms the Cadeby Formation ('Magnesian Limestone') outcrop. This porous and hard limestone forms a dramatic elevated ridge and west facing escarpment for much of the length of its outcrop, for example Bolsover Castle. River erosion has also resulted in the creation of steep valleys and gorges such as at Cresswell Crags and Pleasley Valley on the Derbyshire and Nottinghamshire border. The Cadeby Formation has been extensively worked as a building stone.

In the Triassic Period that followed, the arid desert-like conditions that prevailed resulted in the oxidation of iron compounds, so the succession of sandstones, breccias and mudstones that were laid down share a characteristically red colouration. The Early Triassic Sandstones and conglomerates of the Sherwood Sandstone Group were deposited by a major river flowing northwards across much of England from northern France. They form moderately elevated and undulating ground in parts of Leicestershire and between Nottingham, and Sherwood Forest where the acid soils support heathland and oak-beech woodland as well as the more recently planted coniferous plantations. This sandstone is a major aquifer and source of water supply for the East Midlands. Following this is the broad outcrop of the Mercia Mudstone Group of Middle and Upper Triassic age. This rock formation is derived from windblown dust that settled into shallow saline lakes and mudflats within an extensive alluvial plain, with deposits up to 300m thick. It was periodically inundated by flash floods that deposited thin beds of siltstone and sandstone. A major fluvial interval occurred in the Late Triassic, depositing the Arden Sandstone Formation. The Mercia Mudstone extends across the western part of Leicestershire, into South Derbyshire and Nottinghamshire, where it forms a lower lying gently undulating landscape, and further north where it underlies the broad Trent valley. The Mercia Mudstone is noted for its gypsum which occurs throughout the sequence. In the upper part of the group, particularly thick sequences occur that have been extensively mined and quarried in Leicestershire and Nottinghamshire. The Mercia Mudstone Group is also extensively quarried for brick making in Leicestershire and Nottinghamshire. Major hills that we see today such as Charnwood Forest, Mountsorrel and Breedon-on-the-Hill, were completely buried by the Triassic sediments.

Jurassic (205-140 Ma)

Within the East Midlands the Jurassic Period is represented as a broad arc of rock formations that extend across the region from the south western perimeter of Northamptonshire, and across the remainder of Northamptonshire, much of the eastern part of Leicestershire and all of Rutland and into Lincolnshire. Jurassic rocks are also present within a limited part of Nottinghamshire, east of the Triassic Mercia Mudstone Vale.

The oldest rock units of the Jurassic Period comprise the Lias Group. These were deposited as layers of mud, lime and sand in a warm, tropical shallow sea that was teeming with life, and which covered much of central England. Generally, this extensive outcrop comprises mudstones with thin beds of limestone, sandstone and ironstone. Because the mudstones are relatively soft and easily eroded they form the lower lying land such as in the Vale of Belvoir and parts of the Trent valley. The Marlstone Rock Formation is a particularly distinctive rock unit within the Lias Group sequence which outcrops in Northamptonshire, Leicestershire and Rutland. Due to its harder character this ironstone often forms an escarpment or capping to the underlying softer mudstones as at the Belvoir Scarp and Laughton Hills in Leicestershire, and the high ground between Caldecott and Uppingham in Rutland. It has been extensively quarried for iron ore and has also been used as a building stone together with sandstone in the underlying Dyrham Formation. The mudstones

within the upper section of the Lias Group, the Whitby Mudstone Formation, cover much of the western side of Rutland and have been worked for bricks at Luffenham and Seaton.

To the east of the Lias Group is the extensive outcrop of marine limestones and mudstones of the Middle Jurassic Inferior and Great Oolite groups. These form part of the extensive stone belt that sweeps south west to north east across England from the Dorset to the North Yorkshire coast. The lowest part of the sequence, the Northampton Sand Formation, was deposited in a shallow marine and estuarine environment. This iron-rich sandstone has been an important source of iron ore, notably in the Corby area, and has also used as a building stone. This is displayed in the many villages within Northamptonshire and Rutland with their distinctive orange brown colour. The overlying Lincolnshire Limestone is an off-white to buff-yellow ooidal limestone. The outcrop is also recognised by its extensive use as a building stone and in the Collyweston Slates near Stamford that has been used since Roman times as a roofing slate. Off-white stones are also clearly visible in ploughed fields. This hard rock gives rise to undulating higher ground and also the west facing escarpment of the Lincoln Edge that overlooks the Vale of Trent. The Lincolnshire Limestone and overlying Great Oolite Group rocks form the raw materials for the cement industry, for example at Ketton near Stamford.

The Great Oolite Group is divided into four formations (the Rutland, Blisworth Limestone, Blisworth Clay and Cornbrash Formations). These varied rocks (limestones and mudstones) were deposited in shallow seas, tidal mudflats, and lagoons and give rise to an undulating landform.

East of the ooidal limestone belt the Upper Jurassic is represented by a succession of softer marine mudstones comprising the Kellaways and Oxford Clay formations, followed by the West Walton, Ampthill Clayand Kimmeridge Clay formations. These softer mudstones run through the central part of Lincolnshire and floor the Vale of Ancholme between the Lincoln Edge limestone ridge to the west and the Lincolnshire Chalk Wolds to the east.

In the northern part of the region the extent of the Jurassic belt is more limited than further south. Here, the width of the outcrop of rocks narrows as the sequence thins and converges on to the Market Weighton Axis in East Yorkshire.

Cretaceous (140 to 65 Ma)

Collyweston Slate used extensively in Stamford, Lincolnshire (© English Heritage/J Humble)

The Cretaceous Period is represented in the extreme east of the region in Lincolnshire. The succession of Cretaceous rocks is linked to the marine sedimentation processes that occurred within the Spilsby Basin, which was separated from the Yorkshire Basin to the north by the Market Weighton Axis, resulting in a sequence of rocks that is particular to this part of the East Midlands Region. The Lower Cretaceous rocks commenced with the Spilsby Sandstone followed by the iron-rich Claxby Ironstone, after which sequences of mudstones, limestones and sandstones were deposited to form the Tealby Formation. A marine transgression laid down the Carlstone Formation, a gritty iron-rich sandstone, followed by the pink limestone of the Hunstanton Formation (Red Chalk). Finally, a further major marine transgression marked the beginning of the Upper Cretaceous with all of England and Wales submerged beneath a warm sub-tropical sea. In Lincolnshire, and eastwards into the area submerged by the North Sea, up to a 500m depth of almost pure limestone, the Chalk, was deposited in four separate formations.

While the eastern part of the Chalk within Lincolnshire is overlain by Quaternary glacial till deposits, and also extends below the North Sea, it is exposed further west to form the greater part of the Lincolnshire Wolds, albeit at a reduced thickness of about 50m. Here it is represented as a distinctive west facing escarpment, particularly in the northern section, and rolling elevated plateau to the east. Where the Chalk has been removed, Lower Cretaceous rocks have been exposed forming a series of secondary ridges and escarpments.

View towards Lincolnshire Wolds from along the New River Ancholme, Lincolnshire (© R Goodison)

Tertiary (65 – 2.6 Ma)

The presence of Tertiary rocks is extremely limited within the East Midlands Region as these deposits have been largely removed through erosion and therefore have no effect on the landform. Some small areas remain however in north west Derbyshire between Longnor and Wirksworth where there are hollows in the Carboniferous Limestone that are filled with silica sand, mudstone and pebble bands, known as 'pocket deposits'. The fossil plants in these beds date to the Late Tertiary (Miocene) and are remnants of river deposits that once covered the area.

Intrusive Igneous Rocks and Tectonic Activity

Although the majority of rock formations in the East Midland Region are of sedimentary origin there are limited outcrops of igneous rocks that give rise to local variations in topography and surface expression.

Intrusive igneous rocks occur in the Charnwood Forest area where at least four periods of intrusion can be recognised. The North and South Charnwood Diorites represent periods of intrusion in the Precambrian. Later intrusions occurred in the Ordovician, when outcrops such as the Mountsorrel Granodiorite and Croft Diorite were formed. Minor dolerite dykes were also intruded in the Carboniferous. These intrusive igneous rocks form the basis for the Charnwood Forest aggregates industry. The quarry at Mountsorrel is one of the largest aggregate quarries in Europe.

The rocks of Charnwood Forest were subjected to considerable folding and uplift during the Silurian, about 420 Ma, during the final stages of the Acadian Orogeny. Once a much higher mountainous area, periods of denudation reduced the mountains to hills and eventually resulted in the core of older rocks being buried beneath softer Triassic deposits. Further denudation in the Cainozoic era has resulted in the exposure of the core of the older rocks so that the isolated hills and craggy peaks, such as Charnwood Forest, rise up above the surrounding Triassic Mudstone plain. The area has been further modified by the more recent cycles of glaciation.

Examples of other limited outcrops of igneous rocks in the region are present in Derbyshire. These date to the Lower Carboniferous Period when volcanic activity on the sea-floor produced lava flows and later intrusions of sills and dykes into the rock sequence, which cooled to form layers of basalt and dolerite. The lava flows are known locally as 'toadstone', and their dark colour is distinctive within the lighter limestone.

Craggy outcrops at Beacon Hill, Charnwood Forest , Leicestershire (© P Wakely)

Quaternary (2.6 – 0Ma)

Superficial Deposits

The bedrock geology is masked in many areas by a wide range of superficial deposits that have been laid down in the Quaternary Period by ice and rivers. The distribution of these unconsolidated deposits is illustrated on Figure 6, Simplified Superficial Geology.

The more recent cycles of Pleistocene glacial periods have had a significant effect on the landscape, culminating in the final, Devensian glaciation that peaked around 30,000 years ago. This ice sheet did not reach the East Midlands but its effects were felt by the melting of the ice sheet which created numerous glacial melt water channels and melting permafrost led to much instability on steep slopes resulting in landslides. The earlier Anglian glaciation, about 440,000 years ago, was responsible for all the glacial deposits found in the region, comprising tills, glaciofluvial and glaciolacustrine deposits. Where glacial till intercepted drainage systems this also resulted in the creation of 'ponded' lake systems and glacial spillways as is evident at Calceby in the south where the headwaters of the Great Eau river backed up and overflowed into the Lymn catchment to form the impressive New England valley near Spilsby.

In the more recent Holocene times after the last ice age, extensive erosion has resulted in much deposition, particularly in river valleys as alluvium and river terrace gravels. Solifluction head deposits occur on valley sides and there are more localised areas of blown sand and peat, most of which are confined to parts of Lincolnshire, notably along the county boundary north of Gainsborough and west of Caistor. Extensive growth of blanket bog peat has occurred in the fens. These superficial deposits have had a significant effect on the landform, particularly at the local scale, and also on drainage patterns and soil characteristics. Some are also an important source of sands and gravels.

The Wash is an extensive inlet of the sea bordering Lincolnshire and the East Midlands region on its western side. Much of the Wash itself is very shallow, with several large sandbanks exposed at low tide, especially along its south coast. Formation of The Wash occurred in the Pleistocene. At the end of the latest glaciation, and while the sea level remained lower than it is today, the rivers Witham, Welland, Glen, Nene, and Great Ouse joined into a large river. The deep valley of the Wash was formed, not by the interglacial river, but by ice of the Wolstonian and Devensian stages flowing southwards up the slope represented by the modern coast and forming tunnel valleys. With the post-glacial rising sea levels, the wash has been gradually infilled with sediment. The area has seen much deposition of sediment and land reclamation, markedly altering the coastline within historical times; several towns once on the coast of the Wash are now some distance inland.

Mineral Resources

The bedrock geology and superficial formations provide a rich and diverse assemblage of mineral resources, which have enabled the East Midlands Region to become one of the largest mineral producers in the country. The mineral resource and its relationship with the underlying geology is described in more detail in Section 3.4.5.

Geodiversity

Geodiversity was first simply defined as the 'variety of rocks, fossils, minerals, soils and natural processes forming our landscape'. This evolved later to include a much broader scope of all features relating to geology, including biodiversity, archaeology, industrial heritage, cultural heritage and art. The key phrase 'the application of practices for their care, maintenance and management for the long term benefit of all' has also been used.

A region's geodiversity is as diverse as the rock types and landforms present. The East Midlands has some of the most diverse geology in England, with rocks ranging from the Precambrian to the present day. These, in turn, have resulted in a very diverse landscape with a wealth of geomorphological features. The rocks reveal a geological history with examples of a diverse range of climates, depositional environments and processes that have helped shape the present day landscape.

Crucial to understanding and promoting the region's geodiversity are the geological Sites of Special Scientific Interest (SSSIs) and Local Geological Sites [formerly Regionally Important Geological and Geomorphological Sites (RIGS)]. The East Midlands' geodiversity includes:

- Sites worthy of protection
- The historical legacy of research within the area
- Past and present mineral workings
- Sites and features used for interpreting Earth science
- The influence of Earth science in shaping the environment
- Geological collections and other records
- Published literature and maps
- The inter-relationship and inter-dependence between Earth science and other interests, e.g. biodiversity, archaeology
- The promotion of geological features for tourism and education purposes.

