# 1. Biodiversity

## 1.1 Introduction

The overview of plans and programmes and baseline information contained in this section provides the context for the assessment of potential effects of the Licensing Plan proposals on biodiversity and nature conservation. Information is presented for both national and regional levels.

Biodiversity in this context is defined by the ***Convention on Biological Diversity***[1] as "*the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.*" Biodiversity is integral to the functioning of ecosystems and these, in turn, provide 'ecosystem services' which include food, flood management, pollination and the provision of clean air and water.

There are links between the biodiversity and nature conservation topic and other topics in the SEA, including water, soil and geology, land use, and climate change.

## 1.2 Review of Plans and Programmes

### 1.2.1 International/European

The UK is a signatory (along with another 189 parties) to the **Convention on Biological Diversity** , Nagoya, Japan, 2010 which sets out a conservation plan to protect global biodiversity, and an international treaty to establish a fair and equitable system to enable nations to co-operate in accessing and sharing the benefits of genetic resources. The new global vision is: "*By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people*." The parties also agreed a shorter-term ambition to "*Take effective and urgent action to halt the loss of biodiversity, [so] that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing the planet's variety of life, and contributing to human well-being, and poverty eradication*".

In March 2010, the European Union (EU) agreed to **an EU vision and 2020 mission for biodiversity**:

- By 2050, EU biodiversity and the ecosystem services it provides - its natural capital - are protected, valued and appropriately restored for biodiversity's intrinsic value and for their essential contribution to human wellbeing and economic prosperity, and so that catastrophic changes caused by the loss of biodiversity are avoided; and

[1] The convention uses this definition to describe 'biological diversity' commonly taken to mean the same as biodiversity.

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- Halt the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restore them insofar as is feasible, while stepping up the EU contribution to averting global biodiversity loss.

The European Commission adopted a new **EU Biodiversity strategy** to help meet this goal. The strategy provides a framework for action over the next decade and covers the following key areas:

- conserving and restoring nature;
- maintaining and enhancing ecosystems and their services;
- ensuring the sustainability of agriculture, forestry and fisheries;
- combating invasive alien species; and
- addressing the global biodiversity crisis.

There are a number of EU Directives focusing on various types of wildlife and habitat that provide a framework for national action and international co-operation for conservation on land and in the sea. In particular the ***Habitats Directive*** and ***Birds Directive*** include measures to maintain or restore important natural habitats and species including through the designation of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). These Directives are transposed into British law through a number of regulations and planning policy documents. The ***Freshwater Fish Directive*** includes measure on the quality of fresh waters needing protection or improvement in order to support fish life.

The ***Marine Strategy Framework Directive (2008/56/EC)*** requires Member States to develop a marine strategy, including determining Good Environmental Status (GES) for their marine waters, and designing and implementing programmes of measures aimed at achieving it by 2020, using an ecosystem approach to marine management. It takes account both of socioeconomic factors and the cost of taking action in relation to the scale of the risk to the marine environment. The Directive was transposed into UK law by the ***Marine Strategy Regulations 2010***. It requires member states to:

- provide an assessment of the current state of their seas by July 2012;
- provide a set of detailed characteristics of what good environmental status means for their waters, and associated targets and indicators, by July 2012;
- establish a monitoring programme to measure progress by July 2014; and
- establish a programme of measures for achieving good environmental status by 2016.

The UK Marine Strategy Part One addresses the first two of these requirements. Future consultation[2] is planned on:

[2] https://www.gov.uk/government/policies/protecting-and-sustainably-using-the-marine-environment/supporting-pages/implementing-the-marine-strategy-framework-directive

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- proposals for the UK monitoring programmes for good environmental status (Autumn 2013); and
- UK programmes of measures for achieving good environmental status (Autumn 2014).

Under the ***Ramsar Convention***, wetlands of international importance are designated as Ramsar Sites. As a matter of policy, Ramsar sites in England are protected as European sites. The vast majority are also classified as SPAs and all terrestrial Ramsar sites in England are notified as Sites of Special Scientific Interest (SSSIs).

### 1.2.2 UK

***The Wildlife and Countryside Act (1981)*** is the main UK legislation relating to the protection of named animal and plant species includes legislation relating to the UK network of nationally protected wildlife areas: Site of Special Scientific Interest (SSSIs[3]). Under this Act, Natural England now has responsibility for identifying and protecting the SSSIs in England. The ***Countryside and Rights of Way Act (2000)*** (CROW) strengthens the powers of Natural England to protect and manage SSSIs. The CROW Act improves the legislation for protecting and managing SSSIs so that:

- Natural England can change existing SSSIs to take account of natural changes or new information;
- all public bodies have a duty to further the conservation and enhancement of SSSIs;
- neglected or mismanaged sites can be brought into favourable management; and
- new offences and heavier penalties now apply to people who illegally damage SSSIs.

The ***UK Biodiversity Action Plan (1994)*** was the UK Government's response to signing the Convention on Biological Diversity (CBD) at the 1992 Rio Earth Summit. The CBD called for the development and enforcement of national strategies and associated action plans to identify, conserve and protect existing biological diversity, and to enhance it wherever possible. The UK Biodiversity Action Plan was then established to conserve and enhance biodiversity in the UK through the use of Habitats and Species Action Plans to help the most threatened species and habitats to recover and to contribute to the conservation of global biodiversity. In 2002, world leaders agreed in Johannesburg on the urgent need to reduce the rate of loss of biodiversity by 2010, and in 2007, they recognised the need to take action to mitigate the impacts of climate change following the 2005 Millennium Ecosystem Assessment.

Since the publication in 2007 of *Conserving Biodiversity - the UK approach*, the context in which the Convention on Biological Diversity (CBD) is implemented in the UK has changed. Strategic thinking in all the four countries (England, Northern Ireland, Scotland and Wales) has pursued a direction away from a piecemeal approach dealing with different aspects of biodiversity and the environment separately,

[3] As amended by the *Countryside and Rights of Way (CROW) Act 2000* and the *Natural Environment and Rural Communities (NERC) Act 2006*

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towards a new focus on managing the environment as a whole, with the true economic and societal value of nature properly acknowledged and taken into account in decision-making in all relevant sectors. In October 2010, 192 governments and the European Union agreed the ***Strategic Plan for Biodiversity 2011-2020***, with its five strategic goals and 20 new global 'Aichi' targets sets a new global vision and direction. The resulting ***UK Biodiversity Framework*** is designed to identify the activities needed to galvanise and complement country strategies, in pursuit of the Aichi targets. As such, it is an important framework that is owned, governed and implemented by the four countries, assisted by Defra and JNCC in their UK co-ordination capacities. Although differing in details and approach, the four UK countries have published strategies which promote the same principles and address the same global targets: joining-up our approach to biodiversity across sectors; and identifying, valuing and protecting our 'Natural Capital' to protect national well-being now and in the future.

The purpose of this **UK Biodiversity Framework**[4] is to set a broad enabling structure for action across the UK between now and 2020:

i. To set out a shared vision and priorities for UK-scale activities, in a framework jointly owned by the four countries, and to which their own strategies will contribute;

ii. To identify priority work at a UK level which will be needed to help deliver the Aichi targets and the EU Biodiversity Strategy;

iii. To facilitate the aggregation and collation of information on activity and outcomes across all countries of the UK, where the four countries agree this will bring benefits compared to individual country work; and

iv. To streamline governance arrangements for UK-scale activity.

The ***Conservation of Habitats and Species Regulations (2010)*** requires that sites of importance to habitats or species are to be designated and any impact on such sites or species must be considered in regards to planning permission applications.

The ***Environmental Protection Act (1990)*** sets out key statutory requirements for the UK regarding environmental protection (including waste and nature conservation).

The ***Marine and Coastal Access Act (2009)*** sets out a number of measures including the establishment of Marine Conservation Zones (MCZs) and Marine Spatial Plans.

The ***National Parks and Access to the Countryside Act (1949)*** aims to conserve and protect countryside and National Parks through legislation.

The ***Overarching National Policy Statement (NPS) for Energy (EN-1)*** sets out the Government's national policy against which proposals for major energy projects will be assessed and decided on by the National Infrastructure Directorate (NID) within the Planning Inspectorate. The NPS identifies a range of

[4] http://jncc.defra.gov.uk/pdf/UK_Post2010_Bio-Fwork.pdf

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generic impacts that may arise from energy development and associated policy including in respect of biodiversity. The ***National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4)*** provides the primary basis for decisions on applications for gas supply infrastructure and gas and oil pipelines considered to be nationally significant in England and Wales.

### 1.2.3 England

***The Natural Environment and Rural Communities (NERC) Act (2006)*** establishes Natural England as the main body responsible for conserving, enhancing and managing England's natural environment. It also covers biodiversity, pesticides harmful to wildlife and the protection of birds.

The ***Natural Environment White Paper (2011)*** recognises that nationally, the fragmentation of natural environments is driving continuing threats to biodiversity. It sets out the Government's policy intent to:

- improve the quality of the natural environment across England;
- move to a net gain in the value of nature;
- arrest the decline in habitats and species and the degradation of landscapes;
- protect priority habitats;
- safeguard vulnerable non-renewable resources for future generations;
- support natural systems to function more effectively in town, in the country and at sea; and
- create an ecological network which is resilient to changing pressures.

By 2020, the Government wants to achieve an overall improvement in the status of the UK's wildlife including no net loss of priority habitat and an increase of at least 200,000 hectares in the overall extent of priority habitats. Under the White Paper, the Government has also put in place a clear institutional framework to support nature restoration which includes Local Nature Partnerships creating new Nature Improvement Areas (NIAs).

***Biodiversity 2020: A strategy for England's wildlife and ecosystem (2011)*** is a new biodiversity strategy for England that builds on the Natural Environment White Paper and provides a comprehensive picture of the Government is implementing the international and EU commitments. It sets out the strategic direction for biodiversity policy for the next decade on land (including rivers and lakes) and at sea. The Strategy has as its mission to halt overall biodiversity loss, support healthy well-functioning ecosystems, and establish coherent ecological networks, with more and better places for nature for the benefit of wildlife and people.

The ***National Planning Policy Framework (NPPF) (2012)*** replaces the majority of previously used planning policy including Planning Policy Statement 9 on Biodiversity and Geological Conservation. The

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NPPF includes key policies to ensure the planning system contributes to and enhances the natural and local environment by:

- protecting and enhancing valued landscapes, geological conservation interests and soils;
- recognising the wider benefits of ecosystem services;
- minimising impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures;
- preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability; and
- remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.

The Framework states that, when preparing plans to meet development needs, the aim should be to minimise pollution and other adverse effects on the local and natural environment. Local planning authorities are expected to set criteria based policies against which proposals for any development on or affecting protected wildlife or geodiversity or landscape areas will be judged. In doing so they must take into account the policies in the Framework including those which set out the circumstances where in order to conserve and enhance biodiversity planning permission should be refused.

***Planning Practice Guidance for Onshore Oil and Gas (2013)*** provides advice on the planning issues associated with the extraction of hydrocarbons. It will be kept under review and should be read alongside other planning guidance and the NPPF. The guidance identifies a range of issues that mineral planning authorities may need to address. Those particularly relevant to biodiversity include internationally, nationally or locally designated wildlife sites, protected habitats and species, and ecological networks.

### 1.2.4 Scotland

***Nature Conservation Act (Scotland) (2004)*** places duties on public bodies in relation to the conservation of biodiversity, increases protection for SSSI, amends legislation on Nature Conservation Orders, provides for Land Management Orders for SSSIs and associated land, strengthens wildlife enforcement legislation, and requires the preparation of a Scottish Fossil Code.

***Scottish Planning Policy (SPP) (2010)*** sets out the Scottish Government's policy on land use planning incorporating the conservation of designated or protected sites and species taking into account the ecosystems and natural processes and seeks to establish integrated habitat networks. Consultation on the revised ***Draft Scottish Planning Policy (2013)*** commenced in April 2013.

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***Planning Advice Note 60 (PAN 60): Planning for Natural Heritage (2000)*** provides advice on how development and the planning system can contribute to the conservation, enhancement, enjoyment and understanding of Scotland's natural environment and encourages developers and planning authorities to be positive and creative in addressing natural heritage issues.

***Scotland's Biodiversity: It's in Your Hands - A strategy for the conservation and enhancement of biodiversity in Scotland*** aims to conserve biodiversity for the health, enjoyment and wellbeing of the people of Scotland now and in the future and provides a 25 year framework in order to achieve this goal. An updated biodiversity strategy is planned for early 2013. The land use strategy for Scotland (***Getting the best from our land - A land use strategy for Scotland*) (2011)** has the objectives of: land-based businesses working with nature; responsible stewardship of Scotland's natural resources; and urban and rural communities better connected to the land.

### 1.2.5 Wales

***Planning Policy Wales (Edition 4) (2012)*** sets out the land use planning policies of the Welsh Assembly Government, including objectives for the conservation and improvement of landscape and biodiversity.

***Technical Advice Note 5 (TAN5): Nature Conservation and Planning (2009)*** sets out how the planning system should contribute to protecting and enhancing biodiversity and geological conservation.

***Wales Environment Strategy Action Plan 2008-2011*** is the second of its type and it facilitates a more strategic approach to environmental improvement and includes actions under the heading biodiversity.

**Sustaining a Living Wales: A Green Paper on a New Approach to Natural Resource Management in Wales (2012)** sets out, and seeks views on, proposals for the management and regulation of the environment in Wales. The consultation will principally inform the proposed Environment and Planning Bills. The central proposal is to move to an ecosystem approach to environmental regulation and management which is expected to:

- improve the resilience and diversity of the environment and its supporting biodiversity;
- provide simpler and more cost-effective regulation; and
- offer greater certainty for decision-makers.

In this context, the Green Paper is underpinned by the aim to "ensure that Wales has increasingly resilient and diverse ecosystems that deliver environmental, economic and social benefits now and in the future".

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## 1.3 Overview of the Baseline

### 1.3.1 UK

Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites are important for biodiversity at the international level. In the UK there are 614 SACs (covering 2,813,359 hectares) (along with 11 candidate SACs [cSAC], 268 SPAs (covering a total of 2,745,677 hectares) and 146 Ramsar sites (covering 782,727 hectares)[5]. **Figure 1.1** illustrates the distribution of European designed sites in England, Scotland and Wales. In addition, there are also over 6,550 nationally designated sites in the UK, known as SSSIs in England, Wales and Scotland, and Areas of Special Scientific Interest (ASSIs) in Northern Ireland.

There are 182 protected areas in UK inshore waters with a marine element, which includes 81 SPAs with marine habitats for birds, 98 SACs with marine habitats or species and three Marine Nature Reserves. In total, the area coverage of these sites exceeds 1.8 million hectares, or 2.2% of UK waters [6].

[5] JNCC, Protected sites http://jncc.defra.gov.uk/page-1456
[6] Defra http://www.defra.gov.uk/foodfarm/fisheries/documents/mpp2009-10info.pdf

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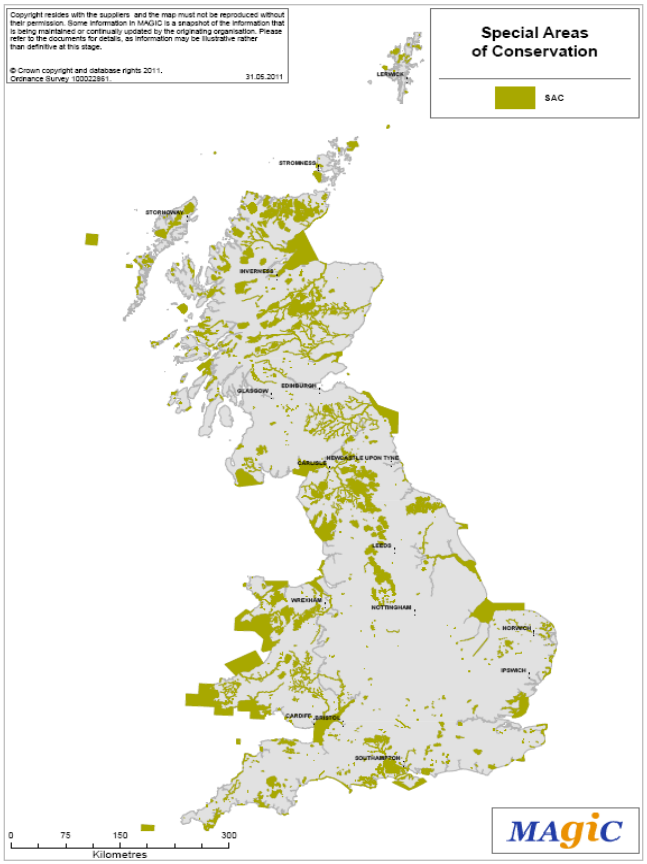
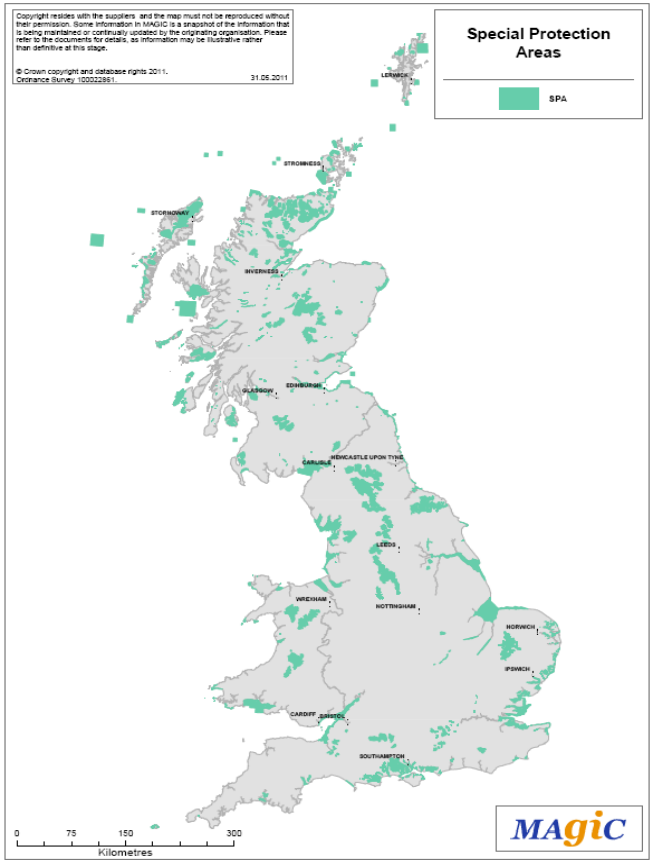
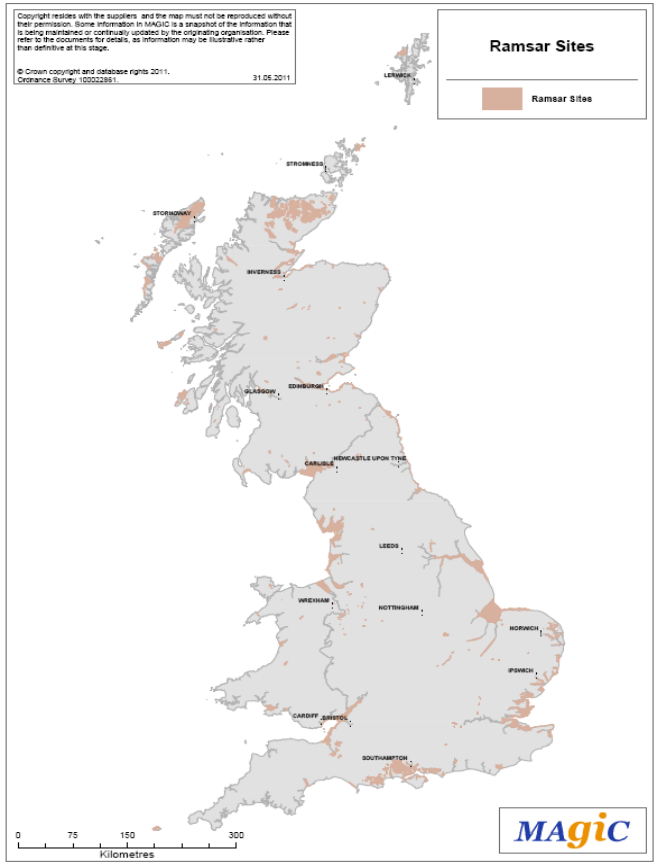
**Figure 1.1 Location of Special Areas of Conservation (SACs), Special Protection Areas (SPA) and Ramsar Sites in the UK**[7]



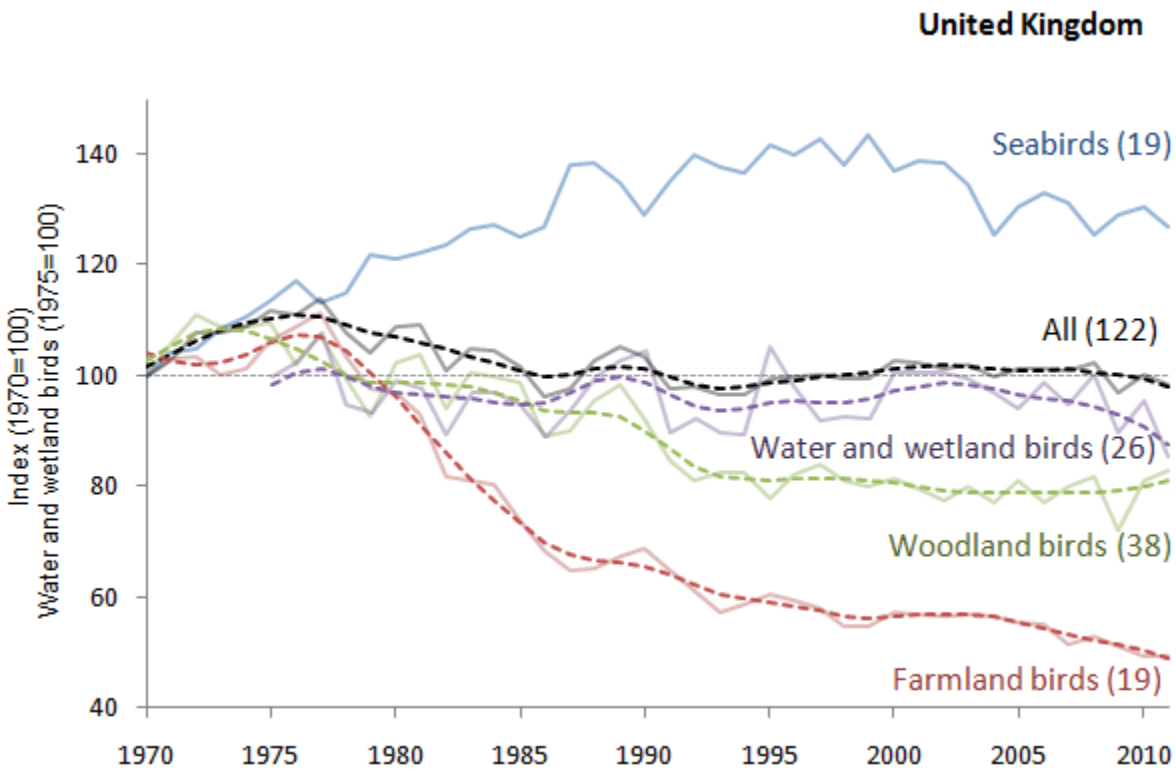




[7] http://webarchive.nationalarchives.gov.uk/20110822131357/http://magic.defra.gov.uk/staticmaps/national.asp

### 1.3.2 Bird Populations

Bird populations are considered to be good indicators of the state of the environment and the countryside. Species typical of farmland, woodland and coastal areas have been used as indicators of the health of their particular habitat (**Figure 1.2** and **Figure 1.3**)[8]. The species used to calculate the indicators are set out in **Appendix C**.

**Figure 1.2 Bird Population Indices, 1970-2011**




Source: JNCC BIYP Webpages (http://www.jncc.gov.uk/page-4235), after Defra, RSPB, BTO, JNCC.

Note: Figures in brackets give the number of species included in each category.

[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/85736/Wild_birds_statistical_release_1970-2011_UK.pdf

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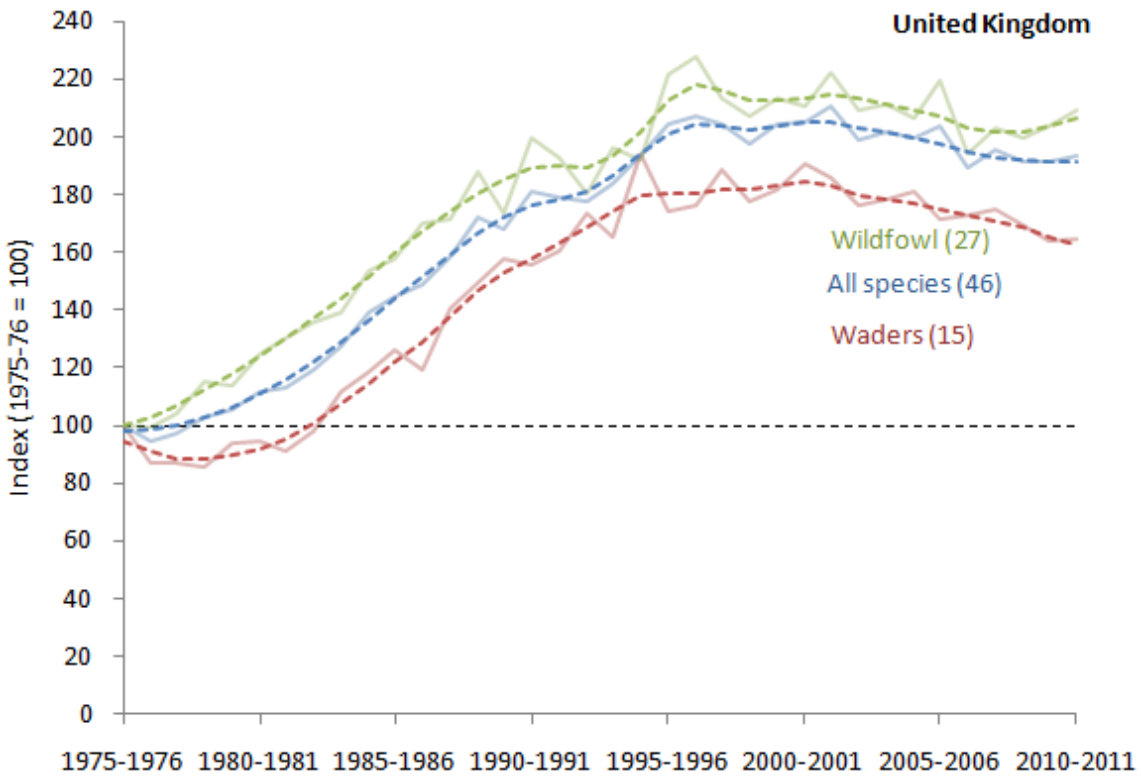
**Figure 1.3 Wintering Waterbird Population Indices, 1970-2011**[9]




In 2011 the **all-species index in the UK** was 4% below its 1970 level. The smoothed index showed a small but statistically significant decline of 2% over the most recent five year period over which trends can reliably be assessed (2005-2010).

In the winter of 2010-11 the **wintering waterbird index in the UK** was 93% higher than its 1975-76 level. The index peaked in the late nineties, and had declined since, with the smoothed index falling by 4% between 2004-05 and 2009-10.

Although there remains uncertainty over the drivers of the overall decline in woodland bird populations in the UK, factors such as changes in woodland structure through aging, a decline in active woodland management and overgrazing by deer are implicated in the steep declines in a number of woodland specialists. In addition, problems overseas may be implicated in the declines of a number of long-distance migrants which breed in UK woodlands and spend the winter in Africa. Milder winters in the last decades may have been beneficial for a number of resident and short-distance migrant species.

Since 2000, populations of breeding farmland birds have declined by almost 14%, whilst water and wetland birds, woodland birds and seabirds have all declined by just over 3%, although the analysis of the underlying trends shows little or no overall change.

[9] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/85736/Wild_birds_statistical_release_1970-2011_UK.pdf

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In 2009-10, populations of the wintering water birds were 83% higher than in 1975-76; populations peaked in 2001-02, but there has been a decline in more recent years; the measure has fallen by almost 8% since the winter of 2000-01.

The long-term decline of farmland birds in the UK has been driven mainly by the decline of those species that are restricted to or highly dependent on farmland habitats (the 'specialists'). Between 1970 and 2010 the population farmland specialists declined by 66% while the farmland generalist population declined by 5%. Of the 12 farmland specialist species, four (grey partridge, turtle dove, tree sparrow and corn bunting) have declined by over 90% relative to 1970 levels. By contrast two farmland specialists, stock dove and goldfinch, have doubled, or nearly so, over the same period. Generalist species have fared better although one, the yellow wagtail, has declined by over 70% relative to 1970. Woodpigeon and jackdaw populations more than doubled over the same period.

The breeding water and wetland bird measure was introduced for the first time in 2009, and can be disaggregated to four sub-habitat indicators showing differing trends, although all are derived from relatively few species trends. Of these, birds of slow flowing and standing water have shown the most positive trend having increased by 57% since 1975, whilst birds of reed bed increased by 7%. Conversely, the index for wet grassland birds decreased by 43%, while the index for fast flowing water birds decreased by 28% compared to 1975.

The wintering water bird measure increased steadily since the 1975-76 baseline to a peak in 1996-97. Although there has been a downward trend since then, with about 8% decline since the winter of 2000-01, the indicator in 2009-10 is still at 83% above its 1975-76 baseline.

In Scotland, waterbird numbers peaked in 1996-7 (120% of 1975-76 baseline), and remained relatively stable until recent years, declining to 107% of the 1975-6 baseline in 2006-07. Geese showed the largest increase, being 294% of the baseline figure in 2006-07. Wildfowl and waders are at 99% and 78% of the baseline their baseline figures respectively in 2006-07.

In Wales, the change in populations of widespread breeding birds is used as a sustainable development indicator, with populations in 1994 taken as the baseline. In 2007, farmland birds showed a net decrease of 7%, woodland birds had risen by 5%, and all other birds (including urban species) had risen by 15%. The net rise across all species from 1994 to 2007 represented in the index was 3%. In Scotland, 50 out of 65 terrestrial breeding bird species surveyed between 1994 and 2008 showed a statistically significant increase in numbers (31% overall). Woodland bird abundance increased by 64% overall, with farmland birds increasing by 26%.

### 1.3.3 Butterfly Populations

This indicator presents a measure of annual populations of specialist butterfly populations (those strongly associated with particular habitats, such as unimproved grassland) and generalist butterflies of

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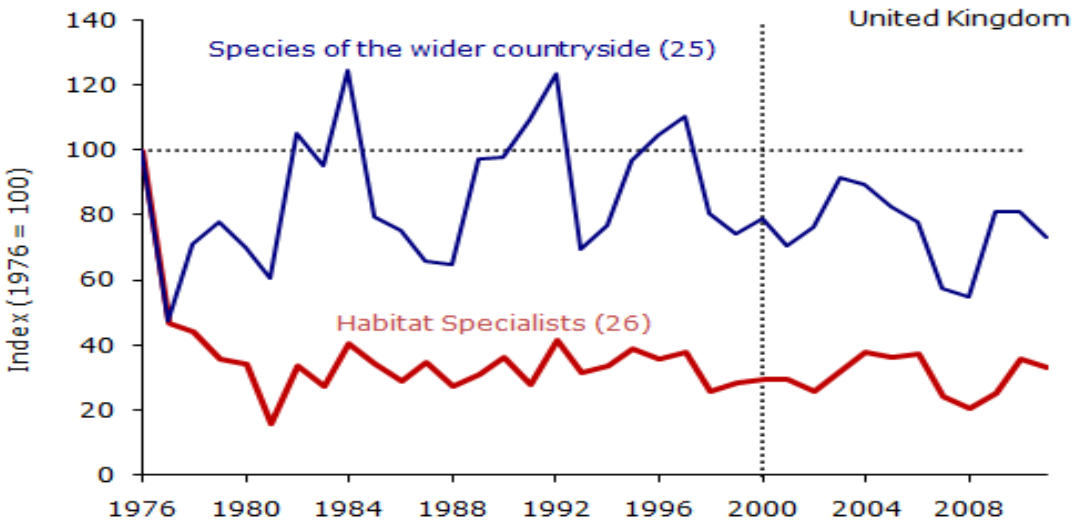
the wider countryside. The data shows a high degree of annual variation[10]. Since 1976, the indices for butterflies associated strongly with semi-natural habitats (specialists) and for those found in the wider countryside show apparent declines of 67% and 27% respectively.

**Figure 1.4 Trends in Butterfly Populations for Habitat Specialists and Generalist Species, 1976-2011**




Source: JNCC BIYP Webpages (http://www.jncc.gov.uk/page-4236) after Butterfly Conservation, CEH, Defra. Note: numbers in brackets indicate number of species included in each category.

Large fluctuations in numbers between years are typical features of butterfly populations. The assessment of change is therefore made on an analysis of the underlying trends undertaken by Butterfly Conservation and the Centre for Ecology and Hydrology. This analysis shows that since 1976 specialists have declined significantly but for species of the wider countryside there has been little or no overall long-term change, although the current index is significantly lower than over the period 1988 to 1996. Since 2000, specialists have shown a small increase from 29% to 33% of the 1976 level.

Species of the wider countryside have shown a small decrease from 79% to 73% of the 1976 level. However, the underlying analysis shows that there was little or no overall change for these measures. In 2011, specialists decreased by 3% since the previous year, whilst wider countryside species decreased by 8%. Data for previous years are also updated retrospectively as there are delays in submitting data, for example, in 2011, extra data were also added for 2009 and 2010. This means that the species indices for previous years will also change, as a new year of data is added to the model that is used to fill in missing data sites.

[10] http://www.jncc.gov.uk/page-4236 [Accessed September 2013]

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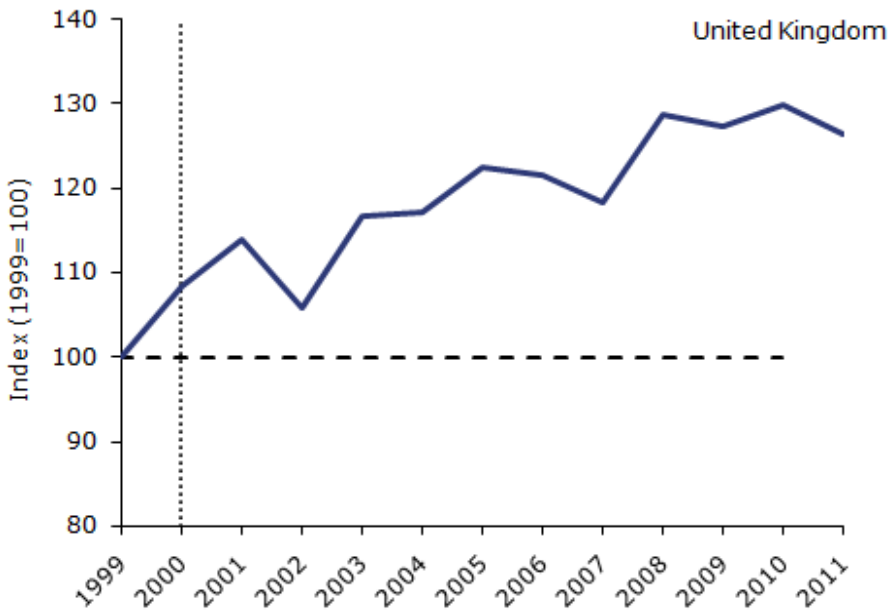
### 1.3.4 Bat Populations

Since 2000, bat populations have increased by a collective total of 20%[11]. A significant increase in the lesser horseshoe bat (*Rhinolophus hipposideros*) is responsible for the positive trend. Prior to this, bats had experienced a major population decline, recently stabilised (and now increasing) due to protection and direct conservation action, though they remain under threat from landscape change and development pressure (see figure 1.5).

**Figure 1.5 Trends in Widespread Bat Populations, 1999-2011**




Source: JNCC BIYP Webpage (http://www.jncc.gov.uk/page-4239) Note: The headline measure is a composite index of six species; Daubenton's, noctule, serotine, lesser horseshoe, common pipistrelle and soprano pipistrelle.

### 1.3.5 Biodiversity

The ***UK Post-2010 Biodiversity Framework***, published in July 2012, has now succeeded the UK BAP. In particular, due to devolution and the creation of country-level biodiversity strategies, much of the work previously carried out under the UK BAP is now focused at a country level. Additionally, international priorities have changed: the framework particularly sets out the priorities for UK-level work to support the Convention on Biological Diversity's (CBD's) *Strategic* ***Plan for Biodiversity 2011-2020*** and its five strategic goals and 20 'Aichi Targets', agreed in October 2010; and the new EU Biodiversity Strategy (EUBS) in May 2011[12].

[11] http://www.jncc.gov.uk/page-4239 [Accessed September 2013]
[12] http://jncc.defra.gov.uk/page-5705

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However, the UK BAP lists of priority species and habitats remain important and valuable reference sources. Notably, they have been used to help draw up statutory lists of priorities in England, Scotland, Wales. These data, last complied in 2008, inform the analysis below.

Based on a comparison of the earliest available and most recent assessment for each habitat, the number either 'stable' or 'increasing' in area has fallen from 21 to 20 (2.5% of the known habitats). Despite this position of little or no overall change, 15 priority habitats (44%) are still declining in extent (**Figure 1.6**).

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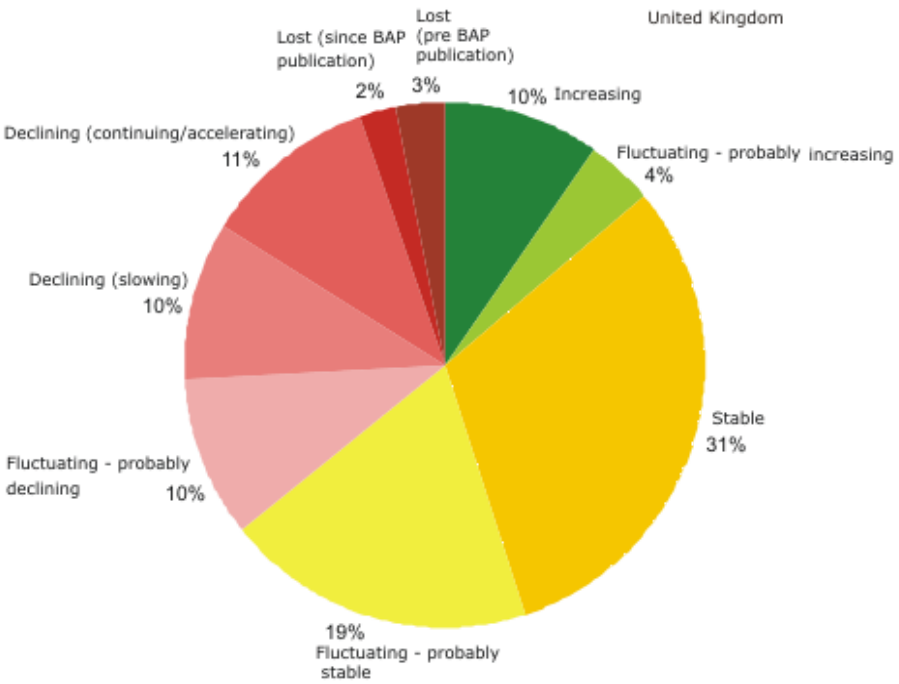
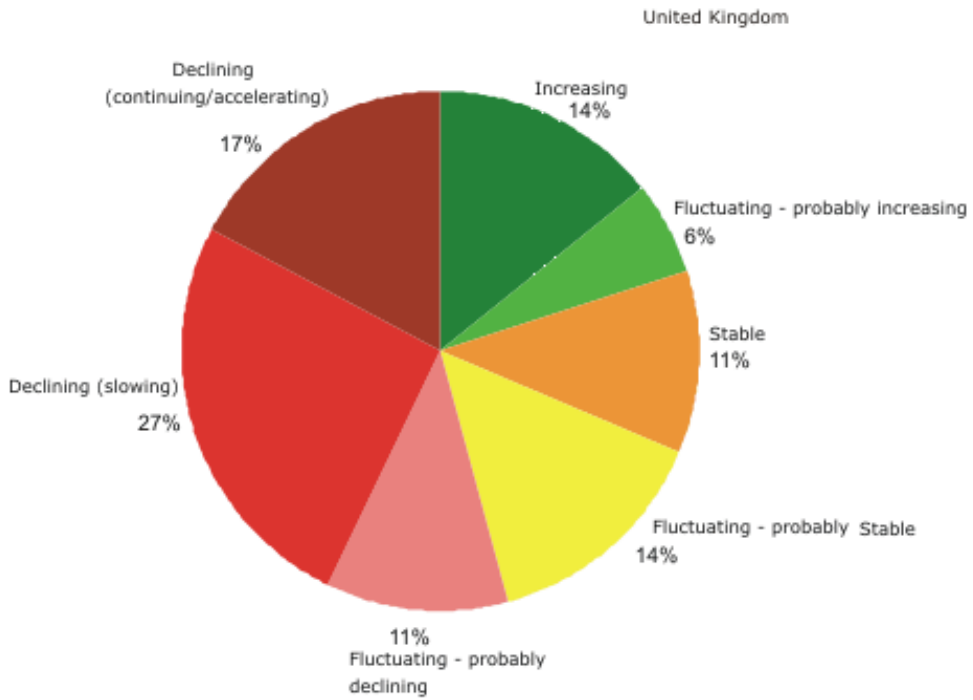
**Figure 1.6 Status of UK Priority Species (A) and Habitats (B) in 2008**

**A**




**B**




*Source: JNCC BIYP Webpages (http://www.jncc.gov.uk/page-4239) Note: based on the 287 species and 35 habitats assessed in 2008 respectively.*

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The number of species that have moved from the decreasing category to 'stable' or 'increasing' outweighs those moving in the other direction, but there are no obvious patterns in these changes. Sixty six of the species that were declining in 2008 were also declining in 2005, while six species changed from 'declining' in 2005 to 'lost' in 2008. This turnover between categories means that while there is an increase in the number of species stable or increasing, it is not necessarily the same species which are improving. Species that have moved from 'decreasing' in 2002 to either 'increasing' or 'stable' in 2008 include the shrill carder bee (*Bombus syvarum*), great yellow bumblebee (*Bombus distinguendus*), reed bunting (*Emberiza schoeniclus*) and the heath tiger beetle (*Cicindela sylvatica*). Very few species have moved from 'increasing' to 'declining' although examples include: Newman's lady fern (*Athyrium flexile*) and fen orchid (*Liparis loeselii*). The ongoing increase in number of species reported as lost, which came from the declining and unknown categories in 2005 is an additional cause for concern.

The indicator shows a very small net decrease in the number of habitats that are stable or increasing and there has been a limited amount of turnover of habitats over the period 1999-2008. Lowland beech and yew woodland habitats were recorded as decreasing in 2002 and increasing in 2008. Lowland calcareous grassland and upland calcareous grassland were both stable in 2002 but decreasing in 2008. There has also been a change in the number of habitats reported as 'unknown' from 11 in 2005 to six in 2008. The number of habitats reported as 'increasing' fell from ten in 2005 to seven in 2008.

In Scotland, 23% of BAP species and 20% of BAP habitats were identified as 'stable', with an additional 4% of species and 13% of habitats recorded as 'increasing' in 2008. In Wales, biodiversity is regarded as a high level summary indicator. In 2005, 34% of Welsh Biodiversity Action Plan (BAP) species were stable or increasing (compared with 22% in 2002) and 18% (2002 and 2005) declining. In 2005, 36% of priority habitats were stable or increasing compared with 20% in 2002. The number of habitats with a 'declining' status has increased from 46% in 2002 to 59% in 2005. The increase in the number of habitats in decline is partly due to a change in the number of habitats considered (five more than in 2002) in addition to an increase in the number of BAP habitats as a whole (by two, both of which were in decline).

### 1.3.6 Condition of Species and Habitat Features (SSSI, SAC, SPA and Ramsar)

A report[13] describing the first six years of common standards monitoring of UK designated sites (SSSI, SAC, SPA and Ramsar) was produced by the JNCC, involving an assessment of the conditions of those features for which the sites were designated. In total, 12,937 feature assessments were carried out between April 1998 and March 2005, representing about 57% of all UK designated features.

In general, taking in all features assessed, the condition of Ramsar and SPA features were found to be the most favourable - 86% and 78% favourable respectively. SSSI features were 57% favourable as opposed to SAC features which were only 37% favourable. The favourable state of Ramsar and SPA sites is largely a reflection of the condition of bird features in general (see table 1.2).

[13] Williams, JM (ed.) (2006). *Common Standards Monitoring for Designated Sites: First Six Year Report*. Peterborough, JNCC.

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**Table 1.2 Condition of Species Features by % Favourable and Recovering**

| Reporting Category | No. of Assessments | % Favourable and Recovering |
|---|---|---|
| Dragonflies and damselflies | 41 | 85.4 |
| Aggregations of non-breeding birds | 732 | 81.3 |
| Amphibians | 49 | 79.6 |
| Assemblages of breeding birds | 180 | 78.9 |
| Mammals | 144 | 77.8 |
| Aggregations of breeding birds | 760 | 75.9 |
| Other invertebrates | 298 | 75.2 |
| Butterflies | 91 | 68.1 |
| Flowering plants and ferns | 324 | 67.3 |
| Non-flowering plants and fungi | 131 | 59.5 |
| Fish | 86 | 37.2 |
| **Species total** | **2,840** | **74.6** |

Bird features were found to be faring well, with between 75% and 81% in a favourable and recovering condition. Mammal, invertebrate and plant features formed an intermediate group, while fish (37.2%) had a low proportion of favourable and recovering assessments.

The JNCC report presented assessments under a range of broad feature categories for species and habitats (see table 1.3).

**Table 1.3 Condition of Habitat Features by % Favourable and Recovering**

| Reporting Category | No. of Assessments | % Favourable and Recovering |
|---|---|---|
| Upland assemblages | 55 | 89.1 |
| Lagoons | 47 | 83 |
| Rocky shores, reefs and caves | 46 | 82.6 |
| Sea cliffs | 180 | 76.1 |
| Intertidal sands and muds | 148 | 75.7 |
| Limestone pavement, inland cliffs and screes | 272 | 73.9 |
| Acid grassland – lowland | 174 | 70.1 |

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| Reporting Category | No. of Assessments | % Favourable and Recovering |
|---|---|---|
| Calcareous grassland – lowland | 625 | 70.1 |
| Blanket bogs | 222 | 68.9 |
| Neutral grassland | 1,074 | 68.2 |
| Subtidal sandbanks | 9 | 66.7 |
| Broadleaved and mixed woodland | 1842 | 66.3 |
| Heathlands – lowland | 374 | 64.4 |
| Fens and marshes – upland | 114 | 64 |
| Dunes, shingle and machair | 342 | 63.7 |
| Standing water | 513 | 63.5 |
| Saltmarsh | 146 | 63 |
| Lowland raised bogs | 199 | 62.3 |
| Fens and marshes – lowland | 789 | 61.2 |
| Coniferous woodland | 56 | 57.1 |
| Calcareous grassland – upland | 84 | 53.6 |
| Acid grassland – upland | 56 | 51.8 |
| Heathlands - upland | 195 | 46.2 |
| Montane grasslands and heaths | 69 | 43.5 |
| Rivers and streams | 89 | 37.1 |
| **Habitats total** | **7,720** | **65.6** |

Many of the features in best condition were ones less easily damaged by human activities; this may be because they are relatively robust or because they are relatively difficult to access (e.g. cliffs). The features which were least favourable were often impacted by factors which operated outside the sites on which they were designated (e.g. drainage conditions for some isolated wetlands, fires on heaths adjacent to housing developments), or which require concerted effort by many agencies (e.g. water quality affecting fish).