The East Midlands has a long history of mining and quarrying that has left behind a legacy of geological exposures. These are coupled with natural exposures in some areas, including the volcaniclastic rocks of Charnwood Forest, and the limestone and 'Millstone Grit' areas of the Peak District. They all require protection and conservation through legislation and working in collaboration with planning departments. Their potential use for education and tourism is critical to their maintenance and upkeep. The sites need to be protected from destruction, through such processes as landfill.

Management plans are needed for many key sites and regular monitoring is required to ensure that access remains easy and that vegetation is kept clear of exposures and rubbish does not accumulate. Consultation with biodiversity specialists is also critical. Close working with all current quarry operators is essential, for drawing up restoration plans that ensure that scientifically important geological exposures are retained.

3.2.2 SOILS

The characteristics of soils in respect of their Natural Drainage, Natural Fertility, Surface Texture and General Soil Condition are illustrated on Figure 8.

The pattern of soils across the region and their characteristics is complex and closely related to the variation of the underlying geology including the superficial deposits, and the hydrological pattern. 'The East Midlands Soil and Environmental Resource Review' (November 2006)[14] provides a comprehensive high level review of the soil resource within the region and their complex relationships with both water and habitats, and in the context of climate change. At the top tier the report classified soil associations into twelve broad categories of soil types, based on their pedological and hydrological characteristics, and their expected behaviour under pressure. These included true peat soils, which only

14 *The East Midlands Soil and Environmental Resource Review', ADAS, (November 2006).*

occur to any significant extent in the Peak District. At a more local level there is, of course, a wide range of soil types with marked variation across the region depending in particular on the underlying geology and the effects of hydrology. Soil types and their characteristics are described in each of the Regional Landscape Character Types.

The majority of the region's soils, and the multiple functions they perform, are considered to be either at risk or potentially at risk from loss or damage arising from a wide range of drivers, with climate change as the principal ecological driver. The study sought to identify what is causing these changes, and the impact they are having on the East Midlands Region.

The study's research and findings into the relationship between land use, soil management and water management has led to the proposal to create 'spongy landscapes' across parts of the East Midlands Region. These can be defined as parts of the landscape where the make up of the soils and habitats can act as a sponge to soak up rainfall and help prevent possible flooding downhill or downstream and erosion. They can therefore act as landscape scale sustainable drainage systems and also offer a range of benefits. As well as contributing to water resource management and limiting flood risk and soil loss, there is the added potential for the creation and management of large scale habitats, the restoration of historic landscapes and the conservation of wetland archaeology.

3.2.3 HYDROLOGY

The hydrology of the East Midlands Region is illustrated on Figure 9.

Most of the rivers that drain the East Midlands Region flow into the North Sea either to The Wash, or into the River Humber although some of the Peak District rivers, notably the Goyt and Etherow, drain to the Mersey. The Trent catchment is the most extensive within the region and includes the River Soar and its tributaries, and eventually flows into the Humber in the north east of the region. The River Ancholme also flows into the Humber but in contrast to the Trent has a very small catchment contained within the Lincoln Edge and Lincolnshire Wolds. Elsewhere, there are a series of catchments that drain into The Wash comprising the Witham, Welland and Nene. The Lincolnshire Wolds separates watercourses that flow west into the Witham and Ancholme catchments, and those that flow east to the North Sea and The Wash.

Very limited sections of the region drain into the Severn and Thames catchments. These are located in the extreme south western part of the region within Leicestershire and Northamptonshire for the Severn, and Northamptonshire in the case of the Thames catchment. Here, an area of elevated land at Arbury Hill marks a nationally important watershed at the heart of the country, separating the catchments of three of England's major river systems: the Nene, the Severn and the Thames. Streams rise in close proximity to form the headwaters of the River Nene that eventually flows into The Wash; the River Leam, a tributary of the Warwickshire Avon, a tributary of the Severn; and the River Cherwell, a tributary of the Thames.

The River Trent is one of England's major rivers and its large catchment area extends across the western, central and northern part of the region. It rises beyond and to the west of the East Midlands Region north of Stoke on Trent. The first settlement on the Trent in the East Midlands is Walton-on-Trent. Between Burton on Trent, again on the western perimeter of the region, and Newark on Trent the river flows along a mainly north easterly course but beyond Newark assumes a predominantly northerly course within the broad clay Vale of Trent, eventually draining into the Humber estuary beyond the region near the village of Alkborough.

Numerous tributaries feed into the Trent, with the major tributaries within the region comprising the broadly south east flowing Rivers Dove and Derwent, which rise in the Peak District and the broadly north flowing River Soar whose lower

reaches, prior to its confluence with the Trent, flows through a valley to the east of Charnwood Forest. Tributary rivers of the Soar extend to the south east of Leicester (River Sence) and to the north east beyond Melton Mowbray (River Wreake) thus further extending the Trent's catchment area.

River Nene near Woodford, Northamptonshire (© River Nene Regional Park/M Williams)

Further east within the region the River Witham rises to the south of Grantham, and together with its tributary the River Brant, flows northwards along the western foot of the Lincoln Edge after which its course changes abruptly to east west with the river passing through the Lincoln Gap and into the broad Lincoln Clay Vale to the east of the Lincoln Edge. The Witham's circuitous course continues as it then assumes a south easterly course to Boston and then to The Wash. To the south east of Grantham the parallel courses of the East Glen and West Glen Rivers flow south eastwards to the lower reaches of the River Welland and then into The Wash.

The northern part of the Lincoln Clay Vale is drained by the River Ancholme, including the canalised course of the New River Ancholme which now forms the principal drainage channel. The north south aligned course of the Ancholme and the canalised watercourse parallels the lower reaches of the River Trent with the two rivers flowing into the River Humber separated by a distance of only about 10 km.

A series of smaller and shorter rivers and watercourses, including the Great Eau, Long Eau and Waithe Beck, rise on the eastern slopes of the Lincolnshire Wolds and flow in a broadly easterly direction across the Lincolnshire Fens and Marshes to the North Sea coast. Another watercourse, the Steeping River, rises in the south eastern part of the Lincolnshire Wolds eventually draining into The Wash south of Skegness.

The River Welland and River Nene are the major river systems in the southern part of the region. Both follow a broadly south west to north east course, eventually draining into the southern side of The Wash beyond the East Midlands Region. The Nene, the most southerly river in the region, rises in the south west of Northamptonshire with a series of tributaries, including the River Ise and Harper's Brook, draining south eastwards into the main river.

River Steeping draining into The Wash. Lincolnshire (© Wash Estuary Strategy Group/R Platts)

In addition to the river systems within the region, Figure 9 illustrates the extent of Flood Zone 3 areas where there is an annual probability of flooding of 1% (1 in 100) or greater from rivers, and 0.5% (1 in 200) or greater from the sea. The River Trent floodplain is the most susceptible to flooding with a broad swathe of Flood Zone 3 designated land along the entire valley bottom that broadens progressively towards the northern boundary of the region. Other main rivers with notable Flood Zone 3 areas comprise the floodplain of the River Nene from Northampton to the eastern boundary of the

region, the River Welland, and the River Witham, (including the section of the river valley that passes through the Lincoln Gap), within the clay vale to the east of the Lincoln Edge and the River Soar to the north of Leicestershire.

3.2.4 LAND USE AND LAND COVER

Agricultural Land Use, Quality and Forest Types/ Ancient Woodland are illustrated on Figure 10. The distribution of Biodiversity Action Plan Habitats is illustrated on Figure 11 and Nature Conservation Designations are illustrated on Figure 12.

Agricultural Land Use

Land use in the East Midlands is dominated by farming. Over 81% of the land area is occupied by agriculture, with most types of modern and traditional farming practices evident in the region. Approximately 47% of the farmed land is of the best and most versatile agricultural quality (Grade 1, 2 and 3a) which is primarily located in the east of the region. This compares to 39% across all of England. The region also has a significant proportion of the total national resource of Grade 1 land (34%)[15]. However, more than 50% of the best and most versatile land is less than 5m above sea level and large areas are therefore prone to or at risk of flooding. The poorer soils (Grade 4 and 5) that are primarily found in Derbyshire and the Peak District, occupy approximately 21% of the region.

In addition to soils, temperature, rainfall and sunshine combine to influence agricultural regimes. Whilst the region is relatively dry, rainfall is sufficient to keep free draining soils fertile and clay vales verdant. Droughts are rare and the timing and duration of frosts encourages a wide range of agricultural crops and good grazing pasture, particularly at lower elevations[16].

The region produces 30% of the nation's vegetables, primarily in the rich and intensively farmed east of the region, but has only 5% of the nation's milk herd[17]. 18% of England's cereal holdings are in the East Midlands. Despite the region containing some of the most productive agricultural systems and soils in the country, 66% of all available agricultural land in the region is now in environmental land management agreements.

Although economic factors are important in influencing types of farming activities, decisions on what is grown or reared in a particular area are also guided by the attributes and limitations of local physical conditions. These influences result in general trends and patterns of land use that may be observed at a regional level. For example, in the hillier north west of the region, livestock farming dominates. Further east, in a broad arc running through Northamptonshire, Leicestershire and Nottinghamshire is a mixed farming regime with a predominance of livestock. In the east of region, across Lincolnshire and east Northamptonshire the agricultural landscape is dominated by arable farms with some livestock. Here, the wholesale conversion of grassland and horticulture to arable, driven by post war European agricultural subsidies, has had a profound influence on the character of the agricultural landscape. Indeed, in Lincolnshire virtually the only land unploughed is that protected by environmental or heritage legislation[18].

The impacts of agricultural specialisation and intensification can be seen across the entire region, and is particularly evident in some areas, such as Lincolnshire. Whilst productivity may be improved or more secure markets accessed by changing farming practices, the detrimental effects on landscape and wildlife are notable. For example, agricultural intensification in predominantly arable areas has led to a significant decline in farmland birds, with some species declining by up to 90% over the past 25 years.

15 *EMDA, The Rural East Midlands in 2007 Summary Report.*

16 *David Stocker, England's Landscape – The East Midlands. English Heritage 2006.*

17 *East Midlands Regional Assembly and East Midlands Biodiversity Forum, Putting Wildlife Back on the Map – The East Midlands Biodiversity Strategy. Consultation Draft. 2004.*

18 *David Stocker, England's Landscape – The East Midlands. English Heritage 2006*

Change is also evident in the more remote or marginal farmlands of the Peak District, where the loss of flower rich grassland is largely a result of a shift from hay to silage production to provide winter feed for livestock. Elsewhere farmers are shifting from livestock to arable production as a result of the BSE crisis and low milk prices, resulting in the further loss of permanent pastures and grassland[19].

The type and nature of farming has a significant impact on the character of the landscape. Variations in land tenure, available resources, size of holding and the techniques and equipment used to farm the land all influence patterns of land use, as well as the type of field boundaries and how they are managed and maintained. Similar variation can be seen in the type of buildings needed to house machinery or stock or to store grain and produce. For example, across the intensively farmed fenlands, the extensive areas of flat or gently undulating land are well suited to arable and vegetable farming. The local landscape is therefore managed accordingly, with large-scale 'industrially farmed' fields, with few dividing hedges, sown annually with crops and harvested using large-scale machines that are housed in modern sheds. Such a farming regime creates an open landscape that retains an exposed, sometimes bleak, and managed character.

By contrast, in the Undulating Mixed Farmlands of Northamptonshire and Leicestershire wide variations of slope, aspect, drainage, and soil productivity have lead to a mixed farming regime, where small, hedged arable fields mark well drained areas, and improved pastures indicate the presence of steep or poorly drained areas bordering rivers and streams. Here, landform combined with the enclosing effects of hedgerows and smaller field sizes, creates an altogether more intimate and 'traditional', rural landscape.

Intensively farmed Fenlands of Lincolnshire (© J Watson)

Undulating Mixed Farmlands of Northamptonshire (© River Nene Regional Park/M Williams)

Parklands

Beyond the agricultural landscape, a number of other land uses have a significant influence on the character of the region's landscape. Parklands and their wider estates are particularly notable and can be observed throughout the region. Many fine country houses were built and parklands, including deer parks, were laid out during the post medieval period, although many have their origins in the estates established in the Saxon or Norman period. In many cases, the influence of the designer or owner was taken far beyond the boundary of

19 *East Midlands Regional Assembly and East Midlands Biodiversity Forum, Putting Wildlife Back on the Map – The East Midlands Biodiversity Strategy. Consultation Draft. 2004.*

the park with avenues of trees stretching for great distances through the surrounding countryside, and trees planted and monuments constructed on prominent hills or important locations. Villages were also demolished and rebuilt and distinctive architectural styles employed in the construction of estate villages, giving unity and strength of character to many settlements in the region.

Water and Wetlands

The East Midlands is largely defined by its rivers: the Trent in Nottinghamshire, the Derwent in Derbyshire, the Soar in Leicestershire, Nene in Northamptonshire and Witham in Lincolnshire being central to the identity of these ancient counties. In addition to being the main communications channels, the river valley corridors have been the focus of habitation throughout history and as such, rich in evidence of past settlement and industry. They are also the focus of the region's biodiversity interest with many of the most significant nature conservation sites outside the Peak District and The Wash located in river valleys or wet areas. Artificial wetlands are also important to defining landscape character and for their wildlife and recreation value, whether these are canals, reservoirs or flooded gravel pits. Overall, there is a paucity of wetland sites within the region with a need to re-create wetland habitats where appropriate.