Lack of remedial management and grazing were mentioned most often as the activities leading to an unfavourable condition. Of particular relevance was that the effects of air pollution on SSSIs were often very difficult to determine given the complex interactions between pollution impacts, management and abiotic influences. This resulted in the impacts of air pollution being substantially under-reported in the assessment.

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### 1.3.7 England

There are over 4,100 SSSIs in England, covering 1,076,986ha (including open water and coastal habitats). In terms of land area, approximately 8% of England is designated as SSSI.[14] In England there are 250 SACs, 85 SPAs and 74 RAMSAR sites[15]. As at 01 May 2012, the overall condition of SSSIs in England was assessed by Natural England to be 37.25% as area favourable; 59.4% area unfavourable recovering; 2.21% area unfavourable no change; 1.11% area unfavourable declining and 0.03% area destroyed/part destroyed[16]. The reasons for adverse conditions at sites are set out in **Table 1.4**. This indicates that planning permission (general) was linked to 0.93% of the area not meeting the Natural England Public Service Agreement (PSA) targets and planning permission (mineral and waste) 0.25%[17]. Whilst these targets have been superseded, they were linked to delivering the commitments in the 2007 Conserving Biodiversity Strategy such as the requirement to have 95% of SSSIs to be in favourable or recovering condition by 2010.

**Table 1.4 Reasons for Adverse Condition Summary**

| Reason for Adverse Condition | Percentage of Unit Area Not Meeting the PSA Target | Reason for Adverse Condition | Percentage of Unit Area Not Meeting the PSA Target |
|---|---|---|---|
| Inappropriate scrub control | 14.46% | Fire - other | 1.73% |
| Under-grazing | 13.95% | Inappropriate coastal management | 1.71% |
| Overgrazing | 11.66% | Vehicles - other | 1.68% |
| Water pollution - agriculture/run off | 11.31% | Moor burning | 1.62% |
| Inappropriate water levels | 10.48% | Earth science feature obstructed | 1.51% |
| Invasive freshwater species | 8.75% | Vehicles - illicit | 1.33% |
| Forestry and woodland management | 5.90% | Planning permission - general | 0.93% |
| Drainage | 5.27% | Inappropriate css/esa prescription | 0.79% |
| Coastal squeeze | 5.16% | Sea fisheries | 0.71% |
| Inappropriate weirs dams and other structures | 4.46% | Air pollution | 0.60% |
| Inappropriate weed control | 4.28% | Peat extraction | 0.50% |
| Water pollution – discharge | 4.25% | Inland flood defence works | 0.40% |
| Inappropriate cutting/mowing | 3.95% | Game management - pheasant rearing | 0.35% |
| Deer grazing/browsing | 3.60% | Game management - other | 0.32% |
| Public access/disturbance | 3.30% | Inappropriate dredging | 0.25% |

[14] Natural England http://www.naturalengland.org.uk/ourwork/conservation/designatedareas/sssi/default.aspx
[15] JNCC Protected sites http://jncc.defra.gov.uk/page-1456
[16] http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?Report=sdrt15&Category=N&Reference=0
[17] http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?Report=sdrt17&Category=N&Reference=0

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| Reason for Adverse Condition | Percentage of Unit Area Not Meeting the PSA Target | Reason for Adverse Condition | Percentage of Unit Area Not Meeting the PSA Target |
|---|---|---|---|
| Inappropriate ditch management | 3.19% | Planning permission - other mineral and waste | 0.25% |
| Siltation | 3.06% | Inappropriate pest control | 0.22% |
| Fish stocking | 2.75% | Earth science feature removed | 0.14% |
| Fertiliser use | 2.67% | Inappropriate stock-feeding | 0.09% |
| Water abstraction | 2.06% | Pesticide/herbicide use | 0.04% |
| Agriculture – other | 1.77% | Other | 14.07% |

## Natural Areas

Natural England has defined 120 (97 terrestrial, 23 marine) geographical areas of the English countryside, distinguished on the merit of their wildlife and other natural features, and also on historic land-use pattern. The boundaries of these zones should be considered as broad transition zones rather than hard, defined edges. The purpose of these areas is to characterise areas of England for their natural features outside, but inclusive of, the network of protected, designated sites (e.g. SPAs, SACs, SSSIs). Natural Areas have been formally defined as “biogeographic zones which reflect the geological foundation, the natural systems and processes and the wildlife in different parts of England, and provide a framework for setting objectives for nature conservation” (UK Biodiversity Steering Group 1995). **Figure 1.7** identifies those Natural Areas of relevance to the current SEA, with details of the character of these Natural Areas set out in **Appendix D**.

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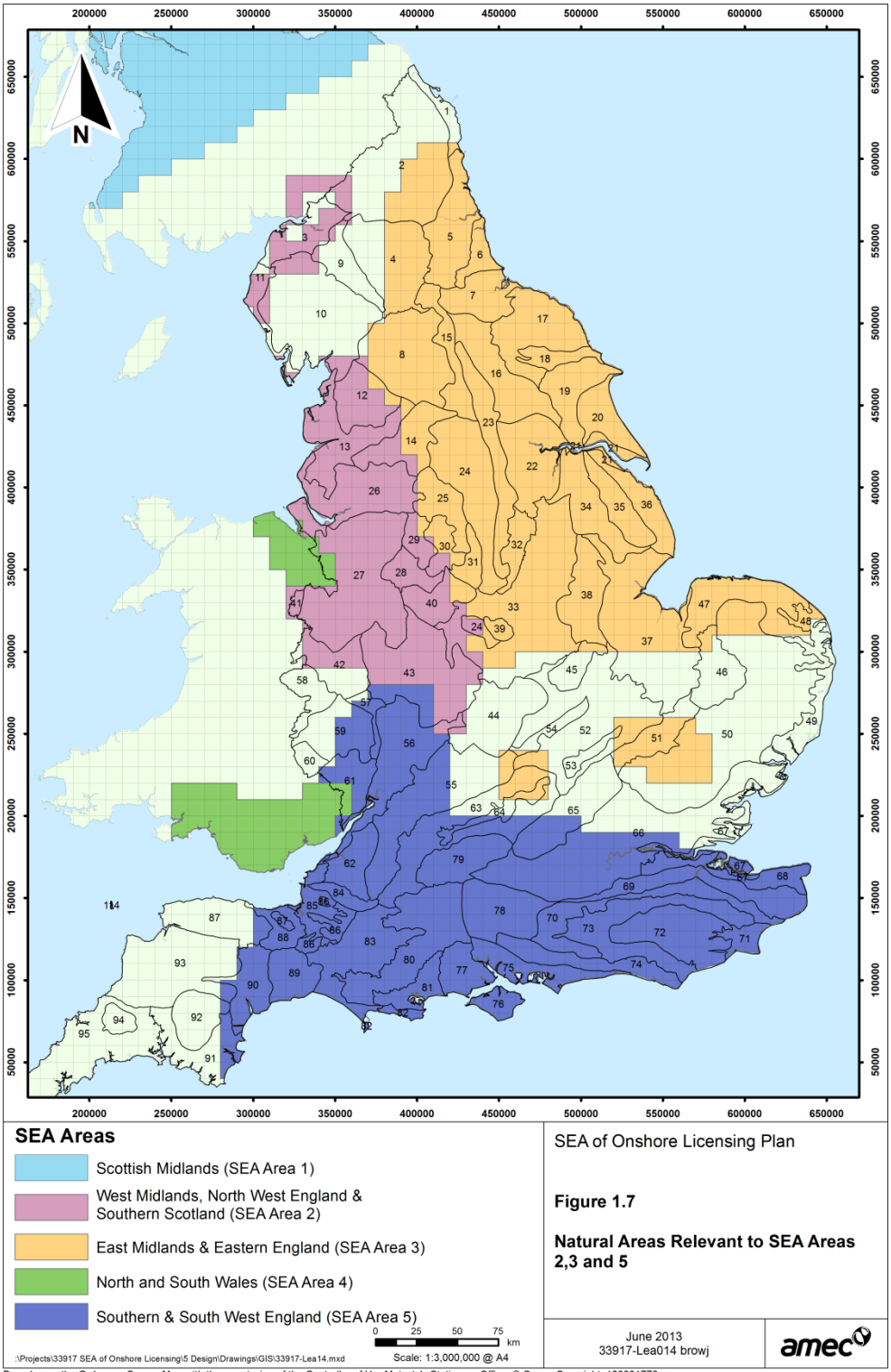
**Figure 1.7 Natural Areas Relevant to SEA Areas 2, 3 and 5**

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### 1.3.8 Scotland

In Scotland there are:

- 153 SPAs, covering an area exceeding 1 million hectares[18]. This includes the Upper Solway Flats and Marshes, which lie partly within England;
- 239 SACs covering an area of approximately 963,000 hectares[19]. This includes three sites that straddle the border with England;
- 51 Ramsar sites covering a total area of about 313,000 hectares. All of these sites are also designated either SPA or SAC[20]; and
- 1,439 SSSIs covering 1,020,223 hectares or 12.7% of Scotland[21].

Scotland has over 1,450 SSSIs covering 13% of the total land area in Scotland. In 2005, 55% of SSSI habitats were in favourable condition, 99% of marine features were favourable, 45% of habitats were unfavourable, unfavourable declining or destroyed. The greatest proportion of unfavourable features was among lowland heath and wetland (81% and 71% unfavourable, respectively). Scottish Natural Heritage identified a series of Natural Zones as part of their Natural Heritage Futures initiative, and used these areas to describe a vision for sustainable use of local natural heritage. Twenty one areas were identified in total, each having their own identity resulting from the interaction of geology, landforms, wildlife and land use.

For the purposes of this SEA, these Natural Zones provide a suitable level at which to describe relevant aspects of the Scottish Midlands environment. Relevant Natural Zones are highlighted in **Figure 1.8**, with details of the general character of each zone and identifies key habitats and features set out in **Table 1.5**.

[18] http://www.snh.gov.uk/protecting-scotlands-nature/protected-areas/international-designations/spa/spa-location/ (accessed 17/05/13).
[19] http://www.snh.gov.uk/protecting-scotlands-nature/protected-areas/international-designations/sac/sac-location/ (accessed 17/05/13).
[20] http://www.snh.gov.uk/protecting-scotlands-nature/protected-areas/international-designations/ramsar-sites/ (accessed 17/05/13).
[21] http://www.snh.gov.uk/protecting-scotlands-nature/protected-areas/national-designations/sssis/sssi-location/ (accessed 17/05/13).

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**Figure 1.8 SNH Futures Natural Zones in Relation to SEA Area 1**

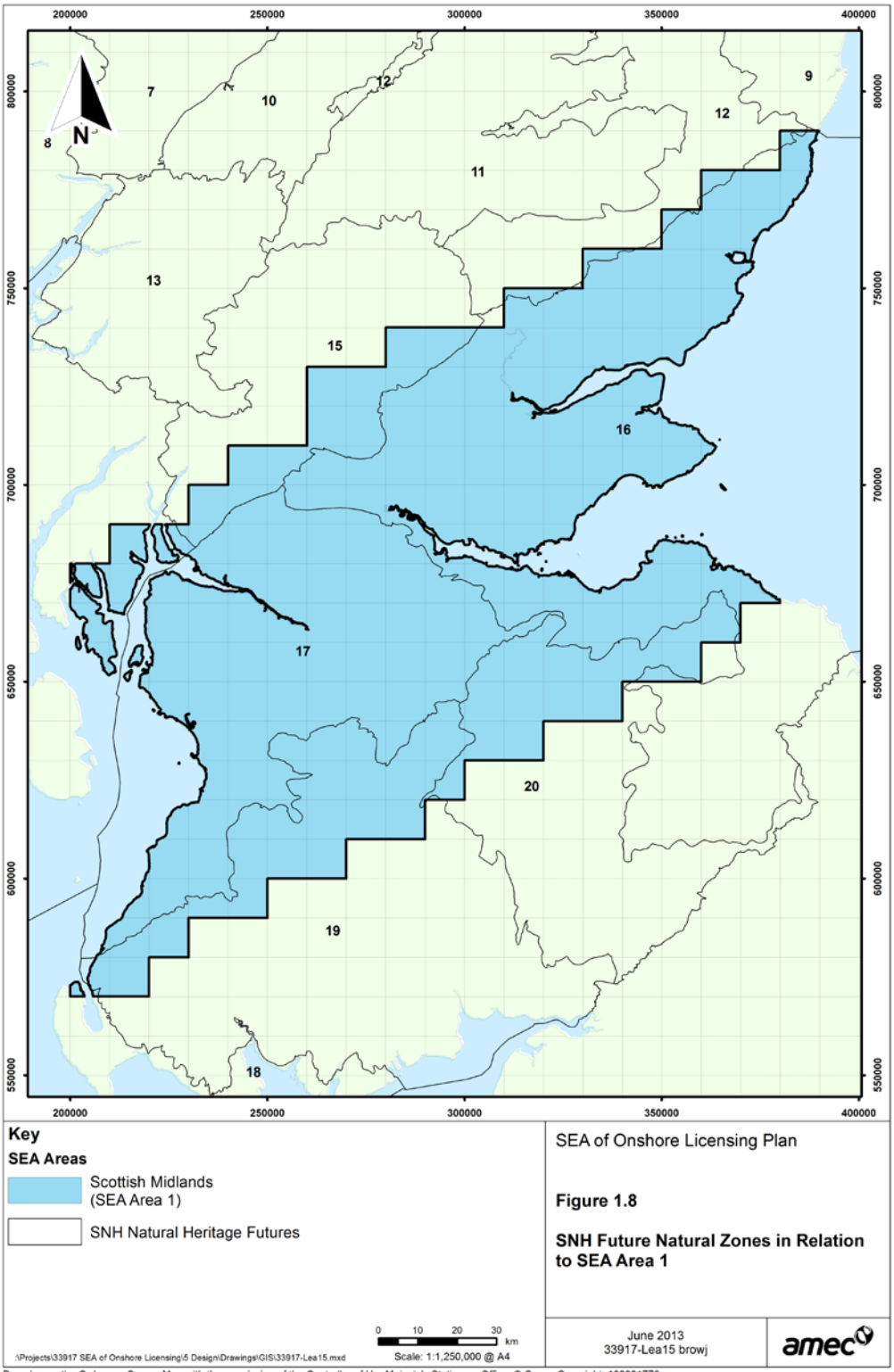


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**Table 1.5 Relevant SNH Futures Natural Zones in SEA Area 1**

| # | Natural Zone | Summary |
|---|---|---|
| 16 | Eastern Lowlands | The low coastline is backed by broad, flat farmed carseland, leading up to the sharply defined, steep sides of the major geological fault lines in the north and west. To the south, the boundary is softer with a more gradual transition to the rolling hills of the Borders. The east coast is deeply incised by the Firths of Tay and Forth. These rivers, along with the Tweed, are the largest in the region, running through wide flood plains to provide the area with rich arable land, allowing extensive areas of intensively managed farmland. The underlying geology and surface deposits in the region give great fertility to the soils of the Mearns and Strathmore, with rich coal and aggregate resources around Fife and the Firth of Forth. Plugs of volcanic rock form the isolated uplands characteristic of the Sidlaws, Ochils, Lomonds and Lothians.<br><br>Coastal areas are characterised by a wide range of habitats including sandflats, mudflats, saltmarsh, brackish lagoons and reedbeds, offshore islands and cliffs. Other water resources include rivers, burns, lochs, small areas of standing water and mires. The largest areas of semi-natural habitat are found in upland areas with heather moorland and unimproved grassland. Woodland is absent from many areas where it would once have been extensive. The largest conurbations are Edinburgh and Dundee with industrial sites located along the coast and estuaries. Outside of these densely populated centred, the area is characterised by smaller towns and villages. |
| 17 | West Central Belt | Beyond the Greater Glasgow conurbation, the dominant impression is that of a well-populated, intensively managed, working landscape. It is predominantly lowland, but with discrete upland areas of grassland, heath, mire, oak/birch woodland, and scrub. Geological features of the region include productive coal measures, ironstones, limestones and oil shales which have been extensively worked. The human influence on the landscape is very apparent with field boundaries, stone dykes, hedgerows, and boundary trees all abundant. Agriculture is typically based on mixture of improved pasture and rough grazing, with more intensive agriculture restricted to drier parts such as Ayrshire.<br><br>The River Clyde along with its estuary and tributaries is a key feature with broadleaved woodland associated with the principal river systems. Freshwater lochs, many of which are used as reservoirs, are widespread and there are numerous and extensive canals in the area. The Inner Clyde Estuary is heavily urbanised and industrialised but opens out into extensive mudflats, sand and shingle, interspersed with coastal grassland and saltmarsh which are important for wintering wildfowl and waders. The area is the hub of the country's transport infrastructure. The industrial heritage of the region has resulted in a large number of closed mines, waste tips, coal and oil-shale bings, leaving contaminated, vacant and derelict land. |
| 19 | Western Southern Uplands and Inner Solway | The landscape is characterised by large, smooth, domed hills dissected by steep-sided valleys and broader glens. Undulating foothills have gently rounded summits in the east and craggier peaks to the west. Plateau moorland in the west is typically bleak, with waterlogged soil, nutrient poor lochs and numerous streams. Woodland is dominated by large-scale conifer plantations, with remnants of native oak, ash and elm woodland remaining in upland areas. The coal measures of southern Ayrshire and southern Lanarkshire support open-cast mining. Small settlements are mainly located along river valleys or in mining districts.<br><br>Open ground is typically acid grassland or heather moorland with bracken and blanket bogs, important breeding habitats for birds of prey and waders, abundant. Mountain heath, with characteristic arctic/alpine flora, is found on the highest ground. Several important rivers including the Clyde and the Doon have sources in the uplands. |
| 20 | Border Hills | Narrow valleys with steep sides cut through rounded hills along with and areas of high level plateau are typical of the border region. Heather moorland, blanket bog, grass heath and modern conifer forests cover hilly ground, while more productive grasslands and native woodland are present in river valleys. Characteristic landscapes are of hill farms, valley, forests and the large houses of landed estates.<br><br>The border region includes the largest area of montane plateau ground over 600m in southern Scotland and associated arctic-alpine flora is present. Blanket bog occurs above 500m on flatter hill slopes with occasional species rich calcareous flushes. At lower altitudes, more freely draining valley slopes support heather moorland. Below unenclosed uplands, most semi-natural habitats are fragmented by intensively farmed land. Most native woodland area has been lost although small pockets remain, restricted to steep slopes. In their place, extensive conifer plantations have developed. Rivers in the region include the Tweed, Annan, Esk and Liddel, which are important habitats for salmon and trout. Most areas of human habitation are concentrated along the valleys with the upland areas relatively undeveloped, except for a growing number of windfarms. |

*Source: Gordon et al. (2002), SNH (2002a-d)*

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### 1.3.9 Wales

More than 10% of Wales' land cover is designated for nature conservation. There are 112 'Natura 2000' sites in Wales (including along the border region with England). These include 10 Ramsar sites, 92 SACs, and 20 SPAs[22]. Other internationally important sites to consider include the Rhinog Biogenetic Reserve in North Wales (Blaenau Ffestiniog WRZ) and the UNESCO biosphere reserve at Cors Fochno in the Dyfi estuary near Borth in Ceredigion (West Wales)[23].

During the 2000-10 monitoring period, the condition of the 112 Natura 2000 habitats was assessed as[24]:

- Favourable - 24%;
- Recovering - 15%; and
- Unfavourable - 61%.

There are 1,047 SSSIs in Wales, covering over 260,600 hectares (ha) which is just over 12.3% of the land area [25]. The 2006 Rapid Review recorded the condition of SSSI features. In Wales, 47% of SSSIs were assessed to high confidence levels and the results showed that 32% of sites were in favourable condition and 68% were in unfavourable condition. However, based on individual features within a SSSI, 47% of features were in favourable condition[26].

There are 73 National Nature Reserves (NNRs) protecting over 26,900 hectares of land in Wales. Data provided by CCW[27] indicates that, as of 2008, 57% of NNRs were in favourable condition (i.e. all assessed features have favourable or unfavourable recovering status). Conversely, 43% of NNRs had one or more features in unfavourable declining condition.

There are 38 priority habitats in Wales (an increase from 37 in 2002). In 2008, 15 priority habitats (40%) were classified as stable or increasing in Wales compared with 11 (30%) in 2002, and 14 (36%) in 2005. However, 20 priority habitats (53%) were declining in 2008 compared to 17 habitats (50%) in 2002, and 23 (59%) in 2005[28]. Habitats within the marine environment exhibit the greatest deterioration, with

[22] JNCC (2013). Protected Sites. Available at:www.jncc.gov.uk/page-4. [Accessed May 2013]
[23] The UNESCO Biosphere Reserve status is awarded in recognition of the way a local community lives sustainably in an area of special landscape quality with a rich wildlife. The designated area includes Aberystwyth, Llanbrynmair, Llanymawddwy, Corris Uchaf, and Aberdyfi.
[24] Welsh Government (2011). State of the Environment (Indicator 21). Available at: www.statswales.wales.gov.uk/TableViewer/document.aspx?ReportId=5830&IF_Language=eng. [Accessed May 2013]
[25] Welsh Government (2012). Sustaining a Living Wales: A Green Paper on a New Approach to Natural Resource Management in Wales. Available at: http://wales.gov.uk/consultations/environmentandcountryside/sustainingwales/?lang=en
[26] CCW (2006). Condition of SSSI Sites and Features. Available at: www.ccw.gov.uk/landscape--wildlife/protecting-our-landscape/special-landscapes--sites/protected-landscapes-and-sites/sssis/sssi--report/condition-of-features.aspx
[27] CCW (2008). Status of National Nature Reserves. Available at: www.ccw.gov.uk/landscape--wildlife/protecting-our-landscape/special-landscapes--sites/protected-landscapes-and-sites/national-nature-reserves/nnr-report/status-of-nnr.aspx
[28] Welsh Government (2010) State of the Environment: Indicator 19a. Available at: www.statswales.wales.gov.uk/TableViewer/document.aspx?ReportId=5762

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continued or accelerated decline across 60% of marine habitats compared to only 8% for terrestrial habitats and 33% for freshwater habitats[29].

## 1.4 Key Environmental Characteristics of those Areas most likely to be Significantly Affected

### 1.4.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

Important river systems in the Scottish Midlands SEA Area include the South Esk, Tay and Tweed with the Firths of Forth and Tay, and the inner Clyde Estuary supporting important coastal habitats and species including a wide variety of seabirds and waterbirds. There are also extensive areas of upland moorland, acid grassland, woodland and blanket bog which support important species assemblages.

Conservation sites of international importance include 41 SAC, 21 SPA, 12 Ramsar and 26 IBA (see **Figure 1.9** and **Figure 1.10**). National and local sites include 10 NNR, 443 SSSI and 39 LNR. A number of reserves are also owned or managed by organisations such as RSPB, National Trust for Scotland and the Scottish Wildlife Trust.

[29] NAT(2011) UK National Ecosystems Assessment Technical Report Available at http://uknea.unep-wcmc.org/

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**Figure 1.9 Conservation Sites of International Importance in SEA Area 1**

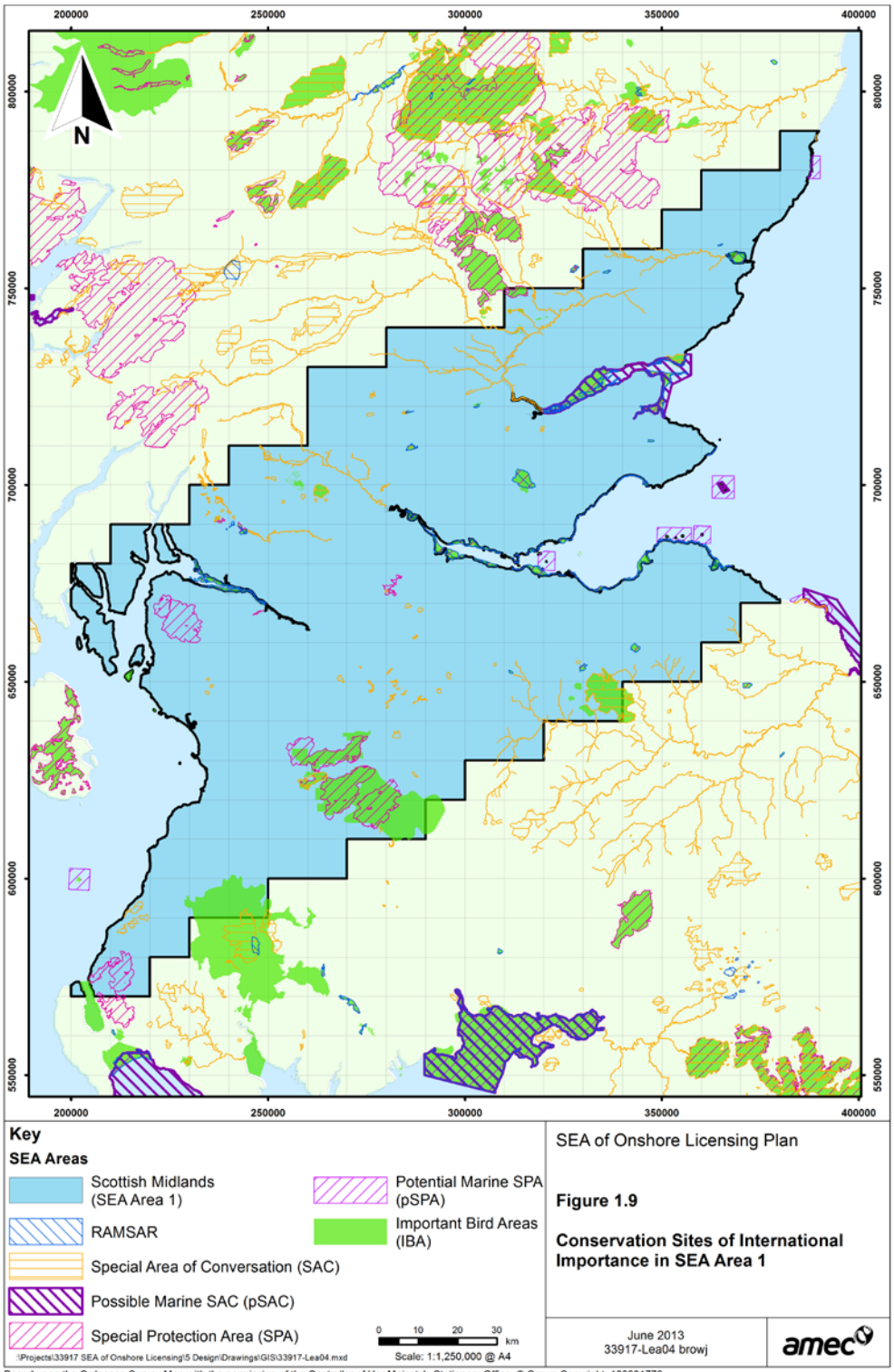


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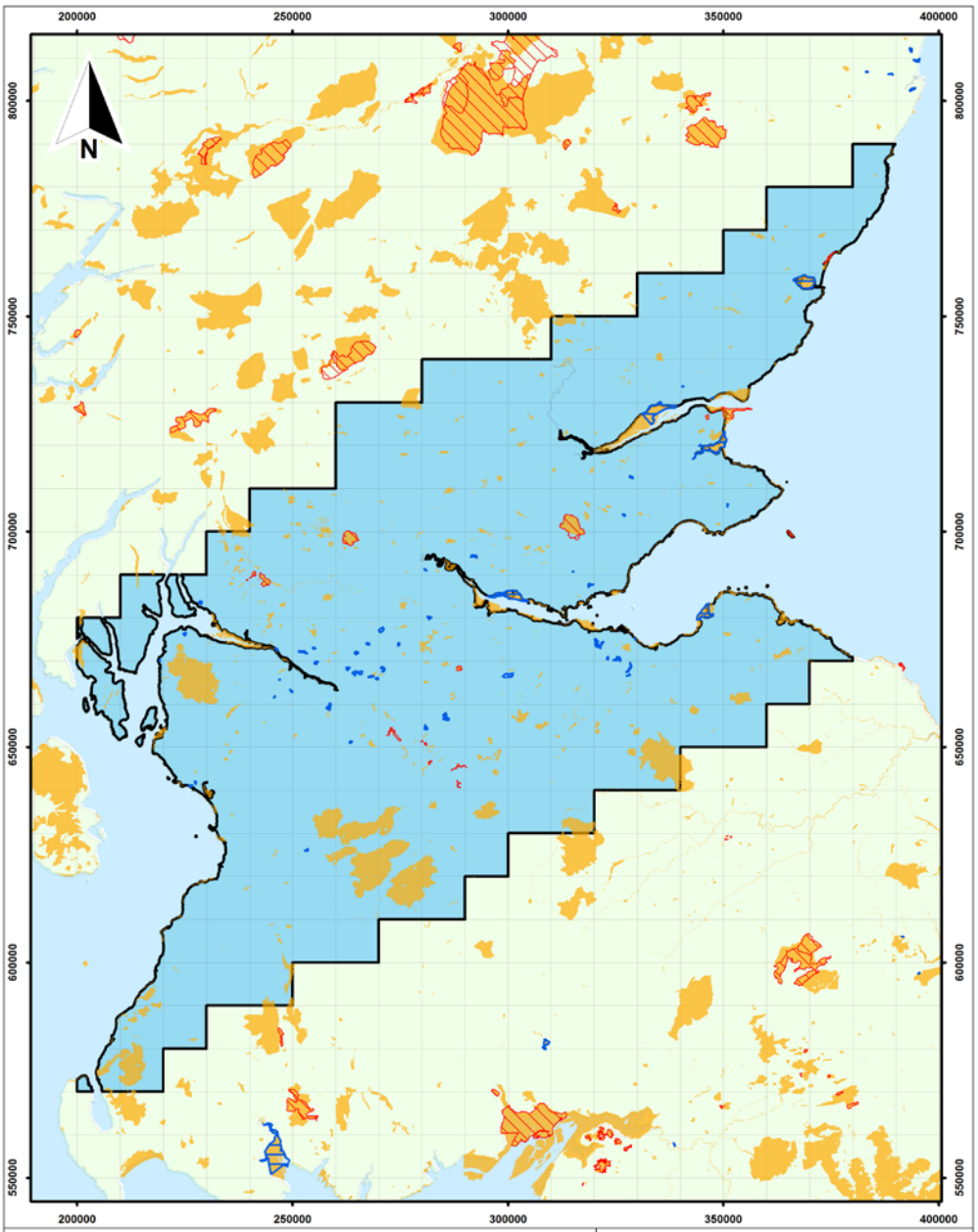
**Figure 1.10 Sites of National and Local Importance in SEA Area 1**




**Key**

**SEA Areas**

- Scottish Midlands (SEA Area 1)
- Local Nature Reserve (LNR)
- National Nature Reserve (NNR)
- Site of Special Scientific Interest (SSSI)

0 10 20 30 km

:\Projects\33917 SEA of Onshore Licensing\5 Design\Drawings\GIS\33917-Lea09.mxd

Scale: 1:1,250,000 @ A4

SEA of Onshore Licensing Plan

**Figure 1.10**

**Sites of National and Local Importance in SEA Area 1**

June 2013
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The Forth Estuary has an intertidal area of 4,798 hectares, covering just over half the area of the estuary as whole. The area is therefore very important for coastal bird sensitivities and a large proportion of the Forth coast supports nationally and internationally important colonies of breeding birds. This is recognised in an Important Bird Area (IBA) covering the entire coast of the inner and outer firth stretching from the River Forth at Stirling, eastwards past Edinburgh and along the coasts of Fife and east Lothian, coincident with both Ramsar and SPA designations. Wintering waterbirds and waterbirds on passage reach substantial populations at certain times of the year. In winter, the area supports over 89,000 overwintering and migratory waterbirds (e.g. bar-tailed godwit, golden plover, red-throated diver, Slavonian grebe, knot, pink-footed goose, redshank, shelduck, turnstone). In summer, the area supports breeding populations of common tern (*Sterna hirundo*), and the sandwich tern (*Sterna sandvicensis*) can be found on passage between July and August.

The River Teith, a major tributary of the Forth, contains anadromous species (i.e. spawning in freshwater but completing lifecycle in the sea) including the Annex II Atlantic salmon (*Salmo salar*) and sea lamprey (*Petromyzon marinus*).

Summary details of relevant International Designations for SEA Area 1 are set out in **Appendix E**.

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### 1.4.2 SEA Area 2: West Midlands, North West England and Southern Scotland

Key habitats for this area are wetlands including pools, rivers, clay pits, canals and mosses support important plant and animal species (e.g. great crested newt, floating water plantain, Atlantic salmon, sea and river lamprey). Other significant habitats include lowland heaths, ancient semi-natural woodlands and unimproved grassland with Cannock Chase, the Peak District Dales and the South Pennine Moors of particular importance. Blanket and raised bogs (either active or degraded/capable of regeneration) in the North West and Midlands represents a significant proportion of England's resource of this priority habitat (complemented by resources in the North East and South West of England) and is a primary feature in a number of SAC sites in the SEA area such as the South Pennine Moors and a qualifying feature in the Ingleborough Complex. The latter site is also notable for its limestone pavements which are also a primary feature of the Morecambe Bay Pavements designation. These pavements, though widely distributed, are uncommon in the UK, covering just 2,000 hectare in total, though the most extensive area of pavement is present in the North of England. The vegetation of limestone pavements is unusual, and a range of calcareous rock, heath, grassland, scrub and woodland NVC types may be present.

Wetland habitats also make the region very important for wildfowl and waders, and the Solway Flats and Marshes and the Duddon Estuary support large numbers of breeding, wintering and migratory birds (e.g. redshank, barnacle goose, pink-footed goose, golden plover, bar-tailed godwit, pintail, and knot). The Morecambe Bay SAC largely coincides with the Duddon Estuary SPA and has a number of features of European importance including mudflats and sandflats not covered by seawater at low tide, large shallow inlets and bays, *Salicornia* and other annuals colonising mud and sand, shifting dunes along the shoreline with *Ammophila arenaria* (`white dunes`), fixed dunes with herbaceous vegetation (`grey dunes`) and dune slacks. The Ribble and Alt estuaries, and the Mersey and the Dee estuaries also support large numbers of breeding, wintering and migratory birds (e.g. golden plover, redshank, ringed plover, dunlin, pintail, shelduck, and teal).

International conservation sites include 26 SAC (and 1 marine candidate SAC), [cSAC], 14 SPA (and one potential SPA [pSPA}, and one marine pSPA), 14 Ramsar and 13 IBA including the Bowland Fells (see **Figure 1.11**). National and local sites include 29 NNRs, 462 SSSIs and 243 LNRs (see **Figure 1.12**). A number of reserves are also owned or managed by organisations such as RSPB, National Trust and Wildlife Trusts. The Mersey Narrows and North Wirral Foreshore pSPA is located adjacent to the Liverpool Bay marine pSPA. The latter site is noted for its wintering populations of red-throated diver and scoter (Article 4.1 and 4.2 respectively). Further north, the Shell Flat and Lune Deep cSAC coincides with the Liverpool Bay pSPA, and has been considered for the Annex I habitats, reefs and sandbanks which are slightly covered by sea water all the time.

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**Figure 1.11 Conservation Sites of International Importance in SEA Area 2**

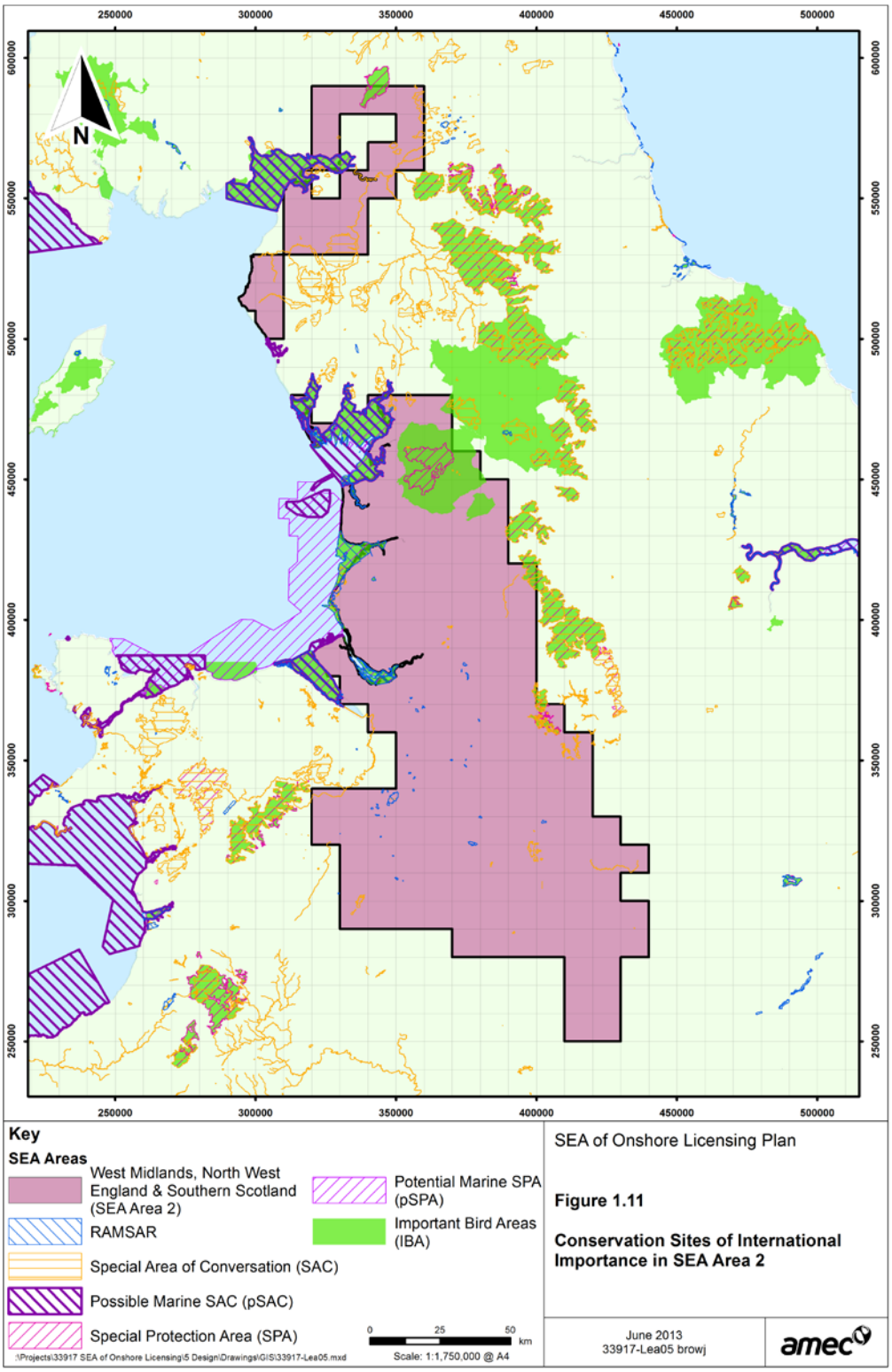


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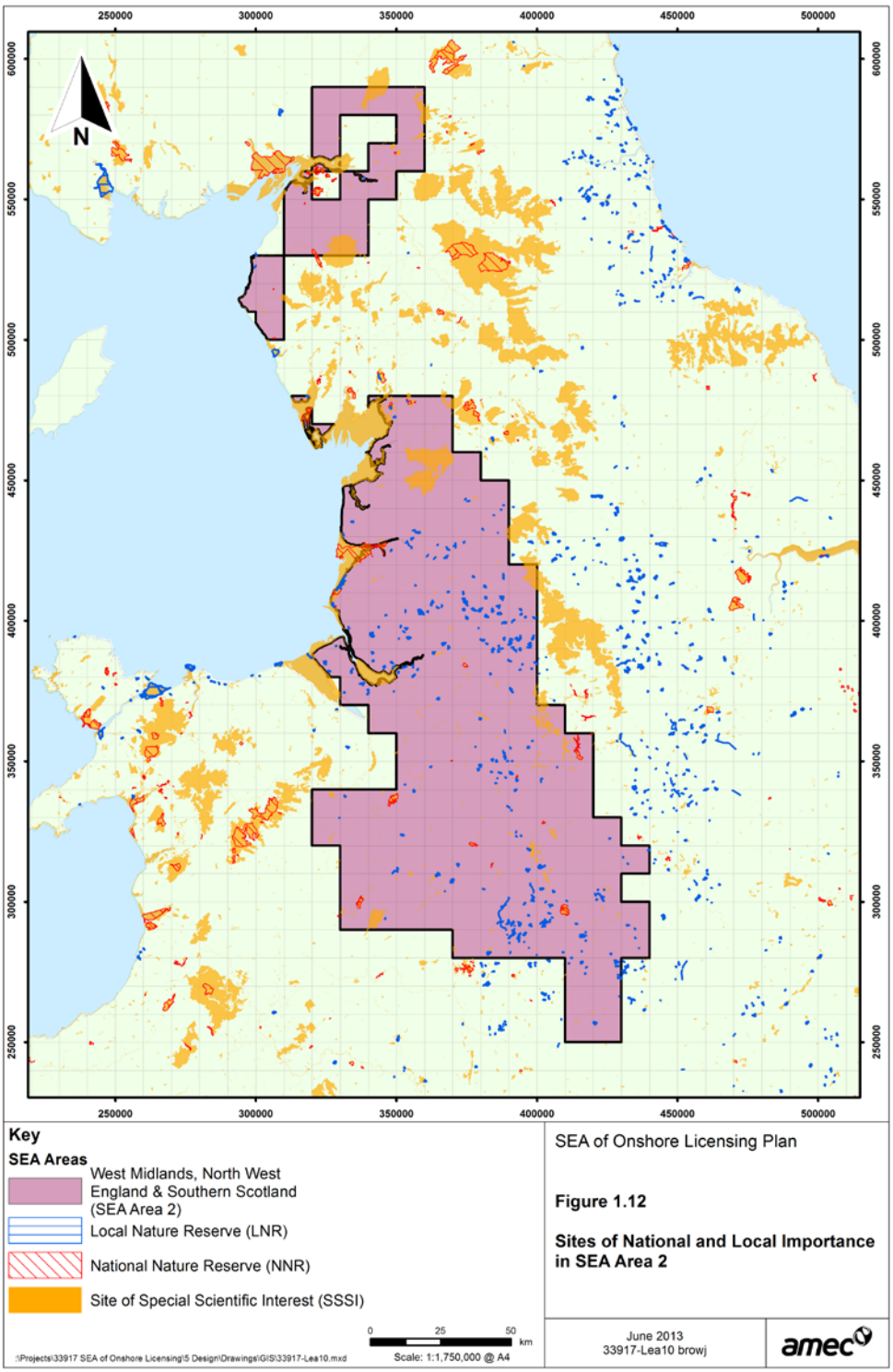
**Figure 1.12 Sites of National and Local Importance in SEA Area 2**

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Summary details of relevant International Designations for SEA Area 2 are set out in **Appendix E**.

### 1.4.3 SEA Area 3: East Midlands and Eastern England

Upland and coastal habitats and species dominate nature conservation designations in the north of the region with coastal and lowland wetland habitats and associated species to the south. Features of importance include the extensive estuarine habitats of the Humber Estuary (mudlflats and coastal saltmarsh), and The Wash and North Norfolk coastal habitats which supports huge numbers of wildfowl and waders (e.g. avocet, bar-tailed godwit, golden plover, whooper swan, ringed plover, black-tailed godwit) and the North York Moors and the Pennines which support important upland habitats and species (e.g. blanket bogs, European dry heaths and wet heaths with *Erica tetralix*). The SEA area also includes the lowland wetland habitats (fens) of East Anglia and the clay lowlands of Lincolnshire and The Wash.

A range of priority habitats identified by the UK Biodiversity Action Plan are present within the region. International conservation sites include 53 SAC, 20 SPA, 14 Ramsar and 22 IBA (see **Figure 1.13**). National and local sites include 59 NNR, 1,084 SSSI and 373 LNR (see **Figure 1.14**). A number of reserves are also owned or managed by organisations such as RSPB, National Trust and Wildlife Trusts.

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**Figure 1.13 Conservation Sites of International Importance in SEA Area 3**

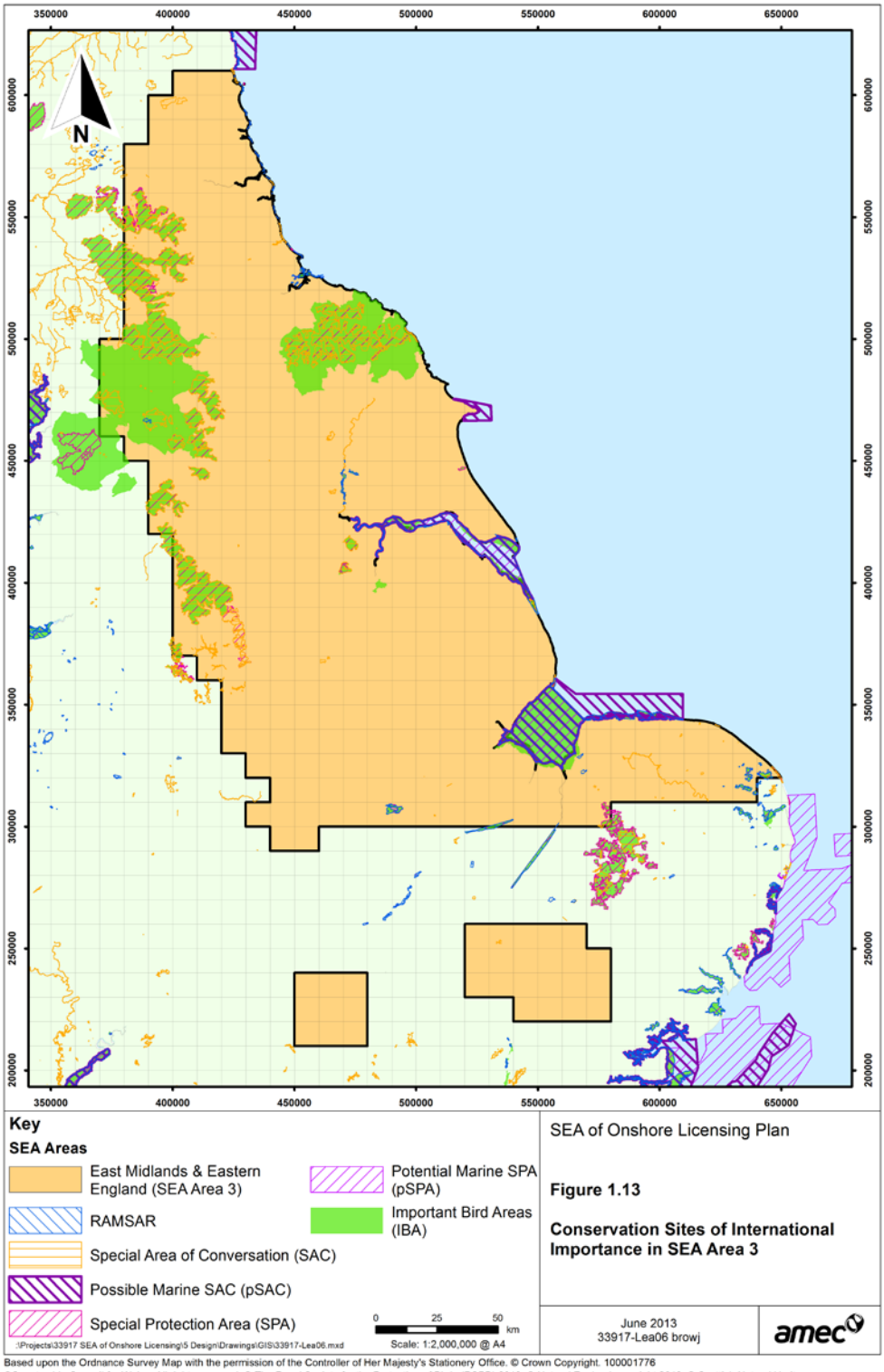


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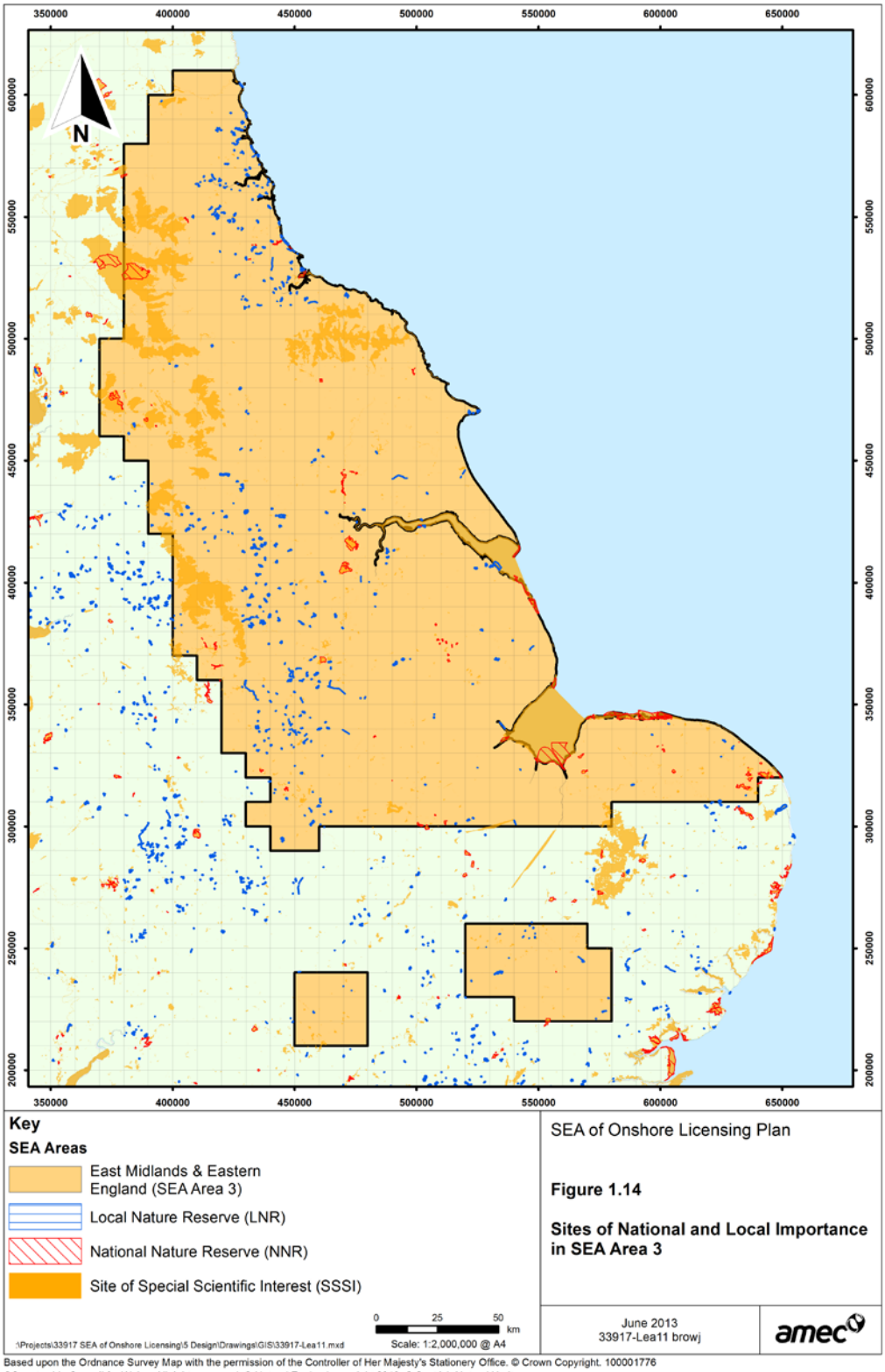
**Figure 1.14 Sites of National and Local Importance in SEA Area 3**

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Summary details of relevant International Designations for SEA Area 3 are set out in Appendix E.