Forestry and Woodland

The region is characterised by lowland mixed deciduous woodlands, alder and willow wet woodlands along river valleys and wetland areas, and upland ash and oak woods in the Peak District as well as a number of coniferous plantations.

Woodland cover in the region is 5.1% of the land area, as compared to 8% for England as a whole. Ancient semi-natural woodlands account for 20% of total woodland, these tend to be confined to some of the most well wooded areas of the region such as the forests of Charnwood, Leighfield and Rockingham.

Trees, forests and woodlands are frequently identified as key characteristics of several of the region's best known areas. They also play an important role in providing habitat for often numerous assemblages of flora and fauna, as well as having a recreational function or contributing to the perceived health or intactness of a landscape. Many woodlands, and notably ancient semi natural woodlands and veteran trees, are also widely cherished as features of the region's cultural heritage. Increasingly, woods and forests are seen as a source of renewable materials and sustainable energy and as an important component in the regeneration of former industrial sites or degraded landscape.

Many woodlands in the region are designated on account of their habitat value. Notable examples include the Peak District Dales woodland and the Birklands and Bilhaugh woodlands in Sherwood Forest which are of European importance.

Birklands and Bilhaugh Woodlands in Sherwood Forest , Nottinghamshire (© P Wakely)

In some areas, such as the fens or lowland vales, forests and woodlands are largely absent, save for small copses and shelter belts. Here, hedgerows and hedgerow trees are important landscape features, particularly older and more characterful specimens, which act as wildlife havens, or simply as vertical elements in otherwise open agricultural landscape.

The creation of new woodlands is also a feature of the region, with several major initiatives. These include The National Forest, Greenwood Community Forest, Sherwood, Rockingham and East Derbyshire Woodlands, and are helping to redress regional deficiencies in woodland cover and contributing to a national programme of multi-purpose woodland.

Biodiversity

The East Midlands, like the rest of Britain, acquired most of its present day species of flora and fauna by re-colonisation following wholesale extermination during the Pleistocene ice ages. At intervals land connected southern England with continental Europe and these areas served as refuges for plants and animals, which were later to spread back into Britain as the ice and tundra conditions receded northwards.

Following a period when only cold-tolerant species could survive, warmer wetter weather allowed the formation of the 'wildwood'. This was the natural environment that Mesolithic hunter-gatherers began to manipulate and domesticate between 10,000 and 5,000 years ago. These communities are thought to have been nomadic, occupying seasonal hunting camps, and were the first agents of landscape change. Despite their high mobility, evidence suggests that areas of wildwood were burnt to create clearings for more efficient hunting.

Since the adoption of settled agrarian lifestyles from approximately 4,000 BC, more rapid and pronounced change to the natural environment occurred. The Neolithic period saw the first significant removal of woodland to allow for lifestyle changes dependent on settled farming. The native wildwood was progressively removed along with the extinction of numerous native species, often through hunting, and the introduction of competing non-native species of plants and animals by new peoples settling in Britain. In more recent centuries, plant hunters and explorers have brought back exotic species primarily for private parks and forestry planting

The long history of settlement and farming in the region has removed all trace of what can be regarded as a wholly natural habitat, and has significantly limited the extent of areas of semi-natural habitat.

The intensification of farming practices since the Agricultural Revolution, and most significantly from the latter half of the 20th century, has had a profound impact on the extent and resilience of semi natural habitats. The result is that the region has the poorest biodiversity in the country[20]. Despite this, the East Midlands Region contains some fine semi-natural habitats. Examples include The Wash, where wide areas of coastline and open water are designated as a Ramsar site in recognition of their international importance, and the South Pennine Moors in the Peak District which are recognised as being of European importance and designated as a Special Protection Area (SPA) and Special Area of Conservation (SAC).

Protected sites, such as Sites of Special Scientific Interest (SSSI) cover only a small area of the East Midlands (approximately 4.5%), which is significantly lower than the national average of around 7%. Of the SSSIs, by area, 95.75% are recorded to be in a favourable or recovering condition (Natural England, 2010). In addition to these nationally protected sites, there are many non statutory sites that are afforded protection at the county and local level, including many Local Wildlife Sites. Whilst it is acknowledged that biodiversity has declined nationally, the East Midlands has probably lost more wildlife than any other region. However, recent activity through Local Biodiversity Partnerships across the region is working positively to help reverse this decline.

20 *East Midlands Regional Assembly and East Midlands Biodiversity Forum, Putting Wildlife Back on the Map – The East Midlands Biodiversity Strategy. Consultation Draft. 2004.*

3.2.5 COASTAL AND OFFSHORE LANDSCAPES

The assessment of coastal and offshore landscapes has benefited from analysis of several data sources. Figure 13 illustrates information concerning offshore geology. Bathymetry (water depth) is illustrated on Figure 14.

The Lincolnshire coast, stretching from the Humber Estuary to The Wash comprises a range of land use and habitat types. It is also a popular destination for tourists and holidaymakers, particularly close to the key destinations of Mablethorpe and Skegness.

In the north, the wide shore is characterised by sand and shingle banks and beaches, together with extensive salt marsh and sand dunes. The dunes are noted for the common occurrence of lyme grass, with Lincolnshire alone holding 26% of the national total of lyme grass foredunes.

Other important habitats include coastal scrub, used extensively by migrating birds for food and shelter, and saline lagoons, where man-made brackish water habitats are important to migratory and overwintering birds.

The Wash is characterised by vast areas of salt marsh, sand banks and mud flats and is designated a Ramsar site, Special Protection Area and candidate Special Area of Conservation. It supports internationally important overwintering bird populations and several nationally important plant communities.

Sea levels in the North Sea are rising, in part as a result of global climate change. Wide areas of farmland are protected from the sea by heavily engineered sea defences, which require regular and costly maintenance. Sustainable approaches to coastal management have recently been employed, with the largest scheme in England having been delivered by a partnership of several parties including Defra and the Environment Agency. Near Boston the defences have been deliberately breached as part of a controlled and coordinated process. By allowing the sea to flood farmland areas, the encroaching sea will encourage the formation of salt marsh, which acts as a natural barrier absorbing the force of the sea.

Duck Point, The Wash Site of Special Scientific Interest , Lincolnshire (© P Wakely)

Freiston Shore Realignment near Freiston, Lincolnshire (© Lincolnshire county Council/J Watson)

In the open sea, a range of commercial activities are evident, including fisheries targeting cod, sole, herring, plaice and sprat, and aggregate extraction. Also evident are offshore wind turbines, albeit at some distance from the coast and major navigations, notably those entering the Humber estuary.

3.3 CULTURAL INFLUENCES

As has been demonstrated previously, all landscape in the region is a direct result of the interaction between humans and their environment, albeit influenced by the physical environment and availability or scarcity of natural resources.

Varying qualities of the region's soils, fisheries, building stone and timber and availability of coal, metals, aggregates, brick clay and water power have influenced the development and distribution of industry, agriculture, woodland, rough ground, settlement and infrastructure, all of which are key elements defining the character of the current landscape. Certain events and activities have left more visible traces than others. For example, hundreds of years of Anglo Saxon settlement, agriculture and ritual are largely invisible to those unaware of the strong relationship which current patterns of settlement and communication routes have with this period, whereas Neolithic and Bronze Age burial monuments, such as those of the Peak District, are a tangible and evocative remnant of the ancient past.

Landscape survey, landscape history, historic landscape characterisation, aerial photography and systematic excavation in advance of development all contribute to our understanding of the landscape's development. Through them we see that the East Midlands region has as complex and intriguing a landscape history as anywhere else in Britain. Whilst much remains to be learnt, a great deal can already be said about the evolution of the region's landscape.

3.3.1 PALAEOLITHIC AND MESOLITHIC (C.500,000- 9,000 BC)

Palaeolithic culture flourished during the Pleistocene geological period when glaciations were interspersed with long periods of more hospitable climate and when humans followed herds of grazing animals into the area that is now the East Midlands. Stone tools and remains of animals found in the caves of Creswell Crags, a limestone gorge honeycombed with caves and smaller fissures, provide evidence for life during the last Ice Age (between 50,000 and 10,000 years ago) including Britain's only known Ice Age rock art. Elsewhere assemblages in the gravel deposits of rivers such as the Nene and Trent provide tantalising evidence of communities who roamed across wide areas, exploiting various habitats and seasonal gathering and hunting grounds.

As the last Ice Age ended around 8,500 BC the glacial ice sheets that stretched over much of the north of England retreated. Sea level rise separated Britain from the Continent and large areas once occupied were inundated by the North Sea. The spreading woodland would have been dominated by birch at first although in time a 'wildwood' of climax species (dominated by oak) developed. The wildwood's character is subject to debate; some support the idea of a shifting mosaic of grazed clearings and wooded areas rather than dense and intractable forest with unwooded areas restricted to particularly steep slopes, rock outcrops or unstable features such as river banks.

Nomadic Mesolithic communities moved through the region's hills and valleys establishing seasonal hunting camps in these woodlands and exploiting migrating herds of large herbivores. Scatters of flint indicate the location of temporary hunting camps. More sophisticated tools and food procurement practices meant that Mesolithic peoples were the first significant human agents for landscape change. Areas of the wildwood may have been burnt to create clearings attracting grazing animals such as red deer.

3.3.3 NEOLITHIC, BRONZE AGE AND IRON (C.4,000BC - AD43)

The change from Mesolithic hunting and gathering towards settled agrarian lifestyles was gradual and influenced by contact with the continent rather than imposed through colonisation of Britain by farming communities. The Neolithic transition

produced new artefacts: querns, sickles, pottery and polished stone axes. Environmental evidence shows how changes in food procurement practice were accompanied by large scale woodland clearance and the introduction of domesticated sheep, cattle and cereals.

As for the Mesolithic, Neolithic settlement sites are difficult to identify in the region though a study in central Kesteven has revealed a fully occupied Neolithic countryside comprising various types of site. Neolithic ritual and religious remains are more visible and are enigmatic reminders of our ancient past. Some, such as the Arbor Low henge circle in Derbyshire, formed parts of extensive ritual landscape; others, then as now, were single features in an agricultural landscape. Many retained importance for several generations, attracting later burials, or being visual markers of territory boundaries.

Aerial view of henge monument at Arbor Low, Derbyshire (© Derbyshire Constabulary)

Woodland clearance accelerated in the Neolithic and Bronze Age as farmland and open rough grazing were established. Such extensive land clearance destabilised the soil which was washed into rivers and streams, as confirmed and dated by silts in the Fens deposited during a short intense period of freshwater sedimentation from the Ouse, Nene and Welland rivers in the mid third millennium BC. By the early Bronze Age ditched and hedged enclosures, divided by droves leading to seasonal grazings, and interspersed with family farms parcelled up large areas of the fen-edge landscape for pastoral farming. On the lighter Peak District soils enclosures may have been predominantly for arable farming. The extensive remaining woodlands would have been increasingly managed for coppice and other resources.

Henge monument at Arbor Low, Derbyshire (© English Heritage/J Humble)

The climate deteriorated in the later Bronze Age (after about 1000 BC) obliging Derbyshire upland settlement to contract to the valleys, causing farmland to revert to scrub; peat formed on the waterlogged soils. Fenland water levels rose, forcing slow abandonment of seasonal grazing and increasing reliance on the more elevated cereal growing land. Late Bronze Age populations may have declined, with a new social hierarchy emerging to exploit a period of crisis, perhaps providing protection in return for agricultural produce. This continued in the Iron Age as increasing competition for land and resources speeded the development of a more territorial society in which many settlements were nucleated, as observed through cropmarks in Lincolnshire and Leicestershire. Some were defended. Hill forts, whether military or symbolic, occupied strategic prominent locations for maximum effect; a concentration of sites can be found in northern Derbyshire.

3.3.4 ROMANO BRITISH PERIOD (AD 43 - AD 410)

In the East Midlands, as for much of England, the Roman invasion was rapidly followed by centralised administration based on towns supported by networks of forts and metalled roads. Although much of the pattern of rural settlement and farming continued, the new towns had a profound and lasting influence on local native communities. The market infrastructure enabled farmers to capitalise on surpluses, and in the early Romano British period produce from the region was probably transported around the Empire.

Roman archaeology in the region is rich; towns, forts, several impressive villa sites and engineering schemes, the latter including the Carr Dyke, the first drainage structure to be built in the Fens. Several modern communication routes such as the Fosse Way and Ermine Street and some modern urban street patterns have Roman origins.

The Empire declined during the 4th century and by the mid 5th century, direct Roman rule had been replaced by local governance. The armies had left, much of the Roman infrastructure was falling out of use and the economy was largely agricultural.

3.3.5 SAXON AND EARLY MEDIEVAL PERIOD (AD 410- AD 1066)

Shortly after the decline of Roman control in Britain, Angles, Jutes and Saxons began to invade and settle the East Midlands. Evidence for early Saxon settlement is relatively sparse, largely due to poor quality pottery and the use of wood for building. There may also have been fewer people living in the area during the Saxon period than in the Iron Age.

Despite this, and in contrast to north western and south eastern England where significant woodland regeneration is evident, wide areas of Romano-British field systems continued to be farmed in the East Midlands albeit with increased pasturing.

Earls Barton Church Tower, Northamptonshire
(© River Nene Regional Park/M Williams)

Woodland did remain important to the rural economy throughout the early medieval period, although it is interesting to note that the 'Central Province'[21] had relatively less woodland than other provinces, mirroring the current situation. There were, however, important tracts of forest, subject to careful husbandry and fully populated with livestock, notably pigs, and perhaps under the nobility's direct responsibility. Centralised control allowed policing of scarce resources and also maintained these areas as royal hunting grounds. Forest names attest to this: Sherwood, 'Shire Wood', was in the ownership of an arm of the royal government and the Peak was 'the forest of Pecsaetan', a Saxon sub-kingdom. Similarly, the Fens were another scarce resource subject to centralised control, this time by royal monasteries.

The origins of Christianity within the region are unclear but another notable feature of the East Midlands landscape are the Saxon churches and monastic sites. At a time when most buildings were simple timber structures, the stone religious buildings would have gained a symbolic permanence in the landscape.

Brixworth Church , Northamptonshire
(© River Nene Regional Park/M Williams)

Parish churches accompanied changes in land holding from the 9th century onwards. Hundreds of the region's churches were first built in the Saxon period and although Norman and later rebuilding expansion and alteration has often removed all visible traces of their origins, the East Midlands retains some of England's most important Saxon churches; Brixworth and Earls Barton in Northamptonshire are two fine examples.

The period also saw major reorganisation of agriculture, which had since the Late Bronze Age developed in a land of ditched enclosures surrounded by fences and hedgerows. Homes and farms had been scattered, suggesting that land was probably individually owned. Conversion to farming in common during the late Saxon period meant that farmers pooled their activity and coordinated where, what and when things were done. An individual's land was held in long unenclosed strips in each of the community's large common fields. Stock was also managed communally, and set to graze the marginal heaths and the common fields when not under the plough. Houses could no longer be scattered, but instead were nucleated into a single place, the village, allowing or necessitating creation of other communal facilities: a green to gather stock; a market to trade and exchange goods; a church for communal worship; and an alehouse.

In Lincolnshire, a distinctive pattern of towns and villages (the Townlands) grew in an arc of higher ground around The Wash. Clinging to gravel and clay islands, they were surrounded by predominantly pastoral fields, and linked by droves which followed dykes.

Place names are perhaps the most direct link to Early Medieval settlement patterns in the region. Most traces of these settlements have been removed or covered by subsequent development and place names are often their only remnant. Early Saxon dispersed settlements are evident in names ending with 'ing' (the village of the followers of a leader), 'tun' or 'ton' (a farm or enclosed land), 'ham' (a dwelling or homestead), 'stoke' (an outlying farm), 'leigh' or 'ley' (a clearing in woodland). 'Haw' indicates a burial mound or hill and 'stow', a sacred place. Names also indicate areas where Vikings either settled or had sufficient influence to affect how places were known: 'thwaite' (woodland clearing), 'thorpe' (outlying farm or settlement) and 'by' (homestead or village).

21 *Brian K Roberts and Stuart Wrathmell, An Atlas of Rural Settlement in England. English Heritage 2000.*

3.3.6 LATER MEDIEVAL AND EARLY MODERN PERIOD (AD 1066 - 1750)

Following Harold's defeat at Hastings in 1066, William the Conqueror allocated confiscated lands to his followers. Fine examples of strategically located motte and bailey castles can be found at Laxton (Nottinghamshire), Egmanton (Nottinghamshire) and Hallaton (Leicestershire). Later castles, and cathedrals, were built in stone, demonstrating the new elite's dominance and power.

Motte and Bailey at Hallaton, Leicestershire (© English Heritage)

Motte and Bailey at Laxton, Nottinghamshire (© English Heritage/J Humble)

Meanwhile the organisation of the East Midlands rural landscape continued relatively unchanged. Growing populations stimulated new villages with new open fields, generally in areas already well settled. Elsewhere, in areas like Charnwood Forest and the Northamptonshire Clay Wolds, populations grew less rapidly. To accommodate growth, many villages expanded into the surrounding open fields. In Lincolnshire, several formerly discrete settlements grew together during the 11th and 13th centuries to form single but polyfocal villages, such as Lindsey, Silkby and Willoughby Kesteven, some of which retain more than one green.

Population growth also necessitated extension of the area cultivated. Between the 11th and 13th centuries some common woodlands, beyond the common fields, were cleared and enclosed in a process known as assarting that created a small-scale and intimate landscape of farms and hamlets linked by winding lanes and irregular fields between patches of surviving woodland. Other new communities were established on heathland, on the edge of moors and within royal woodlands.

The Medieval period was one of prosperity, wealth and economic diversity. Local trades included tanning, cooperage, brewing and baking. Streams were dammed to harness water power for fulling and corn mills. Fishing continued in the rivers and in the Forests, trees were felled, oak bark was stripped for tanning and wood was burned to produce charcoal. Rapid population growth led to increased demand on productive agricultural land.

During the early 14th century the East Midlands, like much of England, experienced profound change. Two key drivers were development of an international wool market, and a fall in population, caused in part by the plague (the Black Death) which first arrived in England in 1348. Much arable land was converted to sheep pastures that required fewer people to manage than the intricate regimes of the common fields. The changes are clearly seen as the ridge and furrow of the common fields, the humps and bumps of deserted villages and the elaborate churches and merchants' houses built on the profits of the international wool trade. Lincoln also prospered, exporting finished cloth all over Europe.

The landscape pattern from the later 14th century was generally settled, albeit with a continuation of the enclosure of former common land by entrepreneurial families. Wool remained the major export, and when war in Europe affected trade, farmers turned to meat production, especially for London markets. Enclosure of common fields for sheep continued to be widespread throughout the region, sometimes obtained strip-by-strip in gradual or piecemeal enclosure. Thus came many of the now familiar single farms set among pasture fields, where once were communally farmed strips of the common fields.

Reclamation of Lincolnshire's coastal marshes and fens gathered pace during this period. Some reclamation was either Roman or Saxon, but from the 16th century drainage was undertaken on a much more massive scale. Cutting of 'drains' and raising of coastal embankments saw large areas come into agricultural use. The increasingly large scale and ambitious schemes of later centuries included longer, straighter drains. Wind pumps were common by the 18th century as the inadequacy of gravity drainage necessitated their construction.

As early as the 13th century, the aristocracy was enclosing hunting grounds with park pales, creating discrete areas managed for the benefit of the chase animals, especially fallow deer. Standard trees in groups, varied undergrowth, clearings (lawns) and lodges and a degree of ornamentalisation were features of medieval parks. In later centuries emparked areas saw the introduction of permanent residences, pleasure grounds and elaborate gardens.

The humble wattle and daub cottages, a feature of villages and farms for several centuries, were replaced by substantial stone buildings, roofed in thatch or slate from quarries such as at Collyweston. Where stone was not readily available elaborate timber frame structures were built. Many of the region's older private residences, in villages and towns, date to the 16th and 17th century period of increased prosperity and private wealth.

The gradual enclosure between 1400 and 1700 of the communal landscape of open fields, commons and woodland for sheep-walks, agricultural closes or parklands, mirrored the growing distinction in society between land owners and the landless. The growing wealth of the emerging middle classes was consolidated in fine town houses and farms while the aristocracy demonstrated their power and wealth through impressive country houses and estates.

3.3.7 INDUSTRIALISATION AND THE MODERN PERIOD (AD1750 -1900)

Between 1750 and 1850 the East Midlands landscape experienced change on a scale not seen since the late Saxon period as a result of widespread and rapid industrialisation and the growth of a property owning democracy.

Building on the process of piecemeal enclosure by private landlords begun in the 14th century, Parliament facilitated a wave of reorganisation through more systematic enclosure. Land was parcelled up into a patchwork of fields, defined by hedgerows and dry stone walls. So complete was this period of enclosure that only one example of the medieval system survives. Common field farming continues to this day at the Nottinghamshire village of Laxton.

Enclosure edged many people out of rural society at a time when a market- orientated society was rapidly developing. Large numbers left the land to find work in manufacturing and service industries in fast expanding towns, cities and factories. Water power drew the earliest factories to valleys where reliable energy could be secured. The Derwent Valley in Derbyshire, the 'cradle of the factory system', and now a World Heritage Site, contained several factories and associated infrastructure and workers' accommodation.

Steam power allowed more flexibility in factory location from the 18th century, enabling industrialisation of the region's other major towns: Nottingham, Leicester and Lincoln. Railways, efficiently transporting coal to boiler and furnace, allowed such towns to prosper and expand, with rows of terraces of workers' houses built, often by factory owners. Welsh slate, again transported by railway, along with red brick, gave the new suburbs a uniform character away from places like the Peak District where readily available gritstone was used.

Growing urban populations required sophisticated sanitation and transport infrastructure. Road, canal, rail and sewage networks expanded and reservoirs were built in the hills to supply the major towns with clean water. The moral and physical health of 19th century urban populations was also catered for through parks, museums and art galleries.

The region's principal manufacturing industries were textiles, leather and boots, and pottery and brick. Stone and gravel were quarried; coal, iron and lead ore mined, iron smelted and lime burnt. Together, these had a profound impact on the urban and rural landscape character of the East Midlands. Whilst much industrial land has been levelled, landscaped or developed, many areas, notably in the Leicestershire and Derbyshire former coalfields retain their industrial character.

The houses and gardens of the elite were often remodelled in the period to follow prevailing fashions or to display complex political or religious ideals, resulting in a rich cultural and artistic legacy. New houses and estates were also established by increasingly wealthy industrialists. Entire villages were sometimes relocated to make room for fashionable new landscaped parks, and were themselves reconstructed as ornamental features.

3.4 CURRENT AND FUTURE LANDSCAPE CHANGE

3.4.1 INTRODUCTION

Change, whether from physical or cultural influences, has always been a feature of the region's landscape. It continues to be so, although there are concerns that if it is left unchecked, the rich and diverse landscape, so cherished by residents of and visitors to the region, will be adversely affected by inappropriate change and development. This is not to suggest that the landscape should remain static, rather that change should be understood in context and managed to bring about positive and sustainable outcomes.

Landscape change is a complex and emotive process. Changes which may be regarded as negative by some may be seen as positive by others and perceptions can change with time. The best example of this arose during the last great episode of landscape change, with the parliamentary enclosures of the 18th and 19th centuries. The 'nature poet' John Clare, a resident of the East Midlands, mourned the loss of the open field landscape and the parcelling up of farmland into a patchwork of hedged and walled enclosures. However, this is the landscape we treasure so much today, regarding a neat landscape of hedged fields interspersed with compact farms as quintessentially English and worthy of protection.

To achieve positive landscape change, it is essential that the communities of the region and those who have control over the main mechanisms for change, are well informed about the diverse character of the landscape and the implications that change can have upon it. The EMRLCA has an important role in this. In addition to presenting a description of the various types of landscape that can be found in the region, the EMRLCA also presents an overview of forces for change acting on each Landscape Character Type and the various mechanisms that can be employed to protect, manage, plan and promote landscape character.

The following pages describe the main forces for change acting on the region today. These are developed in greater detail for the relevant Landscape Character Types in which they occur.

3.4.2 BUILT DEVELOPMENT

The post-war period has witnessed a rural revolution. Increased personal mobility, improvements in public transport provision and advances in telecommunications technology have made some rural areas relatively accessible. These trends, coupled with an enhanced perception of rural life and decline in the profitability of agricultural land, are placing increasing pressures on the countryside to accommodate built development. In parallel with this, existing towns and villages and in particular brownfield sites within them and their undeveloped fringes, are also under considerable pressure to accommodate housing and employment sites.

Housing Provision

The East Midlands Regional Plan March 2009[22], contains the most recent housing projections for the region. Based on guidance published by the National Housing and Planning Advice Unit and the Government's Housing Green Paper (2007), the Secretary of State proposes that the East Midlands region must accommodate 452,300 new dwellings during the plan period 2006 – 2026. This represents a substantial increase from the predictions contained within the original Draft East Midlands Regional Plan (2006), and it is likely that up to 40% of these proposed dwellings will need to be accommodated on greenfield land.

The East Midlands Regional Plan aims to concentrate new development in existing urban areas and establishes a target for 60% of new housing to be built on previously developed land. This target has been exceeded in 2006/07; however, there are significant variations between counties. In 2006/07 over 99% of new development in Nottingham was accommodated on previously developed land, compared to under 30% in the Peak District. The Regional Plan also states that the needs of rural areas should also be provided for, particularly the supply of affordable housing. As such, any new development on greenfield land or in rural communities should seek to respect the distinctive character of the rural landscape and townscape.