### 1.4.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

Important river systems, including the Wye and Tywi in the south and the Dee in the north, support important habitats and species including twaite and allis shads, salmon and lampreys, recognised in SAC designations for these areas. Surrounding river valleys support woodland and bat sites. Grassland, heath and woodland habitats are protected with the extensive Berwyn and South Clwyd Mountains and Halkyn Mountain sites of particular importance. There are also a number of important sites for great crested newts. The Severn and Dee estuaries are important for a wide range of waterbirds and wildfowl, and offshore, the Liverpool Bay pSPA is being considered for it's over wintering populations of red-throated diver and common scoter.

A range of priority habitats identified by the UK Biodiversity Action Plan are present within the region. International conservation sites include 32 SAC, three SPA, five Ramsar and four IBA (see **Figure 1.15**). National and local sites include 15 NNR, 272 SSSI and 43 LNRs (see **Figure 1.16**). A number of reserves are also owned or managed by organisations such as RSPB, National Trust and Wildlife Trusts.

The Dee Estuary supports a number of conservation designations (SPA, SAC, Ramsar, SSSI) alluding to the national and international importance of the area for conservation. The SAC is designated primarily due to the occurrence of Annex I habitats including mudflats and sandflats not covered by seawater at low tide (i.e. intertidal), *Salicornia* and other annuals colonising mud and sand and Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*), and Annex II species including lamprey (sea and river) and the petalwort (*Petalophyllum ralfsii*). The area of saltmarsh and mudflat also lends itself to substantial populations (>90,000) of overwintering waterfowl, making the Dee Estuary SPA of international importance. The principal species involved include bar-tailed godwit, pintail, red knot, oystercatcher, shelduck and redshank. SEA Area 4 borders on to the Liverpool Bay marine pSPA which is noted for its wintering populations of red-throated diver and scoter (Article 4.1 and 4.2 respectively).

Further upstream, the River Dee and Bala Lake SAC has a certain dependency on the quality of the estuarine and offshore area further north and west due to the presence of anadromous species including the Atlantic salmon and sea lamprey, which require an unobstructed route upstream to spawn. The same considerations apply to the Usk and Wye SACs, adjacent to the Severn Estuary SAC and Ramsar site, and the Tywi SAC to the west of Area 4.

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**Figure 1.15 Conservation Sites of International Importance in SEA Area 4**

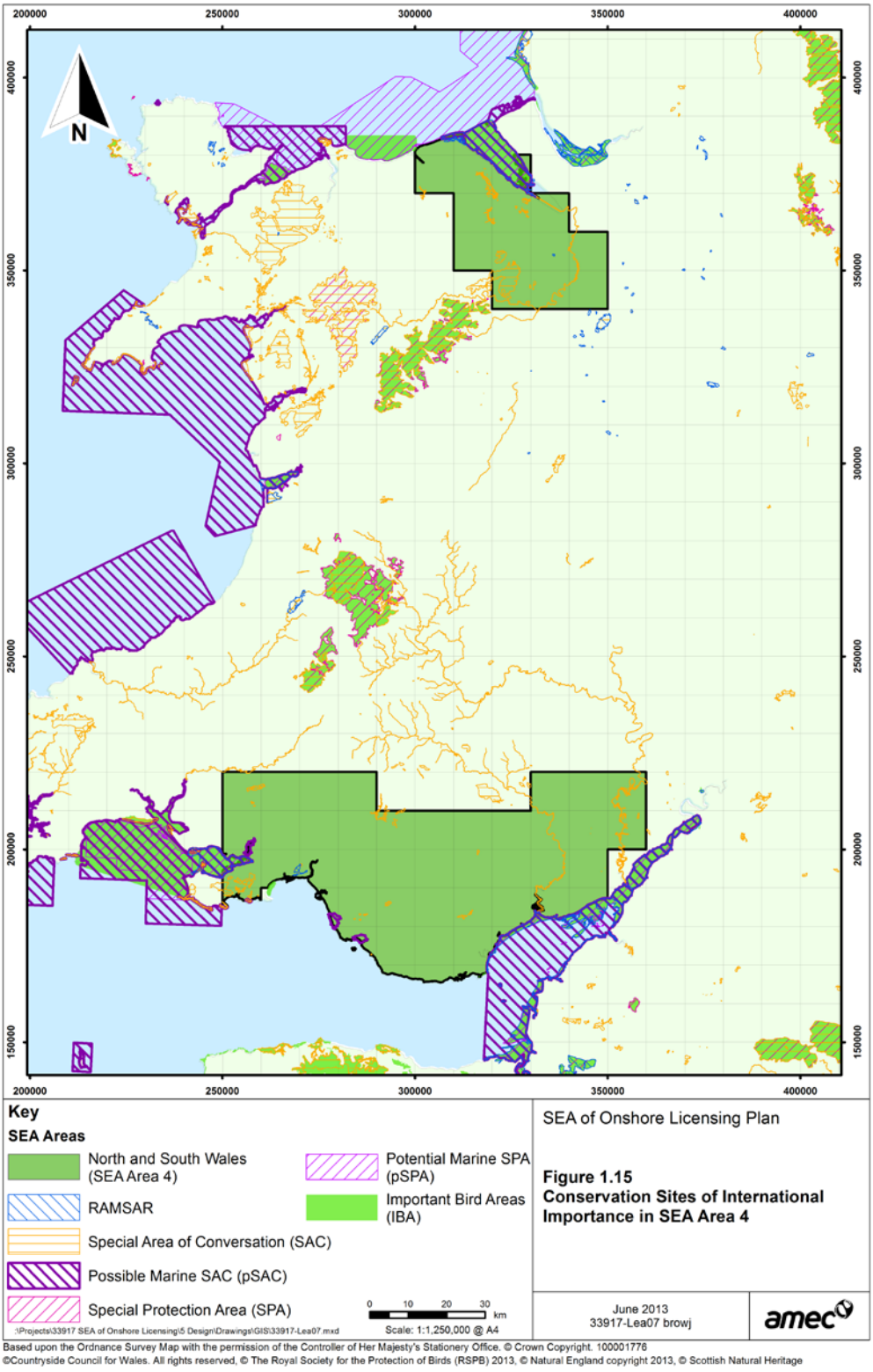
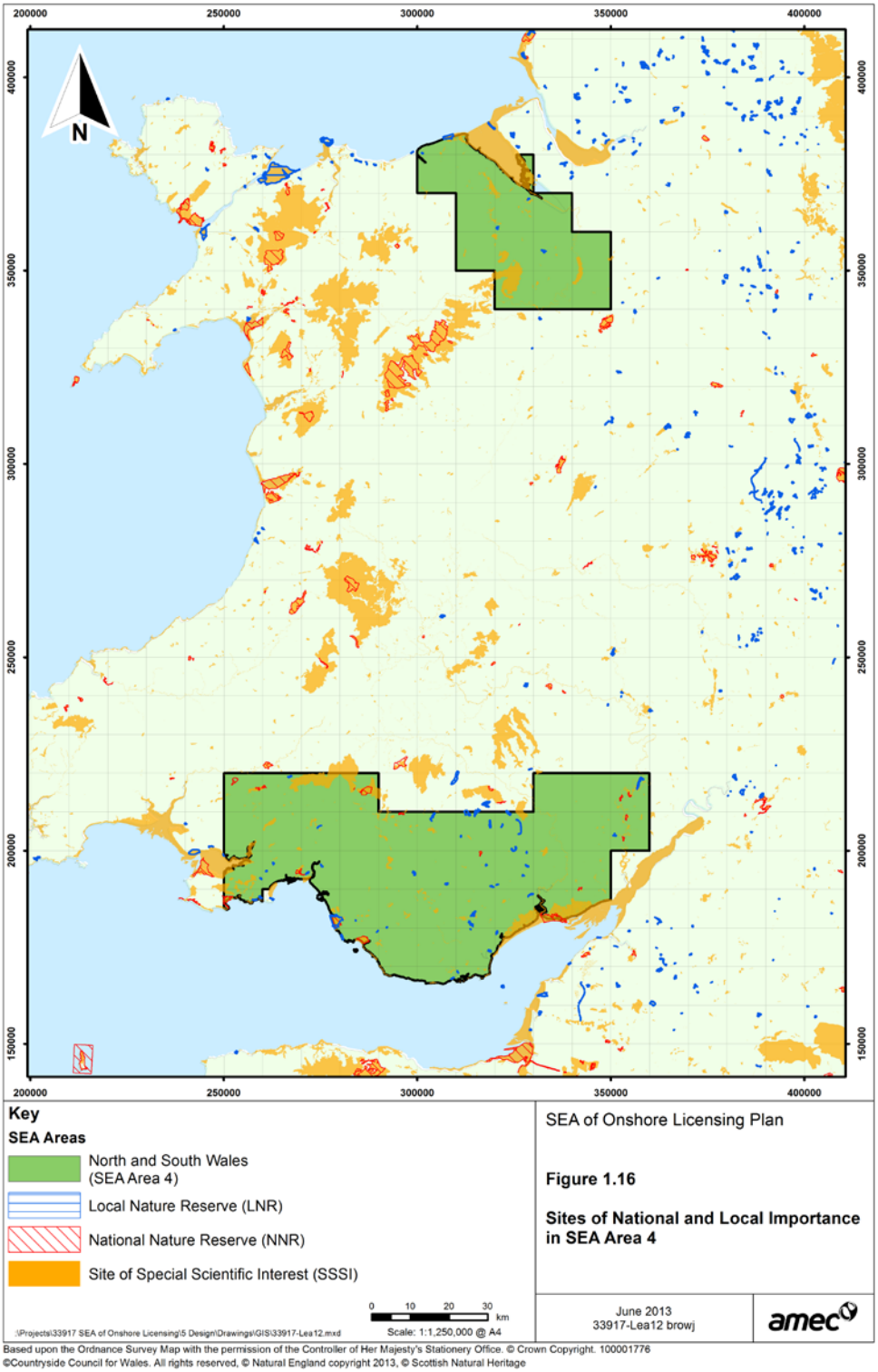


**Figure 1.16 Sites of National and Local Importance in SEA Area 4**




Summary details of relevant International Designations for SEA Area 4 are set out in **Appendix E.**

### 1.4.5 SEA Area 5: Southern and South West England

Species-rich chalk downlands and heathlands are particularly extensive and cover large parts of the south coast. River valleys and wetlands, upland areas, and a range of coastal habitats are of international importance. The area also contains densely wooded areas with extensive tracts of ancient woodland. There are a large number of important bird sites including coastal areas and wetlands for waterbirds and wildfowl.

A range of internationally and nationally important habitats are present within the Area 5. International conservation sites include 97 SAC, 30 SPA, 23 Ramsar and 32 IBA (see **Figure 1.17**) such as the Severn Estuary SAC and Ramsar site and Thames Estuary SPA. National and local sites include 76 NNR, 1,415 SSSI (seven of which cross into Wales) and 527 LNRs (**Figure 1.18**). In addition to these sites, The Outer Thames marine pSPA and Margate and Long Sands marine pSAC occur adjacent to SEA Area 5. These sites are being considered for the qualifying species, red-throated diver, and habitat, sandbanks which are slightly covered by sea water all the time, respectively. A number of reserves are also owned or managed by organisations such as the RSPB, National Trust and Wildlife Trusts (e.g. Slimbridge).

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**Figure 1.17 Sites of International Importance in SEA Area 5**

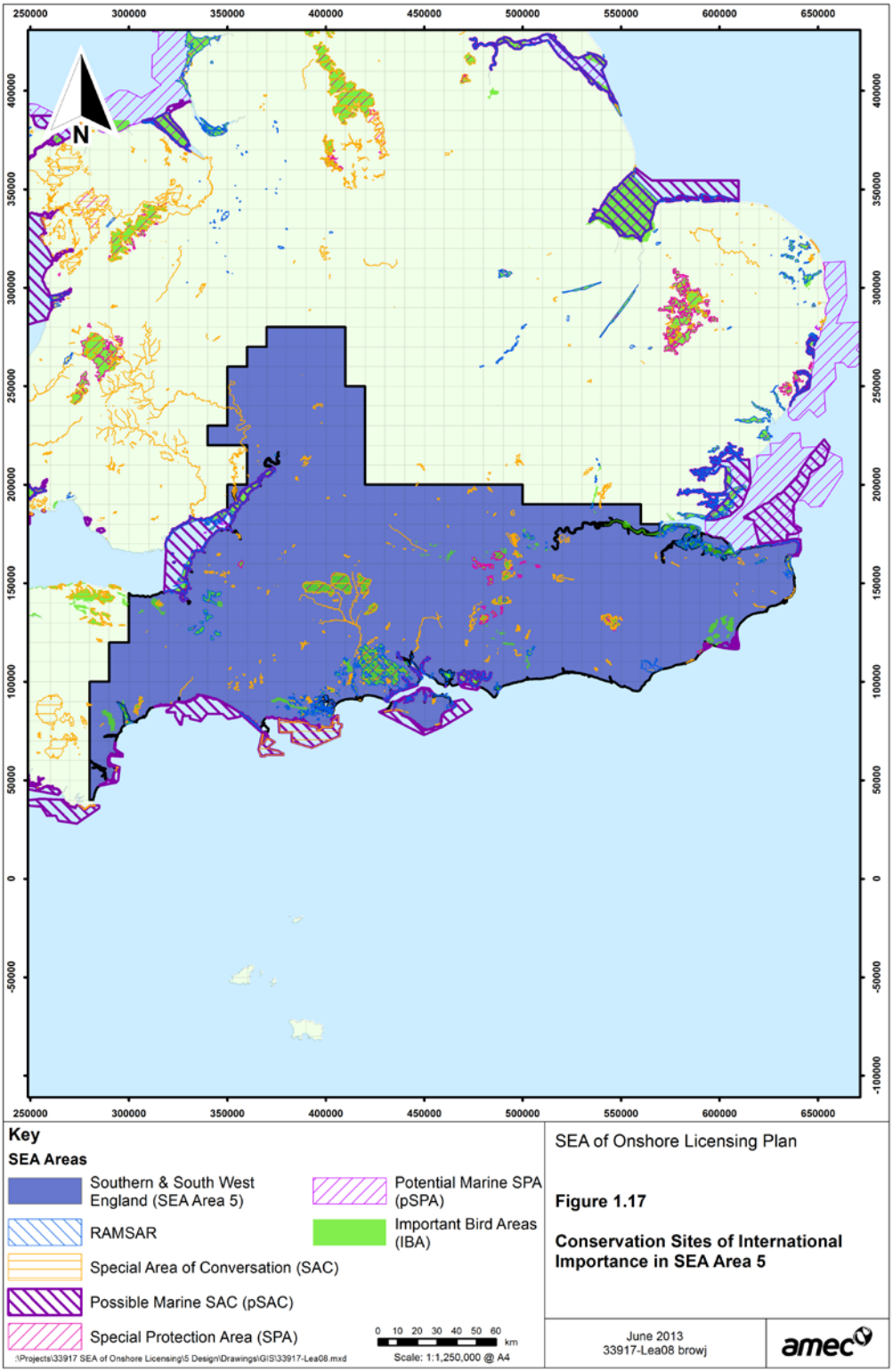


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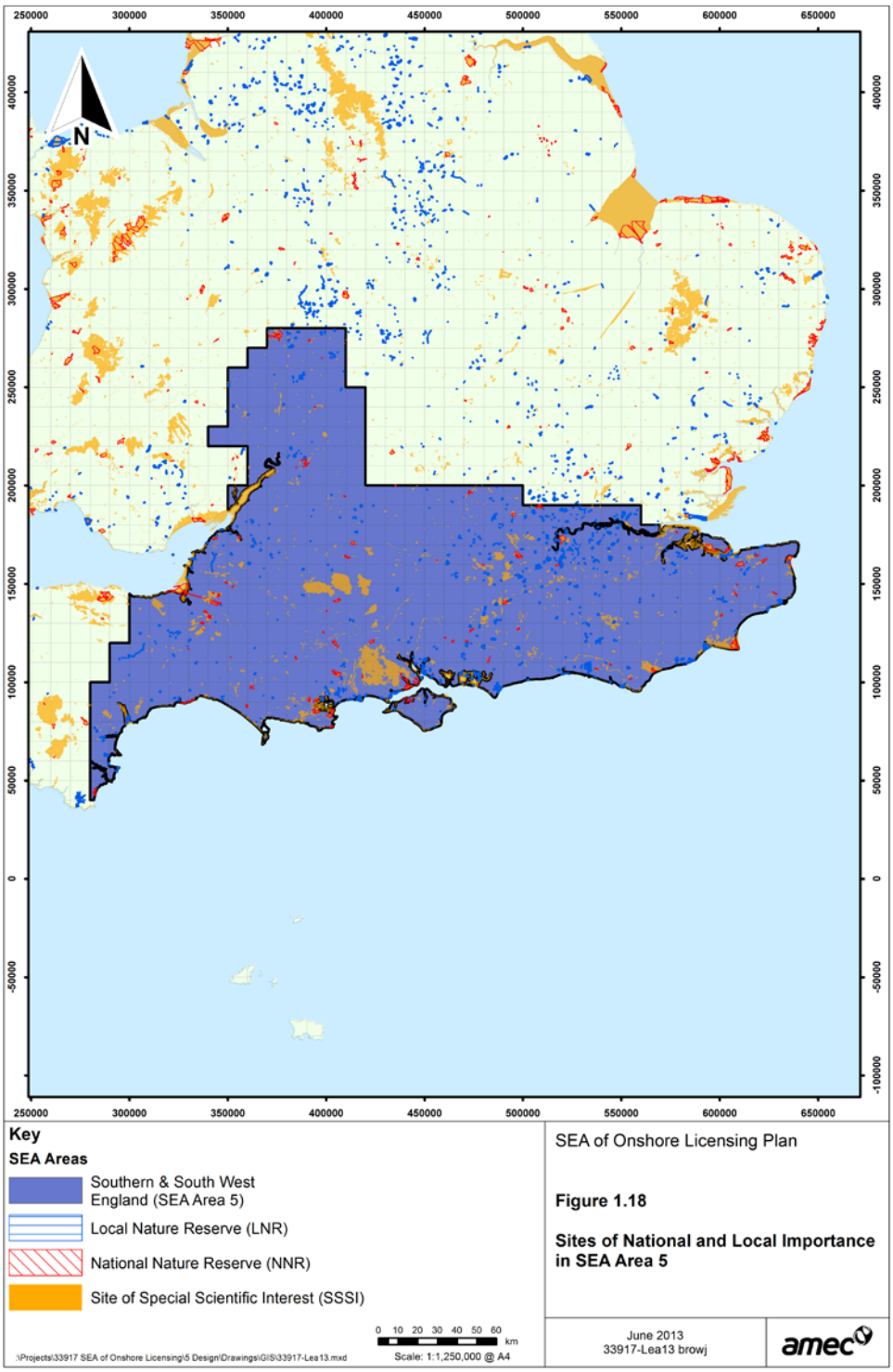
**Figure 1.18 Sites of National and Local Importance in SEA Area 5**

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Summary details of relevant International Designations for SEA Area 5 are set out in **Appendix E.**

## 1.5 Summary of Existing Problems for Biodiversity and Nature Conservation Relevant to Onshore Oil and Gas Licensing

The SEA directive requires consideration of any existing environmental problems which are relevant to the plan or programme, particularly those areas of environmental importance such as those pursuant to directives 79/409/EC and 92/43/EC (the Birds and Habitats Directives). An analysis of the causes of unfavourable condition and threats to the range of habitats by Natural England has revealed the key pressures and risks to be:

- habitat destruction and fragmentation by development;
- agricultural intensification and changes in agricultural management practices;
- changes in woodland and forestry management;
- water abstraction, drainage or inappropriate river management;
- inappropriate coastal management;
- lack of appropriate habitat management;
- atmospheric pollution (acid precipitation, nitrogen deposition);
- water pollution from both point and wider (diffuse) agricultural sources;
- climate change and sea level rise;
- sea fisheries practices;
- recreational pressure and human disturbance; and
- invasive and non-native species[30].

The same threats occur across the devolved administration in the UK. For example, the Scottish Biodiversity Group's report, Action for Scotland's Biodiversity (2000) identified seven key issues for biodiversity in Scotland: farming, forestry and fisheries as the main three, along with land development, air quality, water quality and transport[31].

**Table 1.6** presents an overview of the key environmental problems relevant to onshore oil and gas licensing.

[30] State of the Natural Environment Report' (2008) http://naturalengland.etraderstores.com/NaturalEnglandShop/product.aspx?ProductID=31a51089-6654-4d48-8f89-30d3c8c66aee
[31] SEPA (2007) State of Scotland's Environment 2006

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**Table 1.6 Environmental Problems Relevant to Onshore Oil and Gas Licensing**

| Problem | Supporting Data | Implications |
|---|---|---|
| Loss of biodiversity | The status of UK priority habitats and species in 2008 indicates that the decline of biodiversity is a major issue. For example, only 31% of the 45 priority habitats and 44% of the 391 priority species were judged to be stable, stable and probably increasing, or increasing, and of those that are stable, some may have populations well below what is recommended. | Ensure potential activities do not adversely affect biodiversity. |
| Unfavourable condition of certain habitat features | Over the period 1999-2005, the national conservation agencies carried out a programme of monitoring the designated features of SSSI, SACs, SPAs and Ramsar sites. 57% of A/SSSI sites were reported in favourable condition, with 37% of SACs, 86% of Ramsars and 73% of SPAs reported as favourable.<br>Conservation features which were least favourable were often impacted by factors which operated outside the sites on which they were designated (e.g. drainage conditions for some isolated wetlands, pollution) and which require concerted effort by many agencies (e.g. water quality affecting fish). | Ensure potential activities do not adversely affect the status of conservation features. |

## 1.6 Likely Evolution of the Baseline

### 1.6.1 UK

The general global trend in biodiversity is generally towards a decreased level of variability among living organisms. The European Commission indicate that "Biodiversity loss has accelerated to an unprecedented level, both in Europe and worldwide. It has been estimated that the current global extinction rate is 1,000 to 10,000 times higher than the natural background extinction rate. In Europe some 42% of European mammals are endangered, together with 15% of birds and 45% of butterflies and reptiles"[32]. The global trend towards a decline in biodiversity is mirrored in the UK. The annual review of biodiversity indicators reveals that of the 35 measures used to compile the 'all measures' summary chart, 17 (49%) show an improvement since 2000, compared with 11 measures (31%) showing improvement over the longer term. Those showing improvement since 2000 include conservation volunteering, the extent of protected sites both on land and at sea, the percentage of woodland certified as sustainably managed, sustainable fisheries, water quality, and expenditure on both UK and international biodiversity.

Measures showing long-term deterioration include populations of farmland birds and woodland birds, populations of butterflies which are strongly associated with semi-natural habitats, bat populations and plant diversity (in woodland and grassland, and in boundary habitats). Some of these measures have continued to deteriorate in the short term (e.g. farmland birds and the plant diversity of boundary habitats). Bat populations have shown improvement since 2000, whilst butterflies have shown little or no overall change for both semi-natural habitat specialists and butterflies of the wider countryside.

[32] European Commission, http://ec.europa.eu/environment/nature/biodiversity/intro/index_en.htm

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A recent report by the UK's non-statutory wildlife organisations[33] sets out the following headline results of their assessment of the state of the UK's biodiversity resource:

- Using records of 3,148 species, some 60% of these have declined over the last 50 years and 31% have declined strongly;
- Half of the species assessed have shown strong changes in abundance or distribution, indicating that recent environmental changes are having a dramatic impact on the nature of the UK's land and seas. There is also evidence to suggest that species with specific habitat requirements are faring worse than generalist species that are better able to adapt to a changing environment;
- A new Watchlist Indicator has been developed to measure how conservation priority species are faring, based on 155 species for which we have suitable data. This group contains many of our most threatened and vulnerable species, and the indicator shows that their overall numbers have declined by 77% in the last 40 years, with little sign of recovery;
- Of more than 6,000 species that have been assessed using modern Red List criteria, more than one in ten are thought to be under threat of extinction in the UK. A further 885 species are listed as threatened using older Red List criteria or alternative methods to classify threat;
- There were considerable (albeit largely unquantified) declines in the UK's wildlife prior to the last 50 years, linked to habitat loss; and
- Climate change is having an increasing impact on nature in the UK. Rising average temperatures are known to be driving range expansion in some species, but evidence for harmful impacts is also mounting[34].

In the UK, there has been an increase in the number of sites and areas protected for biodiversity, flora and fauna[35] (**Figure 1.19**).

[33] Burns F, Eaton MA, Gregory RD, *et al*. (2013) *State of Nature report*. The State of Nature partnership at http://www.rspb.org.uk/Images/stateofnature_tcm9-345839.pdf
[34] UK Biodiversity Indicators in Your Pocket 2012, http://jncc.defra.gov.uk/pdf/BIYP_2012.pdf
[35] http://jncc.defra.gov.uk/page-4241

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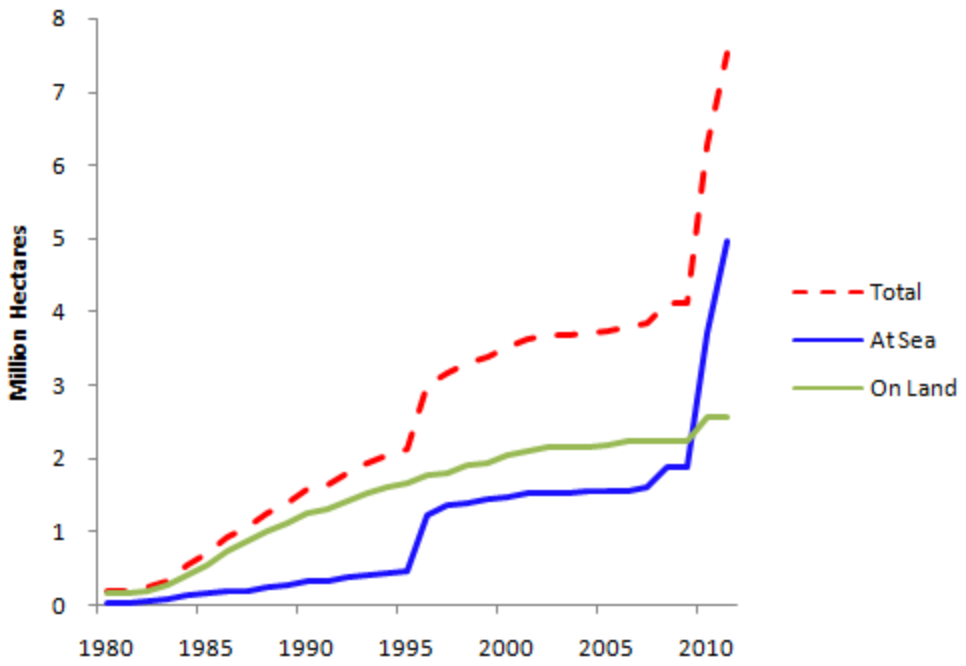
**Figure 1.19 Extent of UK Nationally and Internationally Important Protected Areas: (i) Total Extent; (ii) on Land; (iii) at Sea, 1980 to 2011**




- The overall total extent of land and sea protected in the UK through national and international protected areas has increased from just under 0.2 million hectares in 1980 to just over 7.5 million hectares in December 2011;

- Since 2000 the total extent of protected areas has more than doubled, from 3.5 million hectares in 2000 to just over 7.5 million hectares in 2011; a large contribution to this has been from the marine environment following the designation of inshore and offshore marine sites under the Habitats Directive – the area of marine protected areas increased by more than 3 million hectares between 2009 and 2011. The extent of protected areas on land has increased by more than half a million hectares since 2000; and

- The indicator also shows the condition of Areas or Sites of Special Scientific Interest (A/SSSIs) on land. A/SSSIs are surveyed periodically to assess whether they are in good condition (favourable) or, if not, they are under positive management (recovering). Since 2005 the percentage of features or area of A/SSSIs in favourable or recovering condition has increased by 18%. This change reflects improved management of sites, but may also be affected by a greater number of sites/features having been assessed over time. The majority of protected areas on land are A/SSSIs, so the condition indicator is not representative of marine sites.

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### 1.6.2 England

Results of the 2012 reporting of biodiversity indicators for England[36] reveal that:

Overall there are 45 individual measures making up the indicators, and since 2000:

- 17 measures (38%) show an improvement;
- 10 measures (22%) show little or no overall change;
- 8 (18%) show a deterioration;
- 3 (6%) have insufficient data for an assessment; and
- 7 (15%) are not assessed.

Those showing a deterioration since 2000 are:

- proportion of Sites of Special Scientific Interest in favourable condition;
- breeding farmland birds;
- butterflies of the wider countryside on farmland;
- plant diversity in neutral grassland and boundary habitats;
- wintering water and wetland birds;
- pressure on biodiversity from invasive species in freshwater environments;
- pressure on biodiversity from invasive species in terrestrial environments; and
- pressure on biodiversity from invasive species in marine environments.

Of those indicators for which it is possible to make a long-term assessment of change, the following 10 measures show a long-term deterioration:

- breeding farmland birds;
- butterflies of the wider countryside on farmland;
- plant diversity in neutral grassland and boundary habitats;
- widespread bats;
- breeding woodland birds;
- butterflies of the wider countryside in woodland;

36https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/85765/Statistical_release_-_England_Biodiversity_Indicators_final.pdf

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- marine ecosystem integrity (size of fish in the North Sea);
- pressure on biodiversity from invasive species in freshwater environments;
- pressure on biodiversity from invasive species in terrestrial environments; and
- pressure on biodiversity from invasive species in marine environments.

In England, in 2009 over 80% of SACs and SPAs were in favourable or recovering condition. SSSI condition in England has experienced a dramatic improvement in the overall site condition over the last 10 years as a result of protection and management [37]. However, some species in particular continue to be impacted upon. The trend in populations of breeding wading birds on unprotected lowland wetland grasslands is towards a major decline[38].

Despite the increase in area protected for its biodiversity there is concern that the protected site network as it exists is insufficient to protect biodiversity in England as a whole and that some species and habitats will be confined to these protected areas and more vulnerable to pressures and threats, including climate change[39].

### 1.6.3 Scotland

In Scotland, in 2008 over 60% of SACs and over 70% of SPAs were in favourable or recovering condition[40]. Results of the 2008 reporting round of the UK Biodiversity Action Plan indicate that in Scotland[41]:

**Habitats:**

- 13% of priority habitats were increasing (compared to 15% in 2005);
- 21% of priority habitats were stable (compared to 20% in 2005);
- 3% of habitats were declining (continuing/accelerating) (compared to 0% in 2005);
- 26% of habitats were declining (slowing) (compared to 29% in 2005);
- 16% of habitats were fluctuating (compared to 2% in 2005);
- 3% of habitats showed no clear trend (compared to 7% in 2005); and
- the status of 21% of habitats was unknown (compared to 27% in 2005).

[37] Natural England (2008) State of the Environment Report
[38] Joint Nature Conservation Committee, Protected Areas, http://www.jncc.gov.uk/page-4241)
[39] Lawton *et al* (2010) Making Space for Nature: A review of England's Wildlife Sites and Ecological Network
[40] Joint Nature Conservation Committee, Protected Areas, http://www.jncc.gov.uk/page-4241)
[41] Biodiversity Action Reporting System, http://www.ukbap-reporting.org.uk/status/uk.asp

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**Species:**

- 4% of species were increasing (compared to 5% in 2005);
- 23% of species were stable (compared to 24% in 2005);
- 15% of species were fluctuating (compared to 3% in 2005);
- 11% of species were declining (slowing) (compared to 9% in 2005);
- 7% of species were declining (continuing/accelerating) (compared to 5% in 2005);
- 1% of species were lost (pre BAP publication) (no change since 2005);
- 7% of species showed no clear trend (compared to 8% in 2005); and
- the status of 32% of species was unknown (compared to 42% in 2005).

The latest monitoring information on biodiversity in Scotland was reported in 2010[42]. Scotland's 2010 biodiversity targets underpin the high level target to halt the loss of biodiversity by 2010. Based on the European Biodiversity Action Plan framework and adopted by the Scottish Biodiversity Committee in March 2008, eight priority objectives, four supporting measures and 37 targets for action have been specified for Scotland. By the end of 2009, 54% of these actions were on target (e.g. - principal pollutant pressures on terrestrial and freshwater biodiversity substantially reduced by 2010'), 27% had room for improvement (e.g. - climate change adaptation and mitigation measures) and 16% were not on target (e.g. - reducing the impact of invasive non-native species)[43]. Consultation on a revised Scottish Biodiversity Strategy is due in 2013[44].

### 1.6.4 Wales

A 2006 review[45] of SSSIs in Wales found that:

- 12% of Wales is designated as SSSI;
- during 2005-6 Wales gained three SSSIs, an additional 399 hectares;
- 71% of SSSIs by area are also sites of international importance for wildlife;
- one quarter of SSSIs can be reached within 1km of a town or city;

[42] Mackey, E.C. and Mudge, G. (2010). Scotland's Wildlife: An assessment of biodiversity in 2010. Scottish Natural Heritage, Inverness. http://www.snh.gov.uk/docs/B811968.pdf
[43] Mackey, E.C. and Mudge, G. (2010). Scotland's Wildlife: An assessment of biodiversity in 2010. Scottish Natural Heritage, Inverness. http://www.snh.gov.uk/docs/B811968.pdf
[44] http://www.biodiversityscotland.gov.uk/doing/framework/strategy/
[45] Countryside Council for Wales (2006) Sites of Special Scientific Interest (SSSIs) in Wales Current state of knowledge Report for April 2005 – Mar 2006

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- 62% of SSSIs by area are classed as open access land;
- from a sample of SSSIs, 47% of designated habitats and species were considered to be in favourable condition;
- 25% of SSSIs by area are known to be owned or managed by conservation sector bodies; and
- 62 infringements to SSSI legislation were reported during 2005-6.

This compares with a 2005 review of SSSIs by CCW which found that 29% of the area covered by SSSIs was in favourable condition, 18% was in unfavourable but recovering condition, with a further 52% being in 'unfavourable and declining' condition. The remaining 1% was classified as partially destroyed. Results of the 2008 reporting round of the UK Biodiversity Action Plan indicate that in Wales [7].

**Habitats:**

- 5% of priority habitats were increasing (compared to 21% in 2005);
- 5% of priority habitats were stable (compared to 13% in 2005);
- 24% of habitats were declining (continuing/accelerating) (compared to 13% in 2005);
- 26% of habitats were declining (slowing) (compared to 41% in 2005);
- 16% of habitats were fluctuating (compared to 8% in 2005); and
- 8% of habitats showed no clear trend (compared to 5% status unknown in 2005).

**Species:**

- 7% of species were increasing (compared to 6% in 2005);
- 15% of species were stable (compared to 18% in 2005);
- 16% of species were fluctuating (compared to 14% in 2005);
- 5% of species were declining (slowing) (compared to 6% in 2005);
- 8% of species were declining (continuing/accelerating) (compared to 7% in 2005);
- 3% of species were lost (pre BAP publication) (compared to 4% in 2005);
- 9% of species showed no clear trend (compared to 6% in 2005); and
- the status of 35% of species was unknown (compared to 37% in 2005).

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## 1.7 Assessing Significance

The objectives and guide questions related to biodiversity and nature conservation which have been identified for use in assessing the effects of Licensing Plan proposals and alternatives are set out in **Table 1.7**, together with reasons for their selection.

**Table 1.7 Approach to Assessing the Effects of the Licensing Plan on Biodiversity and Nature Conservation**

| Objective/Guide Question | Reasoning |
|---|---|
| **Objective: To protect and enhance biodiversity (habitats, species and ecosystems) working within environmental capacities and limits.** | The SEA Directive requires that the likely significant effects on biodiversity should be taken into account in the Environmental Report. |
| Will the Licensing Plan proposals protect and/or enhance internationally designated nature conservation sites? e.g. SACs, SPAs and Ramsars? | The Habitats Directive designates SPAs and SACs to maintain or restore important natural habitats and species. |
| Will the Licensing Plan proposals protect and/or enhance nationally designated nature conservation sites? e.g. SSSIs? | The Wildlife and Countryside Act includes legislation relating to protected sites. Devolved administrations are preparing detailed action plans on protecting habitats and species e.g. Biodiversity 2020 – A Strategy for England's Wildlife and Ecosystem Services. |
| Will the Licensing Plan proposals affect animals or plants including protected species? | The Wildlife and Countryside Act includes legislation relating to protected sites. Devolved administrations are preparing detailed action plans on protecting habitats and species. |
| Will the Licensing Plan proposals affect the structure and function of natural systems (ecosystems)? | Biodiversity is a highly sensitive receptor. It is likely that many of the other topics considered in this report will have an effect on biodiversity. Ecosystems will be sensitive to these interconnected effects. |
| Will the Licensing Plan proposals affect public access to areas of wildlife interest? | The National Parks and Access to the Countryside Act 1949 addresses public rights of way and access to open land |
| Will the Licensing Plan proposals have an impact on fisheries? | Various inland waters could be affected by the licencing proposals. Therefore the provisions of the Freshwater Fish Directive apply which include measures on the quality of fresh waters needing protection or improvement in order to support fish life. |

**Table 1.8** sets out guidance that will be utilised during the assessment to help determine the relative significance of potential effects on the biodiversity and nature conservation objective. It should not be viewed as definitive or prescriptive; merely illustrative of the factors that may be considered as part of the assessment process.

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**Table 1.8 Illustrative Guidance for the Assessment of Significance for Biodiversity and Nature Conservation**

| *Effect* | *Description* | *Illustrative Guidance* |
|---|---|---|
| ++ | Significant positive | • Option would have a significant and sustained positive impact on European or national designated sites and/or protected species. (e.g. – fully supports all conservation objectives on site, long term increase in population of designated species);<br>• Option would have a strong positive effect on local biodiversity (e.g. – through removal of all existing disturbance/pollutant emissions, or creation of new habitats leading to long term improvement to ecosystem structure and function);<br>• Option will create new areas of wildlife interest with improved public access in areas where there is a high demand for access to these sites. |
| + | Minor Positive | • Option would have a minor positive effect on European or national designated sites and/or protected species (e.g. – supports one of the conservation objectives on site, short term increase in population of designated species);<br>• Option may have a positive net effect on local biodiversity (e.g. – through reduction in disturbance/pollutant emissions, or some habitat creation leading to temporary improvement to ecosystem structure and function);<br>• Option will enhance existing public access to areas of wildlife interest in areas where there is some demand for these sites. |
| 0 | No (neutral effects) | • Option would not have any effects on European or national designated sites and/or any species (including both designated and non-designated species);<br>• Option would not affect public right of way or access to areas of wildlife interest. |
| - | Minor Negative | • Option would have minor short-term negative effects on non-designated conservation sites and species (e.g. – through a minor increase in disturbance/pollutant emissions, or some loss of habitat leading to temporary loss of ecosystem structure and function);<br>• Option will decrease public access to areas of wildlife interest in areas where there is some demand for these sites. |
| -- | Significant negative | • The option would have a negative effect on European or national designated sites and/or protected species (i.e. on the interest features and integrity of the site, by preventing any of the conservation objectives from being achieved or resulting in a long term decrease in the population of a priority species). These effects could not be reasonably mitigated;<br>• Option would have significant negative effects on local biodiversity (e.g. – through an increase in disturbance/pollutant emissions, or considerable loss of habitat leading to long term loss of ecosystem structure and function). |
| ? | Uncertain | • From the level of information available the impact that the option would have on this objective is uncertain. |

## 1.8 Assessment of Effects

This section comprises the assessment of the potential activities that could follow on from the licensing round on the biodiversity objective. There are a total of six main stages of oil and gas exploration and production (including gas storage) that are the subject of the assessment. These are highlighted in **Table 1.9** for both conventional and unconventional oil and gas together with an overview of the associated key activities at each stage. Please note that Stages 1, 2 and 4 do not necessarily apply to gas storage, depending on the history of the particular site.

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**Table 1.9 Oil and Gas Exploration and Production Lifecycle and Key Activities**

| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| 1. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. |
| 2. | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring.* | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. |
| 3. | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring* | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. |
| 4. | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring.* | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. |
| 5. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. |
| 6. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. |

Note: Exploration wells most usually move from Stage 2 to Stage 4, though some may be used for long-term production testing (which would require new consents including planning permission) and some may be retained and their sites redeveloped as a production project (this would also require new consents including planning permission). For the purposes of this assessment, the appraisal stage (a term commonly used in industry) spans Stages 2 and 3.

*Conventional oil and gas exploration and production activities (stages 2 to 4 above) can occasionally include hydraulic fracturing. However, the need to undertake hydraulic fracturing is relatively uncommon and has therefore not been considered in the assessment of conventional oil and gas activities as part of this SEA.

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### 1.8.1 Conventional Oil and Gas

The assessment of the six main stages of conventional oil and gas production is contained in **Table 1.10**. The first two columns describe the exploration and production stage. The third and fourth columns summarise the expected effects on the biodiversity objective for both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report). The rationale for this relationship is explained in more detail in the final column and includes:

- the nature and scale of the potential effects on the biodiversity objective;
- when the effect could occur (timing) and its degree of permanence;
- what mitigation measures might be appropriate for potentially significant negative effects on the biodiversity objective;
- what options there are to enhance positive effects; and
- assumptions and uncertainties that underpin the assessment.

**Table 1.10 Assessment of Effects: Conventional Oil and Gas**

| **Objective 1: Biodiversity** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0/?** | **0/?** | **Assessment of Effects:**<br>Stage 1 of the oil and gas exploration and production lifecycle would comprise non-intrusive activities. Site identification, selection and characterisation and the securing of development and operation permits would be expected to be largely desk-based and in consequence, no significant effects on biodiversity would be anticipated from these activities.<br>However, there potentially could be disturbance effects associated with seismic testing, particularly in the breeding season or for vulnerable species.<br>Vibroseis is the most common method of seismic survey and typically involves 3-5 large vibrator units which sub-sonically vibrate the ground while a number of support vehicles record the returning shock waves for analysis. As highlighted in the 2010 Environmental Report[46], surveys tend to be spatially restricted due to the requirement for roads or other hard surfaces accessible by vehicle. Where roads have to be constructed to facilitate access to sites, any adverse effects would be temporary with land restored following completion of the surveys. Where shot-hole techniques are utilised (which involve the use of explosions as a source of seismic energy), the requirement for large vehicular access would be likely to be reduced whilst it would be expected that shot holes would be infilled after use. |

[46] DECC (2010) *Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds: Environmental Report*

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| Objective 1: Biodiversity | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Taking into account the fact that any adverse effects on biodiversity would be temporary and cover a small area, this stage has been assessed as having a neutral effect on this objective, although there is uncertainty associated with potential effects on sensitive species.<br>**Low and High Activity Scenarios:**<br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed). Given that any adverse effects associated with seismic surveys are likely to be minor, temporary and localised, there is not expected to be any substantial difference in the type and magnitude of effects between low and high activity scenarios. Further, it is anticipated that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible thus reducing the potential for adverse effects.<br>**Mitigation:**<br>• Sites selected should be of low biodiversity value, and the presence of any sensitive species identified through desk-based assessment, walk-over surveys, and detailed species-specific surveys.<br>• Site design and layout should retain or minimise loss of any valuable habitats or species whilst avoiding habitat fragmentation, particularly associated with road, rail and pipeline infrastructure. Opportunities for habitat creation and enhancement should be identified for implementation during construction, operation and decommissioning phases.<br>**Assumptions:**<br>• It is assumed that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible.<br>• It is assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>**Uncertainties:**<br>• Effect of seismic surveys on noise-sensitive species, particularly in the breeding season. |
| 2 | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring. | **0/?** | **-/?** | **Assessment of Effects:**<br>There would be the potential for well pad construction and drilling activities to result in the loss and/or fragmentation of habitat, the effects being direct (such as loss to hard engineering such as drilling pads or access roads) or indirect (such as disturbance from noise, human presence and light pollution). Disturbance effects could be particularly significant for sensitive species or during the breeding season.<br>The accidental release of substances such as diesel and drilling fluids, silt-laden run-off and the deposition of pollutants associated with transport movements could also negatively affect biodiversity. |

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| Objective 1: Biodiversity | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | At this stage no sites have been selected and the potential effects would be dependent upon local biodiversity characteristics, including the sensitivity of habitats and species.<br>**Low and High Activity Scenarios:**<br>There would potentially be a difference between the effects associated with low and high activity scenarios, where a greater density of exploration activity across the license area means a greater likelihood of habitat and species disturbance because of more sites being active as well as cumulative impacts associated with their development. Consequently, potential adverse impacts on biodiversity may be more widespread. However, the likely area of land-take under the high scenario is 12-18ha and therefore, even in the most densely drilled areas where the minimum pad distance is 5km, overall there are unlikely to be any significant effects on biodiversity. There could, however, be some localised disturbance effects, particularly if there is a potential overlap with the sphere of influence of large designated sites (for example bird feeding areas).<br>**Mitigation:**<br>• The mitigation considerations identified for site investigation would apply as well as consideration of potential cumulative impacts assessed, particularly under the high activity scenario. This could, for example, include the phasing of well pad development to avoid cumulative effects, as well as the timing of construction to take account of any sensitive species which may be present.<br>**Assumptions:**<br>• It is assumed that well pad site identification and construction and exploration activity is undertaken in light of good knowledge of local biodiversity character and vulnerabilities.<br>**Uncertainties:**<br>• Effects on operations on sensitive species and the cumulative impacts of operations such as traffic movements. |
| 3 | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring | **0/?** | **-/?** | **Assessment of Effects:**<br>There could be a range of direct effects on biodiversity associated with production development activity, including habitat loss, severance (associated with road and pipeline construction, for example) and species disturbance including noise, human activity and light pollution which could affect sensitive species, particularly during the breeding season. The accidental release of pollutants such as diesel, drilling fluids and the deposition of emissions associated with transport movements, could affect habitats and species, depending on their sensitivity. However, both the circumstances and the precise impacts of these events are uncertain. |

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| Objective 1: Biodiversity | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Low and High Activity Scenarios:**<br>There could be some differences between the effects associated with the low and high activity scenarios, whereby a greater density of activity has cumulatively greater impacts, particularly where pads are prepared in relative proximity to one another and/or in close succession, and increases risks associated with site activities. However, the scale of operations, even under the high scenario of 6 pads covering 12-18ha, means that any adverse effects are likely to be localised and relatively minor in character.<br>**Mitigation:**<br>• The mitigation measures identified for site investigation and exploration should be continued i.e. habitat and species monitoring, attention to the timing of activities to avoid direct and indirect impacts. In addition, the effects of production development activities should be closely monitored for adverse and cumulative impacts, particularly under the high activity scenario. The timing of activities should also be considered, as should risks associated with the discharge of pollutants. It may be necessary to establish a buffer zone around protected areas, the size of which relates to its character. Habitat creation and/or enhancement should be progressed as appropriate to anticipate decommissioning.<br>**Assumptions:**<br>• It is assumed that production development activity is undertaken in light of good knowledge of local biodiversity character and vulnerabilities.<br>**Uncertainties:**<br>Effects on operations on sensitive species and cumulative impacts of operation, particularly under the high activity scenario. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>Assuming that all operational activities would take place within the already identified site area, there would be no additional landtake and hence no direct effects on biodiversity. However, there would be the potential for some continued disturbance and/or displacement as a result of operational activities, including noise, human activity and light pollution which could affect sensitive species, particularly during the breeding season. The accidental release of pollutants could also affect both habitats and species.<br>**Low and High Activity Scenarios:**<br>There could be some differences between the effects associated with the low and high activity scenarios, whereby a greater density of activity has cumulatively greater impacts and increases risks associated with site activities. However, the predicted scale of operations, being a maximum of 6 pads covering 2-18ha under the high scenario, means that any cumulative impacts are unlikely to be significant. |

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| Objective 1: Biodiversity | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Mitigation:**<br>• The effects of production activities should be closely monitored for adverse and cumulative impacts, particularly under the high activity scenario. The timing of activities and their potential effects on sensitive species should also be considered, as should risks associated with the discharge of pollutants.<br>**Assumptions:**<br>• It is assumed that production activity is undertaken in light of good knowledge of local biodiversity character and vulnerabilities.<br>**Uncertainties:**<br>Effects on operations on sensitive species and cumulative impacts of operation. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>All activities associated with decommissioning would take place within the existing site area and therefore no further effects on biodiversity are anticipated.<br>**Low and High Activity Scenarios:**<br>There are no anticipated differences between low and high activity scenarios.<br>**Mitigation:**<br>• Prior to site restoration, habitats and species surveys should be undertaken to determine biodiversity value and opportunities for protection and enhancement in consultation with interested organisations such as Wildlife Trusts. A site management plan might be appropriate.<br>**Assumptions:**<br>• None.<br>**Uncertainties:**<br>• None. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>All activities associated with site restoration would take place within the existing site area and therefore no further effects on biodiversity are anticipated. Following closure, it is assumed that the site would be restored to as near its preconstruction condition as possible, although if any visual screening planted as part of the operation were removed, this may have acquired biodiversity value.<br>**Low and High Activity Scenarios:**<br>There are likely to be no significant differences between the scenarios, although cumulative impacts associated with the high scenario could occur, for example through the presence of a network of sites in a locality being restored in close succession. |

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## Objective 1: Biodiversity

| *Stage* | *Description* | *Score* | | *Commentary* |
|---|---|---|---|---|
| | | *Low Activity Scenario* | *High Activity Scenario* | |
| | | | | However, with the likely number of pad sites being 6 under the high activity scenario, any effects are unlikely to be significant or widespread.<br>**Mitigation:**<br>• As for decommissioning.<br>**Assumptions:**<br>• Site restoration to original condition is feasible.<br>**Uncertainties:**<br>• Changes in site character (such as mature screening planting) which may have acquired biodiversity value. |

### *Summary*

The effects of the conventional oil and gas activity on biodiversity interests are considered to range from neutral to minor negative (with attendant uncertainty), according to the stages and scale of operation. Notwithstanding work to avoid direct impacts on designated sites, there potentially could be negative effects associated with production development activity under the high scenario, associated with habitat and species disturbance arising from direct and indirect activities, although the precise effects are unlikely to be widespread given the maximum scale of operations under the high scenario. More generally, there could be negative effects associated with exploration drilling, well pad construction and production activity, related to habitat loss and also indirect effects associated with noise, human activity and light pollution, although again the cumulative impacts are unlikely to be significant given the predicted overall scale of the operations. Other stages of the process are likely to produce no overall effect, assuming that suitable knowledge of locally, regionally and nationally important habitats and species exists to anticipate and/or avoid any impacts. The following mitigation is recommended:

- **Site investigation:** Sites selected should be of low biodiversity value, and the presence of any sensitive species identified through desk-based assessment, walk-over surveys, and detailed species-specific surveys. Site design and layout should retain or minimise loss of any valuable habitats or species whilst avoiding habitat fragmentation, particularly associated with road, rail and pipeline infrastructure. Opportunities for habitat creation and enhancement should be identified for implementation during construction, operation and decommissioning phases.
- **Site Construction:** The mitigation measures identified for site investigation and exploration should be continued as appropriate. In addition, the effects of production development activities should be closely monitored for adverse and cumulative impacts, particularly under the high activity scenario. The timing of activities should also be considered, as should risks associated with the discharge of pollutants. It may be necessary to establish a buffer zone around protected areas, the size of which relates to its character. Habitat creation and/or enhancement should be progressed as appropriate.
- **Site production:** The effects of production activities should be closely monitored for adverse and cumulative impacts, particularly under the high activity scenario. The timing of activities should also be considered, as should risks associated with the discharge of pollutants.
- **Site Decommissioning:** Prior to site restoration, habitats and species surveys should be undertaken to determine biodiversity value and opportunities for protection and enhancement in consultation with interested organisations such as Wildlife Trusts. A site management plan might be appropriate.

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

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## 1.8.2 Unconventional Oil and Gas

The assessment of the six main stages of unconventional oil and gas production is contained in **Table 1.11** under both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report).

**Table 1.11 Assessment of Effects: Unconventional Oil and Gas**

| **Objective 1: Biodiversity** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0/?** | **0/?** | **Assessment of Effects:**<br>It is assumed that the activities associated with this stage are the same as for conventional oil and and gas exploration, namely that oil and gas exploration and production lifecycle would comprise non-intrusive activities. Site identification, selection and characterisation and the securing of development and operation permits would be expected to be largely desk-based and in consequence, no significant effects on biodiversity would be anticipated from these activities.<br>However, there potentially could be disturbance effects associated with seismic testing, particularly in the breeding season or for vulnerable species.<br>Vibroseis is the most common method of seismic survey and typically involves 3-5 large vibrator units which sub-sonically vibrate the ground while a number of support vehicles record the returning shock waves for analysis. As highlighted in the 2010 Environmental Report[47], surveys tend to be spatially restricted due to the requirement for roads or other hard surfaces accessible by vehicle. Where roads have to be constructed to facilitate access to sites, any adverse effects would be temporary with land restored following completion of the surveys. Where shot-hole techniques are utilised (which involve the use of explosions as a source of seismic energy), the requirement for large vehicular access would be likely to be reduced whilst it would be expected that shot holes would be infilled after use.<br>Taking into account the fact that any adverse effects on biodiversity would be temporary and cover a small area, this stage has been assessed as having a neutral effect on this objective, although there is uncertainty associated with potential effects on sensitive species.<br>**Low and High Activity Scenarios:**<br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed), being 60-90ha compared to 240-360ha. Consequently, the total volume of greenfield land that may be required to support new site access may be greater whilst adverse impacts on land uses may be more widespread. |

[47] DECC (2010) *Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds: Environmental Report.*

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| Objective 1: Biodiversity | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Further, there may be increased risk of loss of high quality agricultural land and/or development taking place on or in close proximity to biologically sensitive sites and species. However, given that any adverse effects associated with seismic surveys are likely to be minor, temporary and localised, there is not expected to be any substantial difference in the type and magnitude of effects between low and high activity scenarios. Further, it is anticipated that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible thus reducing the potential for adverse effects.<br>**Mitigation:**<br>• Sites selected should be of low biodiversity value, and the presence of any sensitive species identified through desk-based assessment, walk-over surveys, and detailed species-specific surveys.<br>• Site design and layout should retain or minimise loss of any valuable habitats or species whilst avoiding habitat fragmentation, particularly associated with road, rail and pipeline infrastructure. Opportunities for habitat creation and enhancement should be identified for implementation during construction, operation and decommissioning phases.<br>• Risks associated with each stage of the operation[48] should be identified and management procedures put in place to address these.<br>**Assumptions:**<br>• It is assumed that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible.<br>• It is assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>**Uncertainties:**<br>• Effect of seismic surveys on noise-sensitive species, particularly in the breeding season. |
| 2 | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. | **0/?** | **-/?** | **Assessment of Effects:**<br>There would be the potential for well pad construction and drilling activities to result in the loss and/or fragmentation of habitat, the effects being direct (such as loss to hard engineering such as drilling pads or access roads) or indirect (such as disturbance from noise, human presence and light pollution). Disturbance effects could be particularly significant for sensitive species or during the breeding season.<br>The accidental release of substances such as diesel and drilling fluids, silt-laden run-off and the deposition of pollutants associated with transport movements could also negatively affect biodiversity. |

[48] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed September 2013] Appendix 6

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| Objective 1: Biodiversity | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | The accidental release of the water used for fracturing (which is potentially contaminated) could be hazardous, both in the immediate site area and at locations identified for treatment and discharge back into the environment.[49,50]<br>**Low and High Activity Scenarios:**<br>There would potentially be a difference between the effects associated with low and high activity scenarios, where a greater density of exploration activity across the license area means a greater likelihood of habitat and species disturbance because of more sites being active as well as cumulative impacts. Thus the total number of well pad sites ranges from 30 to 120 under the low and high activity scenarios respectively, with direct land-take being between 60 and 360ha. Whilst overall there are unlikely to be any significant impacts on biodiversity, there could be some localised disturbance effects, particularly if there is a potential overlap with the sphere of influence of large designated sites (for example bird feeding areas), and there are a series of a well pads in a locality. Combined with the impacts of linear infrastructure such as roads and pipelines, the overall effects of a high activity scenario in a locality could cumulatively have a negative impact, although the the precise impacts are uncertain and dependent upon mitigation.<br>**Mitigation:**<br>• The mitigation considerations identified for site investigation apply as well as consideration of potential cumulative impacts assessed, particularly under the high activity scenario. The timing of activities (seasonally and project phasing) should also be considered, as should risks associated with the discharge of pollutants which could damage local and distant aquatic environments. These should be identified and addressed in the risk management plan identified in Stage 1.<br>**Assumptions:**<br>• It is assumed that well pad site identification and construction and exploration activity is undertaken in light of good knowledge of local biodiversity character and vulnerabilities.<br>**Uncertainties:**<br>• Effects on operations on sensitive species and cumulative impacts of operation, particularly under the high activity scenario.<br>• Ease of fracturing water decontamination and disposal. |

[49] See Tyndall Centre for Climate Change Research (2011) *Shale gas: a provisional assessment of climate change and environmental impacts* para 4.2.2
[50] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed September 2013] Appendix 6

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| Objective 1: Biodiversity | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 3 | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. | **-/?** | **-/?** | **Assessment of Effects:**<br>There could be a range of direct effects on biodiversity associated with production development activity, including habitat loss (from the landtake for the 2-3ha pad), severance (associated with road and pipeline construction, for example) and species disturbance including noise, human activity and light pollution which could affect sensitive species, particularly during the breeding season. There could be localised disturbance effects, resulting from traffic movements[51] and associated pollution[52], although the precise impacts are uncertain and dependent upon mitigation such as routing of traffic.<br>The accidental release of pollutants could also affect both habitats and species.<br>Water used during the fracturing process could potentially affect habitats and species especially during times of water stress, although this will be subject to assessment by the water companies and Environment Agency (or Natural Resources Wales or SEPA) controls (depending on the location of the pads). Risks associated with the introduction of invasive species through water carried to the site, for example have been identified[53].<br>**Low and High Activity Scenarios:**<br>There could be differences between the effects associated with the low and high activity scenarios (ranging from 30-120 pad sites and land-take of 60-360ha), whereby a greater level and density of activity has cumulatively greater impacts (particularly if pads are prepared in relative proximity to one another and/or in close succession), and increases risks associated with site activities.<br>**Mitigation:**<br>• The mitigation measures identified for site investigation and exploration should be continued as appropriate. In addition, the effects of production development activities should be closely monitored for adverse and cumulative impacts, particularly under the high activity scenario. The timing of activities should also be considered, as should risks associated with the discharge of pollutants. It may be necessary to establish a buffer zone around protected areas, the size of which relates to its character. Habitat creation and/or enhancement should be progressed as appropriate. |

[51] See: IOD (2012) *Getting Shale Gas Working* http://www.iod.com/influencing/policy-papers/infrastructure/infrastructure-for-business-getting-shale-gas-working Table 34 p.117
[52] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed September 2013] p.viii
[53] AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed September 2013] Appendix 6

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| Objective 1: Biodiversity | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Assumptions:**<br>• It is assumed that production development activity is undertaken in light of good knowledge of local biodiversity character and vulnerabilities and that appropriate measures have been taken to mitigate these through measures such as the buffering of protected sites and identification of potential pollutant pathways.<br>• That no drill cuttings are used for site landscaping.<br>**Uncertainties:**<br>• Effects on operations on sensitive species and cumulative impacts of operation, particularly under the high activity scenario.<br>Ease of fracturing water decontamination and disposal. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | - | - | **Assessment of Effects:**<br>Assuming that all operational activities would take place within the already identified site area, there would be no additional landtake and hence direct effects on biodiversity. However, there would be the potential for continued disturbance and/or displacement as a result of operational activities, including noise, traffic movements[54], human activity and light pollution which could affect sensitive species, particularly during the breeding season. The accidental release of pollutants, including untreated flowback water from refracturing could also affect both habitats and species[55].<br>Indirect pollution could occur[56] through the migration of contaminants from the target fracture formation through subsurface pathways including: the outside of the wellbore itself; other wellbores (such as incomplete, poorly constructed, or older/poorly plugged wellbores); fractures created during the hydraulic fracturing process; or natural cracks, fissures and interconnected pore spaces. The effects are highly uncertain, however, given the distances between shale gas formations and groundwater.<br>Additional abstraction of water to supply wells could affect wetland ecosystems through the lowering of groundwater levels, particularly in times of water stress.[57] However, it is assumed that 90% of wells will be supplied by mains water. |

[54] See: IOD (2012) *Getting Shale Gas Working* http://www.iod.com/influencing/policy-papers/infrastructure/infrastructure-for-business-getting-shale-gas-working Table 34 p.117
[55] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed September 2013] Appendix 6
[56] See Tyndall Centre for Climate Change Research (2011) *Shale gas: a provisional assessment of climate change and environmental impacts* p.59
[57] See Tyndall Centre for Climate Change Research (2011) *Shale gas: a provisional assessment of climate change and environmental impacts* p.59

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| Objective 1: Biodiversity | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Low and High Activity Scenarios:**<br>There could be some differences between the effects associated with the low and high activity scenarios, whereby a greater density of activity has cumulatively greater impacts such as through the impacts of vehicle movements[58]. Up to 120 well pad sites could be operational under the high scenario with commensurately greater risk of adverse cumulative impacts in particular localities.<br>**Mitigation:**<br>• The potential impacts of production activities should be closely monitored for potential adverse and cumulative impacts such as disturbance effects of operations and potential risks associated with the accidental discharge of pollutants such as fracturing fluids and untreated flowback water stored on site. This is particularly the case under the high activity scenario where there could be concentrations of well pads in a locality. Specific measures on risk management should include: the implementation of already prepared plans to monitor impacts on sensitive species (both on- site and through vehicle movements) and accident prevention measures relating to the use and storage of material.[59]<br>**Assumptions:**<br>• It is assumed that production activity is undertaken in light of good knowledge of local biodiversity character and vulnerabilities.<br>**Uncertainties:**<br>• Effects on operations on sensitive species and cumulative impacts of operation, particularly under the high activity scenario.<br>• Impacts on groundwater levels of abstraction of water for fracturing.<br>Operations relating to the decontamination of fracturing water and its disposal. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>All activities associated with decommissioning would take place within the existing site area and therefore no further effects on biodiversity are anticipated.<br>**Low and High Activity Scenarios:**<br>There are no anticipated differences between low and high activity scenarios. |

[58] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed September 2013] p.viii
[59] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed September 2013] p.129-138

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| Objective 1: Biodiversity | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Mitigation:**<br>• Prior to site restoration, habitats and species surveys should be undertaken to determine biodiversity value and opportunities for protection and enhancement in consultation with interested organisations such as Wildlife Trusts. Site management plans might be appropriate, particularly where opportunities for enhancement have been identified.<br>**Assumptions:**<br>• None identified at this stage<br>**Uncertainties:**<br>• None identified at this stage |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>All activities associated with site restoration would take place within the existing site area and therefore no further effects on biodiversity are anticipated. Following closure, it is assumed that the site would be restored to as near its preconstruction condition as possible, although if any visual screening planted as part of the operation were removed, this may have acquired biodiversity value.<br>**Low and High Activity Scenarios:**<br>There are likely to be no significant differences between the two scenarios, although cumulative impacts associated with the high scenario could occur, for example through the presence of a network of sites in a locality being restored in close succession which could disrupt the activities of mobile species and where sites have become established and perhaps become valuable in their own right.<br>**Mitigation:**<br>• As for decommissioning.<br>**Assumptions:**<br>• Site restoration to original condition is feasible.<br>**Uncertainties:**<br>• Changes in site character (such as mature screening planting) which may have acquired biodiversity value. |

***Summary***

The effects of the unconventional oil and gas activity on biodiversity interests are considered to be combinations of both neutral and negative in character, according to the stages and scale of operation, particularly under the high scenario where the risks of the accidental release of pollutants, for example, are greater by virtue of the scale of activity. Notwithstanding work to avoid direct impacts on designated sites, there could still be negative effects associated with production development activity under the high scenario, associated with habitat and species disturbance arising from direct and indirect activities, although the precise effects are uncertain. More generally, there could be negative effects associated with exploration drilling, well pad construction and production activity, related to the direct effects of habitat loss and also indirect effects associated with noise, human activity and light pollution. Other stages of the process are likely to produce no overall effect, assuming that suitable knowledge of habitats and species exists to avoid or mitigate any immediate impacts. The following mitigation is recommended:

- **Site investigation:** Sites selected should be of low biodiversity value, and the presence of any sensitive species identified through desk-based assessment, walk-over surveys, and detailed species-specific surveys. Site design and layout should retain or minimise loss of any valuable habitats or species whilst avoiding habitat fragmentation, particularly associated with road, rail and pipeline infrastructure. Opportunities for habitat creation and enhancement should be identified for implementation during construction, operation and decommissioning phases.

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| Objective 1: Biodiversity | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| • **Site Construction:** The mitigation measures identified for site investigation and exploration should be continued as appropriate. In addition, the effects of production development activities should be closely monitored for adverse and cumulative impacts, particularly under the high activity scenario. The timing of activities should also be considered, as should risks associated with the discharge of pollutants. It may be necessary to establish a buffer zone around protected areas, the size of which relates to its character. Habitat creation and/or enhancement should be progressed as appropriate.<br>• **Site production:** The effects of production activities should be closely monitored for adverse and cumulative impacts, particularly under the high activity scenario. The timing of activities should also be considered, as should risks associated with the discharge of pollutants.<br>• **Site Decommissioning:** Prior to site restoration, habitats and species surveys should be undertaken to determine biodiversity value and opportunities for protection and enhancement in consultation with interested organisations such as Wildlife Trusts. A site management plan might be appropriate. | | | | |

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 1.9 Virgin Coal Bed Methane

The effects of exploration and production activities associated with VCBM are similar to those described in the assessment of effects of unconventional oil and gas (Stages 1 to 6) although hydraulic fracturing is not normally required. No attempt has been to provide an indication of low and high levels of activity.

## 1.10 Gas Storage

The development of gas storage capacity is likely to entail the following activities:

1. Construction and Installation of Pipelines and Storage Facilities;
2. Storage operations; and
3. Decommissioning.

The likely effects of these activities are appraised in **Table 1.12**.

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**Table 1.12 Assessment of Effects: Gas Storage**

| Objective 1: Biodiversity<br>*Stage Description* | *Score* | *Commentary* |
|---|---|---|
| **Construction & Installation of Pipelines and Storage Facilities** | **-/?** | **Assessment of Effects:**<br>There could be a range of direct effects on biodiversity associated with gas transmission and storage development activity, including habitat loss, severance (associated with road and pipeline construction, for example) and species disturbance including noise, human activity and light pollution which could affect sensitive species, particularly during the breeding season. The accidental release of pollutants could also affect both habitats and species.<br>**Mitigation:**<br>• Sites selected should be of low biodiversity value, and the presence of any sensitive species identified through desk-based assessment, walk-over surveys, and detailed species-specific surveys. Site design and layout should retain or minimise loss of any valuable habitats or species whilst avoiding habitat fragmentation, particularly associated with road, rail and pipeline infrastructure. Opportunities for habitat creation and enhancement should be identified for implementation during construction, operation and decommissioning phases.<br>**Assumptions:**<br>• It is assumed construction development activity is undertaken in light of good knowledge of local biodiversity character and vulnerabilities.<br>**Uncertainties:**<br>• Effects on operations on sensitive species and cumulative impacts of operations, particularly under the high activity scenario. |
| **Storage Operations** | **0** | **Assessment of Effects:**<br>No effects identified.<br>**Mitigation:**<br>• The safety of transport and storage activities should be closely monitored for adverse and cumulative impacts.<br>**Assumptions:**<br>• It is assumed that all operational activities are carried under HSE/PADHI guidelines.<br>**Uncertainties:**<br>• None identified. |
| **Decommissioning** | **0** | **Assessment of Effects:**<br>All activities associated with site restoration would take place within the existing site area and therefore no further effects on biodiversity are anticipated. Following closure, it is assumed that the site would be restored to as near its preconstruction condition as possible, although if any visual screening planted as part of the operation were removed, this may have acquired biodiversity value.<br>**Mitigation:**<br>• Prior to site restoration, habitats and species surveys should be undertaken to determine biodiversity value and opportunities for protection and enhancement in consultation with interested organisations such as Wildlife Trusts. A site management plan might be appropriate. |

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| **Objective 1: Biodiversity** | | |
|---|---|---|
| ***Stage Description*** | ***Score*** | ***Commentary*** |
| | | **Assumptions:**<br>• Site restoration to original condition is feasible.<br>**Uncertainties:**<br>• Changes in site character (such as mature screening planting) which may have acquired biodiversity value. |

***Summary***

The effects of gas storage activity on biodiversity interests are considered to range from neutral to potentially minor negative, according to the stages and scale of operation. Notwithstanding work to avoid direct impacts on designated sites, there could still be negative effects associated with development activity under the high scenario in particular, associated with the construction of pipelines and storage facilities, related to the direct effects of habitat loss and also indirect effects associated with noise, human activity and light pollution. Operation and decommissioning of the facilities is likely to produce no overall effect, assuming that suitable knowledge of habitats and species exists to avoid or mitigate any immediate impacts. The following mitigation is recommended:

- **Site Investigation and Construction:** The mitigation measures identified for site investigation and exploration should be continued as appropriate. In addition, the effects of production development activities should be closely monitored for adverse and cumulative impacts, particularly under the high activity scenario. The timing of activities should also be considered, as should risks associated with the discharge of pollutants. It may be necessary to establish a buffer zone around protected areas, the size of which relates to its character. Habitat creation and/or enhancement should be progressed as appropriate.
- **Site operation:** The safety of transport and storage activities should be closely monitored for adverse and cumulative impacts.
- **Site Decommissioning:** Prior to site restoration, habitats and species surveys should be undertaken to determine biodiversity value and opportunities for protection and enhancement in consultation with interested organisations such as Wildlife Trusts. Site management plans might be appropriate.

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 1.10.1 SEA Areas

The following sections consider in-turn the potential effects of Licensing Plan activities on the biodiversity objective in the five SEA Areas. The assessment draws on the findings presented in **Table 1.10** and **Table 1.11** above and takes account of the environmental characteristics of the areas as detailed in **Section 2.5**.

## 1.10.2 SEA Area 1: Scottish Midlands (including the Inner Forth)

Figure 1.1 shows the international, national and local designations associated with SEA Area 1. Important river systems in the Scottish Midlands SEA Area include the South Esk, Tay and Tweed with the Firths of Forth and Tay, and the inner Clyde Estuary supporting important coastal habitats and species including a wide variety of seabirds and waterbirds. There are also extensive areas of upland

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moorland, acid grassland, woodland and blanket bog which support important species assemblages. Conservation sites of international importance include 41 SAC, 21 SPA, 12 Ramsar and 26 IBA. National and local sites include 10 NNR, 443 SSSI and 39 LNR. A number of reserves are also owned or managed by organisations such as RSPB, National Trust for Scotland and the Scottish Wildlife Trust.

The Forth Estuary has an intertidal area of 4,798 ha, covering just over half the area of the estuary as whole. The area is therefore very important for coastal bird sensitivities and a large proportion of the Forth coast supports nationally and internationally important colonies of breeding birds. This is recognised in an Important Bird Area (IBA) covering the entire coast of the inner and outer firth stretching from the River Forth at Stirling, eastwards past Edinburgh and along the coasts of Fife and east Lothian, coincident with both Ramsar and SPA designations. Wintering waterbirds and waterbirds on passage reach substantial populations at certain times of the year. In winter the area supports over 89,000 overwintering and migratory waterbirds (e.g. bar-tailed godwit, golden plover, red-throated diver, Slavonian grebe, knot, pink-footed goose, redshank, shelduck, turnstone). In summer the area supports breeding populations of common tern (*Sterna hirundo*), and the sandwich tern (*Sterna sandvicensis*) can be found on passage between July and August.

The River Teith, a major tributary of the Forth, contains anadromous species (i.e. spawning in freshwater but completing lifecycle in the sea) including the Annex II Atlantic salmon (*Salmo salar*) and sea lamprey (*Petromyzon marinus*).

The presence of internationally, nationally and locally protected areas across SEA Area 1 suggests that considerable care will be required in locating potential test and operational sites. Particularly vulnerable sites include:

- The river systems of the Esk, Tay and Tweed and associated downstream estuaries;
- Moorland areas of the southern uplands, extensive areas of which are designated as Important Bird Areas and SSSIs; and
- Local nature reserves which are scattered across the area but collectively form a significant resource.

Some of the protected sites in Area 1, such as the Important Bird Areas/SSSIs of the southern uplands are spatially extensive, and could require an additional buffer area to avoid possible encroachment of impacts associated with the construction and operational activities identified in sections 1.8.1 and 1.8.2.

## Conventional Oil and Gas

For both the low and high activity scenarios for conventional oil and gas and the low activity scenario for unconventional oil and gas, the scale of activity is unlikely to have a significant negative impact under any stage of the process.

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### Unconventional Oil and Gas

There could be some impacts under the high scenario for unconventional oil and gas where more spatially and temporally intensive activity might be expected. Avoiding direct impacts on protected areas should help to mitigate adverse impacts on biodiversity, along with the use of other measures, particularly under the high scenario for unconventional oil and gas where the cumulative effects associated with spatial concentrations of activity could be an issue. Buffering of protected areas could be required to provide additional protection to particular species (such as some birds which have a wider feeding area than a protected area) or sites which have a hydrological connection. In some cases, this could reduce the area for planning permission for exploration and/or drilling sub might be granted (for example in the southern uplands where there are extensive Important Bird Areas).

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 1 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

There are no overall predicted impacts associated with gas storage.

## 1.10.3 SEA Area 2: West Midlands, North West England and Southern Scotland

Key habitats for this area are wetlands including pools, rivers, clay pits, canals and mosses support important plant and animal species (e.g. great crested newt, floating water plantain, Atlantic salmon, sea and river lamprey). Other significant habitats include lowland heaths, ancient semi-natural woodlands and unimproved grassland with Cannock Chase, the Peak District Dales and the South Pennine Moors of particular importance. Blanket and raised bogs (either active or degraded/capable of regeneration) in the North West and Midlands represents a significant proportion of England's resource of this priority habitat (complemented by resources in the North East and South West of England) and is a primary feature in a number of SAC sites in the SEA area such as the South Pennine Moors and a qualifying feature in the Ingleborough Complex. The latter site is also notable for its limestone pavements which are also a primary feature of the Morecambe Bay Pavements designation. These pavements, though widely distributed, are uncommon in the UK, covering just 2,000ha in total, though the most extensive area of pavement is present in the North of England. The vegetation of limestone pavements is unusual, and a range of calcareous rock, heath, grassland, scrub and woodland NVC types may be present.

Wetland habitats also make the region very important for wildfowl and waders, and the Solway Flats and Marshes and the Duddon Estuary support large numbers of breeding, wintering and migratory birds (e.g. redshank, barnacle goose, pink-footed goose, golden plover, bar-tailed godwit, pintail, and knot). The Morecambe Bay SAC largely coincides with the Duddon Estuary SPA and has a number of features of European importance including mudflats and sandflats not covered by seawater at low tide, large

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shallow inlets and bays, *Salicornia* and other annuals colonising mud and sand, shifting dunes along the shoreline with *Ammophila arenaria* (`white dunes`), fixed dunes with herbaceous vegetation (`grey dunes`) and dune slacks. The Ribble and Alt estuaries, and the Mersey and the Dee estuaries also support large numbers of breeding, wintering and migratory birds (e.g. golden plover, redshank, ringed plover, dunlin, pintail, shelduck, and teal).

International conservation sites include 26 SAC (and 1 marine candidate SAC), [cSAC], 14 SPA (and one potential SPA [pSPA}, and one marine pSPA), 14 Ramsar and 13 IBA including the Bowland Fells. National and local sites include 29 NNRs, 462 SSSIs and 243 LNRs. A number of reserves are also owned or managed by organisations such as RSPB, National Trust and Wildlife Trusts. The Mersey Narrows and North Wirral Foreshore pSPA is located adjacent to the Liverpool Bay marine pSPA. The latter site is noted for its wintering populations of red-throated diver and scoter (Article 4.1 and 4.2 respectively). Further north, the Shell Flat and Lune Deep cSAC coincides with the Liverpool Bay pSPA, and has been considered for the Annex I habitats, reefs and sandbanks which are slightly covered by sea water all the time.

The presence of internationally, nationally and locally protected areas across SEA Area 2 suggests that considerable care will be required in locating potential test and operational sites. Particularly vulnerable sites include:

- The upland areas of Cumbria and northern Lancashire (such as the Bowland Fells), much of which is covered by various international and national designations;
- Esturine habitats such as the Solway, Lune, Ribble, Alt Mersey and Dee, as well as the wider Liverpool Bay area which supports significant assemblages of protected species; and
- Local nature reserves which are scattered across the area but collectively form a significant resource.

Some of the protected areas in Area 2, such as the Important Bird Areas/SSSIs of the Bowland Fells and the estuarine and coastal habitats to the west are spatially extensive, and could require an additional buffer area to avoid possible encroachment of impacts associated with the construction and operational activities identified in sections 1. 8.1 and 1.8.2.

## Conventional Oil and Gas

For both the low and high activity scenarios for conventional oil and gas, the scale of activity is unlikely to have a significant negative impact under any stage of the process.

## Unconventional Oil and Gas

There could be some impacts under the high scenario for unconventional oil and gas where more spatially and temporally intensive activity might be expected. Avoiding direct impacts on protected areas should help to mitigate adverse impacts on biodiversity, along with the use of other measures, where the cumulative effects associated with spatial concentrations of activity could be an issue. Buffering of

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protected areas could be required to provide additional protection to particular species (such as some birds which have a wider feeding area than a protected area) or sites which have a hydrological connection. In some cases, this could reduce the area for planning permission for exploration and/or drilling sub might be granted (for example around the Bowland Fells and in the vicinity of the west coast where there are extensive protected areas).

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 2 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

There are no overall predicted impacts associated with gas storage.

## 1.10.4 SEA Area 3: East Midlands and Eastern England

Upland and coastal habitats and species dominate nature conservation designations in the north of the region with coastal and lowland wetland habitats and associated species to the south. Features of importance include the extensive estuarine habitats of the Humber Estuary (mudlflats and coastal saltmarsh), and The Wash and North Norfolk coastal habitats which supports huge numbers of wildfowl and waders (e.g. avocet, bar-tailed godwit, golden plover, whooper swan, ringed plover, black-tailed godwit) and the North York Moors and the Pennines which support important upland habitats and species (e.g. blanket bogs, European dry heaths and wet heaths with *Erica tetralix*). The SEA area also includes the lowland wetland habitats (fens) of East Anglia and the clay lowlands of Lincolnshire and The Wash. A range of priority habitats identified by the UK Biodiversity Action Plan are present within the region. International conservation sites include 53 SAC, 20 SPA, 14 Ramsar and 22 IBA. National and local sites include 59 NNR, 1,084 SSSI and 373 LNR. A number of reserves are also owned or managed by organisations such as RSPB, National Trust and Wildlife Trusts.

The presence of internationally, nationally and locally protected areas across SEA Area 3 suggests that considerable care will be required in locating potential test and operational sites. Particularly vulnerable sites include:

- The Pennine Uplands and North York Moors, significant areas of which are designated as SPAs, IBAs and SSSIs;
- Esturine habitats such as the Humber and the Wash; and
- Local nature reserves which are scattered across the area but collectively form a significant resource.

Some of the protected areas in Area 3, such as the Important Bird Areas/SPAa/SSSIs of the Pennines and the North York Moors and the estuarine and coastal habitats to the east are spatially extensive, and

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could require an additional buffer area to avoid possible encroachment of impacts associated with the construction and operational activities identified in sections 1. 8.1 and 1.8.2.

### Conventional Oil and Gas

For both the low and high activity scenarios for conventional oil and gas the scale of activity is unlikely to have a significant negative impact under any stage of the process.

### Unconventional Oil and Gas

There could be some impacts under the high scenario for unconventional oil and gas where more spatially and temporally intensive activity might be expected. Avoiding direct impacts on protected areas should help to mitigate adverse impacts on biodiversity, along with the use of other measures, where the cumulative effects associated with spatial concentrations of activity could be an issue. Buffering of protected areas could be required to provide additional protection to particular species (such as some birds which have a wider feeding area than a protected area) or sites which have a hydrological connection. In some cases, this could reduce the area for planning permission for exploration and/or drilling sub might be granted (for example around the Pennines, the North York Moors and in the vicinity of the east coast where there are extensive protected areas).

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 3 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

There are no overall predicted impacts associated with gas storage.

## 1.10.5 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

Important river systems, including the Wye and Tywi in the south and the Dee in the north, support important habitats and species including twaite and allis shads, salmon and lampreys, recognised in SAC designations for these areas. Surrounding river valleys support woodland and bat sites. Grassland, heath and woodland habitats are protected with the extensive Berwyn and South Clwyd Mountains and Halkyn Mountain sites of particular importance. There are also a number of important sites for great crested newts. The Severn and Dee estuaries are important for a wide range of waterbirds and wildfowl, and offshore, the Liverpool Bay pSPA is being considered for its over wintering populations of red-throated diver and common scoter.

A range of priority habitats identified by the UK Biodiversity Action Plan are present within the region. International conservation sites include 32 SAC, 3 SPA, five Ramsar and four IBA. National and local

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sites include 15 NNR, 272 SSSI and 43 LNRs. A number of reserves are also owned or managed by organisations such as RSPB, National Trust and Wildlife Trusts.

The Dee Estuary supports a number of conservation designations (SPA, SAC, Ramsar, SSSI) alluding to the national and international importance of the area for conservation. The SAC is designated primarily due to the occurrence of Annex I habitats including mudflats and sandflats not covered by seawater at low tide (i.e. intertidal), *Salicornia* and other annuals colonising mud and sand and Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*), and Annex II species including lamprey (sea and river) and the petalwort (*Petalophyllum ralfsii*). The area of saltmarsh and mudflat also lends itself to substantial populations (>90,000) of overwintering waterfowl, making the Dee Estuary SPA of international importance. The principal species involved include bar-tailed godwit, pintail, red knot, oystercatcher, shelduck and redshank. SEA Area 4 borders on to the Liverpool Bay marine pSPA which is noted for its wintering populations of red-throated diver and scoter (Article 4.1 and 4.2 respectively).

Further upstream, the River Dee and Bala Lake SAC has a certain dependency on the quality of the estuarine and offshore area further north and west due to the presence of anadromous species including the Atlantic salmon and sea lamprey, which require an unobstructed route upstream to spawn. The same considerations apply to the Usk and Wye SACs, adjacent to the Severn Estuary SAC and Ramsar site, and the Tywi SAC to the west of Area 4.

The presence of internationally, nationally and locally protected areas across SEA Area 4 suggests that considerable care will be required in locating potential test and operational sites. Particularly vulnerable sites include:

- The esturine habitats associated with the River Dee, River Severn and Tywi; and
- Local nature reserves which are scattered across the area but collectively form a significant resource.

## Conventional Oil and Gas

For both the low and high activity scenarios for conventional oil and gas the scale of activity is unlikely to have a significant negative impact under any stage of the process.

## Unconventional Oil and Gas

For the high scenario for unconventional oil and gas where more spatially and temporally intensive activity might be expected. Avoiding direct impacts on protected areas should help to mitigate adverse impacts on biodiversity, along with the use of other measures, where the cumulative effects associated with spatial concentrations of activity could be an issue. Buffering of protected areas could be required to provide additional protection to particular species (such as some birds which have a wider feeding area than a protected area) or sites which have a hydrological connection. In some cases, this could reduce the area for planning permission for exploration and/or drilling sub might be granted (for example around the estuaries of the Severn, Tywi and Mersey where there are extensive protected areas).

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### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 4 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

There are no overall predicted impacts associated with gas storage.

## 1.10.6 SEA Area 5: Southern and South West England

Species-rich chalk downlands and heathlands are particularly extensive and cover large parts of the south coast. River valleys and wetlands, upland areas, and a range of coastal habitats are of international importance. The area also contains densely wooded areas with extensive tracts of ancient woodland. There are a large number of important bird sites including coastal areas and wetlands for waterbirds and wildfowl.

A range of internationally and nationally important habitats are present within the Area 5. International conservation sites include 97 SAC, 30 SPA, 23 Ramsar and 32 IBA such as the Severn Estuary SAC and Ramsar site and Thames Estuary SPA. National and local sites include 76 NNR, 1,415 SSSI (seven of which cross into Wales) and 527 LNRs. In addition to these sites, The Outer Thames marine pSPA and Margate and Long Sands marine pSAC occur adjacent to SEA Area 5. These sites are being considered for the qualifying species, red-throated diver, and habitat, sandbanks which are slightly covered by sea water all the time, respectively. A number of reserves are also owned or managed by organisations such as the RSPB, National Trust and Wildlife Trusts (e.g. Slimbridge).

A notable feature of the protected areas which characterise Area 5 is their spatial complexity, being highly fragmented and apart from the coastal and esturine habitats, lacking large contiguous protected areas which characterise Areas 1, 2 and 3. However, particular concentrations of protected areas are associated with the estuaries of the Thames, Severn and Solent, as well as the uplands of Salisbury Plain and the complex habitats of the New Forest. These could require an additional buffer area to avoid possible encroachment of impacts associated with the construction and operational activities identified in sections 1. 8.1 and 1.8.2.

### Conventional Oil and Gas

For both the low and high activity scenarios for conventional oil and gas the scale of activity is unlikely to have a significant negative impact under any stage of the process.

### Unconventional Oil and Gas

For the high scenario for unconventional oil and gas where more spatially and temporally intensive activity might be expected. Avoiding direct impacts on protected areas should help to mitigate adverse

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impacts on biodiversity, along with the use of other measures, where the cumulative effects associated with spatial concentrations of activity could be an issue. Buffering of protected areas could be required to provide additional protection to particular species (such as some birds which have a wider feeding area than a protected area) or sites which have a hydrological connection. In some cases, this could reduce the area for planning permission for exploration and/or drilling sub might be granted (for example around the estuaries of the Thames, Severn and Solent).

## Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 5 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

## Gas Storage

There are no overall predicted impacts associated with gas storage.

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# 2. Population

## 2.1 Introduction

In the absence of detailed SEA guidance on the content of the population topic, 'population' includes information on demographics and generic socio-economic issues. The overview of plans and programmes and baseline information contained in this section provides the context for the assessment of potential effects of the Licensing Plan proposals on population and socio-economics. Information is presented for both national and regional levels.

There are links between the population topic and a number of other SEA topics, in particular the effects of population on human health, material assets, air quality and climate change.

## 2.2 Review of Plans and Programmes

### 2.2.1 International/European

***Europe 2020*** is Europe's economic growth strategy. It aims to deliver growth that is smart, sustainable and inclusive and set objectives on employment, innovation, education, social inclusion and climate/ energy - to be reached by 2020. The ***European Employment Strategy*** takes inspiration from Europe 2020 and seeks to engender full employment, quality of work and increased productivity as well as the promotion of inclusion by addressing disparities in access to labour markets. These overarching aims are further espoused in the ***Integrated Guideline for Growth and Jobs 2008-11*** and later documents relating policy objectives into broad actions for the member states (***A Shared Commitment for Employment***, 2009; and, ***Implementation of the Lisbon Strategy Structural Reforms in the context of the European Economic Recovery Plan***, 2009).

The United Nation's ***Aarhus Convention (2001)*** grants the public rights and imposes on parties and public authority's obligations regarding access to information, public participation and access to justice. It contains three broad themes or 'pillars':

- access to information;
- public participation; and
- access to justice.

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The ***SEA Directive*** creates the following requirements for public consultation:

- Authorities which, because of their environmental responsibilities, are likely to be concerned by the effects of implementing the plan or programme, must be consulted on the scope and level of detail of the information to be included in the Environmental Report. These authorities are designated in the SEA Regulations as the Consultation Bodies (Consultation Authorities in Scotland);
- The public and the Consultation Bodies must be consulted on the draft plan or programme and the Environmental Report, and must be given an early and effective opportunity within appropriate time frames to express their opinions;
- Other EU Member States must be consulted if the plan or programme is likely to have significant effects on the environment in their territories; and
- The Consultation Bodies must also be consulted on screening determinations on whether SEA is needed for plans or programmes under Article 3(5), i.e. those which may be excluded if they are not likely to have significant environmental effects.

### 2.2.2 UK

The ***Plan for Growth (2011)*** announced a programme of structural reforms to remove barriers to growth for businesses and equip the UK to compete in the global race. These reforms span a range of policies including improving UK infrastructure, cutting red tape, root and branch reform of the planning system and boosting trade and inward investment, to achieve the government's four ambitions for growth:

- creating the most competitive tax system in the G20;
- encouraging investment and exports as a route to a more balanced economy;
- making the UK the best place in Europe to start, finance and grow a business; and
- creating a more educated workforce that is the most flexible in Europe.

***Achieving strong and sustainable economic growth (2013)*** details how the government is removing barriers to growth allowing the UK to compete in a rapidly changing global economy. Included within the policy are a number of actions to attract investment within the UK, supporting local growth, investing in infrastructure and creating a more educated and flexible workforce.

In 2011, the UK Government published an updated ***National Infrastructure Plan***. This contains major commitments to improve the UK's transport and broadband networks as well as steps to attract major new private sector investment. A key goal is to ensure the security of electricity and gas within the UK. The Plan seeks to clarify the potential contribution of shale gas and other unconventional resources to indigenous gas supplies through updated estimates of shale gas resource.

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Within the ***Budget 2013*** a *'generous new tax regime'* including shale gas field allowance was announced to encourage early investment in the shale gas industry in the UK. Also, it was announced that by summer 2013 new planning guidance would be available to allow benefits for local communities affected by shale gas proposals.

### 2.2.3 England

The ***Local Growth White Paper (2010)*** sets out the Government overarching goal is to promote strong, sustainable and balanced growth. It restates the Government's role in providing the framework for conditions for sustainable growth by:

- creating macroeconomic stability, so that interest rates stay low and businesses have the certainty they need to plan ahead;
- helping markets work more effectively, to encourage innovation and the efficient allocation of resources;
- ensuring that it is efficient and focused in its own activities, prioritising high-value spending and reducing tax and regulatory burdens; and
- ensuring that everyone in the UK has access to opportunities that enable them to fulfil their potential.

The White Paper focuses on the approach to local growth proposing measures to shift power away from central government to local communities, citizens and independent providers. It introduced Local Enterprise Partnerships (LEPs) to provide a vision and leadership for sustainable local economic growth. The number of LEPs has increased to 39 from the 24 originally announced. Across England the LEP's are at different stages of establishment and are subject to further development and consultation. LEPs will be expected to fund their own day to day running costs but may wish to submit bids to the Regional Growth Fund (RGF). The RGF is a discretionary £1.4 billion Fund operating for three years between 2011 and 2014 to stimulate enterprise by providing support for projects and programmes with significant potential for creating long term private sector led economic growth and employment and, in particular, help those areas and communities that are currently dependent on the public sector make the transition to sustainable private sector-led growth and prosperity.

The ***National Planning Policy Framework (NPPF) (2012)*** states that mineral planning authorities should clearly distinguish between three phases of development (exploration, appraisal and production) for onshore oil and gas development. It also states that constraints on production and processing within areas licensed for oil and gas development should be addressed.

### 2.2.4 Scotland

The ***Scottish Government Economic Strategy (2011)*** identifies six strategic priorities which will accelerate recovery, drive sustainable economic growth and develop a more resilient and adaptable economy. These priorities are:

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- supportive business environment;
- transition to a low carbon economy;
- learning skills and well-being;
- infrastructure development and pace;
- effective government; and
- equity.