In order to deliver the regional housing target, a number of initiatives have been pursued by the Government, which will seek to concentrate development in key areas. North Northamptonshire and West Northamptonshire form part of the Milton Keynes and South Midlands Growth Area, one of four areas designated in the Sustainable Communities Plan[23] to alleviate current housing pressures in the South East. Elsewhere in the region delivery will be facilitated by Growth Points, an initiative to provide support to local communities who wish to pursue large scale and sustainable growth. Locations include the '6Cs Growth Point covering Leicester, Nottingham and Derby, Lincoln, Grantham, Newark on Trent and Gainsborough. There is also potential for new 'eco' towns or settlements in the East Midlands. Several proposals have already been put forward in the region and the Government has indicated that further consideration will be given to future proposals.

The East Midlands Regional Plan: Partial Review – Options Consultation[24] was published at the end of June 2009, setting out a range of options and questions on a number of key issues with the aim of accommodating long term projected development growth in the region up to 2031.

Whilst the proposals for Growth Points and new 'eco'-towns or settlements are intended to deliver sustainable development, there will inevitably be some loss of greenfield land and change to the character of the landscape. Green Infrastructure (GI)[25] associated with major growth has the potential to bring about environmental

22 *East Midlands Regional Plan (2009) – http://www.gos.gov.uk/497296/docs/229865/East_Midlands_Regional_Plan2.pdf*
23 *Sustainable Communities: Building for the Future (2003) - http://www.communities.gov.uk/documents/communities/pdf/146289.pdf*
24 *East Midlands Regional Plan: Partial Review – Options Consultation (2009) - http://www.emra.gov.uk/files/partial-review-options-consultation.pdf*
25 *Green Infrastructure for the East Midlands - http://www.emgin.co.uk/default.asp?PageID=51&n=GIN+Links*

enhancement and strengthen local landscape character. However, like built development, GI planning needs to be considered and designed for its local context. In conjunction with the 6Cs New Growth Point, a Strategic Green Infrastructure (GI) Strategy for the 6Cs Growth Point has been developed setting out priorities and opportunities for action and mechanisms for funding. The Lincoln GI Strategy has also been developed as part of a strategic approach to GI implementation.

In addition to the 'planned' growth described above, incremental growth within and on the fringes of existing towns and rural settlements is also occurring across the region. Such developments can result in a loss of distinctiveness and diminished sense of identity and historic settlement character. However, such developments can also provide opportunities to enhance the appearance of the region's towns and villages, particularly at the urban rural interface, through careful consideration of landscape and townscape character and historic settlement patterns to help mitigate the impact of development. Developers should also be encouraged to consider locally distinctive building styles, use of materials, massing and layouts. Whilst the intention would not necessarily be to replicate the prevailing vernacular style, it may help to initiate a creative and sustainable local response which enhances, rather than dilutes, local distinctiveness. There should also be a place for the use of innovative architectural solutions that take inspiration from local distinctiveness and character whilst utilising eco-friendly and high quality design.

Employment Provision

New employment provision is essential to the future prosperity of the region. The Regional Economic Strategy (RES), produced in 2006 by the East Midlands Development Agency (EMDA), sets out a range of actions to promote a competitive regional economy. Regeneration activity is generally focused on areas that exhibit high and concentrated levels of deprivation, including those areas in the Northern sub-region linked to the decline of the coal and manufacturing industries.

A number of regional studies into employment land have been undertaken in recent years by the East Midlands Regional Assembly (EMRA) and EMDA, and have since been updated and extended by the Regional Employment Land Supply Study (RELS)[26] in 2006. The study forecasts relatively little demand for additional employment land in the region. This is largely due to the shift away from industrial space into offices, which occupy space at a higher density, and the relative oversupply of suitable sites.

The focus of regeneration activity on existing communities and the low demand for additional employment land means that employment provision is likely to have a lesser impact on landscape character than new housing. Nevertheless, where there is a concentration of commercial and industrial activity, such as large scale distribution sheds and industrial development, particularly adjacent to the major road networks and on the fringes of urban areas, these will continue to have a significant impact on the landscape.

Despite this, careful consideration needs to be given to ensuring all new development is carefully sited, planned and designed. Issues of tranquillity and perceptions of remoteness should be considered as well as ensuring important or valued landscape features are not lost or adversely affected by new development. In relatively deprived communities, particularly in locations blighted by former coalfields, regeneration activity has a significant role in enhancing landscape character. However, proposals for further development should be carefully considered against the capacity of the landscape to accommodate change and the need to protect features of the area's industrial past.

Consideration should also be given to the acknowledged role that landscape plays in attracting new investment, helping businesses retain a skilled and motivated workforce, stimulating regeneration and raising land and property values.

26 *Regional Employment Land Supply Study (2006) - http://www.emra.gov.uk/files/file1040.pdf*

3.4.3 INFRASTRUCTURE

The term 'Infrastructure' has been used to describe the underlying framework of features and systems serving an area, such as transport and telecommunications that are deemed essential to the stability and future growth of the East Midlands.

Transport Infrastructure

The East Midlands, along with the South West Region, has seen the highest growth in traffic in the UK between 1995 and 2006, with an increase of 21% on major roads[27]. Furthermore, the Government's Transport White Paper[28] forecasts that personal motor travel and road freight in the UK will continue to increase, with traffic levels expected to increase by 40% between 2000 and 2025.

The Transport White Paper emphasises that while there is a growing demand for transport, providing more capacity on our roads and railways, it is not a long term solution as the damage to the country's environment, including landscape character, would be unacceptable. Transport based policies in the Regional Plan therefore generally encourage development of sustainable transport modes, reducing the need for travel and improving opportunities for walking, cycling and public transport. However, this does not exclude proposals for new transport infrastructure and a number of major road/rail improvements projects are identified, along with proposals for several new bypass schemes. Some schemes, such as improvements to the A46 between Newark and Widmerpool, have already been approved and are under construction. In particular, traffic and congestion is a problem in and around the Three Cities Sub-Area (Nottingham, Leicester and Derby) and funding has been allocated to investigate improving roads and public transport in the sub region.

Potential future expansions may also be considered at the East Midland Airport. Such development may increase the overall footprint of the airport and associated transport infrastructure, as well as increased noise and lighting associated with aircraft movement. Any improvements will need to be carefully considered in relation to the potential impact on landscape character.

M1 Motorway through Charnwood Forest, Leicestershire (© Leicestershire County Council)

The Regional Plan also makes provision for five new strategic distribution centres at several locations across the region. While priority will be given to rail-based sites these will operate at inter-modal terminals and will require good access to the highway network. These major infrastructure projects could potentially have significant impacts on landscape character and historical resources and need to be planned, designed and managed carefully.

Minor road improvements can also affect landscape character, especially in rural areas. In particular, the insensitive use of kerbs, road markings, street furniture and signs all bring a degree of standardisation to the countryside, which can erode distinctive features of local character.

It is not only the character of the terrestrial landscape that is influenced by a growing demand for transport. The Southern North Sea, the area

27 *East Midlands State of the Region Report (2008) - http://www.emra.gov.uk/files/sor_2008-_full_report.pdf*

28 *The Future of Transport: a network for 2030 (2004) - http://www.dft.gov.uk/about/strategy/whitepapers/fot/*

of sea off the Lincolnshire coast extending from Flamborough in the north to Dover in the south, contains some of the world's busiest shipping lanes[29]. The continued growth of the petroleum industry in particular, has had a significant effect on shipping, increasing the number of vessels passing through the area. Shipping can have a significant impact on tranquillity and visual amenity, especially around main fishing ports. There is also increased risk of environmental damage from additional vessels. However, shipping is responsible for a relatively small proportion of all marine pollution in the UK, with much of the pollution being traced back to centres of population and industrial and agricultural operations.

Transmission Lines and Communication Masts

Overhead transmission lines and communication masts can impair views and visual amenity. The Government has published a draft for consultation on a new national Policy Statement on the future development of the nation's electricity transmission network for new electricity lines with a voltage of higher than 132 kilovolts (kV), and which could result in growth and reinforcement of electricity transmission lines. Work is ongoing to identify solutions which will allow the creation of a network which facilitates the achievement of Government's energy and climate change policy in an economic and efficient manner. This includes the achievement of the 2020 renewable targets as well as ensuring that electricity supply remains secure and affordable.

In the absence of regional or sub regional guidance or specific development proposals, it is not possible to determine the full impact of new transmission lines or masts. However, they can have an urbanising effect on areas which are remote and rural in character. Careful consideration should be given to siting, potential to underground lines, use of materials and shared use of infrastructure in order to minimise adverse effects.

As major transmission lines often extend across the region, there is potential for the development of a strategic regional and sub regional approach and guidance to accommodating new transmission lines. In view of its regional perspective, the findings of the EMRLCA could play an important part in helping to inform such guidance.

3.4.4 ENERGY

As described in the East Midlands Regional Energy Strategy[30], the Government has adopted a 10% renewable energy target to 2010 and a 20% target by 2020. Renewable energy currently only contributes 1.4% to the region's energy generation capacity, so the East Midlands will need to see a significant increase in renewable technology. The Regional Plan sets targets for renewable energy sources including micro-generation, biomass and wind energy schemes. While micro-generation and biomass schemes have the potential to change the landscape, it is wind energy schemes that are likely to have the greatest impact due to their scale.

The majority of the region's wind turbines are located in Lincolnshire, taking advantage of the coastal winds. The landscape of the Lincolnshire Coast is therefore experiencing the greatest degree of change. The Yes2Wind website[31] lists eleven onshore wind energy schemes in the county, with a further thirteen proposed (accurate at July 2009). It is notable that the AECOM study commissioned by EMRA[32] predicts that two-thirds of renewable energy in the region will come from onshore wind in future, equivalent to 159-310 turbines or 16-30 wind energy schemes by 2031. As targets for renewable energy sources rise, along with obligations on suppliers and subsidies for developers to source a certain percentage of electricity from renewable sources, it seems likely that there will be an increase in wind energy schemes away from the coast in rural and urban fringe areas. Upland areas in particular, which are

29 *The Southern North Sea Marine Natural Area: A contribution to regional planning and management of the sea around England (2004) - http://www.naturalengland.org.uk/ourwork/conservation/biodiversity/englands/marinenaturalareas.aspx*

30 *The East Midlands Energy Challenge: The Regional Energy Strategy (2004) - http://www.emra.gov.uk/files/energy-strategy-part1.pdf*

31 *http://www.yes2wind.com/*

32 *Faber Maunsell/AECOM. Reviewing Renewable Energy and Energy Efficiency Targets for the East Midlands. Final Report for EMRA. June 2009.*

the windiest areas of the region outside the coast, are likely to be under pressure to accommodate new installations. Whilst wind energy schemes are of obvious benefit in reducing environmental impacts associated with energy production, they have the potential to impact on landscape character including the cumulative impact of intervisible windfarms. Wind turbines and associated infrastructure can also change the perception of scale in the landscape and sense of tranquillity and remoteness.

In view of the increasing pressure for the establishment of wind energy schemes in the region, both onshore and offshore, a regional and sub regional strategic guidance to accommodating commercial wind energy in the region would be helpful. The findings of the EMRLCA can have an important role in helping to inform such guidance as a result of its regional approach and perspective.

In relation to the Peak District National Park, a Peak Sub Region Climate Change Study was published in 2009,[33] focusing on the capacity and potential for renewables and low carbon technologies, and incorporating a landscape sensitivity study of the area.

Small scale wind initiatives are also an important consideration. As technology improves and the cost of implementation falls, there is likely to be a growing demand amongst private land holders and communities for micro-generation. The incremental effects of such developments will require careful consideration.

In addition to wind energy schemes, the region is pursuing a range of initiatives to reduce energy demand and consumption. Priorities include:

- Reducing the need for energy;
- Using energy more efficiently;
- Using energy from renewable sources; and
- Making clean and efficient use of fossil fuels.

Wind turbines near Depping St Nicholas, Lincolnshire (© Wash Estuary Strategy Group/A Lambert)

Of particular relevance to landscape character is the use of biomass from forestry residues and energy crops, all of which are a major resource in the region. The production of energy crops in particular can dramatically change the landscape; this is discussed in more detail under the heading 'Agriculture, Land Management and Fishing'. There are also a number of sites considered suitable for small scale hydro and solar energy production.

In relation to the seascape, the British Wind Energy Association (BWEA) website[34] lists two existing offshore wind energy schemes and a further two under construction, approximately 5km from Skegness. The Government has also identified the area around The Wash as of national importance for offshore wind power, and a further five sites are awarded i.e. allocated for future development. Furthermore, the Southern North Sea contains a series of gas fields which are licensed for extraction. The process of granting new licences, or the abandonment and decommissioning of existing infrastructure, can have significant impacts on seascape character, marine habitats and visual amenity.

33 *Peak Sub Region Climate Change Study, Peak District National Park, 2009*
34 *http://www.bwea.com/*

3.4.5 MINERALS AND WASTE

The mineral resources within the East Midlands Region are extensive and varied as a result of the wide ranging bedrock geology as well as superficial deposits. The principal resource can be divided into four main categories. Firstly, energy minerals, principally comprising coal, together with localised and smaller quantities of oil and gas; secondly, aggregates consisting of a range of materials: sand and gravel derived from both superficial deposits and bedrock, and crushed rock from dolostone, limestones, sandstone and igneous rocks; thirdly, building materials: brick clay, building stone, fireclay (building products), roofing slate, cement, and materials for more specialist markets, including pottery and gravestones; and finally, metal and other ores: iron, lead, copper, barite, fluorspar, calcite and calcium carbonate. From a geodiversity perspective, around 60 different minerals have been found in the rocks of Charnwood Forest. In addition to these main categories, smaller quantities of gypsum, high purity limestone, and locally distinctive building stone are extracted and distributed to more specialist markets. Mudstones from the Mercia Mudstone Group have also been extensively worked across their outcrop as a source of 'marl' or clay. This was often used to help improve light gravel soils.