The ***Draft Scottish Planning Policy (2013)*** is a statement of Scottish Government policy on how nationally important land use planning matters should be addressed in Scotland. The draft was issued for consultation on 30 April 2013.

***Working for Growth: A Refresh of the Employability Framework for Scotland (2012)*** provides a clear framework to strengthen Scotland's focus on jobs and growth. It does so under the following themes:

- Strategy and Effective Leadership;
- Better Integration and Partnership Working;
- Towards Prevention - Tackling Inequality; and
- Improving Performance.

A report completed for Scottish Government by UK Commission for Employment and Skills (UKCES) entitled ***Towards Ambition 2020: skills, jobs, growth for Scotland*** found that Scotland's skills base has improved considerably but this has not translated into higher productivity and economic growth. In response to this Scottish Government prepared ***Skills for Scotland: Accelerating the Recovery and Increasing Sustainable Economic Growth (2010).*** This strategy focuses on the following four key themes:

- Empowering people;
- Supporting employers;
- Simplifying the skills system; and
- Strengthening partnerships.

### 2.2.5 Wales

The ***Programme for Government (2011)*** includes a chapter on *Growth and Sustainable Jobs.* The aim of this chapter is to *"strengthen the conditions that will enable business to create jobs and sustainable economic growth."* It includes the following key principles:

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- further integrating economic, education, skills, procurement and planning policies to deliver greater benefits to the Welsh economy;
- encouraging greater levels of private sector investment and employment;
- increasing the links between academia and businesses; and
- positioning Wales as a low carbon, green economy.

With respect to economic development, the ***Planning Policy Wales (2012),*** sets out that the planning system should support economic and employment growth alongside social and environmental considerations within the context of sustainable development. To this end, the planning system, including planning policies, should aim to ensure that the growth of output and employment in Wales as a whole is not constrained by a shortage of land for economic uses. Local planning authorities should aim to facilitate the provision of sufficient land required by the market, except where there are good reasons to the contrary. In addition, wherever possible local planning authorities should seek to guide and control economic development to facilitate regeneration and promote social and environmental sustainability.

The ***Wales Spatial Plan (2008)*** contains the following key themes which relate to population:

- building sustainable communities;
- promoting a sustainable economy; and
- respecting distinctiveness.

***Technical Advice Note 12 (TAN12)*** sets out the Assembly Government's policies and objectives in respect of the design of new development, including; ensuring attractive, safe public spaces and ensuring ease of access for all.

***Welsh Office Circular 3/85 - Planning Control over Oil and Gas Operations (1985)*** gives information on national policy and provides guidance on the issues to be taken into account when deciding planning applications for onshore oil and gas development.

## 2.3 Overview of the Baseline

### 2.3.1 UK

#### National Demographics

In mid 2011, the resident population of Great Britain was 63,232,600 [1] (49.1% male and 50.9% female) and 64.7% of the population was working age (aged 16 to 64).

[1] Office for National Statistics 2011 mid-year population estimates.

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The working age population from Dec 2012 to Feb 2013 was broken down as follows[2]:

- 77.8% economically active;
- 71.4% in employment; and
- 8.1% unemployed.

The breakdown of qualifications of the working age population in 2012 was as follows:

- 34.4% had NVQ4 and above;
- 55.1% had NVQ3 and above;
- 71.8% had NVQ2 and above;
- 84.0% had NVQ1 and above;
- 6.3% had other qualifications; and
- 9.7% have no qualifications.

In England and Wales, between 2011 and 2012 estimates from the Crime Survey England and Wales (CSEW) indicate that burglary fell by 13%, and vehicle related theft fell by 10%. However, bicycle theft increased by 12%. All CSEW crime fell by 7%.

**Table 2.1 Number of Crimes Recorded by the Police in England and Wales**[3]

| Type of Crime | 2011 | 2012 | Change |
|---|---|---|---|
| | Number of Offences (thousands) | | % |
| Vandalism | 1,948 | 1,811 | -7 |
| Burglary | 731 | 633 | -13 |
| Vehicle-related theft | 1,195 | 1,073 | -10 |
| Bicycle theft | 429 | 482 | +12 |
| Other household theft | 1,304 | 1,355 | +4 |
| Household acquisitive crime | 3,659 | 3,543 | -3 |
| All household crime | 5,607 | 5,354 | -5 |

[2] NOMIS, Official Labour Market Statistics, Annual Population Survey, https://www.nomisweb.co.uk
[3] Home Office, British Crime Survey in England and Wales (2013), http://www.ons.gov.uk/ons/taxonomy/index.html?nscl=Crime+in+England+and+Wales

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| Type of Crime | 2011 | 2012 | Change |
|---|---|---|---|
| | Number of Offences (thousands) | | % |
| Theft from the person | 595 | 575 | -7 |
| Other theft of personal property | 1,076 | 1,023 | -3 |
| All violence | 2,126 | 1,981 | -4 |
| Personal acquisitive crime | 1,918 | 1,845 | -5 |
| All personal crime | 3,797 | 3,580 | -6 |
| All CSEW (Crime Survey England & Wales) Crime | 9,405 | 8,933 | -7 |

In 2011/12, the UK had a total of 32,518 schools which were broken down as follows:

- 3,095 nursery (141,600 students);
- 21,165 primary (5,006,700students);
- 4,072 secondary (3,855,600 students);
- 2,502 non maintained (591,400 students);
- 1,281 special (105,000 students); and
- 403 pupil referral units (12,400 students) [4].

(Total of 9,121,300 pupils at maintained schools and a further 591,400 at non-maintained schools.)

## National Socio-Economic Baseline

In 2011, UK per capita Gross Value Added (GVA) was £21,368 [5]. The 2011 headline estimates show that both total GVA and GVA per head at current basic prices have increased in all UK regions. In 2011, London's gross value added (GVA) per head of population was 66.8% above the average for the United Kingdom (UK), while that of Wales was 26.5% below the average.

In 2012, the median full-time gross hourly pay in UK was £12.82 (males' median being £13.41 and the female median being £12.01). This compares to £11.98 in 2008 [6].

[4] DCSF, Education and Training Statistics for the United Kingdom: 2012, https://www.gov.uk/government/publications/education-and-training-statistics-for-the-uk-2012
[5] Regional, sub-regional and local gross value added 2012, Office of National Statistics http://www.ons.gov.uk/ons/rel/regional-accounts/regional-gross-value-added--income-approach-/december-2012/rft-gva-nuts1.xls
[6] Official Labour Market Statistics, Annual survey of hours and earnings –resident analysis 2012, NOMIS https://www.nomisweb.co.uk/output/dn87000/{AFB7B1A5-142C-4D4F-BDE2-467C1389CB90}/nomis_2009_08_20_160703.xls

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In the period February to April 2012 the UK had a total of 29,280,000 [7] people in employment aged 16 and over, up 166,000 on the quarter. The number of people employed in the private sector increased by 205,000 to reach 23.38 million but the number of people employed in the public sector fell by 39,000 to reach 5.90 million.

In Feb 2012 - Apr 2012, the UK had an unemployment rate of 8.2% (all people of working age). This is a reduction of 0.2% on the previous quarter and compares to the previous year when the UK had an unemployment rate of 5%.

The recent UK recession has caused a downturn in many sectors and markets of the UK economy. UK gross domestic product (GDP) in volume terms decreased by 0.3% in the first quarter of 2012, revised from a previously estimated decline of 0.2%. Production industries fell by 0.4%, within which manufacturing output was flat whilst the output the service industries rose slightly by 0.1% [8].

In 2011, oil and gas provided some 73% of the UK's total primary energy. The UK was the third largest gas and second largest oil producer in Europe. Production was 656 million boe. The oil and gas industry paid £11.2 billion in corporate taxes on production in 2011/12, almost 25% of total corporation taxes received by the Exchequer. The wider supply chain is estimated to have contributed another £6 billion in corporation and payroll taxes [9].

The oil and gas industry supported at least 440,000 jobs in the UK with 32,000 in direct employment, 207,000 in the wider supply chain, 100,000 induced by the economic activity of the employees and 100,000 jobs exporting goods and services.

The Select Committee report on *The Impact of Shale Gas on Energy Markets* includes a summary on potential impacts on shale gas industry on jobs and skills. It states that estimates on the number of jobs that the shale gas industry could create in the UK vary greatly, ranging from thousands to tens of thousands. The UK already has extensive drilling experience from the conventional gas industry in the North Sea, some of which could be transferable to the onshore industry. However, given the specialist and capital intensive nature of shale gas operations it could result in few local employment benefits. The Report suggests that the government should work with the industry and relevant sector skills council to develop a skills action plan for *shale gas similar to the recently published Nuclear Supply Chain Action Plan* [10].

[7] Labour Market Statistics, June 2012,Office of National Statistics http://www.ons.gov.uk/ons/rel/lms/labour-market-statistics/june-2012/index.html
[8] UK Snapshot, Office of National Statistics http://www.ons.gov.uk/ons/dcp171778_264972.pdf
[9] Oil and Gas UK (2012) 2012 Economic Report http://www.oilandgasuk.co.uk/cmsfiles/modules/publications/pdfs/EC029.pdf

[10] The Impact of Shale Gas on Energy Markets 2013, House of Commons http://www.publications.parliament.uk/pa/cm201213/cmselect/cmenergy/785/78502.htm

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## 2.3.2 England

### Demographics

In mid-2011, England had a resident population of 53,107,200 (49.2% males and 50.8% females) and 64.8% of the population was of working age (aged 16 to 64) [11].

In Jan 2013 to Mar 2013 the working age population breakdown was as follows:

- 77.9% were economically active;
- 71.6% of working age population were in employment; and
- 7.8% of working age population were unemployed [12].

The working age population in 2012 had the following qualification breakdown:

- 34.2% have NVQ4 and above;
- 54.9% have NVQ3 and above;
- 71.8% have NVQ2 and above;
- 84.2% have NVQ1 and above;
- 6.3% have other qualifications; and
- 9.5% have no qualifications.

In 2010-11, England had 24,372 schools:

- 423 nursery (39,300 students);
- 16,818 primary (4,213,300 students);
- 3,268 secondary (3,213,800 students);
- 2,421 non maintained (581,800 students);
- 1,039 special (89,200 students); and

[11] 2011 mid-year population estimates, NOMIS https://www.nomisweb.co.uk/reports/lmp/gor/2092957699/report.aspx?town=england

[12] Labour Force Survey NOMIS http://www.nomisweb.co.uk/reports/lmp/gor/2092957699/report.aspx

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- 403 pupil referral units (12,400 students) [13].

### Socio-Economic Baseline

In 2011, England's per capita Gross Value Added (GVA) was 21,349 [14].

In 2012, the median full-time gross hourly pay in England was £12.98 (males' median being £13.58 and the female median being £12.11). This compares to £12.85 in 2011 and represents growth of 1.01% in nominal hourly total full time pay over the previous year [15].

In Dec 2012 to Feb 2013, England had an unemployment rate of 8% (all people of working age). This compares to same time period in the previous year when it had an unemployment rate of 8.3%.

## 2.3.3 Scotland

### Demographics

In mid-2011, Scotland had a resident population of 5,254,800 (48.5% male and 51.5% female) and 65.6% of the population is of working age (aged 16 to 64) [16].

In Dec 2012 to Feb 2013 the working age population breakdown was as follows:

- 77.4% were economically active;
- 71.7% of working age population were in employment; and
- 7.3% of working age population were unemployed [17].

The working age population in 2012 had the following qualification breakdown:

- 33.9% have NVQ4 and above;
- 49.3% have NVQ3 and above;
- 63.8% have NVQ2 and above;

[13] Department for Education, Education & Training Statistics for the UK, 2011 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/167202/main_20text_20v022011.pdf.pdf
[14], Regional, sub-regional and local gross value added 2011 http://www.ons.gov.uk/ons/rel/regional-accounts/regional-gross-value-added--income-approach-/december-2012/rft-gva-nuts1.xls,
[15] ONS: Earning by workplace https://www.nomisweb.co.uk/reports/lmp/gor/2092957699/report.aspx?town=england
[16] Office for National Statistics 2011 mid-year population estimates http://www.gro-scotland.gov.uk/files2/stats/population-estimates/mid-2011/mid-2011-population-estimates.pdf
[17] NOMIS, Official Labour Market Statistics, https://www.nomisweb.co.uk/reports/lmp/gor/2013265931/report.aspx?town=scotland

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- 73.6% have NVQ1 and above;
- 7.6% have other qualifications; and
- 13.3% have no qualifications.

Differences in legal systems and police recording mean that the recorded crime figures for Scotland are not directly comparable with recorded crime figures for England and Wales. In Scotland, overall crimes recorded by police was 314,186, a 3% drop compared to 2010-11. Over the same time period, theft of motor vehicles and non-sexual crimes of violence decreased by 19% and 17% respectively [18].

In 2012, Scotland had 5,132 schools:

- 2,645 pre-school (97,985 students);
- 2,064 primary (370,680 students);
- 365 secondary (293,562 students); and
- 155 special (6,976 students) [19].

## Socio-Economic Baseline

In 2011, Scotland's per capita Gross Value Added (GVA) was 20,571, an increase of 1.3% compared to 2010 [20].

In 2012, the median full-time gross hourly pay in Scotland was £12.67 (males' median being £13.17 and the female median being £11.91). This compares to £12.38 in 2011 and represents growth of 2.3% in nominal hourly total full time pay over the previous year [21].

In 2012, Scotland had a total of 2,621,000 jobs [22].

In Dec 2012 to Feb 2013, Scotland had an unemployment rate of 7.3% (all people of working age). This compares to the same time the previous year when it had an unemployment rate of 8.1%.

[18] Scottish Government, High Level of Summary of Statistics Trends: 2012 http://www.scotland.gov.uk/Resource/0041/00419592.xls

[19] Scottish Government, Summary Statistics for schools in Scotland, 2012 http://www.scotland.gov.uk/Resource/0041/00410232.pdf

[20] Regional, sub-regional and local gross value added 2012 http://www.ons.gov.uk/ons/rel/regional-accounts/regional-gross-value-added--income-approach-/december-2012/rft-gva-nuts1.xls

[21] NOMIS, Official Labour Market Statistics, 2012 https://www.nomisweb.co.uk/reports/lmp/gor/2013265931/report.aspx?town=scotland

[22] Office for National Statistics, Regional Labour Market Statistics, April 2013

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### 2.3.4 Wales

#### Demographics

In mid-2011, the resident population of Wales was 3,063,800 and 63.4% of the population were of working age (49.1% males and 50.9% females) [23].

In Dec 2012 to Feb 2013, the working age population was broken down as follows:

- 75% economically active;
- 68.9% in employment; and
- 8.2% unemployed [24].

The working age population in 2012 had the following qualifications:

- 30.3% NVQ4 and above;
- 51.7% NVQ3 and above;
- 69.7% NVQ2 and above;
- 82% NVQ1 and above;
- 6.6% other qualifications; and
- 11.4% no qualifications.

In 2012, Wales had 1,698 schools:

- 22 nursery (1,530 students);
- 1,412 primary (262,144 students);
- 221 secondary (198,015 students); and
- 43 special (4,254 students) [25].

[23] Office for National Statistics 2011 mid-year population estimates https://www.nomisweb.co.uk/reports/lmp/gor/2013265930/report.aspx?town=wales
[24] NOMIS, Official Labour Market Statistics https://www.nomisweb.co.uk/reports/lmp/gor/2013265931/report.aspx?town=scotland

[25] Statistics for Wales, School Census, 2012 http://wales.gov.uk/docs/statistics/2012/120711sdr1082012en.pdf

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### Socio-Economic Baseline

In 2011, Wales' per capita Gross Value Added (GVA) was 15,698, an increase by 1.9% compared to 2010 [26].

In 2012, the median full-time gross hourly pay in Wales was £11.48 (males' median being £12.00 and the female median being £10.83). This compares to £11.46 in 2011[27].

In 2012, Wales had a total of 1,384,000 jobs[28].

In Dec 2012 to Feb 2013, Wales had an unemployment rate of 8.2% (all people of working age). This compares to the previous year when it had an unemployment rate of 8.9%.[29]

## 2.4 Characteristics of those Areas most likely to be Significantly Affected

### 2.4.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

### Demographics

Within the Scottish Midlands, the Central Belt supports the highest population densities, being greatest in the cities of Glasgow, Edinburgh and also to the north east in Dundee. The population density in the areas intervening these centres (Fife, North Lanarkshire, West Lothian) still contain relatively high densities compared with more rural areas to the north and south of the central belt (e.g. Stirling, Perth and Kinross, South Lanarkshire, Scottish Borders). The population and population density of each relevant administrative area is shown in **Table 2.1**.

### Socio-Economic Baseline

Deprivation is not measured at the UK level and measured independently by the devolved administrations. Therefore, it is not possible to do a direct comparison between SEA Area 1 and the other areas. However, it is possible to compare the relative deprivation levels between the different local authorities within this area.

The Scottish Index of Multiple Deprivation (SIMD) identifies small area concentrations of multiple deprivation across all of Scotland in a consistent way. In this context, deprivation is defined more widely as the range of problems that arise due to lack of resources or opportunities, covering health, safety,

[26] Regional, sub-regional and local gross value added 2012 http://www.ons.gov.uk/ons/rel/regional-accounts/regional-gross-value-added--income-approach-/december-2012/rft-gva-nuts1.xls,
[27] NOMIS, Official Labour Market Statistics, Annual survey of hours and earnings - resident analysis https://www.nomisweb.co.uk/reports/lmp/gor/2013265930/report.aspx?town=wales
[28] ONS https://www.nomisweb.co.uk/reports/lmp/gor/2013265930/report.aspx
[29] NOMIS, Official Labour Market Statistics, National Indicators, June-August 2009, https://www.nomisweb.co.uk/articles/news/files/LFS%20headline%20indicators.xls

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education, employment, housing and access to services, as well as financial aspects. The SIMD uses data relating to multiple aspects of life in order to gain the fullest possible picture of deprivation across Scotland. Seven different aspects are identified - the seven SIMD domains - and data from these domains are combined to produce the index.

Glasgow and Inverclyde are the most deprived areas with 33.6% and 29.1% of their intermediate geographies ranked within the 10% most deprived. Aberdeenshire and East Renfrewshire are the least deprived with 44.6% and 43.3% of their intermediate geographies ranked within the 10% least deprived.

**Table 2.2 Mid 2011 Population Estimate for Administrative Areas and Levels of Deprivation in Scottish Midlands SEA Area**

| Area | Area ($km^2$) | Population | Density (persons per $km^2$) | % of Area** within Top 10% Most Deprived Area in Scotland | % of Area** within top 10% Least Deprived Area in Scotland |
|---|---|---|---|---|---|
| Aberdeenshire* | 6,313 | 247,600 | 39.22 | 4.0% | 44.6% |
| Angus | 2,182 | 110,600 | 50.69 | 1.4% | 3.5% |
| Clackmannanshire | 159 | 50,800 | 319.50 | 12.5% | 6.3% |
| Dumfries & Galloway* | 6,426 | 148,100 | 23.05 | 4.1% | 2.6% |
| Dundee City | 60 | 145,600 | 2426.67 | 20.1% | 7.3% |
| East Dunbartonshire | 175 | 104,600 | 597.71 | 1.6% | 30.7% |
| East Lothian | 679 | 98,200 | 144.62 | 0.0% | 12.5% |
| East Renfrewshire | 174 | 89,900 | 516.67 | 2.5% | 43.3% |
| Edinburgh | 264 | 495,400 | 1876.52 | 7.1% | 31.7% |
| Falkirk | 297 | 154,400 | 519.87 | 4.6% | 9.1% |
| Fife | 1,325 | 367,400 | 277.28 | 5.3% | 7.9% |
| Glasgow | 175 | 598,800 | 3421.71 | 33.6% | 3.2% |
| Inverclyde | 160 | 79,200 | 495.00 | 29.1% | 0.9% |
| Midlothian | 354 | 82,400 | 232.77 | 1.8% | 11.6% |
| North Lanarkshire | 470 | 326,700 | 695.11 | 13.9% | 1.4% |
| Perth & Kinross* | 5,286 | 149,500 | 28.28 | 1.1% | 8.0% |
| Renfrewshire | 261 | 170,700 | 654.02 | 15.0% | 5.1% |
| Scottish Borders* | 4,732 | 113,200 | 23.92 | 3.1% | 0.8% |
| West Dunbartonshire | 159 | 90,400 | 568.55 | 17.8% | 0.0% |
| West Lothian | 427 | 173,000 | 405.15 | 1.9% | 10.4% |
| Stirling* | 2,187 | 90,800 | 41.52 | 4.5% | 10.0% |

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| Area | Area (km$^2$) | Population | Density (persons per km$^2$) | % of Area** within Top 10% Most Deprived Area in Scotland | % of Area** within top 10% Least Deprived Area in Scotland |
|---|---|---|---|---|---|
| **Scottish Midlands Total** | **32,265** | **3,796,500** | **117.67** | **-** | **-** |
| **Scotland Total** | **77,925** | **5,254,800** | **67.43** | **-** | **-** |
| **UK Total** | **242,514** | **63,232,600** | **260.74** | **-** | **-** |

Source: Office for National Statistics and Scottish Index of Multiple Deprivation(2012)

Note: *only part of this administrative area resides within the SEA area

** local authorities split into intermediate geographies areas

## 2.4.2 SEA Area 2: West Midlands, North West England and Southern Scotland

### Demographics

The West Midlands and North West England SEA area has a high population density in most administrative areas (particularly the West Midlands, Merseyside and Greater Manchester), with concentrations of population centred on the urban areas of Liverpool, Blackpool, Manchester and Birmingham. The high collective population density for all the administrative areas in the SEA area is over 2.5 times that of the national figure, and over 1.5 times that of England.

**Table 2.3 Mid 2011 Population Estimate for Administrative Areas in West Midlands, North West England and Southern Scotland SEA Area**

| Area | Area (km$^2$) | Population | Density (persons per km$^2$) |
|---|---|---|---|
| Lancashire | 2,903 | 1,171,600 | 403.58 |
| Blackburn with Darwen | 137 | 147,700 | 1078.10 |
| Merseyside | 645 | 1,380,800 | 2140.78 |
| Warrington | 181 | 202,700 | 1119.89 |
| Greater Manchester | 1,276 | 2,685,400 | 2104.55 |
| Cheshire | 2,083 | 329,500 | 158.19 |
| Cumbria | 6,768 | 499,800 | 73.85 |
| Blackpool | 35 | 142,100 | 4060.00 |
| Halton | 79 | 125,700 | 1591.14 |
| Shropshire | 3,197 | 307,100 | 96.06 |
| Telford & Wrekin | 290 | 166,800 | 575.17 |
| Worcestershire* | 1,741 | 566,600 | 325.45 |
| Staffordshire | 2,620 | 849,500 | 324.24 |

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| Area | Area ($km^2$) | Population | Density (persons per $km^2$) |
|---|---|---|---|
| Stoke-on-Trent | 93 | 248,700 | 2674.19 |
| West Midlands | 902 | 2,739,700 | 3037.36 |
| Warwickshire | 1,975 | 546,600 | 276.76 |
| Dumfries & Galloway* | 6,426 | 148,100 | 23.05 |
| Scottish Borders* | 4,732 | 113,200 | 23.92 |
| **West Midlands/North West England/ Southern Scotland Total** | **18,157** | **12,742,300** | **681.37** |
| **England Total** | **130,281** | **53,107,200** | **407.64** |
| **United Kingdom Total** | **242,514** | **63,232,600** | **260.74** |

Source: Office for National Statistics

Note: *only part of this administrative area resides within the SEA area

## Socio-Economic Baseline

Given that the majority of this region is within England the English indices of deprivation have been used to give an indication of the level of deprivation. **Table 2.4** shows that levels of deprivation within this region are high compared to other regions, with a higher proportion of local authorities within the region are ranked within the 10% most deprived in England considerably higher than the proportion within the least deprived areas.

**Table 2.4 Levels of Deprivation in West Midlands and North West England**

| | % of Local Authorities within the Region that are Within | |
|---|---|---|
| **Region** | **the 10% Most Deprived in England** | **the 10% Least Deprived areas in England** |
| North West | 20.2% | 6.6% |
| West Midlands | 16.0% | 7.0% |

Source: English Indices of Deprivation (2010)

## 2.4.3 SEA Area 3: East Midlands and Eastern England

## Demographics

Northumberland, Durham, North Yorkshire, Lincolnshire and Norfolk have a relatively low population density compared to administrative areas in the East Midlands, including South Yorkshire, West Yorkshire, Nottinghamshire, Leicestershire and Derbyshire. The principal population centres in this SEA are the urban areas of Newcastle, Leeds, York and Hull in the North, and Nottingham, Leicester and Derby in the South.

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**Table 2.5 Mid 2011 Population Estimate for Administrative Areas in East Midlands, and Eastern England**

| Area | Area ($km^2$) | Population | Density (persons per $km^2$) |
|---|---|---|---|
| Northumberland | 5,013 | 316,300 | 63.10 |
| Tyne and Wear | 540 | 1,104,100 | 2044.63 |
| Durham | 2,226 | 513,000 | 230.46 |
| Darlington | 197 | 105,600 | 536.04 |
| Hartlepool | 94 | 92,100 | 979.79 |
| Middlesbrough | 54 | 138,400 | 2562.96 |
| Redcar and Cleveland | 245 | 135,200 | 551.84 |
| Stockton-on-Tees | 204 | 191,800 | 940.20 |
| North Yorkshire | 8,038 | 601,200 | 74.79 |
| South Yorkshire | 1,552 | 1,343,800 | 865.85 |
| West Yorkshire | 1,552 | 2,227,400 | 1435.18 |
| York UA | 272 | 197,800 | 727.21 |
| East Riding of Yorkshire | 2,409 | 334,700 | 138.94 |
| North Lincolnshire | 846 | 167,500 | 197.99 |
| Derby | 78 | 248,900 | 3191.03 |
| Derbyshire | 2,547 | 770,700 | 302.59 |
| North East Lincolnshire | 192 | 159,700 | 831.77 |
| Kingston upon Hull | 71 | 256,100 | 3607.04 |
| Nottinghamshire | 2,085 | 786,800 | 377.36 |
| Nottingham | 75 | 303,900 | 4052.00 |
| Lincolnshire | 5,921 | 714,800 | 120.72 |
| Leicestershire | 2,083 | 651,200 | 312.63 |
| Leicester | 73 | 329,600 | 4515.07 |
| Rutland | 382 | 37,600 | 98.43 |
| Peterborough | 343 | 184,500 | 537.90 |
| Cambridgeshire* | 3,046 | 622,300 | 204.30 |
| Norfolk* | 5,371 | 859,400 | 160.01 |
| **East Midlands and Eastern England Total** | **45,986** | **13,394,400** | **291.27** |
| **England Total** | **130,281** | **53,107,200** | **407.64** |
| **UK Total** | **242,514** | **63,232,600** | **260.74** |

Source: Office for National Statistics
Note: *only part of this administrative area resides within the SEA area

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## Socio-Economic Baseline

**Table 2.6** shows that there are low levels of deprivation within this region, as the percentage of local authorities within the 10% most deprived areas in England is lower than those within the least deprived, especially within the East of England.

**Table 2.6 Measures of Deprivation within the East Midlands and East of England**

| | % of Local Authorities within the Region that are Within | |
|---|---|---|
| **Region** | **the 10% Most Deprived in England** | **the 10% Least Deprived in England** |
| East Midlands | 7.4% | 10.5% |
| East of England | 2.8% | 15.4% |

Source: English Indices of Deprivation (2010)

## 2.4.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

## Demographics

The North and South Wales SEA area takes in those areas of Wales which are most heavily populated, namely Cardiff, Swansea and the Valleys in the South. The relatively high population density in these areas (**Table 2.7**) can be seen by comparison with the national (Wales) total.

## Socio-Economic Baseline

Deprivation is not measured at the UK level and measured independently by the devolved administrations. Therefore, it is not possible to do a direct comparison between SEA Area 4 and the other areas. However, it is possible to compare the relative deprivation levels between the different local authorities within this area. Merthyr Tydfil and Blaenau Gwent are the most deprived areas with 25% and 23.4% of their LSOA [30] ranking within the top 10% most deprived areas. Cardiff and Monmouthshire are the least deprived with 26.1% and 19% ranking within the top 10% least deprived areas (none of the LSOA's within Monmouthshire are ranked within the most deprived areas).

[30] Wales is divided into 1,896 Lower-Layer Super Outputs Areas (LSOA). Each LSOA has about 1,500 people.

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**Table 2.7 Mid 2011 Population Estimate for Administrative Areas in North and South Wales**

| Area | Area ($km^2$) | Population | Density (persons per $km^2$) | % of Area** within 10% Most Deprived Area in Wales | % of Area** within 10% Least Deprived Area in Wales |
|---|---|---|---|---|---|
| Flintshire | 438 | 152,700 | 348.63 | 4.3% | 16.3% |
| Wrexham | 498 | 135,100 | 271.29 | 5.9% | 10.6% |
| Denbighshire | 844 | 93,900 | 111.26 | 10.3% | 6.9% |
| Monmouthshire | 850 | 91,500 | 107.65 | 0.0% | 19.0% |
| Blaenau Gwent | 109 | 69,800 | 640.37 | 23.4% | 0.0% |
| Torfaen | 126 | 91,200 | 723.81 | 6.7% | 5.0% |
| Newport | 73 | 145,800 | 1997.26 | 16.0% | 9.6% |
| Caerphilly | 278 | 178,800 | 643.17 | 14.5% | 3.6% |
| Cardiff | 140 | 345,400 | 2467.14 | 15.8% | 26.1% |
| Merthyr Tydfil | 111 | 58,900 | 530.63 | 25.0% | 0.0% |
| Rhondda, Cynon, Taff | 424 | 234,400 | 552.83 | 10.9% | 17.0% |
| Neath Port Talbot | 442 | 139,900 | 316.52 | 15.4% | 5.5% |
| Bridgend | 246 | 139,400 | 566.67 | 10.6% | 7.1% |
| The Vale of Glamorgan | 335 | 126,700 | 378.21 | 5.9% | 10.6% |
| Carmarthenshire | 2,394 | 184,000 | 76.86 | 5.4% | 0.9% |
| Neath Port Talbot | 441 | 139,900 | 317.23 | 15.4% | 5.5% |
| Powys | 5,181 | 133,100 | 25.69 | 1.3% | 5.0% |
| Swansea | 378 | 238,700 | 631.48 | 10.9% | 17.0% |
| **North and South Wales Total** | **13,308** | **2,699,200** | **202.83** | **-** | **-** |
| **Wales Total** | **20,732** | **3,063,800** | **147.78** | **-** | **-** |
| **United Kingdom Total** | **242,514** | **63,232,600** | **260.74** | **-** | **-** |

Source: Office for National Statistics

Note: *only part of this administrative area resides within the SEA area

## 2.4.5 SEA Area 5: Southern and South West England

The collective population density for all the administrative areas in this SEA area is significantly larger than the national and English averages. The area of Greater London has the largest population density of any administrative area in the UK. Southampton and Bristol also have very high population densities. The other principal population centres in the South and South West are Reading, Bournemouth, Portsmouth, Brighton, Plymouth and Exeter.

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**Table 2.8 Mid 2011 Population Estimate for Administrative Areas in Southern and South West England**

| Area | Area ($km^2$) | Population | Density (persons per $km^2$) |
|---|---|---|---|
| Devon* | 6,564 | 747,700 | 113.91 |
| Somerset | 3,451 | 531,600 | 154.04 |
| Dorset | 2,542 | 431,800 | 169.87 |
| Wiltshire | 3,255 | 474,300 | 145.71 |
| North Somerset | 375 | 203,100 | 541.60 |
| Bath and North East Somerset | 351 | 175,500 | 500.00 |
| South Gloucestershire | 497 | 263,400 | 529.98 |
| Bristol | 110 | 428,100 | 3891.82 |
| Gloucestershire | 2,653 | 598,300 | 225.52 |
| Worcestershire | 1741 | 566,600 | 325.45 |
| Herefordshire* | 2,180 | 183,600 | 84.22 |
| Swindon | 230 | 209,700 | 911.74 |
| West Berkshire | 704 | 154,100 | 218.89 |
| Oxfordshire* | 2,605 | 654,800 | 251.36 |
| Hampshire | 3,679 | 1,322,100 | 359.36 |
| Poole | 65 | 148,100 | 2278.46 |
| Bournemouth | 46 | 183,500 | 3989.13 |
| Southampton | 50 | 235,900 | 4718.00 |
| Isle of Wight | 380 | 138,400 | 364.21 |
| Wokingham | 179 | 154,900 | 865.36 |
| Windsor and Maidenhead | 198 | 145,100 | 732.83 |
| Slough | 33 | 140,700 | 4263.64 |
| Surrey | 1,663 | 1,135,400 | 682.74 |
| West Sussex | 1,991 | 808,900 | 406.28 |
| East Sussex | 1,709 | 527,200 | 308.48 |
| Brighton and Hove | 83 | 273,000 | 3289.16 |
| Kent | 3,544 | 1,466,500 | 413.80 |
| Greater London | 1,580 | 8,204,400 | 5192.66 |
| Medway | 192 | 264,900 | 1379.69 |
| Thurrock | 163 | 158,300 | 971.17 |
| Reading | 40 | 155,300 | 3882.50 |

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| Area | Area ($km^2$) | Population | Density (persons per $km^2$) |
|---|---|---|---|
| **Southern and South West England** | **42,853** | **21,085,200** | **492.04** |
| **England Total** | **130,281** | **53,107,200** | **407.64** |
| **UK Total** | **242,514** | **63,232,600** | **260.74** |

Source: Office for National Statistics

Note: *only part of this administrative area resides within the SEA area

### Socio-Economic

**Table 2.9** shows that the Southern of England has low levels of deprivation, especially within the South East where the proportion of local authorities within the 10% least deprived areas in England greatly outweighs the proportion of local authorities within the 10% most deprived.

**Table 2.9 Measures of Deprivation within the South West, South East of England and London**

| Region | % of Local Authorities within the Region that are Within | |
|---|---|---|
| | the 10% Most Deprived in England | the 10% Least Deprived Areas in England |
| South West | 3.8% | 9.5% |
| South East | 2.3% | 21.1% |

Source: English Indices of Deprivation (2010)

## 2.5 Summary of Existing Problems Relevant to Onshore Oil and Gas Licensing

The following existing problems for the population topic have been identified:

- The growing population within the UK will increase population densities and, in-turn, the likelihood of communities being within close proximity to onshore oil and gas development. This will increase the likelihood of operations having, or being perceived to have, a negative impact on communities. This is likely put the oil and gas industry under increased scrutiny and pressure; and

- The local employment benefits of oil and gas development, and in particular hydraulic fracturing are under dispute. Although figures on employment increases are recognised in some sources, others consider that the specialist nature of shale gas operations will result in few local employment benefits. If local employment benefits are not realised than the perception of negative local impacts may outweigh the perception of positive impacts.

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## 2.6 Likely Evolution of the Baseline

### 2.6.1 UK

#### Demographics

The current UK population is generally increasing, and projected to reach 73.2 million by 2035 [31].

The age structure of the UK population is moving towards an ageing population: those of pensionable age are projected to increase by 28% from 2010 to 2035 (note that the pensionable age is to change over this period). Those aged between 15-64 years are projected to decrease from 62.1% to 60.5% of the population, whilst those under 16 are projected to decrease from 18.7% to 17.9% of the population by 2033

There are no formal targets for population growth in the UK. Immigration policy has shifted towards a points based system within an upper limit since 2011 [32] and this is likely to slow overall immigration to the UK.

#### Socio-Economic

There are current uncertainties over market conditions and a range of economic forecasts available indicate a number of future scenarios. The Bank of England recently noted that economic recovery in the UK remains weak and uneven. Despite a growth in domestic demand and employment in 2012, there was a pronounced fall in exports [33].

### 2.6.2 England

#### Demographics

Between 2010 and 2033, the population of England is projected to increase from 52.2 million to 62.1 million, an increase of 19.0% [34].

#### Socio-Economic

GVA for England in 2011 per head was £21,349. This was higher than the UK figure of £20,873 and almost 27% higher than the value for Northern Ireland.

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[31] ONS, National Population Projections 2010based, http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2010-based-projections/sum-2010-based-national-population-projections.html
[32] http://www.ukba.homeoffice.gov.uk/sitecontent/newsarticles/2011/april/07annual-limit-immigration

[33] Bank of England, Inflation Report 2013
http://www.bankofengland.co.uk/publications/Documents/inflationreport/2013/ir13mayo.pdf
[34] ONS, National Population Projections 2010based, http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2010-based-projections/sum-2010-based-national-population-projections.html

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### 2.6.3 Scotland

#### Demographic

Between 2010 and 2035, the population of Scotland is projected to increase from 5.2 to 5.8 million, an increase of 11.5% [35].

Scotland has a population target of matching the average European (EU15) population growth over the period from 2007 to 2017. Population growth in 2008 was slower than that of the EU 15 countries, and the gap in annual growth rates has increased [36].

#### Socio-Economic

Scottish GDP grew 0.5% during the fourth quarter of 2012. On an annual basis, comparing the latest quarter to the same period in the previous year, Scottish GDP grew 0.4% [37].

The key targets for Scotland in terms of economic development to 2017 are to:

- match the GDP growth rate of the small independent EU countries;
- raise Scotland's GDP growth rate to the UK level by 2011;
- rank in the top quartile for productivity amongst our key trading partners in the OECD;
- maintain the position on labour market participation as the top performing country in the UK and close the gap with the top 5 OECD economies;
- match average European (EU-15) population growth over the period from 2007 to 2017, supported by increased healthy life expectancy in Scotland over this period;
- increase overall income and the proportion of income earned by the three lowest income deciles as a group; and
- to narrow the gap in participation between Scotland's best and worst performing regions [38].

[35] ONS, National Population Projections 2010based, http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2010-based-projections/sum-2010-based-national-population-projections.html

[36] Scottish Government, http://www.scotland.gov.uk/About/scotPerforms/purposes/population
[37] Scottish Government Statistics, Key Economy Statistics.
[38] Scottish Government, Government Economic Strategy, http://www.scotland.gov.uk/Resource/Doc/202993/0054092.pdf

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## 2.6.4 Wales

### Demographic

The population of Wales is projected to increase to 3.3 million by 2035 (a 10% increase compared to 3 million in 2010). Although more births than deaths are projected throughout most of the projection period, net inward migration is the main reason for projected population growth [39].

### Socio-Economic

The longer term trend for the Index of Production for Wales shows a fall of 0.4% when comparing the four quarters until the end of 2012 to the four quarters of 2011. The fall over the longer term in Wales was largely accounted for by falls in computer and electronic products and transport equipment. The longer term trend for the Index of Construction for Wales shows a fall of 10.9% when comparing 2012 to 2011.

The sub-index Electricity, Gas and Water Supply accounts for 20.6% of the Welsh Index of Production under the 2009 weights. This sector has shown an increase in output for Wales over the longer term and a sharp increase over the short term, despite a fall in this sector in the UK [40].

For the four quarters to Q2 2010, the value of exports of goods from Wales fell by 15.6% on the previous four quarters and rose by 35.5% over 1999. Exports to EU countries accounted for 56% of the total in the latest four quarters, compared to 52% in the previous four quarters [41].

## 2.6.5 SEA Areas

### SEA Area 1: Scottish Midlands (including the Inner Forth)

The population in Scotland as a whole is projected to increase by 5.5% by 2020 (5,486,000 compared to 5,222,000 in 2010). By 2035 continued growth is expected with a projected increase of 10.2% compared to 2010, with a total population of 5,755,000 expected [42].

[39] ONS, National Population Projections 2010based, http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2010-based-projections/sum-2010-based-national-population-projections.html

[40] Welsh Government (2013) Index Production for Wales and Index of Construction for Wales Q3 2012 http://wales.gov.uk/docs/statistics/2013/130117index-production-construction-quarter-3-2012en.pdf

[41] Statistics for Wales, Key Economic Statistics, September 2010, http://wales.gov.uk/docs/statistics/2010/100917sb772010en.pdf

[42] General Register Office for Scotland (2011) Population projections of Scotland (2010 based)

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## SEA Area 2: West Midlands, North West England and Southern Scotland

The populations of West Midlands and North West England are expected to increase at a slower rate than England as a whole. However, considerable growth is still expected within these regions with a projected increase of 7% and 4% respectively by 2021 compared to 2011. Furthermore, although the growth in this region is less than expected for other regions, given that the population density in this region is currently higher than other regions at 681.37 people per square kilometre compared to a UK average of 260.7 people per square kilometre it will remain one of the more densely populated regions in the UK.

**Table 2.10 Population Change in West Midlands and North West England 2011 to 2021**

| Region | Population (thousands) | | % Population Change |
|---|---|---|---|
| | Mid 2011 | Mid 2021 | |
| West Midlands | 5,609 | 5,989 | 7% |
| North West England | 7,056 | 7,364 | 4% |
| England total | 53,107 | 57,688 | 8.6% |

Source: Interim 2011-based subnational population projections for England

## SEA Area 3: East Midlands and Eastern England

East England is expected to have the greatest population growth of all the regions outside of London with a projected increase of 10.2% expected by mid 2021 compared to population in mid 2011. The population of the East Midlands is also expected to increase significantly within the same time period (8.6%). Current population densities are low within this region compared to other areas in the UK (291.27 people per square kilometre compared to a UK average of 260.7). However, a faster than average increase in the East of England followed by a slower than average increase in densely populated areas, will narrow this gap.

**Table 2.11 Population Change in East Midlands and East of England 2011 to 2021**

| Region | Population (thousands) | | % Population Change |
|---|---|---|---|
| | Mid 2011 | Mid 2021 | |
| East Midlands | 4,537 | 4,928 | 8.6% |
| East of England | 5,862 | 6,458 | 10.2% |
| England total | 53,107 | 57,688 | 8.6% |

Source: Interim 2011-based subnational population projections for England

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### SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

The population in Wales as a whole is projected to increase by 5.5% by 2020 (5,486,000 compared to 5,222,000 in 2010). By 2035 continued growth is expected with a projected increase of 10.2% compared to 2010, with a total population of 5,755,000 expected [43].

### SEA Area 5: Southern and South West England

The South West and the South East of England are expected to increase at a similar rate to the rest of England. The South East will increase at a rate slightly faster than the England average (9.2% compared to 8.6%) whereas the South West will increase at a rate slightly slower than the England average (8.3%). Population densities within these regions are already high compared to other regions in the UK (492.1 people per square kilometre compared to 260.7 people per kilometre for the UK average) and this will continue to increase.

**Table 2.12 Population Change in the South West, South East and London 2011 to 2021**

| Region | Population (thousands) | | % Population Change |
|---|---|---|---|
| | Mid 2011 | Mid 2021 | |
| South West | 5,301 | 5,743 | 8.3% |
| South East | 8,653 | 9,453 | 9.2% |
| England total | 53,107 | 57,688 | 8.6% |

Source: Interim 2011-based subnational population projections for England

## 2.7 Assessing Significance

The objectives and guide questions related to population which have been identified for use in the appraisal of the effects of Licensing Plan proposals and alternatives are set out in **Table 2.13**, together with reasons for their selection.

**Table 2.13 Approach to Assessing the Effects of the Licensing Plan Proposals on Population**

| Objective/Guide Question | Reasoning |
|---|---|
| **Objective: Promote a strong, diverse and stable economy with opportunities for all; minimise disturbance to local communities and maximise positive social impacts.** | The Licensing Plan proposals could contribute to sustainable economic growth and positive social impacts within the community through the provision of jobs. |

[43] General Register Office for Scotland (2011) Population projections of Scotland (2010 based)

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| Objective/Guide Question | Reasoning |
|---|---|
| Will the activities that follow the licensing round affect the social infrastructure and amenities available to local communities? | Any development has the potential to impact on the local social infrastructure and amenities which could affect the quality of life of individuals in the community. |
| Will the activities that follow the licensing round affect local population demographics and/ or levels of deprivation in surrounding areas? | The Licensing Plan proposals may result in change to population demographics (e.g. – through in migration of workers skilled to work in the industry). Changes to local population demographics have the potential to impact on local economy and demand for community facilities such as healthcare, education and recreation. Changes to these factors may alter the levels of deprivation in the area. |
| Will the activities that follow the licensing round affect opportunities for investment, education and skills development? | Investment, education and skills development are vital for economic growth. |
| Will the activities that follow the licensing round affect the number or types of jobs available in local economies? | Affecting the number or type of jobs will have influences on the local economy and productivity. The majority of jobs within shale gas industry are highly skilled (e.g. – geologists and drilling experts) and this may have an influence on the types of jobs within the local area. |
| Will the activities that follow the licensing round affect how diverse and robust local economies are? | A diverse and robust economy is important to ensure economic growth, this is especially relevant given the uncertain nature of climate change and its potential impacts. |
| Will the activities that follow the licensing round affect the affordability of gas for households? | Affecting the price of gas could have an impact on household expenditure on energy bills which could impact on the affordability of heating homes and quality of life, especially for low income homes. |

**Table 2.14** sets out guidance that will be utilised during the assessment to help determine the relative significance of potential effects on the population objective. It should not be viewed as definitive or prescriptive; merely illustrative of the factors that may be considered as part of the assessment process.

**Table 2.14 Illustrative Guidance for the Assessment of Significance for Population**

| Effect | Description | Illustrative Guidance |
|---|---|---|
| ++ | Significant Positive | • Option will incorporate the provision of social infrastructure and amenities;<br>• Option will provide educational services/facilities and offer long term opportunities for skills development including, for example, apprenticeship schemes;<br>• Option will generate in excess of 4,400 full time equivalent (FTE) employment opportunities per annum[1], a large proportion of which will benefit the local community;<br>• Option will generate significant investment in local supply chains fostering economic growth, generating indirect employment opportunities and enhancing the robustness of the local economy (e.g. through the procurement of local contractors to undertake construction activities);<br>• Option will significantly enhance the attractiveness of the area to existing and prospective residents and businesses (e.g. through the generation of employment opportunities). |

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| Effect | Description | Illustrative Guidance |
|---|---|---|
| + | Minor Positive | • Option may stimulate limited investment in existing services and amenities (e.g. associated with any increase in the work place population);<br>• Option will provide some educational opportunities and skills development including, for example, apprenticeship schemes;<br>• Option will generate some full time equivalent (FTE) employment opportunities per annum which may benefit the local community;<br>• Option will generate limited investment in local supply chains (e.g. through the procurement of local contractors to undertake construction activities);<br>• Option will generate savings by reducing national public expenditure associated with afloat storage;<br>• Option will enhance the attractiveness of the area to existing and prospective residents and businesses (e.g. through the generation of employment opportunities and provision of infrastructure). |
| 0 | Neutral | • Option will not affect social infrastructure and amenities available to local communities;<br>• Option will not affect the provision of educational services/facilities or offer opportunities for skills development;<br>• Option will not affect any local employment opportunities/increase local unemployment rates;<br>• Option will have no effect on wider economic benefits/undermine the growth and diversity of the local economy;<br>• Option will not affect the attractiveness of the area to existing and prospective residents and businesses. |
| - | Minor Negative | • Option will cause some disruption to existing services and amenities available to local communities which is likely to be felt in the short term;<br>• Option will lead to a minor increase in local unemployment (e.g. due to the cessation of some activities or rationalisation of activities on sites);<br>• Option will reduce the resilience and diversity of the local economy (e.g. through loss of local supply chain opportunities);<br>• Option will reduce local investment in an area affect growth of local economy;<br>• Option will undermine the attractiveness of the area to existing and prospective residents and businesses (e.g. as due to impacts arising from construction activities or concerns regarding operational impacts of oil and gas development);<br>• Option will undermine the quality of life of the local population (e.g. due to noise and vibration associated with HGV movements during construction or operation) such that some complaints could be expected. |
| -- | Significant Negative | • Option will result in the loss of existing services and amenities available to local communities (e.g. where development is proposed on a site in community use);<br>• Option will lead to a significant and sustained increase in local unemployment (e.g. due to the closure of sites);<br>• Option will significantly reduce the resilience and diversity of the local economy (e.g. through significant loss of local contracts and supply chain opportunities);<br>• Option will lead to a significant reduction in investment in an area that will affect the growth of local economy (e.g. directly through substantial reduction is sites and activities, and indirectly through causing businesses to relocate out of the area);<br>• Option will significantly undermine the attractiveness of the area to existing and prospective residents and businesses (e.g. as due to impacts arising from construction activities or concerns regarding the operational impacts of oil and gas development);<br>• Option will seriously undermine the quality of life of the local population (e.g. due to noise and vibration associated with HGV movements during construction or operation of facilities) such that the project and Local Authority would be likely to experience a considerable number of complaints. |

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| Effect | Description | Illustrative Guidance |
|---|---|---|
| ? | Uncertain | • From the level of information available the impact that the option would have on this objective is uncertain. |

[1] The proposed threshold of significance represents 1% of total existing jobs supported by the oil and gas industry in the UK.

## 2.8 Assessment of Effects

This section comprises the assessment of the potential activities that could follow on from the licensing round on the Population objective. There are a total of six main stages of oil and gas exploration and production (including gas storage) that are the subject of the assessment. These are highlighted in **Table 2.15** for both conventional and unconventional oil and gas together with an overview of the associated key activities at each stage. Please note that Stages 1, 2 and 4 do not necessarily apply to gas storage, depending on the development history of the particular site.

**Table 2.15 Oil and Gas Exploration and Production Lifecycle and Key Activities**

| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| 1. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. |
| 2. | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring.* | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. |
| 3. | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring* | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. |

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| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| 4. | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring.* | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. |
| 5. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. |
| 6. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. |

Note: Exploration wells most usually move from Stage 2 to Stage 5 though some may be used for long-term production testing (which would require new consents including planning permission) and some may be retained and their sites redeveloped as a production project (this would also require new consents including planning permission). For the purposes of this assessment, the appraisal stage (a term commonly used in industry) spans Stages 2 and 3.

*Conventional oil and gas exploration and production activities (stages 2 to 4 above) can occasionally include hydraulic fracturing. However, the need to undertake hydraulic fracturing is relatively uncommon and has therefore not been considered in the assessment of conventional oil and gas activities as part of this SEA.

### 2.8.1 Conventional Oil and Gas

The assessment of the six main stages of conventional oil and gas production is contained in **Table 2.16**. The first two columns describe the exploration and production stage. The third and fourth columns summarise the expected effects on the population objective for both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report). The rationale for this relationship is explained in more detail in the final column and includes:

- the nature and scale of the potential effects on the population objective;
- when the effect could occur (timing) and its degree of permanence;
- what mitigation measures might be appropriate for potentially significant negative effects on the population objective;
- what options there are to enhance positive effects; and
- assumptions and uncertainties that underpin the assessment.

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**Table 2.16 Assessment of Effects: Conventional Oil and Gas**

| **Objective 2 : Population** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>Site identification, selection and characterisation and the securing of necessary development and operating permits are not expected to generate local employment opportunities.<br>Seismic surveys are expected to provide some work for specialist roles, such as surveyors and geologists. However, this work is likely to provide short term contracts rather than FTE positions. This in addition to the specialist nature of the work means that stage 1 is not expected to result in local employment opportunities and therefore has a neutral effect on this objective.<br>There may be an increase in vehicular movements to conduct the seismic surveys but this is expected to be very small scale and therefore is not expected to have an impact on the quality of life for populations surrounding road networks.<br>**Low and High Activity Scenarios:**<br>It can be reasonably assumed that under the high activity scenario, there would be more survey work; however, it is still at a modest scale and therefore it is unlikely that the additional survey work would translate into any additional employment opportunities and therefore a neutral effect would be expected on the objective.<br>**Mitigation:**<br>• Any opportunities to employ local contractors to carry out the seismic surveys should be identified. Although due consideration and adherence to local employment legislation is required (i.e. – no discrimination on any ground).<br>**Assumptions:**<br>• It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>**Uncertainties:**<br>• None identified. |

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 2 | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring. | **+/-** | **+/-** | **Assessment of Effects:**<br>Activities associated with pad preparation are expected to generate construction jobs in the short term. Depending on the location of the site, there may be a need to construct road connections or enhancements to existing road networks which would generate further construction jobs. The potential for these jobs to directly benefit the local community would depend on the balance between skilled and unskilled construction posts required and the availability of individuals in the local labour market with those skills and relevant experience. It would also depend on the recruitment policies of the contractors to undertake the work and unless clear contract direction was given to ensure that member of the local community were given preference, the temporary construction employment opportunities created may not benefit the local community to any substantial extent.<br>Well design, construction, completion and testing will generate more specialist oil and gas jobs which are highly skilled (such as geologists/geophysicists, drillers, mudloggers and engineers). Currently the UK oil and gas sector is predominately offshore and supports some 440,000 jobs (32,000 of these jobs are directly employed by oil and gas companies and major suppliers)[44]. It is considered that many of these skills could be transferrable to onshore. Therefore, given the scale of current industry compared to scale expected (a maximum of 30 boreholes drilled) it is assumed that the UK industry could support conventional oil and gas scenarios. The potential for these jobs to benefit local employment will depend on the availability of individuals in the local labour market with the necessary skills.<br>There may be potential to ensure training opportunities (e.g. – apprenticeship schemes) for the benefit of the local community and to address any skills gaps. This would require collaboration with local training providers and support from the National Apprenticeship Services (NAS).<br>The scale of work is such there may be some indirect jobs generated within the supply chain (e.g. – metal manufacturers, manufacturers of drilling equipment). However, this is not certain and at this scale it is quite likely that demand may be meet through imports of equipment from abroad (e.g. – the US).<br>Overall, stage 2 will generate some FTE posts within the local area but given that the scale of work expected under conventional oil and gas is small and temporary (4-5 weeks per well for drilling) and the uncertainty as to whether this will generate local employment, this will not be significant. |

[44] Oil & Gas UK (2012) Economic Report: Summary & Key Facts http://www.oilandgasuk.co.uk/cmsfiles/modules/publications/pdfs/EC029.pdf [Accessed September 2013]

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Depending on the location and proximity of local populations, there may be a negative effect on quality of life from construction and drilling activities (e.g. – noise, vibration and air quality). However, provided regulatory construction requirements are followed this is not expected to have an adverse impact on local communities.<br><br>Vehicular movements will be required to transport materials to and from the site during each of the activities under this stage. It is estimated that stage 2 will generate some 6-7 vehicle movements a day. This may be noticeable in residential and rural areas and therefore could have an adverse impact on quality of life for the local community (e.g. – through noise, vibration or increased traffic congestion on roads). However, given the short term nature of the work (7-8 weeks), this is not expected to be significant.<br><br>It is not expected that the activities under this stage would incorporate the provision of new community facilities/amenities and temporary job activities related to construction activities would be of a sufficient scale to warrant investment in additional services or facilities for leisure, recreation, education, health etc.<br><br>**Low and High Activity Scenarios:**<br><br>The total number of boreholes is 6 times greater under the high activity than low activity scenario (30 compared to 5). Depending on the phasing of exploratory drilling, this may result in an short term increase in total number of jobs (if a high number of boreholes were to be drilled at the same time) or sustaining a similar number of jobs for a longer period of time (if the drilling of boreholes was to be spread over a longer period of time). In either case, given that the total number of boreholes in the high activity scenario is still modest it is fairly unlikely that there will be more than one borehole being drilled within the same local area at the same time. Therefore, the likelihood of cumulative effects leading to more jobs within a local area is low (although could occur at county or regional level).<br><br>Given that it is assumed that there will be a distance of greater than 5km between well pad sites, it is not expected that there will be negative cumulative impacts on local community quality of life through generation of noise, dust and vibrations during construction or construction related HGV movements.<br><br>**Mitigation:**<br><br>• Any opportunities to employ local contractors or individuals for works or for the use of local materials and suppliers should be identified. Although due consideration and adherence to local employment legislation is required (i.e. – no discrimination on any ground);<br><br>• Any increase in demand for services and accommodation arising from the works and its potential effect on the existing community should be considered carefully; |

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Licensee to provide training opportunities to local community[45];<br>• Adopt HGV routing which seeks to avoid residential areas.<br>**Assumptions:**<br>• It can be reasonably assumed that the scale of construction work undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed);<br>• Drilling process is expected to last 4-5 weeks per well and last for 24 hours a day.[46];<br>• There will be a minimum distance of 5km between well pad sites;<br>• It is estimated that stage 2 conventional oil and gas will generate approximately 6-7 vehicle movements a day for a duration of 7-8 weeks.[47]<br>**Uncertainties:**<br>The location of the well pad sites is not known, therefore the proximity to local residents and the existing skill/labour availability within the local workforce is unknown. |
| 3 | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring. | **+/-** | **+/-** | **Assessment of Effects:**<br>The majority of activities associated with stage 3 (i.e. - pad preparation and well construction) are expected to be largely similar to stage 2. In addition to the activities in stage 2, there would be the need for provision of pipeline connections, construction of facilities and the size of the well pad would increase from 1 hectare to 2-3hectares. These factors would generate additional construction jobs. Given that it is expected that there will be 2 wells per well pad and the first well will have been constructed and completed in stage 2 it is expected that the number of specialist oil and gas jobs (including drillers, engineers and geologists) will be similar as under stage 2.<br>In the same way as stage 2, the potential for these jobs to directly benefit the local community would depend on the balance between skilled and unskilled construction/oil and gas posts required and the availability of individuals in the local labour market with those skills and relevant experience. It would also depend on the recruitment policies of the contractors to undertake the work and unless clear contract direction was given to ensure that member of the local community were given preference, the temporary |

[45] Under the model licensing conditions of the PEDL the licensee may be required by DECC to provide training to the local community.

[46] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

[47] For further information on how vehicle movement figures were estimated please refer to Table 4.9 in the main report

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | employment opportunities created may not benefit the local community to any substantial extent.<br>There may be potential to ensure training opportunities (e.g. – apprenticeship schemes) for the benefit of the local community. This would require collaboration with local training providers and support from the National Apprenticeship Services (NAS).<br>Overall, the total number of well pad sites and wells expected under conventional oil and gas is small (maximum of 12 wells) therefore it is not expected to generate a significant total number of jobs on a UK level. Furthermore, the scale of jobs is not expected to generate many indirect (through the supply chain) or induced jobs.<br>Depending on the location and proximity of local populations, there may be a negative effect on quality of life from construction and drilling activities (e.g. – noise, vibration and air quality). However, provided regulatory construction requirements are followed this is not expected to have an adverse impact on local communities.<br>Vehicular movements will be required to transport materials to and from the site during each of the activities under this stage. It is estimated that this would be of the scale 5-6 vehicle movements a day. This may have an adverse impact on quality of life for the local community within residential or rural areas (e.g. – through noise, vibration or increased traffic congestion on roads). However, given the short term nature of the work (7-8 weeks), this is not expected to be significant.<br>It is not expected that the activities under this stage would incorporate the provision of new community facilities/amenities and temporary job activities related to construction activities would be of a sufficient scale to warrant investment in additional services or facilities for leisure, recreation, education, health etc.<br>**Low and High Activity Scenarios:**<br>The total number of well pad sites is twice as high under high activity scenario. Therefore the total number of jobs generated at the UK level will be greater. However, given that the total number of well pad sites in the high activity scenario is still low (6) it is fairly unlikely that there will be more than one well pad site within the same local area. Therefore, the likelihood of cumulative effects leading to more jobs within a local area is low (although could occur at county or regional level).<br>Given that it is assumed that there will be a distance of greater than 5km between well pad sites, it is not expected that there will be negative cumulative impacts on local community quality of life through generation of noise, dust and vibrations during construction or construction related HGV movements.<br>**Mitigation:**<br>• Any opportunities to employ local contractors or individuals for works or for the use of local materials and suppliers should be identified. Although due consideration and adherence to local employment legislation is required (i.e. – no discrimination on any ground). |

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Any increase in demand for services and accommodation arising from the works and its potential effect on the existing community should be considered carefully.<br>• Adopt HGV routing which seeks to avoid residential areas.<br>• Licensee to provide training opportunities to local community[48]<br>**Assumptions:**<br>• It can be reasonably assumed that the scale of construction and oil and gas work undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>• Drilling process is expected to last 4-5 weeks per well and last for 24 hours a day.[49]<br>• During this stage it is estimated that there will be approximately 5-6 vehicle movements a day across the 7-8 weeks.[50]<br>**Uncertainties:**<br>• The location of the well pad sites is not known, therefore the proximity to local residents and the existing skill/labour availability within the local workforce is unknown. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>A small number of FTEs will be required for routine and scheduled maintenance and also to respond to any emerging issues. This is expected to be very small scale (2 FTEs per 5 wells) and therefore is expected to have a neutral effect on this objective.<br>Given the moderate number of wells under conventional oil and gas scenarios the volumes of oil/gas produced is not expected to be enough to have an impact on gas prices. Therefore a neutral effect is expected on affordability of gas for households and businesses.<br>**Low and High Activity Scenarios:**<br>The total number of wells under the high activity scenario is twice as high as under the low activity scenario. Therefore, it is considered that more maintenance jobs will be generated at the UK level. However, given the very small number of staff required per well this is still considered to be a neutral effect. |

[48] Under the model licensing conditions of the PEDL the licensee may be required by DECC to provide training to the local community.

[49] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

[50] For further information on how vehicle movement figures were estimated please refer to Table 4.9 in the main report

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Furthermore, the production of oil/gas is expected to be double under the high activity scenario. However, the scale is still too slight to have any substantial impact on energy prices.<br>**Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• Two FTE for each wells will be required for maintenance activities[51].<br>**Uncertainties**<br>• None identified. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **+/-** | **+/-** | **Assessment of Effects:**<br>Decommissioning is expected to generate employment opportunities for the duration of the works although the number of opportunities created is currently uncertain. However, the scale of work expected and the temporary nature of work expected mean the generation of jobs is not expected to be significant.<br>The potential for these jobs to directly benefit the local community would depend on the balance between skilled and unskilled posts required and the availability of individuals in the local labour market with those skills and relevant experience. It would also depend on the recruitment policies of the contractors employed to undertake the work and unless clear contract direction was given to ensure that members of the local community were given preference, the temporary employment opportunities created through the decommissioning phase may not benefit the local community to any substantial extent.<br>Depending on the location and proximity of local populations, there may be a negative effect on quality of life from construction and drilling activities (e.g. – noise, vibration and air quality). However, provided regulatory construction requirements are followed this is not expected to have an adverse impact on local communities.<br>Vehicular movements will be required to transport materials to and from the site during each of the activities under this stage. The total number of movements is unknown, however, it is assumed likely to be of a smaller scale than that in stage 2 (given that there will be no drilling activities or associated vehicle movements). This may have an adverse impact on quality of life for the local community within residential or rural areas if located in along the transport route (e.g. – through noise, vibration or increased traffic congestion on roads). However, given the short term nature of the work this is not expected to be significant. |

[51] Regeneris Consulting (2011) Economic Impact of Shale Gas Exploration and Production in Lancashire & the UK http://www.shalegas-europe.eu/en/index.php/resources/library/economic-impact/39-economic-impact-of-shale-gas-exploration-production-in-lancashire-and-the-uk [Accessed September 2013]

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Low and High Activity Scenarios:**<br>The total number of well pad sites under the high activity scenario is twice as high as under the low activity scenario. Therefore, it is considered that more jobs will be generated during the decommissioning of these sites.<br>However, given that the total number of well pad sites in the high activity scenario is still low (6) it is fairly unlikely that there will be more than one well pad site within the same local area. Therefore, the likelihood of cumulative effects leading to more jobs within a local area is low (although could occur at county or regional level).<br>Given that it is assumed that there will be a distance of greater than 5km between well pad sites, it is not expected that there will be negative cumulative impacts on local community quality of life through generation of noise, dust and vibrations during construction or construction related HGV movements.<br>**Mitigation:**<br>• Any opportunities to employ local contractors or individuals for works or for the use of local materials and suppliers should be identified. Although due consideration and adherence to local employment legislation is required (i.e. – no discrimination on any ground).<br>• Any increase in demand for services and accommodation arising from the works and its potential effect on the existing community should be considered carefully.<br>• Adopt HGV routing which seeks to avoid residential areas<br>**Assumptions:**<br>• It can be reasonably assumed that the scale of construction and oil and gas work undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>**Uncertainties:**<br>• The location of the well pad sites is not known, therefore the proximity to local residents and the existing skill/labour availability within the local workforce is unknown. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0/+** | **0/+** | **Assessment of Effects:**<br>Site restoration and relinquishment is expected to generate a number of remediation and restoration jobs. The number of jobs will depend on the level of contamination on site. However, this is not expected to be significant.<br>There may also be an increase in vehicular movements to conduct surveys and for restoration but this is expected to be small scale and therefore is not expected to have an effect on this objective. |

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## Objective 2 : Population

| *Stage* | *Description* | *Score* | | *Commentary* |
|---|---|---|---|---|
| | | *Low Activity Scenario* | *High Activity Scenario* | |
| | | | | **Low and High Activity Scenarios:**<br>It can be reasonably assumed that under the high activity scenario, there would be restoration and survey work required and therefore a higher number of jobs associated with carrying out the work. However these jobs would be still be of a minor scale and therefore a neutral effect would be expected on this objective.<br>**Mitigation:**<br>• Adopt HGV routing which seeks to avoid residential areas.<br>**Assumptions:**<br>• It can be reasonably assumed that the scale of work associated with site restoration and relinquishment undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>**Uncertainties:**<br>• The level of restoration and reclamation required will differ per site therefore is it difficult to determine the level of activity required with any certainty. |

### *Summary*

Stages 2, 3 and 5 are expected to have a mixed positive and negative effect on this objective. In Stage 2 and 3 activities associated with pad preparation will generate construction jobs, and well design, construction, completion and testing activities will generate specialist oil and gas jobs (such as geologists and engineers). The transport of materials to and from site during Stages 2 and 3 is expected to generate vehicle movements (of a scale 5-7 movements a day). There is potential for this to have an adverse impact on the quality of life for communities along the transport route through the generation of noise, vibration and noise pollution. However, the moderate scale of work required (a maximum of 30 boreholes/6 well pad sites) and the temporary nature of work (approximately 7-8 weeks per stage) mean that neither positive nor negative effects are expected to be significant.

Stage 5 also has a mixed minor positive and negative score due to the temporary generation of jobs and vehicle movements associated with decommissioning activities; albeit the scale of both of these is less than under Stages 2 and 3. Stage 6 may generate some remediation/restoration jobs but this is expected to be minor resulting in a neutral/minor positive score.

Stages 1 and 4 are not expected to have an effect on population.

**Mitigation Summary**

- Any opportunities to employ local contractors or individuals for works or for the use of local materials and suppliers should be identified. Although due consideration and adherence to local employment legislation is required (i.e. – no discrimination on any ground).
- Any increase in demand for services and accommodation arising from the works and its potential effect on the existing community should be considered carefully.
- Adopt HGV routing which seeks to avoid residential areas.

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

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## 2.8.2 Unconventional Oil and Gas

The assessment of the six main stages of unconventional oil and gas production is contained in **Table 2.17** under both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report).

**Table 2.17 Assessment of Effects: Unconventional Oil and Gas**

| **Objective 2 : Population** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0/+** | **+** | **Assessment of Effects:**<br>The type of activities under stage 1 are expected to be the same under unconventional as conventional oil and gas. Given the greater number of well sites expected under unconventional oil and gas it can reasonably be expected that there will be a greater volume of work associated with site identification, securing relevant permits and seismic surveys. This may result in a small number of specialist FTE positions in the short term<br>There may be an increase in vehicular movements to conduct the seismic surveys but this is expected to be very small scale and therefore is not expected to have an impact on the quality of life for populations surrounding road networks.<br>**Low and High Activity Scenarios:**<br>It can be reasonably assumed that under the high activity scenario, there would be more survey work and therefore a higher number of jobs associated with carrying out the work. It is expected that the scale of jobs created under the high activity scenario will have a positive effect on this objective whereas it is expected that under the low activity scenario that there will be a neutral or a minor positive effect.<br>**Mitigation:**<br>• Any opportunities to employ local contractors to carry out the seismic surveys should be identified. Although due consideration and adherence to local employment legislation is required (i.e. – no discrimination on any ground).<br>**Assumptions:**<br>• It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>**Uncertainties:**<br>• None identified. |
| 2 | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion; | **+/-** | **+/-** | **Assessment of Effects:**<br>The scale and magnitude of effects associated with Stage 2 of the unconventional oil and gas exploration and production lifecycle will be greater than under conventional oil and gas. This is due to the additional activity expected; i.e. - the need for hydraulic fracturing as well as a greater number of boreholes and depth of each well. |

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • Hydraulic fracturing;<br>• Well testing including flaring. | | | This will lead to the generation of more construction jobs associated with pad preparation, provision of road connections and well construction. It will also lead to a greater number of oil and gas specific jobs in well completion, hydraulic fracturing and testing.<br>In addition to direct jobs, there will be generation of indirect jobs within the supply chain (e.g. – drilling equipment manufacturers and leases) and jobs induced via expenditure of employed staff (mostly expected within the accommodation and service sectors).<br>The potential for these jobs to directly benefit the local community would depend on the balance between skilled and unskilled construction and oil and gas posts required and the availability of individuals in the local labour market with those skills and relevant experience. It is uncertain what proportion of jobs generated will be within the UK or the local area. In existing examples within the UK (e.g. – Preese Hill Lancashire) around 15% of jobs were sourced from within the local area, resulting from a number of the more localised contracts (pad preparation, security, some haulage activities etc) and the extensive hotel and related expenditure on visiting workers. In the example considered, some 17% of expenditure is shown to be deployed on Lancashire workers/suppliers, with a third going overseas. This leakage overseas is due to mainly drilling and fracturing equipment and some specialist staff being sourced from abroad (mostly the US).[51] It is possible that a considerable scale of activity of could result in significant migration of workers to the UK/local area from abroad (but this is not certain).<br>There may be potential to ensure training opportunities (e.g. – apprenticeship schemes) for the benefit of the local community. This would require collaboration with local training providers and support from the National Apprenticeship Services (NAS). A large scale skills action plan could be developed through collaboration with government and industry as recently implemented within the nuclear sector.<br>Overall, the total number of direct jobs (within construction and oil/gas sectors), indirect jobs (within the supply chain) and induced jobs (from increased expenditure) is expected to have a positive impact on local communities through the provision of work. However, due to the overall scale and temporary nature of the work as well the uncertainty as to whether these jobs will be sourced from the local area, this is not expected to be significant.<br>It is not expected that the activities under this stage would incorporate the provision of new community facilities/amenities and temporary job activities related to construction activities would be of a sufficient scale to warrant investment in additional services or facilities for leisure, recreation, education, health etc.<br>Depending on the location and proximity of local populations, there may be a negative effect on quality of life from construction and drilling activities (e.g. – noise, vibration and air quality). However, provided regulatory construction requirements are followed this is not expected to have an adverse impact on local communities. |

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Should activities take place at or in close proximity to popular tourist destinations then there could be the potential for disturbance to visitors which, allied with any negative perceptions of unconventional oil and gas exploration and production, may have an adverse impact on the visitor economy. However, provided regulatory construction requirements are followed this stage is not expected to result in unacceptable levels of disturbance to visitors. Further, it would be expected that any adverse impact on visitor perception would be minor given the dispersed nature of the activities and be felt in the short term only as the extent of any negative perceptions are likely to reduce over time. In consequence, Stage 2 is not expected to have a significant negative effect on the visitor economy.<br>Vehicular movements will be required to transport materials to and from the site during each of the activities under this stage, especially related to the provision of water for hydraulic fracturing. It is estimated that approximately 14-36 vehicle movements a day will be generated over a 12-13 week period. This scale of movement may have an adverse impact on traffic congestion, noise or air quality depending on existing roads, traffic and air quality. There is potential for this to have a noticeable impact for rural communities or communities directly adjacent to minor roads during this period. However, given that these movements are temporary this is not expected to have a significant effect.<br>**Low and High Activity Scenarios:**<br>The total number of drilled boreholes is expected to be significantly greater under the high activity scenario. This will result in the generation of more direct, indirect and induced jobs. In addition, the likelihood of having more than one well pad site within close proximity will be greater. Therefore there is potential for cumulative positive impacts to occur if more than one site employs workers from the local area.<br>Given that well pad sites are assumed to be more than 5km apart it is assumed that the potential for cumulative negative impacts on local community quality of life as a result of construction activities and HGV movements will be low (from increased congestion and noise, dust, vibrations).<br>**Mitigation:**<br>• Any opportunities to employ local contractors or individuals for works or for the use of local materials and suppliers should be identified. Although due consideration and adherence to local employment legislation is required (i.e. – no discrimination on any ground)<br>• Any increase in demand for services and accommodation arising from the works and its potential effect on the existing community should be considered carefully.<br>• Adopt HGV routing which seeks to avoid residential areas.<br>• Government should work together with industry to develop a skills and supply chainaction plan for shale gas (similar to the Nuclear Supply Chain Action Plan). |

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | A body could be set up as a focal point for skills in this field (similar to OPITO for offshore oil and gas in UK).[52]<br>• Development of real-time data on upcoming shale gas projects would help the supply chain to plan ahead (similar to Project Pathfinder on offshore oil and gas in UK).[52]<br>• Licensee to provide training opportunities to local community.[53]<br>**Assumptions:**<br>• It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>• Drilling process is expected to last 4-5 weeks per well and last for 24 hours a day.[54]<br>• Licensee to provide training opportunities to local community[55]<br>• Stage 2 is estimated to generate approximately 14-36 vehicle movements a day over a 12-13 week period.[56]<br>**Uncertainties:**<br>• The proportion of jobs that will be generated within the UK is uncertain. Estimates range from 33% leakage overseas (based on current example test site at Preese Hall) to 5% leakage overseas (if current suppliers and labourers were to migrate to the UK).[51]<br>• The proportion of jobs generated that will be within the local area is also uncertain. Estimates range from 17% (based on current example test site at Preese Hall) to more than 70% (based on in-migration to the local area).[51]<br>• The location of the well pad sites is not known, therefore the proximity to local residents and the existing skill/labour availability within the local workforce is unknown.<br>• The phasing of well site development is unknown. This will affect the phasing of jobs. |

[52] As recommended in IoD (2013): Getting Shale Gas Working http://www.iod.com/influencing/policy-papers/infrastructure/infrastructure-for-business-getting-shale-gas-working [Accessed September 2013]

[53] Under the model licensing conditions of the PEDL the licensee may be required by DECC to provide training to the local community.

[54] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

[55] Under the model licensing conditions of the PEDL the licensee may be required by DECC to provide training to the local community.

[56] For further information on how vehicle movement figures were estimated please refer to table 4.9 in the main report

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 3 | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. | **+/-** | **++/-/--** | **Assessment of Effects:**<br>The majority of activities associated with stage 3 (i.e. - pad preparation and well construction) are expected to be largely similar to stage 2. However, the scale, magnitude and duration of effects at this stage is expected to be significantly greater due to the need to drill more wells. In addition, there would be the need for provision of pipeline connections and facilities which would generate additional construction jobs. This would also lead to a greater number of indirect jobs within the supply chain and induced jobs when compared to stage 2.<br>The total number of jobs that will be generated is uncertain and will depend on the phasing of construction of wells. It is expected that there will be an increase in the number of wells constructed each year, until a peak is reached when up 180-360 wells are constructed within a year, which may last several years, and then the number of wells constructed will decrease. The number of jobs generated will follow a similar pattern. At years of peak activity, approximately 16,000-32,000 of FTEs may be generated across the UK under the high activity scenario (including direct, indirect and induced jobs).[57] This peak is anticipated to be reached after 5 years and would last 4 years and will then decrease as fewer wells are constructed.<br>The potential for these jobs to directly benefit the local community would depend on the balance between skilled and unskilled construction and oil and gas posts required and the availability of individuals in the local labour market with those skills and relevant experience. It is uncertain what proportion of jobs generated will be within the UK or the local area. In existing examples within the UK (e.g. – Preese Hill Lancashire) around 15% of jobs were sourced from within the local area.[51] It is possible that a considerable volume of could result in significant migration of workers to the UK/local area from abroad (but this is not certain).<br>There may be potential to ensure training opportunities (e.g. – apprenticeship schemes) for the benefit of the local community. This would require collaboration with local training providers and support from the National Apprenticeship Services (NAS). A large scale skills action plan could be developed as recently implemented within the nuclear sector.<br>The scale of construction work and associated movement of HGVs will be considerably greater under stage 3 compared to stage 2. As a result, depending on the proximity to sensitive sites, likelihood/magnitude of negative impact on quality of life will be greater (through the generation of noise, dust and vibrations).<br>Vehicular movements will be required to transport materials to and from the site during each of the activities under this stage, especially related to the provision of water for hydraulic fracturing. |

[57] It is recognised that this is considerably less than the 74,000 jobs estimated in the IoD (2013): Getting Shale Gas Working Report, however, it is based on a different phasing of wells and refers to FTEs as opposed to jobs.

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Overall it is estimated that there will be approximately 16-51 vehicle movements to the site each day during stage 3 over a 32-145 week period[58], depending on the activity scenario. This scale of movement may have an adverse impact on traffic congestion, noise or air quality depending on existing roads, traffic and air quality. There is potential for this to have a sustained and locally significant effect on rural communities or communities directly adjacent to minor roads during this period. However, potentially adverse effects can be expected to be mitigated by regulatory and planning controls, which could cover the development of a transport plan, the scheduling, timing and frequency of movements, speed restrictions and the use of alternative routes to and from the site. For urban areas and communities adjacent to major roads, and at a regional or national level, these effects from increased vehicle movements are not expected to be significant.<br><br>Under the UKOOG Community Engagement Charter, benefits from shale gas exploration and production would be provided to host local communities and county/unitary authorities in the form of an initial community contribution of £100,000 per well pad where hydraulic fracturing takes place.<br><br>**Low and High Activity Scenarios:**<br><br>Under the low activity scenario the total number of jobs (including direct, indirect and induced) that could be generated at peak production is estimated at approximately 2,600-5,300 FTEs. However, this is scale of job generation is only expected to last for the short term (2-3 years) and will then decrease as the construction of wells decreases.[59]<br><br>Under the high activity scenario at peak some 16,000-32,000 FTE positions (including direct, indirect and induced jobs) are estimated to be generated. This would have a significant impact on employment in the UK oil and gas sector and would represent an increase in jobs of 7%, although the benefit this would have on local employment will highly depend on the location of the site and the local skills of the workforce. The peak period of activity is expected to last for 4 years.[59]<br><br>The likelihood of having more than one well pad site within close proximity to another will be greater under the high activity scenario. Therefore there is potential for cumulative positive impacts to occur if more than one site employs workers from the local area.<br><br>Under the low and high activity scenarios it is expected that total UK community contributions under the UKOOG Community Engagement Charter could be between £3,000,000 and £12,000,000. |

[58] For further information on how vehicle movement figures were estimated please refer to Table 4.9 in the main report

[59] For further information on how employment figures are estimated please refer to Tables 4.7 and 4.8 in the main report

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Under the high activity scenario, vehicle movements could range from 16-51 HGV movements per day per pad over a 73-145 week period. Actual vehicle movements will depend on a number of factors including: the number of wells drilled and their phasing; the volumes of water needed; how water is sourced and whether it is tankered to the site; the volumes of waste and wastewater generated; the methods of waste treatment; and the extent to which treatment occurs on or off site. The additional vehicle movements could lead to congestion on local roads that lead to the site, depending on site access, timing and existing traffic flows. Increases in vehicle movement could generate emissions and dust potentially affecting those with respiratory problems as well as noise and vibrations which may cause stress/anxiety to residents principally alongside local transport corridors within rural areas. The effects on the local community could be significant but will be highly dependent on the location of sites, the frequency, timing and routing of HGV movements, the proximity to sensitive receptors, existing levels of noise/air pollutants and prevailing health issues. The potentially adverse effects can be expected to be mitigated by regulatory and planning controls, which could cover the development of a transport plan, the scheduling, timing and frequency of movements, speed restrictions and the use of alternative routes to and from the site. For urban areas and communities adjacent to major roads, and at a regional or national level, these effects from increased vehicle movements are not expected to be significant.<br>**Mitigation:**<br>• Any opportunities to employ local contractors or individuals for works or for the use of local materials and suppliers should be identified. Although due consideration and adherence to local employment legislation is required (i.e. – no discrimination on any ground)<br>• Any increase in demand for services and accommodation arising from the works and its potential effect on the existing community should be considered carefully.<br>• Adopt HGV routing which seeks to avoid residential areas.<br>• Government should work together with industry to develop a skills action plan for shale gas (similar to the Nuclear Supply Chain Action Plan). A body could be set up as a focal point for skills in this field (similar to OPITO for offshore oil and gas in UK).[60]<br>• Development of real-time data on upcoming shale gas projects would help the supply chain to plan ahead (similar to Project Pathfinder on offshore oil and gas in UK).[52] |

[60] As recommended in IoD (2013): Getting Shale Gas Working http://www.iod.com/influencing/policy-papers/infrastructure/infrastructure-for-business-getting-shale-gas-working [Accessed September 2013]

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Assumptions:**<br>• It can be reasonably assumed that the scale of construction work undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>• Benefits of £100,000 per well site (where hydraulic fracturing takes place) will be provided to local communities at the exploration/appraisal stage under the UK OOG Community Engagement Charter.<br>• Stage 3 is estimated to generate 16-51 vehicle movements a day over a 73-145 week period (depending on activity scenario). [61]<br>• Costs per well range from £5m per well[62] to approximately £10.4m per well.[63] Assumed value of £8.9m per well, consistent with Regeneris report[53].<br>• Under the low activity scenario assume that all wells will be operational by the end of year 9. Assume a maximum of 5 well pad sites to be constructed within one year, resulting in completion of 30-50 wells.<br>• Under the high activity scenario assume that all wells will be operational by the end of year 12. Assume a maximum of 15 well pad sites to be constructed within one year, resulting in completion of 180-360 wells.<br>• Assume approximately 38 direct jobs generated per well.[64]<br>**Uncertainties:**<br>• The proportion of jobs that will be generated within the UK is uncertain. Estimates range from 33% leakage overseas (based on current example test site at Preese Hall) to 5% leakage overseas (if current suppliers and labourers were to migrate to the UK).[51]<br>• The proportion of jobs generated that will be within the local area is also uncertain. Estimates range from 17% (based on current example test site at Preese Hall) to more than 70% (based on in-migration to the local area).[51] |

[61] For further information on how vehicle movement figures were estimated please refer to Table 4.9 in the main report

[62] Based on lower range of drilling costs per lateral used with IoD (2013) Report, originally from Bloombery New Energy Finance statistics

[63] Based on £8,970,000 cost quoted in scenarios used in Regeneris (2011) Economic Impact of Shale Gas Exploration & Production in Lancashire and the UK

[64] For more information on the calculation of number of jobs refer to Table 4.7 in the main report

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Any values provided on the number of jobs generated are for indicative purposes only as they are based on a number of uncertain assumptions (for example phasing of well development, proportion of jobs within the UK).<br>• The phasing of well site development may alter from that assumed. This would have an impact on the phasing of jobs.<br>• The location of the well pad sites is not known, therefore the proximity to local residents and the existing skill/labour availability within the local workforce is unknown. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | **+/-** | **++/-** | **Assessment of Effects:**<br>A small number of FTEs will be required for routine and scheduled maintenance and also to respond to any emerging issues. However, this is expected to be very small scale (2 FTEs per 5 wells).<br>It is expected that each well will need to be re-fractured once during its 20 year production lifetime. This would provide some work for specialised positions. However, this will be temporary (as each well can be fractured within approximately 3 days). Re-fracturing would also result in the need for HGV movements to deliver water and chemicals to site. The number of vehicles per day is uncertain (due to the difficulty in predicting the duration of movements of water to site for fracking), however the scale of movement may have an adverse impact on traffic congestion, noise or air quality depending on existing roads, traffic and air quality. There is potential for this to have a noticeable impact for rural communities or communities directly adjacent to minor roads during this period. However, given the short term nature of this work, this is not expected to be significant.<br>Under the UKOOG Community Engagement Charter benefits to the value of 1% of revenue from production could be allocated to the local community and county level during production. How these benefits are spent will be decided by the local community and county council. It should be noted that there is not a current definition of local community, so it is uncertain who the recipients would be, although it is likely to be either that parish/town council or the district/borough council. There is potential for this to be spent on local social infrastructure and amenities which would have a positive effect on this objective. It is estimated that the gas production of a well would generate approximately £1.0million in revenue per annum[65] which would result in benefits to the value of £10,000 per year per well. Over the lifetime of the well (20 years) this could amount to £200,000 being paid to the local community (per well). However, in reality it is expected that the production of the well will be greater in the first years and will decrease in the years following. |

[65] Assuming gas wholesale price of £0.22/$m^3$ (taken from DECC (2013) *UK energy sector indicators 2013: energy prices and competition dataset* https://www.gov.uk/government/publications/uk-energy-sector-indicators-2013) and www.parliament.uk/briefing-papers/sn04153.pdf

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Low and High Activity Scenarios:**<br>Given the number of wells expected under the high activity scenario is significantly greater than the low activity scenario then it is expected that there would be a greater number of jobs created. However, the small number of jobs required for production/maintenance and the temporary nature of jobs required for re-fracturing wells (several days per well) result in this effect still being considered as minor.<br>Under the high activity scenario, due to the higher number of wells per well pad, it is expected that communities will receive a greater value of payments through the UKOOG Community Engagement Charter. Based upon the assumption that each well will generate revenues of approximately £1.0 million per annum, a local community is estimated to receive between £2.4-4.8 million over the lifetime of a well pad. These payments may have a locally significant positive effect on this objective, depending on how the money is spent. Under the low activity scenario benefits are expected to be between £1.2-2.4 million per well pad.<br>Given that well pad sites are assumed to be more than 5km apart it is assumed that the potential for cumulative negative effects on local community quality of life as a result of construction activities and HGV movements will be low (from increased congestion and noise, dust, vibrations).<br>**Mitigation:**<br>• Adopt HGV routing which seeks to avoid residential areas.<br>**Assumptions:**<br>• Two FTE for each wells will be required for maintenance activities[66].<br>• A share of proceeds of 1% of revenue will be provided; 2/3 of this will be allocated to the local community and 1/3 at the county level.[67]<br>• Each well will need to be re-fractured once during its 20 year production lifetime.<br>**Uncertainties:**<br>• The impact of unconventional gas production on gas prices within the UK has not reached a consensus and there *remains substantial uncertainty about the impact shale gas will have on gas prices*.[68] |

[66] Regeneris Consulting (2011) Economic Impact of Shale Gas Exploration and Production in Lancashire & the UK http://www.shalegas-europe.eu/en/index.php/resources/library/economic-impact/39-economic-impact-of-shale-gas-exploration-production-in-lancashire-and-the-uk [Accessed September 2013]

[67] UK00G Community Engagement Charter (2013) http://www.ukoog.org.uk/elements/pdfs/communityengagementcharterversion6.pdf [Accessed September 2013]

[68] House of Commons: Energy and Climate Change Committee (2012/13): The impact of shale gas on energy markets: Vol 1 http://www.publications.parliament.uk/pa/cm201213/cmselect/cmenergy/785/785.pdf [Accessed September 2013]

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **+/-** | **+/-** | **Assessment of Effects:**<br>The type of activities required under stage 5 of unconventional oil and gas lifecycle and considered to be similar to stage 5 under conventional oil and gas lifecycle. However, the magnitude and duration of impacts will be greater due to the greater number of wells that need to be decommissioned.<br>Decommissioning is expected to generate employment opportunities for the duration of the works although the number of opportunities created is currently uncertain. However, the scale of work expected and the temporary nature of work expected mean the generation of jobs is not expected to be significant.<br>The potential for these jobs to directly benefit the local community would depend on the balance between skilled and unskilled posts required and the availability of individuals in the local labour market with those skills and relevant experience. It would also depend on the recruitment policies of the contractors employed to undertake the work and unless clear contract direction was given to ensure that members of the local community were given preference, the temporary employment opportunities created through the decommissioning phase may not benefit the local community to any substantial extent.<br>Vehicular movements will be required to transport materials to and from the site during each of the activities under this stage. The total number of movements is unknown, however, it is assumed likely to be of a smaller scale than that in stage 2 (given that there will be no drilling activities or associated vehicle movements). This may have an adverse impact on quality of life for the local community within residential or rural areas if located in along the transport route (e.g. – through noise, vibration or increased traffic congestion on roads). However, given the short term nature of the work this is not expected to be significant.<br>**Low and High Activity Scenarios:**<br>The total number of well pad sites under the high activity scenario is significantly greater compared to the low activity scenario. Therefore, it is considered that more jobs will be generated during the decommissioning of these sites. However, this is still not expected to be significant.<br>Given that well pad sites are assumed to be more than 5km apart it is assumed that the potential for cumulative negative impacts on local community quality of life as a result of construction activities and HGV movements will be low (from increased congestion and noise, dust, vibrations).<br>**Mitigation:**<br>• Any opportunities to employ local contractors or individuals for works or for the use of local materials and suppliers should be identified. Although due consideration and adherence to local employment legislation is required (i.e. – no discrimination on any ground).<br>• Any increase in demand for services and accommodation arising from the works and its potential effect on the existing community should be considered carefully. |

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Adopt HGV routing which seeks to avoid residential areas.<br>**Assumptions:**<br>• It can be reasonably assumed that the scale of construction and oil and gas work undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>**Uncertainties:**<br>• The location of the well pad sites is not known, therefore the proximity to local residents and the existing skill/labour availability within the local workforce is unknown. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0/+** | **0/+** | **Assessment of Effects:**<br>Site restoration and relinquishment is expected to generate a number of remediation and restoration jobs. The number of jobs will depend on the level of contamination on site. However, this is not expected to be significant.<br>There may also be an increase in vehicular movements to conduct surveys and for restoration but this is expected to be small scale and therefore is not expected to have an effect this objective.<br>**Low and High Activity Scenarios:**<br>It can be reasonably assumed that under the high activity scenario, there would be restoration and survey work required and therefore a higher number of jobs associated with carrying out the work. However these jobs would be still be of a minor scale and therefore a neutral effect would be expected on this objective.<br>**Mitigation:**<br>• Adopt HGV routing which seeks to avoid residential areas.<br>**Assumptions:**<br>• It can be reasonably assumed that the scale of work associated with site restoration and relinquishment undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>**Uncertainties:**<br>• The level of restoration and reclamation required will differ per site therefore is it difficult to determine the level of activity required with any certainty. |

***Summary***

At peak under Stage 3 it is expected that 180-360 wells will be constructed in a year. Following this assumption it is estimated that approximately 16,000-32,000 jobs may be generated under high activity scenario (including direct construction and oil and gas jobs, indirect supply chain jobs and induced jobs due to increased expenditure). The peak period is anticipated to occur after the fifth year of phased development and last for 4 years before then decreasing. The number of vehicle movements under Stage 3 is estimated to be of the scale 16-51 movements a day over a 73-145 week period. This could have a potentially significant negative effect on local rural communities directly adjacent to the transport route, depending on factors such as existing roads, traffic and air quality. The significant number of jobs expected in the short term, along with the payments made to local communities under the UKOOG Community Engagement Charter along with the potential for adverse impacts on local communities due to vehicle movements result in Stage 3 obtaining a mixed significant positive/potentially significant negative score.

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| Objective 2 : Population | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| The activities under Stage 2 will be similar to those under Stage 3. However, given that there is only one borehole/well expected per well pad at this stage the scale of activity will be less. Therefore the generation of jobs will be less and the HGV are expected to be for a shorter duration lower resulting in Stage 2 scoring a mixed minor positive/significantly negative.<br>Although the number of jobs expected to be generated under Stage 4 are considered to be low, the payments made to local communities under the community charter engagement during production may result in a significantly positive effect on this objective.<br>The jobs and HGV movements generated due to decommissioning activities under Stage 5 is expected to be of a smaller scale than Stage 2 and are such that a mixed minor/negative score is given.<br>Stages 1 and 6 are expected to generate a small number of jobs for seismic surveys and restoration/reclamation respectively. This may lead to minor positive effects under high activity scenario.<br>**Mitigation Summary**<br>• Any opportunities to employ local contractors to carry out the seismic surveys should be identified. Although due consideration and adherence to local employment legislation is required (i.e. – no discrimination on any ground).<br>• Any increase in demand for services and accommodation arising from the works and its potential effect on the existing community should be considered carefully.<br>• Adopt HGV routing which seeks to avoid residential areas.<br>• Government should work together with industry to develop a skills action plan for shale gas (similar to the Nuclear Supply Chain Action Plan). A body could be set up as a focal point for skills in this field (similar to OPITO for offshore oil and gas in UK).[69]<br>• Development of real-time data on upcoming shale gas projects would help the supply chain to plan ahead (similar to Project Pathfinder on offshore oil and gas in UK).[52] | | | | |

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 2.9 Virgin Coal Bed Methane

The effects of exploration and production activities associated with VCBM are similar to those described in the assessment of effects of unconventional oil and gas (Stages 1-6) although hydraulic fracturing is not normally required. No attempt has been to provide an indication of low and high levels of activity.

## 2.10 Gas Storage

The development of gas storage capacity is likely to entail the following activities:

[69] As recommended in IoD (2013): Getting Shale Gas Working http://www.iod.com/influencing/policy-papers/infrastructure/infrastructure-for-business-getting-shale-gas-working [Accessed September 2013]

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1. Construction & Installation of Pipelines and Storage Facilities;
2. Storage operations; and
3. Decommissioning.

The likely effects of these activities are appraised in **Table 2.18** below.

**Table 2.18 Assessment of Effects: Gas Storage**

| **Objective 2: Population** | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| 1 | **Construction and Installation of Pipelines and Storage Facilities** | **+** | **Assessment of Effects:**<br>Activities associated with construction and installation of pipelines and storage facilities is expected to generate construction jobs in the short term. Depending on the location of the site, there may be a need to construct road connections or enhancements to existing road networks which would generate further construction jobs. The installation of pipelines is also likely to require a number of posts specialised in the gas industry. The potential for these jobs to directly benefit the local community would depend on the balance between skilled and unskilled construction/gas posts required and the availability of individuals in the local labour market with those skills and relevant experience.<br>There may be an increase in the number of vehicle movements associated with transporting required materials to and from the site. However, this is expected to be short term and minor and therefore is not expected to have an adverse impact on the quality of life of local community located in close proximity to the site or HGV route network.<br>**Mitigation:**<br>• Any opportunities to employ local contractors or individuals for works or for the use of local materials and suppliers should be identified. Although due consideration and adherence to local employment legislation is required (i.e. – no discrimination on any ground).<br>• Avoid HGV routing through residential or sensitive areas.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• The location of the pipelines and storage facilities is not known, therefore the proximity to local residents and the existing skill/labour availability within the local workforce is unknown. |
| 2 | **Storage Operations** | **0** | **Assessment of Effects:**<br>Although gas storage operations may generate some work for maintenance and monitoring, this is not expected to generate FTE positions. Therefore, it is expected to have a neutral effect on this objective.<br>There may be a slight increase in vehicular movements under this stage, however, this is expected to be minimal and therefore is not expected to have an effect on this objective. |

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| Objective 2: Population | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| | | | **Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• None identified. |
| 3 | **Decommissioning** | + | **Assessment of Effects:**<br>Decommissioning is expected to generate employment opportunities for the duration of the works although the number of opportunities created is currently uncertain. However, the scale of work expected and the temporary nature of work expected mean the generation of jobs is not expected to be significant.<br>The potential for these jobs to directly benefit the local community would depend on the balance between skilled and unskilled posts required and the availability of individuals in the local labour market with those skills and relevant experience. It would also depend on the recruitment policies of the contractors employed to undertake the work and unless clear contract direction was given to ensure that members of the local community were given preference, the temporary employment opportunities created through the decommissioning phase may not benefit the local community to any substantial extent.<br>There may be an increase in the number of vehicle movements associated with transporting required materials to and from the site. However, this is expected to be short term and minor and therefore is not expected to have an adverse impact on the quality of life of local community located in close proximity to the site or HGV route network.<br>**Mitigation:**<br>• Avoiding routing HGV through residential areas.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• The location of the pipelines and storage facilities is not known, therefore the proximity to local residents and the existing skill/labour availability within the local workforce is unknown. |

***Summary***

The generation of short term construction and specialist gas positions as a result of activities under stage 1 is expected to have a minor positive effect on local employment. However the potential for these positions to benefit the local community will depend on the local labour market and skills available compared to the jobs generated. Similarly, the generation of short term decommissioning jobs under stage 3 is expected to have a minor positive effect on this objective.