The region has been a major producer and exporter of primary aggregates and high quality minerals for a long period, and continues to make a significant contribution to the UK's mineral production. There are consequences associated with this activity, however. The legacy arising from earlier periods of working, notably the decline of the coal industry, has both physical and social manifestations. There are also current and future effects of the continuing extraction, notably direct changes to the landscape during and after the extraction process, as well as indirect effects associated with the demands on the transport infrastructure particularly in rural areas and on tranquillity. It is notable, however, that around 1,150ha of mineral worked and derelict land has been restored to woodland and other habitats and recreation use in The National Forest.

Energy Minerals

Coal: The region has a long history of coal mining linked to its extensive coal reserves. North East Derbyshire was the region's principal area of coal production, although extraction was also widespread in Nottinghamshire within the concealed coalfield, and also in Leicestershire and South Derbyshire. More recently, the Asfordby Coalfield (Leicestershire) was worked for a very short period. The deep-mine coal industry has seen major contraction since the early 1990s, leaving a legacy of dereliction and removal of formerly widespread infrastructure such as mines, bell-pits, tips, railways and railway yards. Subsequently, large-scale programmes of reclamation of coal spoil heaps and other industrial dereliction have changed the appearance of the landscape, creating an emerging juvenile landscape with a mosaic of new farmland, open spaces and areas of built development. Nevertheless, the legacy of the coal mining industry is of industrial archaeological interest and headstocks such as at Snibston and Pleasley are now designated as Scheduled Ancient Monuments.

The closure of many collieries across areas of Nottinghamshire, Leicestershire and Derbyshire has had devastating impacts on local communities, and proposals seek to develop new industrial or commercial sites as a catalyst for economic regeneration. Examples of regeneration schemes include Markham Vale, an 85 hectare business park centred around the mostly derelict Markham Colliery Site, and the innovative Sherwood Energy Village, a mixed use development that has been established in response to the closure of Ollerton Colliery. The establishment of The National Forest is also linked to the wider regeneration of the coalfield area.

While there are relatively few applications for deep-mine workings, there is continued pressure for open-cast coal mining although overall this has declined. Open-cast mines can recover a greater proportion of the coal deposit than underground methods and are therefore more economically viable. This method can result in significant environmental disruption as well as social impacts unless carefully controlled.

Oil and Gas: Although a more limited resource at a regional level, Lincolnshire, Leicestershire and Nottinghamshire support, or have supported, a number of onshore oilfields which cumulatively make a modest contribution to total output. Welton oilfield, north east of Lincoln, is one of the largest onshore oilfields in the UK; others include Gainsborough, Whisby / Doddinton and Saltfleetby. Methane gas is worked as coal mine methane and abandoned mine methane at four localities in Nottinghamshire. The continuing demand for energy may precipitate further exploration for these resources and hence the potential impact of future sites.

Aggregates

The East Midlands region is both the largest producer and exporter of aggregates in the country dispatching over 50% of the output to other regions.

Sand and Gravel: Sand and gravel extraction is widespread across the region. The Trent Valley is the principal extraction area with quarries located along the valley from south of Derby in a broad sweep extending north eastwards to the region's northern boundary. Quarries are also located within the Trent's tributaries, the Dove, Idle, Soar and Wreake. The Nene Valley in Northamptonshire is also an important source of sand and gravel. In the past, areas of glaciofluvial sand and gravel have been worked for aggregate.

Where workings have taken place in these rivers, much of the floodplain is dominated by active gravel working, the lakes created on former workings and backfilled quarries. Mitigation measures for gravel extraction, often fringed by poplars, do not always suit the character of the landscape; however, in some areas new recreational and nature conservation sites have developed. For example, the lakes in the Nene Valley are now recognised for their exceptionally high biodiversity interest for migrating or overwintering fowl with a number of lakes designated either as SSSIs or SACs.

Sand and gravel extraction also occurs in the Southern North Sea. As pressure on land-based sources continues to increase, there is likely to be an increase in marine dredging for sand and gravel. In addition to the sand and gravel derived from superficial river deposits, the Sherwood Sandstone that outcrops in Nottinghamshire is an important source of silica and has more specialist uses including the glass industry.

Hard Crushed Rock: Crushed rock aggregates output in the East Midlands amounts to 33% of English production. This reflects the availability of suitable hard rocks at or near the surface, coupled with the convenient geographical location of the region.

Igneous rocks are currently extensively worked in and around Charnwood Forest in Leicestershire, producing in excess of 10 million tonnes of aggregate each year. The quarry at Mountsorrel is one of the largest aggregates quarry in the UK. The rocks quarried include intrusive igneous rocks and Charnian volcaniclastic sediments. The crushed stone is exported by road and rail to many areas of England as this is the main source of this type of aggregate.

The region supports a wide range of limestones attributable to the different geological rock formations. Derbyshire and the Peak National Park together produce more limestone than any county in the UK and from some of the largest quarries in Europe. These Carboniferous Limestone quarries are concentrated around Buxton and Wirksworth. Much smaller quarries exploiting the same rock are also found elsewhere in Derbyshire, and in Leicestershire at Breedon Hill and Cloud Hill. Other limestones comprise the 'Magnesian Limestone' in Derbyshire / Nottinghamshire, such as at Bolsover Moor Quarry, and the Ooidal Jurassic Limestone that outcrops in Northamptonshire, Rutland and across Lincolnshire. The principal Jurassic Limestone quarries are worked extensively from Lincoln southwards along the Lincolnshire Edge, into the South Lincolnshire Uplands and Rutland. Chalk is also quarried in the north east of the region, with a notable quarry at Mansgate Hill Quarry. As well as their use as a crushed aggregate, limestones have been quarried for a variety of uses, including cement, building stones and lime.

Quarry at Breedon on the Hill (© English Heritage)

In general, the high demand for aggregates has important implications for the landscape, creating visual intrusion, resulting in the loss of surrounding landscape features, and reducing the sense of tranquillity and remoteness. Abandoned quarry and mining landscapes are commonplace, leaving a permanent mark on the landscape. When land based mineral extraction is complete, restoration of sites can provide a range of opportunities for new uses; however, this can take a considerable amount of time. The sites can form an important geodiversity resource that can be used for teaching at all levels, scientific research and leisure. Proposals for agriculture, forestry, wildlife habitats or recreation can have a positive impact on landscape character, and play an important role in recognising the area's industrial heritage. However, reclamation schemes which introduce permanent structures, infrastructure and facilities have the potential to erode rural character and nature conservation value.

Building Materials

Brick Clay: Many of the mudstone formations in the East Midlands have been worked for brick clay in the past. In many cases, bricks were sourced from a pit dug close to new buildings. Today, the main focus of the industry is in the red and green mudstones, siltstones and sandstones of the Mercia Mudstone Group in west Leicestershire and Nottinghamshire, with Ibstock being the best known. Coal Measures mudstones are worked for bricks in Derbyshire.

Building Stones: A wide variety of hard rocks has been used as building stones in the region. These include the Charnian and igneous rocks of Charnwood Forest, the 'Magnesian Limestone' (Bulwell Stone), the Carboniferous Limestone and Millstone Grit for buildings and dry stone walls, Jurassic Limestones, sandstones and ironstones, notably the Lincolnshire Limestone, Northampton Sand and Marlstone Rock Formations and Triassic sandstones. There are currently no specific building stone quarries open, although some quarries provide it as a sideline and there are operational quarries in Derbyshire with permission for 'block stone' production. With the increasing drive towards the conservation of old buildings and using original materials for repair work, there may be economic incentives for quarries to reopen in the future.

Fireclay: Fireclay has been extensively quarried in the Derby and Swadlincote areas as a source of pottery clay and around Derby, it has been used for china. The Swadlincote industry centred more on industrial pottery such as roofing materials, pipes and sanitary ware . Other historical pottery industries include the Ticknall pottery of South Derbyshire. This industry flourished from the 15-19th centuries and its remains can still be found in the fields around the village.

Roofing Slate: Roofing slate has been quarried in two areas of the East Midlands. Probably the most famous is the Swithland Slate industry in Charnwood Forest. The first recorded working of this industry dates back to Roman times. The industry thrived until the middle of the 18th

century, when with the advent of the railways, cheaper Welsh slate flooded into the area and the industry rapidly died. Also quarried for roofing tiles was the Collyweston Slate. Not a true slate, this is a fissile limestone from the Lincolnshire Limestone. These are one of the most distinctive and familiar features of the historic towns and villages around the village of Collyweston in Northamptonshire. The area where they are found includes North Northamptonshire, South Lincolnshire, Rutland, and north west Cambridgeshire. There is evidence to show that the Romans used it a as a roofing slate, with a well organised industry in medieval times. Like the Swithland Slate, the incoming of the Welsh slate marked the end for the industry.

Cement: The East Midlands is an important cement-producing region accounting for approximately 25% of UK output. Cement manufacture occurs at three localities in the East Midlands region, at Hope and Buxton in the Peak District and at Ketton, near Stamford. This latter quarry works the Lincolnshire Limestone Formation as the limestone component and the Rutland and Blisworth Clay Formations as the clay fraction. The quarry boasts the exposure of a complete sequence through the Middle Jurassic of the East Midlands, with the lowermost Upper Jurassic and upper most Lower Jurassic also exposed. Past cement workings were in the basal limestone-mudstone sequence of the Lias Group at Barnstone in Leicestershire.

Gravestones: The Swithland Slate was also extensively used for gravestones and many graveyards in and around Charnwood Forest display fine examples of the stone. Like the roofing slates, its use declined with the introduction of cheaper Welsh slate. Gravestones have also been responsible for yielding the first fossils, comprising burrows, to be found in the Swithland Slate.

Metal, Other Ores and Specialist Materials

Iron Ore: Iron ore has been extensively quarried in the region in two main areas: the Marlstone Rock Formation of Leicestershire and the Marlstone and Northampton Sand Formation of Northamptonshire. These mainly supplied works in Holwell in Leicestershire and the Corby Steel Works in Northamptonshire. The iron production industry in the Corby area goes back at least to Roman times, using charcoal from the Rockingham Forest. Where the ironstone gullets have not been infilled, they remain a feature in this part of Northamptonshire and many are now designated as SSSIs/SINCs. Small scale extractions of iron ore have also occurred in the Derbyshire coalfield.

Lead: Lead mining in Derbyshire has been traced back to the Bronze and Iron Ages. It is documented from the 12th century and in particular at its peak in the 17-19th centuries. The source of the lead is the Peak Limestone Group (Carboniferous Limestone) in the Peak District, with some very local sources such as at Dimminsdale in South Derbyshire. Most of the mining was undertaken by the sinking of bell pits. These workings have had a dramatic impact on the local landscape and the lead rakes that are visible today are a tangible reminder of past mining activity.

Gypsum: Gypsum occurs extensively in the Mercia Mudstone Group. Two thick workable seams occur in the Tutbury and Newark gypsums, and are extensively mined and quarried in Nottinghamshire and Leicestershire. .

Other ores worked in the East Midlands include copper; fluorspar, mainly used in the production of hydrofluoric acid; barite, mainly used as a weighting agent for drilling fluids in oil and gas exploration; calcite, used as decorative stone; and calcium carbonate, used as industrial fillers and coatings.

Landfill and Waste

There is a growing movement towards the adoption of sustainable waste management systems, primarily being driven through policy and legislation at the European level, such as the Waste Framework Directive and Landfill Directive. The Regional Waste Strategy (RWS) sets out the priorities and targets for waste management, including zero growth in waste at the regional level, reducing the amount of waste accommodated in landfill sites and increasing the amount of waste recycled and composted. The RWS also establishes current and future trends in the region; waste arisings were estimated to be 25.6 million tonnes in 2004, rising to 39.4 million tonnes by 2020 if recovery, recycling and minimisation measures are not employed.

Considering current legislation and policy, the East Midlands looks set to experience rapid development of waste recovery/treatment infrastructure. Impacts are likely to be minimised by proposals representing extensions to existing industrial areas and waste management sites; however, new facilities can be intrusive in a landscape that is particularly remote and rural in character. New facilities also generate significant heavy goods traffic, placing further pressure on the landscape.

The RWS also indicates that the region has limited capacity in its remaining landfill sites. Should waste management practice continue in its current form, it is estimated that capacity will be exhausted in under 8 years and new landfill sites or extensions to existing facilities will need to be found. While the disposal of waste by landfilling in disused mineral workings provides a means of waste management, the lack of inert waste available for use in the reclamation of gravel extraction pits is a limiting factor. This in turn increases the pressure for restoration to water and wetland features within the river valleys and resultant change in landscape character.