Although a small number of maintenance/operational jobs may be provided under stage 2, this is not expected to result in FTEs and therefore scores neutral.

**Mitigation Summary**

- Any opportunities to employ local contractors or individuals for works or for the use of local materials and suppliers should be identified. Although due consideration and adherence to local employment legislation is required (i.e. – no discrimination on any grounds)
- Avoid routing HGV through residential areas.

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| Objective 2: Population | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Stage*** | ***Description*** | | | | ***Score*** | | ***Commentary*** | | | |
| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 2.11 SEA Areas

The following sections consider in-turn the potential effects of Licensing Plan activities on the population objective in the five SEA Areas. The assessment draws on the findings presented in **Table 2.11** and **Table 2.12** above and takes account of the environmental characteristics of the areas as detailed in **Section 2.5**.

### 2.11.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

#### Conventional Oil and Gas

Due to the low level of activity expected under conventional oil and gas (a maximum of 6 well pads), it is expected that the demand for oil and gas and construction workers should be able to be met across all of the SEA Areas.

The greatest population densities are observed within major cities such as Glasgow and Dundee. This will increase the likelihood of residential areas being within close proximity to well pad sites and therefore would increase the likelihood of communities experiencing negative effects on quality of life related to construction and associated HGV movements (including impacts on noise, vibration and air quality). However, rural areas to the North and South of the central belt have lower population densities when compared to other areas within the UK which would decrease this risk.

#### Unconventional Oil and Gas

The scale of work is significantly greater under unconventional oil and gas due to construction of significantly greater number of wells and well pads. This will generate a high demand of construction and oil and gas jobs in the short term.

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Just over half of the UK offshore oil and gas workers live in Scotland and 25% of the total oil and gas UK workforce live within the North East of Scotland (including Aberdeen, Dundee, Inverness) [70]. Many of these skills will be transferrable to the onshore oil and gas sector and therefore the new developments may be able to source a considerable proportion of workers from the local community. Therefore, depending on the location of unconventional oil and gas development, the benefit to employment in local communities is likely to be much greater in SEA Area 1 than other areas of the UK.

Risks of negative impacts on quality of life associated with construction and associated HGV movement under Stages 2, 3 and 5 will be greater for unconventional oil and gas due to the greater scale of construction work expected.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 1 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

The scale of work expected under gas storage is expected to be considerably lower than unconventional or conventional oil and gas. It is expected that the small number of jobs generated during Stages 1 and 3 should be able to be sourced within the local area.

## 2.11.2 SEA Area 2: West Midlands, North West England and Southern Scotland

### Conventional Oil and Gas

Due to the low level of activity expected under conventional oil and gas (a maximum of six well pads), it is expected that the demand for oil and gas and construction workers should be able to be met across all of the SEA Areas.

Both the West Midlands and North West England have higher rates of unemployment than the UK average (9.9% and 8.2% respectively compared to the UK average of 7.8%). As a result, the potential for generation of local jobs or training schemes (such as apprenticeship programmes) to address unemployment, skill provision and deprivation may be greater than other areas of the UK.

Most of the administrative areas in SEA Area 2 have a high population density when compared to other areas in the UK (particularly the West Midlands, Merseyside and Greater Manchester). This will increase the likelihood of residential areas being within close proximity to well pad sites and therefore would increase the likelihood of communities experiencing negative effects on quality of life related to

[70] UKCS Offshore Workforce Demographics Report (2013) http://publ.com/Gt7Tvqe#20

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construction and associated HGV movements (including impacts on noise, vibration and air quality) in Stages 2 and 3 and decommissioning activities in Stage 5. In addition, many of these areas have experienced quality of life issues associated with mining and industry previously and so any concentration of conventional oil and gas activity may unintentionally reinforce a perspective of concentrating development in those areas, whose environments are still recovering from past industrial legacies.

### Unconventional Oil and Gas

The scale of work is significantly greater under unconventional oil and gas due to construction of significantly greater number of wells and well pads. This will lead to a greater demand for construction and oil and gas workers. In the North West construction professionals make up a higher proportion of total workforce in Scotland than compared to the UK as a whole (6.7% compared to 6.2%) [71]. This suggests that there may be a greater availability of local skilled construction workers to carry out construction work in Stages 2 and 3, and decommissioning work in Stage 5. Therefore the benefit to employment in local communities may be greater than other regions of the UK.

Risks of negative impacts on quality of life associated with construction and associated HGV movement under Stages 2, 3 and 5 will be greater for unconventional oil and gas due to the greater scale of construction work expected.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 2 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

The scale of work expected under gas storage is expected to be considerably lower than unconventional or conventional oil and gas. It is expected that the small number of jobs generated during Stages 1 and 3 should be able to be sourced within the local area.

## 2.11.3 SEA Area 3: East Midlands and Eastern England

### Conventional Oil and Gas

Due to the low level of activity expected under conventional oil and gas (a maximum of six well), it is expected that the demand for oil and gas and construction workers should be able to be met across all of the SEA Areas.

[71] NOMIS (2013) http://www.nomisweb.co.uk/reports/lmp/gor/2013265931/report.aspx?town=scotland

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### Unconventional Oil and Gas

The scale of work is significantly greater under unconventional oil and gas due to construction of significantly greater number of wells and well pads. This will lead to a greater demand for construction and oil and gas workers. Construction professionals make up a higher proportion of total workforce in Eastern England than compared to the UK as a whole (7.5% compared to 6.2%) [72]. In addition a high proportion of UK offshore oil and gas workforce are within the North East, predominantly centred around the fabrication industry in Newcastle [73]. This suggests that there may be a greater availability of local skilled workers to carry out construction work in Stages 2 and 3, and decommissioning work in Stage 5. Therefore the benefit to employment in local communities may be greater than other regions of the UK.

Risks of negative impacts on quality of life associated with construction and associated HGV movement under Stages 2, 3 and 5 will be greater for unconventional oil and gas due to the greater scale of construction work expected.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 3 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

The scale of work expected under gas storage is expected to be considerably lower than unconventional or conventional oil and gas. It is expected that the small number of jobs generated during Stages 1 and 3 should be able to be sourced within the local area.

## 2.11.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

### Conventional Oil and Gas

Due to the low level of activity expected under conventional oil and gas (a maximum of six well pads), it is expected that the demand for oil and gas and construction workers should be able to be met across all of the SEA Areas.

Overall the population density within Wales is considerably less than the UK average, which reduces the likelihood of sites or HGV movements being within close proximity to residential areas reducing likelihood for negative impact on quality of life (through generation of noise, dust and vibrations). Swansea, Cardiff and the Valleys have the highest population densities amongst Wales.

[72] NOMIS (2013) http://www.nomisweb.co.uk/reports/lmp/gor/2013265931/report.aspx?town=scotland

[73] UKCS Offshore Workforce Demographics Report (2013) http://publ.com/Gt7Tvqe#20

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### Unconventional Oil and Gas

The scale of work is significantly greater under unconventional oil and gas due to construction of significantly greater number of wells and well pads. This will lead to a greater demand for construction and oil and gas workers. Wales has a slightly higher unemployment rate when compared to the rest of the UK (8.2% compared to 7.8%). However, it is less likely to have a workforce skilled within oil and gas than other areas of the UK. There is potential for training schemes focused on gaining skills within this sector could improve employment opportunities in this region provided employment opportunities were provided. However, this is considered to be short term as the drilling operations are unlikely to last long term.

Risks of negative impacts on quality of life associated with construction and associated HGV movement under Stages 2, 3 and 5 will be greater for unconventional oil and gas due to the greater scale of construction work expected.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 4 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

The scale of work expected under gas storage is expected to be considerably lower than unconventional or conventional oil and gas. It is expected that the small number of jobs generated during Stages 1 and 3 should be able to be sourced within the local area.

## 2.11.5 SEA Area 5: Southern and South West England

### Conventional Oil and Gas

Due to the low level of activity expected under conventional oil and gas (a maximum of six well pads), it is expected that the demand for oil and gas and construction workers should be able to be met across all of the SEA Areas.

The population density within this area is significantly larger than the national averages, which increases the likelihood of sites or HGV movements being within close proximity to residential or other sensitive areas and therefore increases the likelihood of construction and associated HGV movements having a negative impact on quality of life (through generation of noise, noise and air emissions).

### Unconventional Oil and Gas

The scale of work is significantly greater under unconventional oil and gas due to construction of

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significantly greater number of wells and well pads. This will lead to a greater demand for construction and oil and gas workers. The South West and the South East have the lowest levels of unemployment (6% compared to 7.8% national average) and lowest levels of deprivation. As a result there may be less opportunity to address unemployment and deprivation issues within this region compared to other areas within the UK.

Risks of negative impacts on quality of life associated with construction and associated HGV movement under Stages 2, 3 and 5 will be greater for unconventional oil and gas due to the greater scale of construction work expected.

## Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 5 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

## Gas Storage

The scale of work expected under gas storage is expected to be lower than unconventional and conventional oil and gas. It is expected that the small number of jobs generated during Stages 1 and 3 should be able to be sourced within the local area.

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# 3. Health

## 3.1 Introduction

The overview of plans and programmes and baseline information contained in this section provides the context for the assessment of potential effects of the Licensing Plan proposals on human health. Information is presented for both national and regional levels.

There are links between the human health topic and other topics in the SEA, specifically population, air, climate change and material assets.

## 3.2 Review of Plans and Programmes

### 3.2.1 International/European

The World Health Organization (WHO) [1] states that *"health promotion goes beyond health care. It puts health on the agenda of policy makers in all sectors and at all levels*; consequently, healthy public policy has been a main goal of health development in many countries. The ***Canadian Lalonde Report (1974)*** identified four health fields independently responsible for individual health: environment, human biology, lifestyle and health care organisation.

The WHO ***Children's Environment and Health Action Plan for Europe (CEHAPE) (2004)*** was launched in June 2004 and signed by all 53 Member States of the WHO European Region, including the UK. The aim of the CEHAPE is to protect the health of children and young people from environmental hazards.

The European Union has a Programme for Community action in the field of Health (2008-2013) and, on the 23/4R[d] October 2007 the Commission adopted a new overarching Health Strategy ***'Together for Health - A Strategic Approach for the EU 2008-2013'***. Community Action focuses on tackling health determinants which are categorized as: personal behaviour and lifestyles; influences within communities which can sustain or damage health; living and working conditions and access to health services; and general socio-economic, cultural and environmental conditions.

The ***SEA Directive*** adopted in 2001 specifically requires the consideration of: "*the likely significant effects on the environment, including on issues such as …, human health, …*" (European Parliament and the Council of the European Union, 2001). The SEA Protocol (United Nations Economic Commission for Europe, 2003) implements the political commitments made at the Third European Conference on Environment and Health and uses the term 'environment and health' throughout. It indicates that health

[1] See the Ottawa Charter adopted at the First International Conference on Health Promotion in 1986.

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authorities should be consulted at the different stages of the process and so goes further than the SEA Directive. Once ratified, it will require changes to the SEA Directive to require that health authorities are statutory consultees.

The WHO publication ***Health Impact Assessment in Strategic Environmental Assessment (2001)*** provides a review of Health Impact Assessment concepts, methods and practice to support the development of a protocol on Strategic Environmental Assessment to the Espoo Convention, which adequately covers health impacts.

### 3.2.2 UK

Many of the national level policies and strategies regarding health are aimed at understanding the trends and nature of health issues within the country, understanding the links between health issues and other related factors (such as economic status, etc.), and, primarily, at reducing the inequalities in health outlooks that are evident between different parts of the country and different sections of the population. Whilst some applicable policies/strategies are contained within adopted strategies, many of the Government's objectives and intended actions are contained within White Papers and guidance papers.

The Health Protection Agency's ***Children's Environment and Health Action Plan, a summary of current activities which address children's environment and health issues in the UK (2007)*** applies the objectives of CEHAPE (2004) to the UK context and ***A Children's Environment and Health Strategy for the United Kingdom (2009)*** provides recommendations from the Health Protection Agency to the UK Government as to how it best can meet its commitment to the CEHAPE.

### 3.2.3 England

In England, the Department of Health is the government department responsible for public health issues. Its work includes setting national standards, shaping the direction of health and social care services and promoting healthier living.

The Government's White Paper, ***Healthy Lives, Healthy People: Our strategy for public health in England (2010)*** recognises that the quality of the environment, including the availability of green space and the influence of poor air quality and noise, affects people's health and wellbeing. It details plans for a shift of power to local communities, including new duties and powers for local authorities to improve the health of local people. From April 2013, the post of Director of Public Health (DoPH) will be created within upper tier and unitary local authorities. The DoPH will be able to influence local services, for example joining up activity on rights of way, countryside access and green space management to improve public health by connecting people with nature.

The ***Health and Social Care Act (2012)*** enacts the proposals set out in the White paper and the subsequent rounds of consultation. The changes are designed to make the NHS more responsive, efficient and accountable, and capable of responding to future challenges. Key elements of the Act

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include: clinically led commissioning, service innovation, giving greater voice for patients, providing a new focus for public health, ensuring greater accountability and streamlining arms length bodies.

The NHS White Paper, ***Equity and excellence: Liberating the NHS (2010)*** sets out the Government's long-term vision for the future of the NHS and consists of three mutually-reinforcing parts:

- putting patients at the heart of the NHS;
- focusing on improving outcomes; and
- empowering local organisations and professionals.

***Liberating the NHS: Legislative framework and next steps (*2010)** is the Government's response to the consultation on the implementation of the White Paper and three further consultations: ***Commissioning for patients (2010)*, *Local democratic legitimacy in health (2010)* and *Regulating healthcare providers (2010)*.** In this document the Government's commitment to the White Paper reforms are reaffirmed and described in detail how developments in light of the consultation will be put into practice across the three parts identified in the white paper above.

### 3.2.4 Scotland

Scottish Government's '***20:20 Vision (2011)'*** sets out their strategic vision for achieving sustainable quality in the delivery of healthcare services across Scotland, in the face of the significant challenges of Scotland's public health record, its changing demography and the economic environment. The ***Healthcare Quality Strategy for NHS Scotland (2010)*** is the approach and shared focus for all the work to realise 2020 Vision. The strategy developed three quality ambitions:

- **Safe** - There will be no avoidable injury or harm to people from healthcare, and an appropriate, clean and safe environment will be provided for the delivery of healthcare services at all time;
- **Person-Centred** - Mutually beneficial partnerships between patients, their families and those delivering healthcare services which respect individual needs and values and which demonstrates compassion, continuity, clear communication and shared decision-making; and
- **Effective** - The most appropriate treatments, interventions, support and services will be provided at the right time to everyone who will benefit, and wasteful or harmful variation will be eradicated.

### 3.2.5 Wales

The White Paper ***Sustainable Social Services for Wales: A Framework for Action (2011)*** highlighted a number of challenges faced by public services in Wales including demographic changes, increased expectations from those who access care and support as well as continuing hard economic realities.

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The draft ***Social Services and Well-being (Wales) Bill (2013)*** was introduced to the National Assembly for Wales in January 2013 in order to address these concerns and is under consultation. If legislation is passed, it will provide the legal framework for improving the well-being of people who need care and support or support and to transform social services in Wales.

***Planning Policy Wales (2012)*** states that planning policies and proposals should contribute to the protection and, where possible, the improvement of people's health and wellbeing. Consideration of the possible impacts of developments - positive and/or negative - on people's health at an early stage will help to clarify the relevance of health and the extent to *which* it needs to be taken into account.

***Together for Health (2011)*** is a five year vision for NHS Wales, based around community services and placing prevention, quality and transparency at the heart of healthcare.

## 3.3 Overview of the Baseline

### 3.3.1 UK

In the UK, during 2008-10, life expectancy at birth was 78.2 years for males and 82.3 years for females [2].

There are high levels of hypertension and overweight/obesity in the UK. Public health trends often correlate with deprivation and these figures for illness are invariably far less favourable in deprived areas [3.]

Deaths from respiratory diseases (including influenza, pneumonia, chronic lower respiratory disease, bronchitis, emphysema and other chronic obstructive pulmonary diseases and asthma) are higher in the UK than in any other EU Member State. In the UK there are 87.7 deaths per 100,000 males and 64.0 deaths per 100,000 females from respiratory diseases, compared to an EU average of 63.4 and 32.5 [4].

### 3.3.2 England

In England, during 2008-10, life expectancy at birth was 78.6 years for males and 82.6 years for females.

In 2011, 47.2% the population in England rated their health as very good; 34.2% as good, 13.1% as fair, 4.2% as bad and 1.2% as very bad[5].

[2] ONS Life expectancy by local areas in the UK 2011, http://www.ons.gov.uk/ons/rel/subnational-health4/life-expec-at-birth-age-65/2004-06-to-2008-10/statistical-bulletin.html
[3] Health Survey for England 2007 Healthy lifestyles: knowledge, attitudes and behaviour Summary of key findings, Office of National Statistics, http://www.statistics.gov.uk/StatBase/Product.asp?vlnk=6637
[4] ONS, United Kingdom Health Statistics 2010, http://www.statistics.gov.uk/downloads/theme_health/ukhs4/ukhs4-2010.pdf
[5] ONS, Census 2011

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The Health Survey for England, published in 2012, includes the following key findings for 2011[6]:

- Overall, more women than men reported that they had provided informal help or support to anyone in the last month because of long-term physical or mental ill-health, a disability or problems relating to old age (19% and 14% respectively);
- Cardiovascular disease (CVD) remains the most common cause of death and still causes a large proportion of ill health. In England and Wales in 2011, CVD accounted for 29% of all deaths;
- In 2011, 7.0% of men and 4.9% of women aged 16 and over had doctor-diagnosed diabetes, the prevalence among men being significantly greater than among women; and
- Around a quarter of adults were obese (24% of men and 26% of women), and 65% of men and 58% of women were overweight or obese.

### 3.3.3 Scotland

In Scotland, during 2008-10, life expectancy at birth was 75.8 years for males and 81.8 years for females [7].

The latest Health Survey for Scotland, published in 2012, includes the following key findings for 2011[8]:

- 76% of adults aged 16 and over described their health as 'good' or 'very good';
- 64.3% of adults were overweight or obese (BMI of 25kg/m$^2$ and over) while 27.7% were obese;
- 15.6% of men and 13.8% of women reported having cardiovascular disease (CVD);
- 6.1% of men and 4.9% of women had doctor diagnosed diabetes;
- 33% of men and 32% of women had hypertension.

### 3.3.4 Wales

In Wales, in 2008-10, life expectancy at birth was 76.6 years for Males and 81.8 years for females[9].

In 2011, 46.6% the population in Wales rated their health as very good; 31.1% as good, 14.6% as fair,

[6] Health Survey for England 2012 http://www.hscic.gov.uk/catalogue/PUB09300
[7] ONS Life expectancy by local areas in the UK 2011, http://www.ons.gov.uk/ons/rel/subnational-health4/life-expec-at-birth-age-65/2004-06-to-2008-10/statistical-bulletin.html

[8] Scottish Health Survey (2012) http://www.scotland.gov.uk/News/Releases/2012/09/stats-health-survey25092012
[9] ONS Life expectancy by local areas in the UK 2011, http://www.ons.gov.uk/ons/rel/subnational-health4/life-expec-at-birth-age-65/2004-06-to-2008-10/statistical-bulletin.html

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5.8% as bad and 1.8% as very bad[10].

The latest Health Survey for Wales, published in 2012, includes the following key findings for 2011[11]:

- 16% of adults reported that their health in general was excellent, 34% very good, 30% good, 15% fair, and 6% poor;
- 20% of adults reported currently being treated for high blood pressure, 14% for a respiratory illness, 12% for arthritis, 11% for a mental illness, 9% for a heart condition, and 7% for diabetes; and
- 34% of adults reported that their day-to-day activities were limited because of a health problem/disability, including 16% who were limited a lot.

## 3.4 Key Characteristics of those Areas most likely to be Significantly Affected

**Table 3.1** presents an overview of health in the regions that comprise England together with Scotland and Wales.

**Table 3.1 Life Expectancy at Birth and General Health of Population in UK Regions**

| Region | Life Expectancy at Birth in Years (in 2008-2010) | | % of Population in Not Good Health* |
|---|---|---|---|
| | Males | Females | |
| North East | 77.2 | 81.2 | 22.7 |
| North West | 77.0 | 81.1 | 20.7 |
| Yorkshire and The Humber | 77.7 | 81.8 | 20.0 |
| East Midlands | 78.4 | 82.4 | 19.6 |
| West Midlands | 77.9 | 82.2 | 20.2 |
| East | 79.6 | 83.2 | 17.5 |
| London | 79.0 | 83.3 | 16.2 |
| South East | 79.7 | 83.5 | 16.4 |
| South West | 79.5 | 83.5 | 18.6 |
| England | 78.6 | 82.6 | 18.6 |

[10] ONS, Census 2011
[11] Welsh Health Survey (2012) http://wales.gov.uk/topics/statistics/headlines/health2012/120919/?lang=en

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| Region | Life Expectancy at Birth in Years (in 2008-2010) | | % of Population in Not Good Health* |
|---|---|---|---|
| | Males | Females | |
| Scotland | 75.8 | 80.4 | - |
| Wales | 77.6 | 81.8 | 22.2 |
| **UK** | **78.2** | **82.3** | **-** |

*=Based on 2011 census % of population who reported their health as fair, bad or very bad

Source: ONS (2011) Life expectancy at birth by local areas in UK and 2011 Census

### 3.4.1 SEA Area 1 Scottish Midlands (including the Inner Forth)

Life expectancy is generally lower for both men and women in Scotland (75.8 years for men and 80.4 years for women) than in other parts of the UK.

### 3.4.2 SEA Area 2 West Midlands, North West England and Southern Scotland

Life expectancy within these regions is slightly less than the UK average. The North West has the lowest life expectancy all of the regions within England (77.0 years for men and 81.1 years for women).

A greater proportion of the population in the North of England described themselves as in 'poor health' compared to the South and the UK as a whole.

### 3.4.3 SEA Area 3 East Midlands and Eastern England

East Midlands and East of England have greater life expectancies than the UK average at 78.4 and 79.6 for men and 82.4 and 83.2 for women respectively. A lower proportion of the population in the East described themselves as not in good health compared to England as a whole.

### 3.4.4 SEA Area 4 North and South Wales (including the Dee/Afon Dyfrdwy)

Life expectancy for men and women in Wales is lower than the UK average (at 77.6 and 81.8 years respectively). The proportion of the population that described themselves as not in good health was higher than compared to all regions in the UK apart from the North East.

### 3.4.5 SEA Area 5 Southern and South West England

Life expectancy in the region is higher for both men and women than the English average. In comparison to other regions in the UK, a lower proportion of the region's population describe themselves as 'not in good health' (16.4% in South East and 18.6% in South West).

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## 3.5 Summary of Existing Problems Relevant to Onshore Oil and Gas Licensing

The following existing problems for health have been identified:

- Health inequalities exist in many communities. This is due a number of factors (and the interplay between them) including housing quality, economic wellbeing, employment, lifestyle, heredity factors, cultural and environmental factors; and
- At present, respiratory illness places a significant burden on the health service. Sustained exposure to elevated air pollution levels (including exposure to elevated concentrations of particulate matter, oxides of nitrogen and sulphur) contributes to this problem. According to Occupational Health and Safety Information Service (2006), mortality rates from respiratory disease are higher in the UK than both the European and EU average. The report also suggests that respiratory disease costs the NHS and society £6.6 billion.

## 3.6 Likely Evolution of the Baseline

### 3.6.1 UK

Life expectancy at birth in the UK has reached its highest level on record for both males and females. From 1985 to 2010 life expectancy steadily increased, from 71.7 to 78.5 years for men and from 77.4 to 82.4 years for women. Females continue to live longer than males, but the gender gap in life expectancy has decreased from 5.7 years in 1985 to 3.9 years in 2010[12].

**Figure 3.1** shows life expectancies from 1985 through to 2035 based on historical mortality rates up to 2010 and from 2010 onwards based on assumed calendar year mortality rates from the 2010-based principal projections. These projections are for period life expectancy at birth (the average number of years a person would live, if he or she experienced the age-specific mortality rates at the time of their birth throughout their life). The projections show the life expectancy is expected to steadily increase to 83.4 years for men and 87.0 for women by 2035.

[12] ONS (2011) 2010 based period life expectancy table http://www.ons.gov.uk/ons/rel/lifetables/period-and-cohort-life-expectancy-tables/2010-based/p-and-c-le.html

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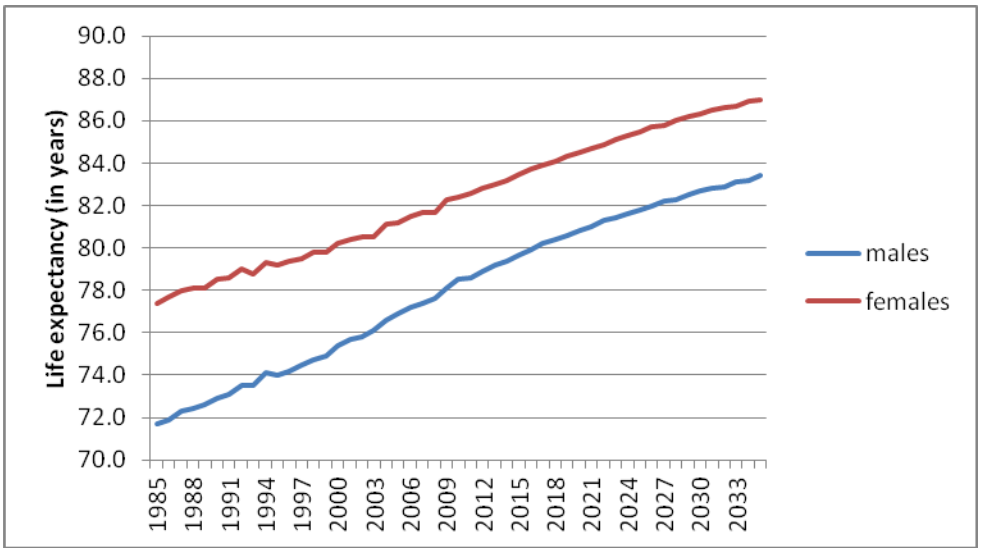
**Figure 3.1 Life Expectancy in UK 1985 - 2035**




Source: ONS (2011) 2010 based period life expectancy table

## England

The current general trend in human health is generally towards improved health, greater life expectancy and reduced mortality from treatable conditions[13].

Life expectancy for males in England has increased from 71.1 years in 1980-82 to 78.7 years in 2009-2011, an increase of 7.6 years. For females, life expectancy increased by 5.6 years from 77.1 to 82.7 years over the same period. As a result, the gap in life expectancy between genders over this time has decreased from 6 years to 4 years difference[14].

Between 1993 and 2011, the proportion of population in England reporting very good and good general health has fluctuated between 74% and 78% among men and between 73% and 76% among women, with no clear pattern of variation. The prevalence of very bad or bad general health has ranged from 4% to 8% across both sexes over the same period[13].

## Scotland

Male life expectancy has improved across Scotland as a whole (from 72.4 years during 1996-98 to 75.4 years during 2007-2009). Female life expectancy has improved across Scotland as a whole (from 78.1

[13] Health Survey for England 2011 Trend Tables, Office of National Statistics, https://catalogue.ic.nhs.uk/publications/public-health/surveys/heal-survey-eng-2011-tren-tabl/HSE2011-Trend-commentary.pdf

[14] England, Interim Life Table 1980-82 to 2009-2011 (2013), Office of National Statistics http://www.ons.gov.uk/ons/rel/lifetables/interim-life-tables/2009-2011/rft-england.xls

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years during 1996-98 to 80.1 years during 2007-09). Alcohol related and attributable hospital patient rates have increased over time for Scotland as a whole, although rates are declining in some areas of Scotland. The number of people being admitted to hospital with heart disease has been declining over time in Scotland as a whole, and in most but not all Community Health Partnerships [15].

NHS Scotland health improvement targets (named HEAT targets based on the four priorities) due for completion in 2013 and onwards include:

- through smoking cessation services, support at least 80,000 successful quits over three year period ending March 2013;
- By March 2013, 90% of clients will wait no longer than three weeks from referral received to appropriate drug or alcohol treatment that supports their recovery; and
- To increase the proportion of people diagnosed and treated in the first stage of breast, colorectal and lung cancer by 25% by 2014-15[16].

## Wales

Life expectancy for males in Wales has increased from 70.4 years in 1980-82 to 77.8 years in 2009-11, an increase of 7.4 years. For females, life expectancy increased by 5.6 years from 76.4 to 82.0 years over the same period. As a result the gap in life expectancy between genders over this time has decreased from 6 years to 4.2 years difference[17].

In Wales the under 75 age standardised mortality rate shows substantial variation across Wales. These differences from the Wales rate are statistically significant. The under 75 age-standardised mortality rate has fallen in all Local Health Board areas in Wales; overall it has declined by 18% between 1998 and 2007. This fall is likely to reflect not only the activities of health services, but also improvements in living standards in the latter part of the 20th Century. The greatest causes of death in people aged under 75 in Wales are cancer, circulatory disease and respiratory disease, together accounting for 40%, 27% and 9% of approximately 11,000 deaths in 2007[18].

Key strategic aims for NHS Wales in the *Together for Health* 5 year vision include:

- reduce health inequality;

[15] NHS Scotland, Health and Wellbeing Profiles 2010, Scotland Overview Report, http://scotpho.org.uk/web/FILES/Profiles/2010/ScotPHO_overview_2010-tiffs-print-and-web.pdf
[16] NHS Scotland, HEAT targets http://www.scotland.gov.uk/About/Performance/scotPerforms/partnerstories/NHSScotlandperformance

[17] Wales, Interim Life Table 1980-82 to 2009-2011 (2013), Office of National Statistics http://www.ons.gov.uk/ons/rel/lifetables/interim-life-tables/2009-2011/rft-wales.xls

[18] NHS Wales, Wales and its Local Health Boards, http://www.wales.nhs.uk/sitesplus/documents/888/All%20Wales%20-%20Eng.pdf

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- reduce obesity, smoking, drug and alcohol abuse;
- making access to primary services easier;
- increasing the range of local services reducing the need for travel;
- guarantee respect and dignity to patients; and
- systems for assuring high quality care will match the best in the world[19].

### 3.6.2 SEA Areas

## SEA Area 1: Scottish Midlands (including the Inner Forth)

Health varies considerably between local community health partnerships in Scotland. Over time the difference in life expectancy between the best of worst performing local areas in Scotland has increased over time. In 1996-98 the difference between East Dunbartonshire (with the highest male life expectancy of 74.8 years) was 7.2 years greater than North Glasgow (with the lowest male life expectancy of 67.6 years). In 2007-09 this gap had increased to 8.5 years between this areas (East Dunbartonshire had a male life expectancy of 78.3 years whilst North Glasgow had a life expectancy of 69.8 years).

A similar trend is observed in female life expectancy where the difference between East Dunbartonshire and North Glasgow was 5.2 years in 1996-98 (approximately 79.7 years in East Dunbartonshire compared to 74.5 years in North Glasgow) which had increased to 6.9 years in 2007-09 (83.1 years compared to 76.2 years)[20].

## SEA Area 2: West Midlands, North West England and Southern Scotland

Male life expectancy within the West Midlands increased by 1.3 years from 2004-08 (76.6 years) to 2008-10 (77.9 years). The same increase was observed within the North West over the same time period (from 75.7 to 77.0 years). Female life expectancy has also increased within these regions; within West Midlands increased by 1.1 years (from 81.1 to 82.2 years) and within the North West increased by 0.8 years (from 80.3 to 81.1 years)[21].

[19] Together for Health (2011) Welsh Government http://wales.gov.uk/docs/dhss/publications/111101togetheren.pdf

[20] NHS Scotland, Health and Wellbeing Profiles 2010, Scotland Overview Report, http://scotpho.org.uk/web/FILES/Profiles/2010/ScotPHO_overview_2010-tiffs-print-and-web.pdf

[21] Life expectancy at birth and at age 65 by local areas in the United Kingdom, 2004–06 to 2008–10, 2011, Office of National Statistics http://www.ons.gov.uk/ons/dcp171778_238743.pdf

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## SEA Area 3: East Midlands and Eastern England

Male life expectancy within the East Midlands increased by 1.1 years from 2004-08 (77.3 years) to 2008-10 (78.4 years). An increase of 1.3 years was observed within Eastern England over the same time period (from 78.3 to 79.6 years). Female life expectancy has also increased within these regions; within West Midlands increased by 1.1 years (from 81.3 to 82.4 years) and within the North West increased by 0.9 years (from 82.3 to 83.2 years)[22].

The health in this East Midlands was considered as similar to the England average for many of the health indicators used for a regional analysis by the ONS. East of England shows one of the best depictions of health across all regions, with almost every indicator used the regional analysis by the ONS, performing better than the England average. Of the 18 indicators, 11 performed significantly better than the England average. This included child obesity, deaths from all causes and deaths from cancer, respiratory and circulatory conditions.

## SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

Rates in all-cause mortality for all ages in Wales have fallen, but the inequality gap has widened substantially. The rate ratio, measuring the gap between the most and least deprived, has steadily increased between 2001-03 to 2007-09 from 1.6 to 1.8 for males, and 1.5 to 1.7 for females.

At health board and local authority level the pattern is not clear and often not statistically significant, but for many areas inequality gaps have widened. The inequality gap has increased, for example in Torfaen and Swansea, and also in females in Cardiff and Vale Health Board. In contrast, the gap in Hywel Dda and Blaenau Gwent has remained essentially unchanged[23].

## SEA Area 5: Southern and South West England

Male life expectancy within the South West of England increased by 1 year from 2004-08 (78.5 years) to 2008-10 (79.5 years). An increase of 1.2 years was observed within Eastern England over the same time period (from 78.5 to 79.7 years). Female life expectancy has also increased within these regions; within South West increased by 0.8 years (from 82.7 to 83.5 years) and within the South East increased by 1.1 years (from 82.4 to 83.5 years)[24].

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[22] Life expectancy at birth and at age 65 by local areas in the United Kingdom, 2004–06 to 2008–10, 2011, Office of National Statistics http://www.ons.gov.uk/ons/dcp171778_238743.pdf

[23] Measuring inequalities: trends in mortality and life expectancy in Wales, 2011, Public Health Wales NHS Trust http://www2.nphs.wales.nhs.uk:8080/PubHObservatoryProjDocs.nsf/($All)/BA402B3D53C6A33D8025795E00556236/$File/InequalitiesProfiles_AllWales_Final_English_v1.pdf?OpenElement

[24] Life expectancy at birth and at age 65 by local areas in the United Kingdom, 2004–06 to 2008–10, 2011, Office of National Statistics http://www.ons.gov.uk/ons/dcp171778_238743.pdf

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The analysis of health within the South West conducted by ONS concludes that the region is in relatively good health, similar to that seen in the South East and the East of England. Like the South East, the high life expectancy appears to be linked to the low mortality rates for cancer, respiratory and circulatory causes, all of which were lower than the England average.

## 3.7 Assessing Significance

The objectives and guide questions related to health which have been identified for use in the appraisal of the effects of Licensing Plan proposals are set out in **Table 3.2**, together with reasons for their selection.

**Table 3.2 Approach to Assessing the Effects of the Licensing Plan on Health**

| Objective/Guide Question | Reasoning |
|---|---|
| **Objective: To protect and enhance health, safety and wellbeing of workers and communities and minimise any health risks associated with onshore oil and gas operations.** | The SEA Directive requires that likely significant effects on human health be taken into account in the Environmental Report. |
| Will the Licensing Plan proposals protect and/or enhance the health and safety of workers, or other people working at the proposed sites? | All employers have a general duty to protect the health and safety of their employees and those affected by their work activities, as set out in the Health and Safety at Work etc Act (1974). |
| Will the Licensing Plan proposals protect and/or enhance the health, safety and well-being of local communities? | There is a duty to protect the health of the local communities including more vulnerable members of the population, such as children as set out in CEHAPE (2004) and UK CEHAPE strategy (2007). |

**Table 3.3** sets out guidance that will be utilised during the assessment to help determine the relative significance of potential effects on the health objective. It should not be viewed as definitive or prescriptive; merely illustrative of the factors that may be considered as part of the assessment process.

**Table 3.3 Illustrative Guidance for the Assessment of Significance for Health**

| Effect | Description | Illustrative Guidance |
|---|---|---|
| ++ | Significant Positive | • Option has a significant positive effect on the likely determinants of good health (including employment opportunity, level of deprivation, physical activity, access to open space and recreational activities, improvements to environmental quality and community safety);<br>• Option has a strong and sustained positive effect on health and wellbeing and acknowledges the health needs of specific groups in society (children, mums to be and the elderly);<br>• Option supports the provision of healthcare facilities. |

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| Effect | Description | Illustrative Guidance |
|---|---|---|
| + | Minor Positive | • Option has a positive effect on the likely determinants of good health (including employment opportunity, level of deprivation, physical activity, access to open space and recreational activities, improvements to environmental quality and community safety);<br>• Option has a positive effect on health and wellbeing and acknowledges the health needs of specific groups in society (children, mums to be and the elderly);<br>• Option may support the provision of healthcare facilities (i.e. as a result of an increase in the local population linked with employment provision). |
| 0 | Neutral | • Option has no observable effects on health and wellbeing of communities. |
| - | Minor Negative | • Option has a negative effect on the likely determinants of good health (including employment opportunity, level of deprivation, physical activity, access to open space and recreational activities, improvements to environmental quality and community safety);<br>• Option has a negative effect on health and wellbeing of specific groups in society (children, mums to be and the elderly);<br>• Option results in some nuisance and/or disruption to communities, such that some complaints could be expected. |
| -- | Significant Negative | • Option has a significant negative effect on the likely determinants of good health (including employment opportunity, level of deprivation, physical activity, access to open space and recreational activities, improvements to environmental quality and community safety);<br>• Option has a significant negative effect on health of specific groups in society (children, mums to be and the elderly);<br>• Option causes statutory nuisance or a sustained and significant nuisance and/or disruption to communities. |
| ? | Uncertain | • From the level of information available the impact that the option would have on this objective is uncertain. |

## 3.8 Assessment of Effects

This section comprises the assessment of the potential activities that could follow on from the licensing round on the health objective. There are a total of six main stages of oil and gas exploration and production (including gas storage) that are the subject of the assessment. These are highlighted in **Table 3.4** for both conventional and unconventional oil and gas together with an overview of the associated key activities at each stage. Please note that Stages 1, 2 and 4 do not necessarily apply to gas storage, depending on the history of the particular site

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**Table 3.4 Oil and Gas Exploration and Production Lifecycle and Key Activities**

| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| 1. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. |
| 2. | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring.* | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. |
| 3. | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring* | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. |
| 4. | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring.* | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. |
| 5. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. |
| 6. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. |

Note: Exploration wells most usually move from Stage 2 to Stage 5, though some may be used for long-term production testing (which would require new consents including planning permission) and some may be retained and their sites redeveloped as a production project (this would also require new consents including planning permission). For the purposes of this assessment, the appraisal stage (a term commonly used in industry) spans Stages 2 and 3.

*Conventional oil and gas exploration and production activities (stages 2 to 4 above) can occasionally include hydraulic fracturing. However, the need to undertake hydraulic fracturing is relatively uncommon and has therefore not been considered in the assessment of conventional oil and gas activities as part of this SEA.

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### 3.8.1 Conventional Oil and Gas

The assessment of the six main stages of conventional oil and gas production is contained in **Table 3.5**. The first two columns describe the exploration and production stage. The third and fourth columns summarise the expected effects on the health objective for both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report). The rationale for this relationship is explained in more detail in the final column and includes:

- the nature and scale of the potential effects on the health objective;
- when the effect could occur (timing) and its degree of permanence;
- what mitigation measures might be appropriate for potentially significant negative effects on the health objective;
- what options there are to enhance positive effects; and
- assumptions and uncertainties that underpin the assessment.

**Table 3.5 Assessment of Effects: Conventional Oil and Gas**

| **Objective 3: Health** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>Site identification, selection and characterisation and the securing of development and operation permits would be expected to be largely desk based. As a result, no effects on health are expected from these activities.<br>Seismic surveys (most commonly vibroseis and shot hole techniques) may generate noise but this is expected to be minimal and temporary and therefore is not expected to have a negative impact on local communities.<br>There may also be an increase in vehicular movements to conduct the seismic surveys but this is expected to be very small scale and therefore is not expected to have an effect this objective.<br>This stage has been assessed as having a neutral effect on this objective.<br>**Low and High Activity Scenarios:**<br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario. However, given that any adverse noise effects associated with seismic surveys are likely to be minor, temporary and localised, there is not expected to be any substantial difference in the type and magnitude of effects between low and high activity scenarios. |

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| Objective 3: Health | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Mitigation:**<br>• Sites selected should avoid residential and other sensitive areas.<br>**Assumptions:**<br>• It is assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>**Uncertainties:**<br>• None identified. |
| 2 | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring. | - | - | **Assessment of Effects:**<br>Activities associated with pad preparation, such as excavation, earth moving, other plant and vehicle transport could potentially negatively affect sensitive residential areas within close proximity to the site through the generation of noise, vibrations and dust. However, given that these activities are expected be typical of the scale of impacts associated with general construction activity and over a short time period any impact is expected to be minor.<br>During the construction of the well, the drilling process will generate noise. Although the drilling for the borehole will be short term (less than 5 weeks), this drilling will be continuous through day and night. However, it is considered that noise levels generated during drilling is such that it can be controlled to avoid risks to health for members of the public.[25]<br>The drilling and flaring process can lead to air emissions of pollutants including PM10, NOx, CO, VOCs and SO2. [26][27] The main issue of potential concern is the risk of emissions of diesel exhaust fumes from well drilling equipment.[28] However, provided the installation is properly designed and managed this is not expected to have a significant adverse effect on health. Provided that regulatory construction requirements are followed, the wells are well designed and the casing is of adequate depth, the risk of contamination of groundwater from drilling muds, additives and naturally occurring chemicals in well cuttings is considered to be very low.[29]Furthermore, if a leakage from the well or an accidental spill were to occur it is considered that adoption of pollution control management procedures within a comprehensive CEMP will help mitigate this risk. |

[25] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

[26] New York State Department of Environmental Conservation (2011) Revised Draft SGEIS on the Oil, Gas and Solution Mining Regulatory Program http://www.dec.ny.gov/energy/75370.html [Accessed September 2013]

[28] Lechtenbohmer et al (2011) Impacts of shale gas and shale oil extraction on the environment and on human health

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| Objective 3: Health | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | The noise levels which would be generated through flaring are uncertain. However noise from flares can be minimised through appropriate flare stack design and it is not expected to have a negative impact on local communities.<br>Given that the oil and gas industry has well established practices to minimise the effects of noise on workers (controls such as safety ear protectors), there should be no negative impact on the health of workers during noise generating activities (such as drilling and fracturing).<br>Furthermore, as with any construction activities, there will be health and safety risks for workers on site. However, provided relevant health and safety legislations are followed (including the Construction (Design and Management) CDM Regulations 2007) and Borehole Sites & Operations Regulations (1995) then it is assumed that such risks are eliminated, avoided or reduced to an acceptable minimum.<br>It is estimated that stage 2 will generate some 6-7 vehicle movements a day in order to transport materials to/from the site over roughly a 7-8 week period.[30] This increase in vehicle movement may generate emissions and dust potentially affecting those with respiratory problems as well as noise and vibrations which may cause stress/anxiety to residents principally alongside local transport networks. However, given the scale of movements is quite low the potential for negative impact will also be low and will also depend on numerous factors such as; the proximity of HGV routes to residential or other sensitive areas and the existing background levels of pollution in these areas.<br>Overall, stage 2 under conventional oil and gas is expected to have a minor negative effect on this objective. This is due to the short term emissions of noise, vibrations, dust and other substances to air during stage 2 activities which are expected to be similar to that under general construction. In addition, drilling will generate emissions to air and continuous noise levels. Given the short term nature of this activity, the impact is expected to be minor.<br>**Low and High Activity Scenarios:**<br>The total number of drilled boreholes is expected to be greater under the high activity scenario. However, given that the total number of boreholes is still considered moderate under the high activity scenario (30), the minimum distance between well pads is assumed to be 5km and the potential negative impacts on health or localised (e.g. – noise, vibrations, air quality) the likelihood of cumulative impacts is low.<br>Given the high number of unconventional well pad sites under the low and high activity scenario there is an increased risk of one of these sites being within the same local area to a conventional well site. Emissions from numerous well developments during drilling and fracturing in a local area or wider region could in principle have an indirect effect of elevating summer ozone levels, which in turn could have an adverse impact on respiratory health.[36] However, this is not currently possible to quantify and is highly uncertain. |

[30] For more information on the calculation of estimate of vehicle movements, please refer to Table 4.9 in the main report.

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| Objective 3: Health | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Mitigation:**<br>• Sites selected should avoid residential areas and other sensitive areas.<br>• Seek to limit noise, dust and mobilisation of any contaminants during construction as part of Construction Environmental Management Plan (CEMP)<br>• Controls, such as safety equipment, for site operatives and visitors on site.<br>• Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas.<br>• The following hierarchal approach to addressing hazards should be followed where possible – eliminate hazards through design; where hazards cannot be designed out they should be isolated or protection to workers and the public should be provided; where the hazard cannot be avoided by protection or isolation, its effects should be mitigated through design, process changes and management control measures.<br>**Assumptions:**<br>• Drilling process expected to last 4-5 weeks per well and last for 24 hours per day.[31]<br>• Majority of wells expected to be laterals.<br>• There will be a minimum distance of 5km between well pad sites.<br>• Stage 2 is estimated to generate some 6-7 vehicle movements a day over a 7-8 week period.[32]<br>• It is assumed that all activities under this stage will be compliant to relevant legislation related to protecting the environment and local community. For example, Water Resources Act 1991 and Water Environment (Controlled Activities) Scotland Regulations 2011 to protect groundwater.<br>**Uncertainties:**<br>• The location of the well pad sites is not known, therefore the proximity to local residents or existing levels of factors which could influence impact on health, such as existing air pollution and noise levels is uncertain. |

[31] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

[32] For more information on the calculation of estimate of vehicle movements, please refer to Table 4.9 in the main report.