There are conflicts between use of old quarries as landfill sites and the desire to preserve them for their geodiversity, recreational, education and tourism resource value. It should be possible for the relevant organisations to work together to achieve all uses; careful landscape restoration of landfill can, in some cases, improve access to former quarry faces, although each proposal should be considered on individual merits

3.4.6 AGRICULTURE, LAND MANAGEMENT AND FISHING

Over 1.2 million hectares of land is used for agriculture in the East Midlands, accounting for approximately 80% of the region's land use[35]. Farming is mainly arable with combinable crops (that is, crops harvested by a combine harvester), accounting for approximately 50% of the region's agriculture area. Grassland and forage (pasture) for livestock is less extensive, but still constitutes over 30% of the agricultural area. Nevertheless, there are notable regional variations, for example, Derbyshire supports a much higher percentage of pasture than the regional average. Other agricultural uses, such as root crops, horticulture and fruit are more localised features[36].

Pasture for livestock in the Peak District, Derbyshire (© English Heritage/J Humble)

35 *Environment Agency - http://www.environment-agency.gov.uk/research/library/publications/41157.aspx*
36 *State of Farming in the East Midlands (2006)*

Agriculture therefore plays an important role in safeguarding the environment, landscape and rural economy; however, the rural landscape of the East Midlands remains under pressure from modern farming practices that threaten to erode local distinctiveness and bring about a degree of standardisation in areas that once were busy and dynamic. Most modern agriculture is based on intensive practices, with an increasing number of farms concentrating on a small number of products to increase efficiency[37]. The process of intensification and specialisation has led to the loss of landscape features, in particular hedgerows, stone walls, field margins and orchards, and introduction of new features such as large agricultural storage sheds and vast fields of single crops, which has altered landscape and biodiversity character.

Changes in management practices can also threaten the natural environment. For example, pesticide and fertiliser applications can reduce the species diversity of field boundaries, whereas intensive stock rearing can cause soil erosion. Indeed, in upland areas of the region, increased grazing pressure is typical, resulting in the loss and fragmentation of semi-natural grassland, heathland and woodland. In lowland areas of the region, under-management is common, with isolated habitats resulting from intensification, being left to decline.

Farmers are increasingly responding to these challenges with support from Environmental Stewardship; an agri-environment scheme which provides funding to farms and land managers to deliver effective environmental management on their land. In relation to the East Midlands Region, as described by the 'Rural East Midlands' report[38], since Environmental Stewardship was launched in 2005, over 500,000 hectares of land has been entered in to the Entry Level Stewardship (basic environmental management, over a 5 year period).

Furthermore, as of July 2006, the East Midlands Region had one of the highest uptake of Entry Level Stewardship in England, second only to the East of England. Examples of projects undertaken in the region include the creation or enhancement of footpaths, hedgerows, dry stone walls and educational access visits.

In addition, over 9,000 hectares of land has been entered into Higher Level Stewardship (HLS), comprising more complex environmental management, over a 10 year period. A wide range of management options are promoted, which are targeted to support key features of the different areas of the English countryside. To further increase the environmental benefits delivered through HLS, Natural England has produced targeting maps, drawing together information on biodiversity, landscape, natural resource protection, public access and historic interests. In the East Midlands, target areas include the Peak District, Lincolnshire Wolds, Sherwood Forest, the Trent Valley, Soar Valley and Charnwood Forest. This will seek to ensure that the most appropriate management activities are undertaken in each area, and contribute to the enhancement of landscape character.

There is likely to be a continued growth in rural diversification, leading to changes in land-use and increased development pressure in rural areas. Indeed, in response to the launch of the Rural Development Programme for England (RDPE) - a new programme to support social and economic development in rural areas, which will run between 2007 and 2013 – EMDA have published the RDPE East Midlands Implementation Plan[39]. While a variety of projects will be supported, specific targets include investment in renewable energy sources and diversification into alternative or non-agricultural activities.

Support for energy crops in particular is likely to change the agricultural landscape of England, with predictions that biomass crops could cover 20% of farmland by 2040[40]. Under the RDPE grants are available for both Short Rotation Coppice (SRC) and

37 *State of the Natural Environment 2008 - http://www.naturalengland.org.uk/publications/sone/sections.aspx*
38 *The Rural East Midlands in 2008 - http://www.emda.org.uk/documents/doclist.asp?action=display&filevar=240*
39 *RDPE: East Midlands Regional Implementation Plan 2007 – 2013 (Draft) - http://www.goem.gov.uk/goem/env-rural/reg-rural/ruralprog0713/*
40 *The Future Character and Function of England's Landscapes (2006)*

Miscanthus, both of which are fast growing, tall energy crops. The Department for Environment, Food and Rural Affairs (DEFRA) has developed a set of regional maps identifying opportunities and optimum sitings for energy crops in England. In the East Midlands, much of the region is considered as having high to medium potential, and careful consideration will need to be given to the environmental impacts of such schemes.

In addition to the changing farming practices described above, there is a growing awareness in the region of the multifunctional benefits of the natural environment and the need to take a coordinated approach to land management. The East Midlands Biodiversity Strategy[41] promotes the creation of a green infrastructure network; a range of interlinked urban and rural assets which have a primary or contributory role for biodiversity, but also provide other benefits, such as flood control, climate amelioration and access to the countryside. The East Midlands Soil and Environmental Resource Review[42] further explores the idea of environmental infrastructure and the link between soil, habitats and landscape. The 6Cs Green Infrastructure Strategy will also add to a suite of studies that are likely to encourage landscape-scale projects, which offer greater potential for landscape protection, planning and management.

In relation to the sea, the East Midlands Region is an important area for fishing activity. In particular, trawling for shrimp occurs along the Lincolnshire coast and in The Wash and dredging for mussels and cockles within the intertidal area of The Wash. While fishing activity is vital for the socio-economic health of fishing communities, it has both direct and indirect impacts on the seascape of the East Midlands, including disturbed seabed and surface sediments, mortality and removal of fish and other non-target species and fishing debris including nets, boxes and buoys. Fishing debris in particular, along with the movements of boats and trawlers, has an impact on visual amenity and tranquillity.

Fishing boats in Boston Harbour, Lincolnshire (© Wash Estuary Strategy Group/P Smith)

3.4.7 FORESTRY AND WOODLAND

The East Midlands Region has approximately 80,000 hectares of woodland. Over 60% of this is broadleaf, less than 20% is conifer and the remainder is mixed woodland and associated habitats. There are almost 6,500 woods over 2 hectares in size in the region and the average woodland covers around 11 hectares. However, as described by The Regional Forest Framework for the East Midlands[43], there are wide variations in woodland cover between counties, with 8% cover in Nottinghamshire and just over 3% in Lincolnshire. Furthermore, the East Midlands is the least wooded region in the country with around 5% cover - well below the national average for England of 8%.

In the past, major efforts have been made to increase the woodland cover of the East Midlands, with over 7,000 hectares planted through initiatives such as The National Forest and Community Forest Schemes. Within The National Forest, 6,000 hectares of woodland has been created, resulting in an increase in woodland cover from 6% to 18%. The Regional Plan continues to promote the creation of new woodlands, highlighting the wide range of social, environmental and economic benefits new woodlands can offer. These are most

41 *Putting Wildlife Back on the Map: A Biodiversity Strategy for the East Midlands (2006)*
42 *East Midlands Soil and Environmental Resource Review (2006)*
43 *Spaces4Trees: The Regional Forest Framework for the East Midlands - http://www.space4trees.org.uk/*

likely to be concentrated around urban areas, either as part of new developments or urban expansions, where they can contribute to the development of green infrastructure. Providing they are carefully planned and designed, new woodlands have the potential to positively impact on landscape character, and create well defined urban edges.

Major Oak, a popular attraction at Sherwood Forest Country Park, Nottinghamshire (© P Wakely)

Existing woodlands, such as Sherwood Forest and Rockingham Forest, are increasingly likely to be managed for multi-functional benefits. Similarly, the Charnwood Forest Regional Park Initiative will also provide a focus for multi-functional uses and benefits. Indeed, the Regional Plan states that existing woodlands can make significant contributions to landscape, biodiversity, and recreation, as well as stimulating the economy through tourism, employment and creating an attractive setting for investment. As such, careful management is required to balance these competing interests and guard against damage or fragmentation. The management of ancient woodlands is particularly important, as these typically have long associated heritage and biodiversity interest.

Many incentives are available for planting and managing new and existing woodlands. The Forestry Commission operates the English Woodland Grant Scheme and is supported by the East Midlands Regional Plan. The aim of the English Woodland Grant Scheme is to sustain and increase the public benefits given by existing woodlands and help create new woodlands to deliver additional public benefit[44]. A variety of grants are also available for farm woodland under the Environmental Stewardship programme, as described under 'Agriculture and Land Management'.

The East Midlands has an aging population of woodland and trees and a large number of them are being lost to damage and decay. In urban areas, public open spaces and alongside highways, many individual trees have been removed in recent years due to concerns about public safety and liability.

The implications of climate change may also affect woodland and tree cover as a result of pests and disease and a greater degree of stress caused by drought and flood events. However, trees and woodlands also have a valuable role to play in the mitigation of climate change impacts. In the right places they aid the management of surface water run-off and provide shade, shelter and humidity in urban microclimates. They also offer an important alternative source of renewable energy, and Government incentives are available to manage woodlands for short rotation coppice and wood fuel as biomass crops to meet renewable energy targets. This has the potential to significantly change the pattern and type of forestry in the region.

3.4.8 TOURISM AND LEISURE

Tourism includes travel and visits for business, professional and domestic purposes as well as for holidays and recreation. It is a key driver for the regional economy and in 2002 was worth approximately £5 billion to the East Midlands and contributed 3.5% to the region's GDP[45]. As such the East Midlands Regional Plan proposes growth in the tourism industry to capture the economic benefits and improve the quality of life in the region.

44 *http://www.forestry.gov.uk/forestry/infd-6dccen*

45 *East Midlands Regional Plan (2009) – http://www.gos.gov.uk/497296/docs/229865/East_Midlands_Regional_Plan2.pdf*

However, many of the areas of the region that are attractive for recreation, leisure and tourism are also important for their landscape heritage, geodiversity and nature conservation interests. Attractions include The Peak District National Park, Sherwood Forest, the Lincolnshire Coast and a variety of historic towns and villages and historic houses and parklands.

There is a need to strike a balance between increasing visitor numbers whilst limiting disturbance and damage to these sites. Furthermore, a large proportion of tourists are also day visitors. As stated in the East Midlands Tourism Strategy[46], over 90% of visits are day trips, with only 10% staying trips. The large number of day visitors means the environmental impact is also proportionally large, particularly in terms of additional car traffic, and this may have significant impacts on landscape character. Specifically, the Tourism Strategy and the Regional Plan identifies a number of major project opportunities in the East Midlands, and seeks to build upon the environmental and recreational offer of a number of locations, including:

- River Trent;
- Rockingham Forest;
- The Fens;
- The Lincolnshire Wolds;
- The National Forest;
- Charnwood Forest; and
- The 'Welland Vale' – the 'Cotswolds of the East'.

These strategies, whilst of obvious benefit to the tourist economy through increasing visitor numbers, will need to be carefully considered in terms of the tranquillity and remoteness of the existing environment. Increases in traffic, road improvements and car parking, litter, signage and built development may threaten visual amenity and landscape character and the very features of the region that attract visitors.

Opportunities to improve the recreation offer of the Lincolnshire Wolds (© Lincolnshire Wolds Countryside Service/D Furlong)

Indeed, many areas in the region have already been heavily influenced by existing tourist and leisure facilities. For example, the Lincolnshire coastal resorts account for a large proportion of the region's tourism and are home to large number of amusements, caravan / camp sites and static caravan parks. Elsewhere, the Peak District National Park and Sherwood Forest, and its association with the legend of Robin Hood, are major tourist destinations, attracting large number of visitors and supporting associated shops, attractions and accommodation. The National Forest is also a major visitor destination, attracting over 7.5m people. The Charnwood Forest Regional Park initiative has also been established in recognition of the unique qualities of Charnwood Forest. This non-statutory partnership led initiative recognises the need for the protection and enhancement of the area and for a co-ordinated approach to the development of plans and policies focused on the area.

An increasing emphasis is now being placed on sustainable and green tourism. As described in the East Midlands Tourism Strategy, the region is distinguished by a blend of diverse natural and historic assets. Preserving and enhancing the quality of the environment is critical to the region's future success as a destination, and a 'greenscape' theme underpins the strategy. Indeed high priority is given to habitat enhancements such as the creation of green corridors and woodland screening

46 *Destination East Midlands: The East Midlands Tourism Strategy 2003-2010 (2003)*

along transport routes and adjacent to built attractions. Providing non-car transport alternatives is also a key priority, minimising the number of car journeys and the impact of car parking in sensitive locations, whilst supporting the growing demand for walking, cycling and riding. Such measures will help ensure strategies to increase visitor numbers and/or develop new facilities and infrastructure will avoid significant impacts on the environment.

3.4.9 ENVIRONMENTAL PROCESSES AND CLIMATE CHANGE

The UK climate has varied greatly over time due to natural causes, but human activities, in particular the emission of greenhouse gases from agriculture, industry and waste disposal, are now believed to be causing major changes to the climate. Scientific evidence suggests that it will influence a great many physical, chemical, biological and human activities which have the potential to result in significant changes to the appearance, and therefore the character, of the landscape.

In the East Midlands it is expected to become wetter in the winter and drier in the summer. There will be an increased risk of extreme weather events such as storms, floods and droughts. The UK Climate Impacts Programme (UKCIP) has used computer modelling to predict changes in the climate change in the UK using two different scenarios, one using high emissions of greenhouse gases and the other using low emissions. The model predicts that, if we continue to discharge large amounts of greenhouse gases, by 2050 the following conditions will apply in the East Midlands[47]:

- Annual mean temperatures could rise by up to 2.3°C, with increases greater in the south of the region than in the north;
- Winter rainfall could increase by up to 13%;
- Summer rainfall could decrease by up to 18%; and
- Sea levels on the East Coast could rise by up to 83cm.

And by 2080:

- Average annual temperatures may increase by up to 5°C;
- Winter rainfall may increase by up to 30%; and
- Summer rainfall may decrease by as much as 60%.

The East Midlands Sustainability Round Table published a report highlighting the potential impact of climate change in the East Midlands[48]. Issues of most relevance to the landscape character of the region include:

Built development

- Increased development on land away from locations such as river corridors and low lying areas that are at risk from flooding; and
- Sustainable design and layout of new development to result in less use of water, energy and raw materials.

Infrastructure

- Pressure for renewable energy infrastructure, such as wind turbines, to reduce emissions; and
- Demand for new coastal and riverine defence works in response to tidal surges and high waves.

Minerals and Waste

- Reducing the amount of waste landfilled and increasing the amount of waste recycled and composted.

47 *http://www.environment-agency.gov.uk/research/library/publications/41159.aspx*

48 *The Potential Impact of climate change in the East Midlands (2004) - http://www.emra.gov.uk/publications/regional-communities-policy/climate-change*

Agriculture and Land Management

- Increased erosion of upland areas such as the Peak District;
- Increased risk of coastal and river flooding and loss of land as a result of rising sea levels and coastal erosion;
- Changing weather conditions leading to longer growing seasons and the ability to grow different types of crops;
- The introduction of energy crops to provide an sustainable source of fuel; and
- Gradual changes in flora and fauna in response to warmer, wetter conditions and more disturbed weather patterns.

Forestry and Woodland

- Suitability of forest tree species may alter due to changes in climatic conditions; and
- Lengthy periods of drought and dry conditions may lead to an increased risk of upland forest fire.

Tourism and Recreation

- Increased number of visitors to the countryside, and to more sensitive areas such as the Peak District and Lincolnshire Wolds, due to higher temperatures.

Climate Change Initiatives

Climate East Midlands is a regional partnership which is responding to the effects of climate change. They are currently overseeing the implementation of the Regional Programme of Action on Climate Change 2008-2011.

In terms of mitigation and adaptation to climate change, the East Midlands Region has also co-ordinated the development of a number of projects[49], including:

- In April 2007, the East Midlands became the first English region to achieve 100% sign-up by local authorities to the Nottingham Declaration on Climate Change;
- The East Midlands undertook Phase 1 of the UK's first region wide Local Climate Impacts Profile (LCLIP) from July 2008 in each of the region's nine Local Area Agreement areas; this work is ongoing and is now in Phase 4;
- A major study is nearing completion on the Economic Impacts of Climate Change (including sub-studies on adaptation/opportunities) in the East Midlands; and
- EMDA piloted approaches to climate change adaptation business support during 2008/9 and are awaiting the results of an evaluation to see how to take this forward.
- Sherwood Adaptation to Climate Change Study: The study aims to assess the vulnerability of environmental assets within the Sherwood NCA to the impacts of climate change and draw together an integrated set of adaptation responses that will ensure their future survival.

3.4.9 ECOSYSTEM SERVICES

Ecosystem services are the wide range of valuable benefits that a healthy natural environment provides for people, either directly or indirectly. The benefits range from the essentials for life, including clean air and a sufficient quantity and quality of water, food and fuel, and freedom from environmentally triggered hazards to those that improve our quality of life and wellbeing, such as recreation and landscape. They also include natural processes, such as climate and flood regulation.

Ecosystem Services can be classified as follows:

- **Supporting services:** services necessary for the production of all other ecosystem services including soil formation, photosynthesis, primary production, nutrient cycling and water cycling.

49 *http://www.defra.gov.uk/ENVIRONMENT/climatechange/adapt/action/regions/east-mid.htm*

- **Provisioning services:** products obtained from ecosystems, including food, fibre, fuel, genetic resources, biochemicals, natural medicines, pharmaceuticals, ornamental resources and fresh water.
- **Regulating services:** benefits obtained from the regulation of ecosystem processes, including air quality regulation, climate regulation, water regulation, erosion regulation, water purification, disease regulation, pest regulation, pollination, natural hazard regulation.
- **Cultural services:** non-material benefits people obtain from ecosystems through the provision of recreational opportunities, access to tranquillity and recognition of a strong sense of place. It covers benefits such as spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences.

The Ecosystem Services approach is a way of thinking about benefits and services, and a framework for managing environmental systems and achieving the goals of sustainable development. It is now becoming embedded in government policy. Defra sees the approach as playing an important part in securing a healthy natural environment through a more strategic and integrated approach to assist decision-making at all scales. In particular, the approach can ensure the development of multi-functional land use and management that helps secure rich and diverse landscapes fit for the future, thereby matching required functional needs with desired landscapes.

There are both opportunities and challenges associated with identifying existing ecosystem services for large tracts of landscape at the regional scale. Provisioning and regulating services have a spatial dimension and can be interpreted and summarised where existing data exists for those landscapes. However, as supporting services are mainly processes, such as nutrient cycling, they don't necessarily have a spatial dimension or spatially expressed data.

As the landscape is a fundamental functional component of and spatial framework for identifying and managing Ecosystem Services, it follows that the EMRLCA and range of RLCTs provide a valuable basis for understanding and expressing the services operating at the regional level. Water catchment management and flood protection are examples of where a regional level approach to managing ecosystem services is essential. Similarly, the effects of climate change and associated mitigation and adaptation, needs a regional perspective particularly where linked to other major regional changes such as considering the future sustainable management of the Lincolnshire coast, initiatives for woodland planting within the region and large scale development, in particular associated with the Growth Points.

3.5 PERCEPTION OF LANDSCAPE

Following post-war movements to protect the countryside, several areas in England were given protective designation under the National Parks and Access to the Countryside Act 1949. This set out to conserve and enhance certain areas for their natural beauty. The East Midlands contains two nationally designated landscape areas; the Peak District National Park and Lincolnshire Wolds Area of Outstanding Natural Beauty (AONB).

These protected areas and indeed other, non-designated areas such as the Fens, are particularly well known for their strength of character, distinctive identity and ability to evoke strong images in the national consciousness. In some cases the perceptions and images evoked by these areas are based on actual experience of the landscape. However, perceptions have also been shaped by indirect experiences, perhaps through literary associations or exposure in the media.

In contrast to the well known areas, vast tracts of the region are little known or appreciated beyond the people who work and live in them. Indeed, it has been noted[50] that the area of designated land in the East Midlands is the lowest of any of the English regions, which has led some to infer erroneously that the region's landscape is of limited significance.

50 *Annex 1- East Midlands Regional Evidence. Rural Development Programme for England – East Midlands Regional Implementation Plan 2007-2013. East Midlands Development Agency, April 2008*

To develop a more informed evidence base on such perceptions, a qualitative social research study has been prepared by Natural England in 'Capturing the Cultural Services and Experiential Qualities of Landscape' (October 2009) and provides baseline evidence of the cultural services and experiential qualities that landscapes provide to society.

The Natural England's Countryside Quality Counts (CQC) project[51], which measures landscape change for National Character Areas, indicates that, when compared to England as a whole, more Character Areas in the East Midlands are judged to be changing or in a neglected state. This may be linked to the inference that many regard the East Midlands landscape as being of limited significance. Neglect and declining character is perhaps most notable close to large towns and major transport infrastructure; areas that are consistently undervalued or misunderstood. However, whilst these areas may be regarded as of limited value or importance nationally, they are often of significant local value and are highly cherished by communities that live within them or use them for recreation.

It is evident that perceptions of the landscape vary, and that much depends on scale, knowledge and understanding of the issues. Perceptions are also subjective, and their formation dependent on a vast range of cultural and physical experiences and associations. The European Landscape Convention acknowledges this important principle and recognises that all landscape matters equally.

In order to introduce a degree of objectivity into the process of understanding how certain aspects of the landscape are perceived, the Campaign to Protect Rural England (CPRE) has measured the degree of tranquillity across England, based on a combination of datasets and survey information[52] (refer to Figure 15). In comparison with other areas of England, the East Midlands ranks 5th out of the nine identified regions, with the North East being the most tranquil and London the least tranquil. Tranquillity also varies across the region. The east of the region is the most tranquil, with Lincolnshire one of the highest ranked local authority areas in England. Conversely, the west of the region is least tranquil, with Derbyshire identified as one of the lowest ranked areas. This is representative of the remote, rural character of the Fens compared to the heavily industrialised landscape of the Coalfields.

It is notable that The National Forest has received very positive community perceptions of the landscape change that has occurred as a result of The National Forest's creation and implementation of its strategy for woodland creation and management. This perception has been independently verified by a number of studies, notably Growing Places: a study of social change in The National Forest (2006) [53]; Community Perceptions of The National Forest (2008)[54]; and a Citizens Panels research (2008)[55] undertaken by The National Forest local authorities.

The CPRE has also mapped night blight, to show the level of light pollution across England[56]. CPRE is particularly concerned about light pollution because darkness at night and starry skies are two features that make the countryside different from towns and cities. Night blight in the East Midlands generally corresponds to changing patterns of tranquillity; the major urban centres of Nottingham, Derby and Leicester are the most heavily polluted, with Lincolnshire the only area left with true dark skies.

51 *http://countryside-quality-counts.org.uk/index*

52 *http://www.cpre.org.uk/campaigns/landscape/tranquillity/national-and-regional-tranquillity-maps*

53 *Growing Places: a study of social change in The National Forest (2006)*

54 *Community Perceptions of The National Forest (2008), Alison Millward Associates*

55 *Citizens Panels Research (2008), National Forest Local Authorities*

56 *http://www.cpre.org.uk/campaigns/landscape/light-pollution/light-pollution-in-your-area*

3.6 SOCIO ECONOMIC

As described by the East Midlands State of the Region Report[57], the most disadvantaged areas in the region include the major urban centres of Nottingham, Derby and Leicester, districts in the Derbyshire Coalfields area and districts in the Lincolnshire coastal area. The range and extent of inequality is demonstrated by the Index of Multiple Deprivation (IMD), a statistical analysis which combines a number of indicators, covering a range of economic, social and housing issues, into a single deprivation score for areas of England.

The IMD for the region is shown on Figure 16. Large parts of East Lindsey and South Holland Districts show the highest levels of deprivation, suggesting a relationship between deprivation and the most remote areas in the region where there is less access to housing and employment opportunities. Parts of North East Derbyshire, Chesterfield and Bolsover Districts also show high levels of deprivation due to the dereliction and unemployment caused by the decline in the coal and manufacturing industries. Interestingly there is a north south divide within the East Midlands Region, with relatively few areas in the south scoring above the regional average for multiple deprivation. This may be attributed to the frequency of urban centres, providing access to housing, employment and other social infrastructure, along with good connections to London and the South East.

The relative prosperity or poverty of the East Midlands Region is closely linked to trends in the UK and global economy. The cycles of economic decline in the UK, the most recent being the 2008-2009 recession, have significant implications for the built and natural environment and potential effect on landscape character. For example, in relation to built development, as consumer confidence and the lack of available funding decreases, there is likely to be less demand for new housing and employment sites. This may reduce pressure on greenfield sites, but may also prevent the regeneration of disused and derelict land and opportunities for the creation of green infrastructure that can enrich landscape character.

In relation to tourism and leisure, the reduced spending power during an economic downturn is likely to result in more demand for holidays in the UK rather than abroad. The increased visitor numbers may benefit the region's economy by generating income for the upkeep of attractions and supporting tourism industry, such as greater demand for accommodation. It may also provide the catalyst for new 'rural' tourism opportunities linked to farming diversification initiatives. However, this in turn can lead to potential changes in the agricultural landscape through adjustments to the farm plan management. More visitors can also have a negative effect by causing additional disturbance and damage to sensitive areas of landscape, particularly to protected landscapes such as the Peak District National Park and the Lincolnshire Wolds AONB, or intruding into the peace and sense of wildness in the more remote coastal landscapes in Lincolnshire.

As a corollary to this, the East Midlands has the benefit of many areas of accessible woodland, for example The National Forest, Sherwood Forest and Rockingham Forest within the River Nene Regional Park. Emerging Regional Forest Parks are proposed at Sherwood and Charnwood, within which are large areas of woodland as well as country parks. These woodlands and network of country parks provide a valuable social resource, as they are accessible to many urban areas, and for limited cost can provide the physical and emotional benefits of outdoor recreation.

57 *http://www.emra.gov.uk/files/sor_2008_full_report.pdf*