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| Objective 3: Health | | | | |
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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 3 | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring. | - | - | **Assessment of Effects:**<br>The majority of activities associated with stage 3 (i.e. - pad preparation and well construction) are expected to be largely similar to stage 2. In addition to the activities in stage 2, there would be the need for provision of pipeline connections, construction of facilities and the size of the well pad would increase from 1 hectare to 2-3hectares. This would slightly increase the scale of activity required and could have some minor effects on this objective.<br>Given that it is expected that there will be 2 wells per well pad and the first well will have been constructed and completed in stage 2 the duration of drilling is expected to be similar to stage 2. As a result, it is considered that the duration of noise, vibrations and risk of emissions to air will be largely similar as stage 2. Similarly, it is considered that noise levels generated during drilling is such that it can be controlled to avoid risks to health for members of the public.[33]<br>Provided that regulatory construction requirements are followed, the wells are well designed and the casing is of adequate depth, the risk of contamination of groundwater from drilling muds, additives and naturally occurring chemicals in well cuttings is considered to be very low.[34] Furthermore, if a leakage from the well or an accidental spill were to occur it is considered that adoption of pollution control management procedures within a comprehensive CEMP will help mitigate this risk.<br>The provision of pipeline connections is not expected to generate any health risks greater than general construction work provided relevant health and safety procedure is followed.<br>It is estimated that 5-6 movements a day will be generated across stage 3 over roughly a 7-8 week period.[35] This increase in vehicle movement may generate emissions and dust potentially affecting those with respiratory problems as well as noise and vibrations which may cause stress/anxiety to residents principally alongside local transport networks. However, given the scale of movements is low the potential for negative impact will also be low.<br>Although the increase of activity will increase the likelihood of accidental discharges (of materials such as drilling muds, additives and naturally occurring chemicals in well cuttings) to water, air or land the probability of this occurring is still considered to be low. Therefore the potential negative impact this could have on local health is still considered to be low (as all materials should be securely contained in site (e.g. – through bunded double skinned containers). Even if a spill was to occur it is considered that adoption of pollution control management procedures within a comprehensive CEMP will help mitigate this risk. |

[33] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

[35] For more information on the calculation of estimate of vehicle movements, please refer to Table 4.10, 4.11 and 4.12 in the main report.

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| Objective 3: Health | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | As with any construction activities, there are health and safety risks for workers on site. However, provided relevant health and safety legislations are followed (including the Construction (Design and Management) CDM Regulations 2007) and Borehole Sites & Operations Regulations (1995) then it is assumed that such risks are eliminated, avoided or reduced to an acceptable minimum.<br><br>**Low and High Activity Scenarios**<br><br>The total number of drilled boreholes is expected to be greater under the high activity scenario. However, given that the minimum distance between well pads is assumed to be 5km and the potential negative impacts on health or localised (e.g. – noise and vibrations during construction and drilling) the likelihood of cumulative impacts is low.<br><br>Given the high number of unconventional well pad sites under the low and high activity scenario there is an increased risk of one of these sites being within the same local area to a conventional well site. Emissions from numerous well developments during drilling and fracturing in a local area or wider region could in principle have an indirect effect of elevating summer o-zone levels, which in turn could have an adverse impact on respiratory health.[36] However, this is not currently possible to quantify and is highly uncertain.<br><br>**Mitigation:**<br><br>• Sites selected should avoid residential and other sensitive areas.<br>• Seek to limit noise, dust and mobilisation of any contaminants during construction as part of Construction Environmental Management Plan (CEMP)<br>• Controls, such as safety equipment, for site operatives and visitors on site.<br>• Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas.<br>• The following hierarchal approach to addressing hazards should be followed where possible – eliminate hazards through design; where hazards cannot be designed out they should be isolated or protection to workers and the public should be provided; where the hazard cannot be avoided by protection or isolation, its effects should be mitigated through design, process changes and management control measures.<br><br>**Assumptions:**<br><br>• Drilling process expected to last 4-5 weeks per well and last for 24 hours per day.[36]<br>• Noise levels associated with hydraulic fracturing expected to be approximately 90dBa at 75m distance.[47] |

[36] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

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| Objective 3: Health | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Majority of wells are expected to be laterals.<br>• A minimum distance of 5km assumed between well pad sites.<br>• Stage 3 is estimated to generate 5-6 vehicle movements a day over a 7-8 week period.[37] It is assumed that all activities under this stage will be compliant to relevant legislation related to protecting the environment and local community. For example, Water Resources Act 1991 and Water Environment (Controlled Activities) Scotland Regulations 2011 to protect groundwater.<br>**Uncertainties:**<br>• The location of the well pad sites is not known, therefore the proximity to local residents or existing levels of factors which could influence impact on health, such as existing air pollution and noise levels is uncertain. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>There is expected to be a minimal level of ongoing noise from the wellhead installations during production at a level unlikely to have any negative effects on the local population.<br>During the production phase substances of concern in terms of contamination of drinking water or spillages include heavy metals, natural gas and Naturally Occuring Radioactive Materials (NORMs) from flowback. However, provided that regulatory construction requirements are followed, the wells are well designed and the casing is of adequate depth, the risk of a spill or leakage is very low. Furthermore, if a leakage from the well or an accidental spill were to occur it is considered that adoption of pollution control management procedures within a comprehensive CEMP will help mitigate this risk preventing contamination.<br>Transportation of materials and equipment during the production and maintenance phase is expected to be much lower than under stages 2 and 3 and therefore is not expected to have an effect on this objective.<br>Overall, stage 4 is expected to have a neutral effect on this objective.<br>**Low and High Activity Scenarios:**<br>The total number of well pad sites is expected to be greater under the high activity scenario. However, given that the minimum distance between well pads is assumed to be 5km and the potential negative impacts on health or localised (e.g. - noise and vibrations during construction and drilling) the likelihood of cumulative impacts is low.<br>Given the high number of unconventional well pad sites under the low and high activity scenario there is an increased risk of one of these sites being within the same local area to a conventional well site. |

[37] For more information on the calculation of estimate of vehicle movements, please refer to Table 4.10, 4.11 and 4.12 in the main report.

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| Objective 3: Health | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Emissions from numerous well developments during fracturing in a local area or wider region could in principle have an indirect effect of elevating summer o-zone levels, which in turn could have an adverse impact on respiratory health.[36] However, this is not currently possible to quantify and is highly uncertain.<br>**Mitigation:**<br>• Seek to limit noise, dust and mobilisation of any contaminants during construction as part of Construction Environmental Management Plan (CEMP)<br>• Controls, such as safety equipment, for site operatives and visitors on site.<br>• Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas.<br>• The following hierarchal approach to addressing hazards should be followed where possible – eliminate hazards through design; where hazards cannot be designed out they should be isolated or protection to workers and the public should be provided; where the hazard cannot be avoided by protection or isolation, its effects should be mitigated through design, process changes and management control measures.<br>**Assumptions:**<br>• A minimum distance of 5km is assumed between well pad sites. It is assumed that all activities under this stage will be compliant to relevant legislation related to protecting the environment and local community. For example, Water Resources Act 1991 and Water Environment (Controlled Activities) Scotland Regulations 2011 to protect groundwater.<br>**Uncertainties:**<br>• The location of the well pad sites is not known, therefore the proximity to local residents or existing levels of factors which could influence impact on health, such as existing air pollution and noise levels is uncertain. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>Health and safety risks associated with the decommissioning process will be similar to those encountered on a conventional demolition site (e.g. risks related to the use of heavy machinery, excavation and lifting) and it is assumed that all standard precautions will be taken to safeguard workers and the public (including site access and a secure site boundary).<br>HGV movements required to remove site equipment from site may generate emissions and dust potentially affecting those with respiratory problems as well as noise and vibrations which may cause stress/anxiety to residents principally alongside local transport networks. The total number of movements is uncertain, however, this is expected to be of minor scale. |

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| Objective 3: Health | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Like conventional site demolition, there is a risk of accidental discharges of demolition-related materials to water, air or land and potential for the creation of new pollution pathways for existing contaminants on the site. However, it is considered that the probability of such effects occurring is low and pollution control management procedures would be adopted to help mitigate this risk.<br><br>Overall, this stage is expected to have a neutral effect on this objective as the health and safety risks associated with decommissioning should be controlled. Although there may be an increase in HGV movement this is not considered at a level likely to have a negative impact on this objective.<br><br>**Low and High Activity Scenarios:**<br><br>The total number of wells is expected to be greater under the high activity scenario. However, given that the total number of well pad sites is considered to be small (6) under the high activity scenario, it is unlikely that there will be more than one well pad site being decommissioned within close proximity at the same time. Therefore, the likelihood of cumulative effects on health is low and little difference is expected between the scenarios.<br><br>**Mitigation:**<br><br>• Controls, such as safety equipment, for site operatives and visitors on site.<br>• Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas.<br>• Regular monitoring and testing of well integrity.<br>• Seek to limit noise, dust and mobilisation of any contaminants during decommissioning as part of an environmental management plan.<br>• Any health and safety risks arising from decommissioning activities should be reduced by making use of BAT.<br><br>**Assumptions**<br><br>• A minimum distance of 5km is assumed between well pad sites.<br>• It is assumed that all activities under this stage will be compliant to relevant legislation related to protecting the environment and local community. For example, Water Resources Act 1991 and Water Environment (Controlled Activities) Scotland Regulations 2011 to protect groundwater.<br><br>**Uncertainties:**<br><br>• The location of the well pad sites is not known, therefore the proximity to local residents or existing levels of factors which could influence impact on health, such as existing air pollution and background noise levels is unknown. |

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| Objective 3: Health | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>The pre-relinquishment survey and inspection is expected to be low impact and is not expected to generate significant levels of noise, dust or emissions to air.<br>Activities during site restoration and reclamation include landscaping, planting and re-vegetation. This, alongside with associated vehicle movements for transportation of materials such as topsoil, may generate noise, vibration, dust or emissions to air. The potential for impact will depend on the level of restoration and reclamation required as well as the distance of residential areas from site. However, this is considered to be minimal.<br>This stage has been assessed as having a neutral effect on this objective.<br>**Low and High Activity Scenarios**<br>The total number of wells is expected to be greater under the high activity scenario. However, given that the total number of well pad sites is considered to be small (6) under the high activity scenario it is unlikely that there will be more than one well pad site being restored within close proximity at the same time. Therefore, the likelihood of cumulative effects on health is low and little difference is expected between the scenarios.<br>**Mitigation:**<br>• Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas.<br>**Assumptions:**<br>• A minimum distance of 5km is assumed between well pad sites.<br>• It is assumed that all activities under this stage will be compliant to relevant legislation related to protecting the environment and local community. For example, Water Resources Act 1991 and Water Environment (Controlled Activities) Scotland Regulations 2011 to protect groundwater.<br>**Uncertainties:**<br>• The level of restoration and reclamation required will differ per site therefore is it difficult to determine the level of activity required with any certainty. |

***Summary***

The effect on this objective ranges from neutral to minor negative between the different stages of the lifecycle. Stage 2 is expected to have a minor negative effect on health. This is mostly due to the potential for generation of noise, vibrations, dust and other emissions to the air to have an adverse impact on the health of local communities in the short term; for example, through HGV movements or pad preparation activities. Risks of contaminating drinking water should be remote provided that wells are well designed, the casing of each well is of adequate depth and there is adequate separation between wells and aquifers. Stage 3 is also expected to have a similar effect on health, due to the similarity in the type of activities. However, given the greater number of wells expected under this stage per well pad the scale, magnitude and duration of effects is expected to be greater. However, this is not expected to be significant, and therefore also scores a minor negative.

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| Objective 3: Health | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| Although the total number of well sites and wells is greater under the high activity scenario, the total number of sites under the high activity scenario is low (6 well pad sites across the UK). Therefore, it is considered unlikely that there will be more than one site within close proximity at the same time. As a result the potential for cumulative impacts resulting in more pronounced impacts is considered low. Given that the negative impacts are generally localised to the local area (e.g. – noise and air quality), and well pad sites are expected to be separated by at least 5km, it is considered that there would be minimal difference on the health objective between the low and high activity scenarios for conventional oil and gas.<br>Stages 1, 4, 5 and 6 score a neutral effect on this objective as the health risks associated with these stages should be controlled and mitigated to prevent any negative impacts.<br>**Mitigation Summary**<br>*Site selection*<br>• Sites selected should avoid residential areas and other sensitive areas.<br>• Ensure at least 600m distance separation between drinking water sources and drilling areas.<br>*Other*<br>• Seek to limit noise, dust and mobilisation of any contaminants during construction as part of an Environmental Management Plan<br>• Controls, such as safety equipment, for site operatives and visitors on site.<br>• Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas.<br>• The following hierarchal approach to addressing hazards should be followed where possible – eliminate hazards through design; where hazards cannot be designed out they should be isolated or protection to workers and the public should be provided; where the hazard cannot be avoided by protection or isolation, its effects should be mitigated through design, process changes and management control measures. | | | | |

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 3.8.2 Unconventional Oil and Gas

The assessment of the six main stages of unconventional oil and gas production is contained in **Table 3.6** under both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report).

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**Table 3.6 Assessment of Effects: Unconventional Oil and Gas**

| **Objective 3: Health** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>The type, scale and magnitude of effects associated with Stage 1 of the unconventional oil and gas exploration and production lifecycle are likely to be similar to those identified in respect of conventional oil and gas and would comprise non-intrusive activities.<br>Site identification, selection and characterisation and the securing of development and operation permits would be expected to be largely desk based. As a result, no effects on health are expected from these activities.<br>Seismic surveys (most commonly vibroseis and shot hole techniques) may generate noise by this is expected to be minimal and temporary and therefore is not expected to have a negative impact on local communities.<br>There may also be an increase in vehicular movements to conduct the seismic surveys but this is expected to be very small scale and therefore is not expected to have an impact this objective.<br>This stage has been assessed as having a neutral effect on this objective.<br>**Low and High Activity Scenarios:**<br>As noted above, this stage of the unconventional oil and gas exploration and production lifecycle would comprise non-intrusive activities such that effects on health are likely to be limited.<br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed). However, given that any adverse noise effects associated with seismic surveys are likely to be minor, temporary and localised, there is not expected to be any substantial difference in the type and magnitude of effects between low and high activity scenarios.<br>**Mitigation:**<br>• Sites selected should avoid residential and other sensitive areas.<br>**Assumptions:**<br>• It is assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>**Uncertainties:**<br>• None identified. |

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| Objective 3: Health | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 2 | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. | - | - | **Assessment of Effects:**<br>The scale and magnitude of effects associated with Stage 2 of the unconventional oil and gas exploration and production lifecycle will be greater than under conventional oil and gas. This is partly due to the additional scale of activity expected (for example a greater number of boreholes and depth of each well) which will increase the scale and duration of activities such as drilling and construction of boreholes/wells. In addition, it will also result in the need for hydraulic fracturing which may impact on this objective through the generation of noise and increasing air emissions.<br>Given that the average size of a well pad is expected to be the same under unconventional as conventional oil and gas, it is expected that the scale of activity for pad preparation will be similar. Activities associated with pad preparation which have the potential to negatively affect residential areas through generation of noise, vibrations and dust (such excavation, earth moving, other plant and vehicle transport) are expected to be typical of the scale of impacts associated with general construction activity. Therefore any negative impact is considered to be minor and temporary.<br>The depth of borehole/well is expected to be greater for unconventional than conventional oil and gas on average. Therefore it is expected that the drilling process will last for a longer duration, increasing the duration of continuous noise from the drilling process. The potential for this to have a negative impact on local populations will depend on the site's proximity to residential areas.<br>The extended duration of the drilling may also increase the risk of emissions of pollutants such as PM10, NOx, CO, VOCs and SO2, from diesel fumes generated from well drilling equipment. However, provided the installation is properly designed and managed this is not expected to have an adverse effect on health.<br>Drilling of unconventional wells to is expected to result in drill cuttings with an average volume of 270m3 per well. There is the potential for these cuttings to have elevated levels of radioactivity which could lead to health concerns if workers were exposed. However, currently there is insufficient information on the potential for radiological levels within gas bearing shales in Europe and the UK to determine the likelihood of encountering such materials[38]. However, established procedures are in place to address radiological risks should they be required. As such a minimal impact on health is expected.<br>Hydraulic fracturing is expected to generate the loudest levels of noise of all the activities under this stage (90dBA at 75m distance) based on the need to use generators to inject high volumes of water to achieve the required pressure. This operation would take several days per well. There is potential for this noise to disturb local residents if within close proximity to residential areas. |

[38] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

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| Objective 3: Health | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Emissions of diesel fumes from fracturing fluid pumps could potentially have a negative impact on local air quality[39], in a similar way as the drilling process. Furthermore, the on-site handling of proppant sand during the fracturing fluid make up operation could lead to generation of significant levels of dust as 0.25% of total sand may be emitted to the air as dust.[40] This would be roughly equivalent to 25-100m3 of sand emitted per well.[41]<br>There is a risk of hydraulic fracturing causing groundwater contamination, principally due to leakages of methane as a result of inadequacies in well cementing or due to the movement of contaminants through existing faults or porous rocks to groundwater resources (although the latter has not been observed in practice and would be unlikely). In addition, other substances (trace elements, NORM and organic material) may be contained in flowback water which, if not controlled, could cause contamination. This could have a negative effect on human health through the contamination of water supply. However, the geological context of shale gas or oil in the UK is one of considerable distances between the target strata to be fractured and likely sources of groundwater (likely to be in excess of 1,000m). With a few exceptions[42], recent research indicates a separation of the order 600m would result in a remote risk of properly injected fluid resulting in contamination of groundwater. Taking into account the requirements for discharge consents/permits and EA/SEPA policy in respect of groundwater protection, it is considered reasonable to suggest that any risk of contamination from fracturing activities is exceptionally low.<br>Geological disturbance caused by hydraulic fracturing may create pathways for the release of other gases apart from shale gas. Radon is a gas of particular concern because high levels of radon in poorly ventilated areas can increase the risk of lung cancer.[43] If new pathways were created that led to the accumulation of radon in buildings and homes this could have a negative impact on human health. Given that radon is colourless and odourless these levels could build up undetected. The likelihood of new pathways being created and scale of such releases is very low but remains currently uncertain given that there no specific locations identified in the draft Licensing Plan. |

[39] Lechtenböhmer et al. (2011) Impacts of shale gas and shale oil extraction on the environment and on human health

[40] Kellam (2012) as referenced in AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission

[41] Based on 5,000-20,000m$^3$ of water used per well within fracturing fluid and the fluid being composed of 98-99% of water, and 1-1.9% proppant (King 2012)

[42] Warner et al (2012 PR) Warner et al (2012) Geochemical evidence for possible natural migration of Marcellus Formation brine to shallow aquifers in Pennsylvania *PNAS*

[43] National Cancer Institute http://www.cancer.gov/cancertopics/factsheet/Risk/radon (accessed September 2013)

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | As with any construction activities, there are health and safety risks for workers on site. However, provided relevant health and safety legislations are followed (including the Construction (Design and Management) CDM Regulations 2007) and Borehole Sites & Operations Regulations (1995) then it is assumed that such risks are eliminated, avoided or reduced to an acceptable minimum.<br>Construction and preparation of the pad may be used as a focus for anti-fracking sentiment and may be subject to protest action from opposition groups and local communities. This could potentially increase the fear of crime through the fear of vandalism and personal injury as a result of an influx of a large number of people into a local area.<br>The noise levels which would be generated through flaring are uncertain. However noise from flares can be minimised through appropriate flare design and it is not expected to have a negative impact on local communities.<br>Given that the oil and gas industry is accustomed to high noise levels and the necessary controls (such as safety headphones) to protect its workforce it is expected that there will be no negative impact on the health of workers during noise generating activities (such as drilling and fracturing).<br>HGV movements will be required to transport materials to and from the site during each of the activities under this stage, especially related to the provision of water for hydraulic fracturing. It is estimated that there will be approximately 14-36 vehicle movements a day over a 12-13 week period[44]. This increase in vehicle movement may generate emissions and dust potentially affecting those with respiratory problems as well as noise and vibrations which may cause stress/anxiety to residents principally alongside local transport networks. However, the potential for negative impact will depend on numerous factors such as the proximity of HGV routes to residential or other sensitive areas and the existing background levels of pollution in these areas. Given the short term nature of this work, the impact is assumed to be minor.<br>There is also potential for negative effects to occur on community health as a result of accidental discharges of construction related materials to water, air or land. However, it is considered that the probability of such effects occurring is low and adoption of pollution control management procedures within a comprehensive CEMP will help mitigate this risk.<br>Overall, taking into account regulatory requirements, the temporary nature of individual activities and the implementation of appropriate management procedures, it is generally anticipated that adverse effects on either public or worker health would be minor. In this respect, Public Health England has recently published a review of the available evidence on potential public health impacts[45]. |

[44] For more information on the calculation of vehicle movements please refer to Table 4.10, 4.11 and 4.12 in the main report

[45] Public Health England (2013) *Review of the Potential Public Health Impacts of Exposures to Chemical and Radioactive Pollutants as a Result of Shale Gas Extraction: Draft for Comment*, available from http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317140158707 [Accessed November 2013]

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | While noting that caution is required in extrapolating evidence from overseas into the UK context, they consider that the potential risks to public health are low if the operations are properly run and regulated.<br>**Low and High Activity Scenarios:**<br>The total number of drilled boreholes is expected to be significantly greater under the high activity scenario<br>As a result there is an increased risk of more than one site being prepared/drilled at the same time. Given that noise, vibration and dust are expected to be highly localised and well pad sites are assumed to be located at least 5km apart the likelihood of cumulative negative impacts as a result of activities under this stage is low. However, emissions from numerous well developments during drilling and fracturing in a local area or wider region could in principle have an indirect effect of elevating summer ozone levels, which in turn could have an adverse impact on respiratory health.[36] This is not currently possible to quantify and is highly uncertain.<br>**Mitigation:**<br>• Sites selected should avoid residential areas and other sensitive areas.<br>• Licensees required to carry out a comprehensive high-level assessment of environmental risks, including risks to human health, and to consult with stakeholders including local communities, as early as practicable in the development of their proposals[46]<br>• Seek to limit noise, dust and mobilisation of any contaminants during construction as part of Construction Environmental Management Plan (CEMP)<br>• Controls, such as safety equipment, for site operatives and visitors on site.<br>• Ensure adequate separation between drinking water sources and drilling areas (will differ depending on geological characteristics at site and surrounding area). No drilling to take place within the inner protection of groundwater source protection zones (SPZ1s).<br>• Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas.<br>• The following hierarchal approach to addressing hazards should be followed where possible – eliminate hazards through design; where hazards cannot be designed out they should be isolated or protection to workers and the public should be provided; where the hazard cannot be avoided by protection or isolation, its effects should be mitigated through design, process changes and management control measures.<br>• Close consultation and full exchange of information with the local community, liaison with the local police and authorities, and the use of appropriate on-site security |

[46] As detailed in written ministerial statement by Edward Davey: Exploration of Shale Gas http://webarchive.nationalarchives.gov.uk/20121217150421/http:/www.decc.gov.uk/en/content/cms/news/wms_shale/wms_shale.aspx (accessed 18th September 2013).

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | should minimise the risk of negative consequences of protest action, such as an increase in fear of crime.<br>**Assumptions:**<br>• Drilling process expected to last 4-5 weeks per well and last for 24 hours per day.[47]<br>• Noise levels associated with hydraulic fracturing expected to be approximately 90dBA at 75m distance.[47]<br>• Chemical additives account for 0.5-2% of fracturing fluid.[47]<br>• A minimum distance of 5km assumed between well pad sites.<br>• Stage 2 is estimated to generate 14-36 vehicle movements a day over a 12-13 week period.[48]<br>• It is assumed that all activities under this stage will be compliant to relevant legislation related to protecting the environment and local community. For example, Water Resources Act 1991 and Water Environment (Controlled Activities) Scotland Regulations 2011 to protect groundwater.<br>**Uncertainties:**<br>• The location of the well pad sites is not known, therefore the proximity to local residents or existing levels of factors which could influence impact on health, such as existing air pollution and background noise levels is unknown. |
| 3 | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. | - | -/-- | **Assessment of Effects:**<br>Most of the activities associated with stage 3 (i.e. - pad preparation, well construction and hydraulic fracturing) are expected to be largely similar to stage 2. However, the scale, magnitude and duration of impact at this stage is expected to be greater given the need to drill, complete and hydraulic fracture a greater number of wells. In addition, there would be the need for provision of pipeline connections which would further increase the scale of activity required.<br>The drilling would last up to 5 weeks per well but would need to be repeated at a site for multiple wells and pads. This would significantly increase the duration of drilling and could result in continuous drilling lasting for up to 2.5 years in some circumstances. However, it is considered that noise levels generated during drilling is such that it can be controlled to avoid risks to health for members of the public.[49] |

[47] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

[48] For more information on the calculation of vehicle movements please refer to Table 4.9 in the main report.

[49] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | With a significant increase in the number of wells there will also be a significant increase in quantities of cutting materials (270m3 per well). There is the potential for these cuttings to have elevated levels of radioactivity which could lead to health concerns if workers were exposed. However, currently there is insufficient information on the potential for radiological levels within gas bearing shales in Europe and the UK to determine the likelihood of encountering such materials[50]. However, established procedures are in place to address radiological risks should they be required. As such a minimal impact on health is expected.<br>The duration of hydraulic fracturing is also expected to increase, although not as considerably as the duration of drilling, given that the process should take several days per well. However, given that hydraulic fracturing generates considerable levels of noise increasing the duration will the potential for this to have a negative impact on local residents, depending on the proximity of the site to residential areas and existing background noise levels, will increase.<br>There is a risk of hydraulic fracturing causing groundwater contamination, principally due to leakages of methane as a result of inadequacies in well cementing or due to the movement of contaminants through existing faults or porous rocks to groundwater resources (although the latter has not been observed in practice and would be unlikely). In addition, other substances (trace elements, NORM and organic material) may be contained in flowback water which, if not controlled, could cause contamination. This could have a negative effect on human health through the contamination of water supply. However, the geological context of shale gas or oil in the UK is one of considerable distances between the target strata to be fractured and likely sources of groundwater (likely to be in excess of 1,000m). With a few exceptions[51], recent research indicates a separation of the order 600m would result in a remote risk of properly injected fluid resulting in contamination of groundwater. Taking into account the requirements for discharge consents/permits and EA/SEPA policy in respect of groundwater protection, it is considered reasonable to suggest that any risk of contamination from fracturing activities is exceptionally low.<br>Geological disturbance caused by hydraulic fracturing may create pathways for the release of other gases apart from shale gas. Radon is a gas of particular concern because high levels of radon in poorly ventilated areas can increase the risk of lung cancer.[52] |

[50] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

[51] Warner et al (2012 PR) Warner et al (2012) Geochemical evidence for possible natural migration of Marcellus Formation brine to shallow aquifers in Pennsylvania *PNAS*

[52] National Cancer Institute http://www.cancer.gov/cancertopics/factsheet/Risk/radon (accessed September 2013).

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | If new pathways were created that led to the accumulation of radon in buildings and homes this could have a negative impact on human health. The likelihood of new pathways being created and scale of such releases is exceptional low; however, as the future locations of licensed activity are unknown, this effect remains uncertain.<br>The provision of pipeline connections is not expected to generate any health risks greater than general construction work provided relevant health and safety procedure is followed.<br>HGV movements will be required to transport materials to and from the site during each of the activities under this stage, especially related to the provision of water for hydraulic fracturing. It is estimated that there will be approximately 16-51 vehicle movements a day over a 32-145 week period (depending on the activity scenario). This increase in vehicle movement may generate emissions and dust potentially affecting those with respiratory problems as well as noise and vibrations which may cause stress/anxiety to residents principally alongside local transport networks within rural areas. However, for urban and communities adjacent to major roads, and at a regional or national level, this is not expected to be significant.<br>As with any construction activities, there are health and safety risks for workers on site. However, provided relevant health and safety legislations are followed (including the Construction (Design and Management) CDM Regulations 2007) and Borehole Sites & Operations Regulations (1995) then it is assumed that such risks are eliminated, avoided or reduced to an acceptable minimum. There is potential for the provision of jobs alongside with significant investment expected under this stage could reduce levels of deprivation within the local area, resulting in a positive impact on this objective. However, this is uncertain and depends on location of site and factors such as existing levels of deprivation.<br>Overall, taking into account regulatory requirements, the temporary nature of individual activities and the implementation of appropriate management procedures, it is generally anticipated that adverse effects on either public or worker health would be minor. In this respect, Public Health England has recently published a review of the available evidence on potential public health impacts[53]. While noting that caution is required in extrapolating evidence from overseas into the UK context, they consider that the potential risks to public health are low if the operations are properly run and regulated.<br>**Low and High Activity Scenarios:**<br>The duration of activities under this stage, especially drilling of wells, will be significantly affected by the number of wells per site. It is expected that under the low scenario activities would last approximately 32-73 weeks and under high activity scenario could last approximately 73-145 weeks. |

[53] Public Health England (2013) *Review of the Potential Public Health Impacts of Exposures to Chemical and Radioactive Pollutants as a Result of Shale Gas Extraction: Draft for Comment*, available from http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317140158707 [Accessed November 2013]

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Under the high activity scenario the increased duration of work would also increase the duration of emissions of dust, noise and vibrations from vehicle movements which increases the potential for a significant negative impact on health for residents principally alongside local transport networks within rural areas. However, this is dependent on the location of the site including the proximity of the site to sensitive populations and existing background levels of noise/air pollutants.<br>The total number of drilled boreholes is expected to be significantly greater under the high activity scenario. As a result there is an increased risk of more than one site being prepared/drilled at the same time. Given that noise, vibration and dust are expected to be highly localised and well pad sites are assumed to be located at least 5km apart the likelihood of cumulative negative impacts as a result of activities under this stage is low. However, emissions from numerous well developments during drilling and fracturing in a local area or wider region could in principle have an indirect effect of elevating summer ozone levels, which in turn could have an adverse impact on respiratory health.[36] This is not currently possible to quantify and is highly uncertain.<br>However, the high activity scenario will also be expected to generate a higher number of job opportunities and higher levels of investment to the local area. There is potential for this to reduce existing levels of deprivation. However, this is highly uncertain.<br>**Mitigation:**<br>• Sites selected should avoid residential and other sensitive areas.<br>• Ensure adequate separation between drinking water sources and drilling areas (will differ depending on geological characteristics at site and surrounding area). No drilling to take place within the inner protection of groundwater source protection zones (SPZ1s).<br>• Seek to limit noise, dust and mobilisation of any contaminants during construction as part of Construction Environmental Management Plan (CEMP)<br>• Controls, such as safety equipment, for site operatives and visitors on site.<br>• Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas<br>• The following hierarchal approach to addressing hazards should be followed where possible – eliminate hazards through design; where hazards cannot be designed out they should be isolated or protection to workers and the public should be provided; where the hazard cannot be avoided by protection or isolation, its effects should be mitigated through design, process changes and management control measures.<br>• Close consultation and full exchange of information with the local community, liaison with the local police and authorities, and the use of appropriate on-site security should minimise the risk of negative consequences of protest action, such as an increase in fear of crime. |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
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| | | | | **Assumptions:**<br>• Drilling process expected to last 4-5 weeks per well and last for 24 hours per day.[54]<br>• Noise levels associated with hydraulic fracturing expected to be approximately 90dBa at 75m distance.[47]<br>• Chemical additives account for 0.5-2% of fracturing fluid.[54]<br>• A minimum distance of 5km assumed between well pad sites.<br>• Stage 3 is estimated to generate 16-51 vehicle movements a day over a 32-145 week period.[55]<br>• It is assumed that all activities under this stage will be compliant to relevant legislation related to protecting the environment and local community. For example, Water Resources Act 1991 and Water Environment (Controlled Activities) Scotland Regulations 2011 to protect groundwater.<br>**Uncertainties**<br>• It is not known how local communities would chose to spend the funds expected under the community engagement charter. Therefore, it is difficult to ascertain whether/the level of impact this could have on this objective. The location of the well pad sites is not known, therefore the proximity to local residents or existing levels of factors which could influence impact on health, such as existing air pollution and background noise levels is unknown. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | - | - | **Assessment of Effects:**<br>The scale of impact is expected to be greater under unconventional oil and gas production stage than compared to conventional oil and gas production. This will be due to the greater number of wells expected per site, the greater number of well pad sites, and the expected need to re-fracture each well once within its 20 year lifetime.<br>There is expected to be a minimal level of ongoing noise from the wellhead installations during production at a level unlikely to have any negative impact on local population.<br>It is expected that each well will need to be re-fractured once during its 20 year production lifetime. As a result, there will be a risk of for emissions from diesel fumes and generation of noise to have a minor negative impact on local health, in a similar way as identified in stage 3. However, this will depend on the location of the site, the proximity to residential areas and existing background levels of noise and air pollution.<br>Transportation of materials and equipment during the production and maintenance phase is expected to be minimal in the most part. |

[54] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

[55] For more information on the calculation of vehicle movements please refer to Table 4.10, 4.11 and 4.12 in the main report.

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| | | | | However, re-fracturing would result in the need for HGV movements of a considerable scale, especially for delivery of water to the site. This increase in vehicle movement may generate emissions and dust potentially affecting those with respiratory problems as well as noise and vibrations which may cause stress/anxiety to residents principally alongside local transport networks within rural areas. However, given the short term nature of this work, this is not expected to be significant.<br><br>During the production phase and any refracturing process substances of concern in terms of contamination of drinking water or spillages include heavy metals, natural gas and Naturally Occurring Radioactive Materials (NORMs) from flowback water.[56] It is expected that the integrity of the well will be tested and any potential failure of the well would be monitored, and remedial measures would be implemented to address any issues identified using established industry processes.[56] This, alongside with the assumption that wells will be located an adequate distance from drinking water, should result in a minimal risk.<br><br>The site may be subject to residual protest action from opposition groups and local communities. This could potentially increase the fear of crime through the fear of vandalism and personal injury as a result of an influx of a large number of people into a local area. However, this is expected to be a much lower risk than compared to previous stages.<br><br>Overall, taking into account regulatory requirements, the temporary nature of individual activities and the implementation of appropriate management procedures, it is generally anticipated that adverse effects on either public or worker health would be minor. In this respect, Public Health England has recently published a review of the available evidence on potential public health impacts[57]. While noting that caution is required in extrapolating evidence from overseas into the UK context, they consider that the potential risks to public health are low if the operations are properly run and regulated.<br><br>**Low and High Activity Scenarios:**<br><br>The total number of drilled boreholes is expected to be significantly greater under the high activity scenario. As a result there is an increased risk of more than one site being prepared/drilled at the same time. Given that noise, vibration and dust are expected to be highly localised and well pad sites are assumed to be located at least 5km apart the likelihood of cumulative negative impacts as a result of activities under this stage is low. |

[56] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

[57] Public Health England (2013) *Review of the Potential Public Health Impacts of Exposures to Chemical and Radioactive Pollutants as a Result of Shale Gas Extraction: Draft for Comment*, available from http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317140158707 [Accessed November 2013]

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| | | | | However, emissions from numerous well developments during drilling and fracturing in a local area or wider region could in principle have an indirect effect of elevating summer ozone levels, which in turn could have an adverse impact on respiratory health.[36] This is not currently possible to quantify and is highly uncertain.<br>**Mitigation:**<br>• Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas.<br>• Ensure adequate separation between drinking water sources and drilling areas (will differ depending on geological characteristics at site and surrounding area). No drilling to take place within the inner protection of groundwater source protection zones (SPZ1s).<br>• injected fluid leading to contamination of groundwater.[58]<br>• Regular monitoring and testing of well integrity.<br>• The following hierarchal approach to addressing hazards should be followed where possible – eliminate hazards through design; where hazards cannot be designed out they should be isolated or protection to workers and the public should be provided; where the hazard cannot be avoided by protection or isolation, its effects should be mitigated through design, process changes and management control measures.<br>**Assumptions:**<br>• Chemical additives account for 0.5-2% of fracturing fluid.[59]<br>• Noise levels associated with hydraulic fracturing expected to be approximately 90dBa at 75m distance.[47]<br>• Each well will need to be re-fractured once during its 20 year production lifetime<br>• A minimum distance of 5km assumed between well pad sites.<br>• It is assumed that all activities under this stage will be compliant to relevant legislation related to protecting the environment and local community. For example, Water Resources Act 1991 and Water Environment (Controlled Activities) Scotland Regulations 2011 to protect groundwater. |

[58] Davies et al (2012) Hydraulic Fractures: How far can they go? *Marine and Petroleum Geology* and Fisher and Warpinkski (2012) Hydraulic-Fracture-Height Growth: Real Data. *SPE Prod & Oper*

[59] AEA (2010) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Uncertainties:**<br>• The location of the well pad sites is not known, therefore the proximity to local residents or existing levels of factors which could influence impact on health, such as existing air pollution and background noise levels is unknown. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0/-** | **-** | **Assessment of Effects:**<br>The type of activities associated with Stage 5 of the unconventional oil and gas production lifecycle are likely to be similar to those identified in respect of conventional oil and gas. However, given the greater number of wells and well pad sites expected under unconventional oil and gas it is expected that the scale and magnitude of impacts will be greater, however, this is still not considered to be significant.<br>Health and safety risks associated with the decommissioning process will be similar to those encountered on a conventional demolition site (e.g. risks related to the use of heavy machinery, excavation and lifting) and it is assumed that all standard precautions will be taken to safeguard workers and the public.<br>HGV movements required to remove site equipment from site may generate emissions and dust potentially affecting those with respiratory problems as well as noise and vibrations which may cause stress/anxiety to residents principally alongside local transport networks. The total number of HGV movements is uncertain but is not expected to be of such a scale to have a significantly negative impact on this objective.<br>As with any demolition site, there is a risk of accidental discharges of demolition-related materials to water, air or land and potential for the creation of new pollution pathways for existing contaminants on the site. However, it is considered that the probability of such effects occurring is low and pollution control management procedures would be adopted to help mitigate this risk.<br>**Low and High Activity Scenarios:**<br>The greater number of wells under the high scenario will result in increased scale of negative impacts over a greater duration. Furthermore, there may be a cumulative effect of more than one site being decommissioned in a local area at the same time. The combined effect of HGV transport and on-site activities could increase the scale such that noise and air emissions have an increased negative impact on health.<br>**Mitigation:**<br>• Controls, such as safety equipment, for site operatives and visitors on site.<br>• Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas.<br>• Regular monitoring and testing of well integrity.<br>• Seek to limit noise, dust and mobilisation of any contaminants during decommissioning as part of an environmental management plan. |

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| | | | | • Any health and safety risks arising from decommissioning activities should be reduced by making use of BAT.<br>**Assumptions:**<br>• A minimum distance of 5km assumed between well pad sites.<br>• It is assumed that all activities under this stage will be compliant to relevant legislation related to protecting the environment and local community. For example, Water Resources Act 1991 and Water Environment (Controlled Activities) Scotland Regulations 2011 to protect groundwater.<br>**Uncertainties:**<br>• The location of the well pad sites is not known, therefore the proximity to local residents or existing levels of factors which could influence impact on health, such as existing air pollution and background noise levels is unknown. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>The type of activities associated with Stage 6 (such as landscaping, planting and re-vegetation) of the unconventional oil and gas production lifecycle are likely to be similar to those identified in respect of conventional oil and gas. However, given the greater number of wells and well pad sites expected under unconventional oil and gas it is expected that the scale and magnitude of impacts will be greater, however, this is still not considered to have a negative impact on this objective.<br>The pre-relinquishment survey and inspection is expected to be low impact and is not expected to generate significant levels of noise, dust or emissions to air.<br>Depending on the level of restoration and reclamation required there may be some generation of noise, vibration, dust or emissions to air. However, this is considered to be minimal.<br>There may also be an increase in vehicular movements to conduct surveys and for restoration but this is expected to be very small scale and therefore is not expected to have an effect on this objective.<br>This stage has been assessed as having a neutral effect on this objective.<br>**Low and High Activity Scenarios**<br>Due to the higher number of well pad sites expected under high activity scenario there may be increased risk of more than one site being restored in a local area at the same time. This could lead to combined effect of HGV transport and on-site activities but given the low scale expected for these activities, this is not expected to have a negative effect on this objective. |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Mitigation:**<br>• Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas.<br>• Any health and safety risks arising from decommissioning activities should be reduced by making use of BAT.<br>**Assumptions:**<br>• A minimum distance of 5km assumed between well pad sites.<br>• It is assumed that all activities under this stage will be compliant to relevant legislation related to protecting the environment and local community. For example, Water Resources Act 1991 and Water Environment (Controlled Activities) Scotland Regulations 2011 to protect groundwater.<br>**Uncertainties:**<br>• The level of restoration and reclamation required will differ per site therefore is it difficult to determine the level of activity required with any certainty.<br>• The location of the well pad sites is not known, therefore the proximity to local residents or existing levels of factors which could influence impact on health, such as existing air pollution and background noise levels is unknown. |

***Summary***

The effect on this objective ranges from neutral to negative between the different stages of the lifecycle. The type of activities are broadly similar to those in conventional oil and gas with the addition of hydraulic fracturing to stages 2 and 3. Although the type of activities are similar, the impacts of these activities are usually of greater magnitude and duration under non-conventional oil and gas due to the greater scale of activity, largely driven by the greater number of wells expected per site. Stage 2 is expected to have a minor negative effect on health. This is mostly due to the potential for generation of noise, vibrations, dust and other emissions to the air to have an adverse impact on the health of local communities in the short term; for example, through HGV movements or pad preparation activities. The greatest potential for negative effects is during hydraulic fracturing process, which generates significant noise levels over several days and there is a potential for emissions from diesel fumes to have a negative impact on health in areas with high background levels of air pollution.

The type of activities for stage 3 are similar to stage 2, however, given the significant increase in the number of wells expected under this stage per well pad the scale, magnitude and duration of effects is expected to be greater, although this is still not expected to have a significant negative effect on health.

Stages 1 and 6 score a neutral effect on this objective as the health risks associated with these stages should be controlled and mitigated to prevent any negative impact.

The total number of well sites and wells is significantly greater under the high activity scenario. Therefore the scale, magnitude and duration of effects is greater under the high activity scenario for the majority of stages. In addition, there is potential for more than one site to be within close proximity at the same time. As a result there is potential for cumulative impacts resulting in more pronounced impacts for local communities.

**Mitigation Summary**

**Site selection**

- Sites selected should avoid residential areas and other sensitive areas.
- Ensure adequate separation between drinking water sources and drilling areas (will differ depending on geological characteristics at site and surrounding area).

**Other**

- Seek to limit noise, dust and mobilisation of any contaminants during construction as part of an Environmental Management Plan
- Controls, such as safety equipment, for site operatives and visitors on site.

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| Objective 3: Health | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| • Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas.<br>• The following hierarchal approach to addressing hazards should be followed where possible – eliminate hazards through design; where hazards cannot be designed out they should be isolated or protection to workers and the public should be provided; where the hazard cannot be avoided by protection or isolation, its effects should be mitigated through design, process changes and management control measures. | | | | |

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 3.9 Gas Storage

The development of gas storage capacity is likely to entail the following activities:

1. Construction and Installation of Pipelines and Storage Facilities
2. Storage operations
3. Decommissioning

The potential effects of these activities on health are discussed in **Table 3.7**.

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**Table 3.7 Assessment of Effects: Gas Storage**

| **Objective 3: Human Health**<br>***Stage Description*** | ***Score*** | ***Commentary*** |
|---|---|---|
| **Construction & Installation of Pipelines and Storage Facilities** | - | **Assessment of Effects:**<br>Activities associated with construction and installation of pipelines and storage facilities which have the potential to negatively affect residential areas through generation of noise, vibrations and dust (such excavation, earth moving, other plant and vehicle transport) are expected to be typical of the scale of impacts associated with general construction activity. Therefore any negative effect is considered to be minor and temporary.<br>The construction and installation of pipelines is not expected to generate any health risks greater than general construction work provided relevant health and safety procedure is followed.<br>As with any construction activity there is the potential for accidental discharges to water, air or land. However, it is considered that the probability of such effects occurring is low and adoption of pollution control management procedures within a comprehensive CEMP will help mitigate this risk.<br>HGV movements required to transport materials to/from site may generate emissions and dust potentially affecting those with respiratory problems as well as noise and vibrations which may cause stress/anxiety to residents principally alongside local transport networks. However, this is not expected to be of a scale that would lead to significant effects.<br>**Mitigation:**<br>• Sites selected should avoid residential areas and other sensitive areas.<br>• Seek to limit noise, dust and mobilisation of any contaminants during construction as part of Construction Environmental Management Plan (CEMP).<br>• Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas.<br>• The following hierarchal approach to addressing hazards should be followed where possible – eliminate hazards through design; where hazards cannot be designed out they should be isolated or protection to workers and the public should be provided; where the hazard cannot be avoided by protection or isolation, its effects should be mitigated through design, process changes and management control measures.<br>**Assumptions:**<br>• It is assumed that the level of construction activity will be similar to general construction.<br>**Uncertainties:**<br>• The location of the well pad sites is not known, therefore the proximity to local residents or existing levels of factors which could influence impact on health, such as existing air pollution and background noise levels is unknown. |

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| **Objective 3: Human Health**<br>***Stage Description*** | ***Score*** | ***Commentary*** |
|---|---|---|
| **Storage Operations** | **0** | **Assessment of Effects:**<br>Storage operations is not expected to generate anything more than a minimal background level of noise. No air emissions are expected associated with this activity.<br>Any vehicular movement associated to storage operations is expected to be very small scale and therefore is not expected to have an effect on this objective.<br>No effects identified.<br>**Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• None identified. |
| **Decommissioning** | **-** | **Assessment of Effects:**<br>There is a risk of accidental discharges of pollutants to water, air or land which could have a negative effect on this objective. However, it is considered that the probability of such effects occurring is low and pollution control management procedures would be adopted to help mitigate this risk.<br>HGV movements required to transport materials and equipment away from site may generate emissions and dust potentially affecting those with respiratory problems as well as noise and vibrations which may cause stress/anxiety to residents principally alongside local transport networks. However, this is not expected to be of a scale that would lead to significant effect.<br>**Mitigation:**<br>• Seek to limit noise, dust and mobilisation of any contaminants during construction as part of Construction Environmental Management Plan (CEMP).<br>• Adopt HGV routing which seeks to avoid residential areas and existing Air Quality Management Areas.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• The location of the well pad sites is not known, therefore the proximity to local residents or existing levels of factors which could influence impact on health, such as existing air pollution and background noise levels is unknown. |

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| **Objective 3: Human Health** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Stage*** | | | | | | | | | | |
| ***Description*** | | | | | ***Score*** | | | | ***Commentary*** | |
| ***Summary*** | | | | | | | | | | |
| The construction and installation of pipelines and storage facilities may have a minor and temporary negative effect on this objective through generation of noise, vibrations and dust from construction activities and associated HGV movements. Similarly, the HGV movements associated with decommissioning activities may lead to a minor negative impact in the short term. Storage operations are expected to have a neutral effect on this objective. | | | | | | | | | | |
| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
| *NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.* | | | | | | | | | | |
| *S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)* | | | | | | | | | | |

## 3.10 Virgin Coalbed Methane

The effects of exploration and production activities associated with VCBM are similar to those described in the assessment of effects of unconventional oil and gas (Stages 1-6) although hydraulic fracturing is not normally required. Generally, commercially viable VCBM tend to be shallower when compared to oil and gas [60], therefore it is expected that the duration of preparation and drilling will be less than under conventional and non-conventional oil and gas. In consequence, the duration and potential for negative impacts from generation of noise, vibration and air pollution is expected to be less. No attempt has been made to provide an indication of low and high levels of activity.

Additional activities, such as dewatering of coal, are not expected to have a negative effect on this objective.

## 3.11 SEA Areas

The following sections consider in-turn the potential effects of Licensing Plan activities on the Health objective in the five SEA Areas. The assessment draws on the findings presented in **Table 3.5** and **Table 3.6** above and takes account of the environmental characteristics of the areas as detailed in **Section 2.5**.

[60] DECC (2010) Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds Environmental Report

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### 3.11.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

#### Conventional Oil and Gas

Health inequality is an increasing issue within Scotland demonstrated by an increasing gap between life expectancy between the best and worst performing local areas over time. Urban areas with considerable levels of deprivation, high population densities and high levels of air pollution are generally the worst performing in terms of health. For example, Glasgow has the lowest life male expectancy of all Scottish local areas (67.6 years), the highest population density (3421.71 people per $km^2$) and several AQMAs due to exceedances of $NO_2$. If a high number of conventional oil and gas sites were to be located within close proximity to these urban areas they could worsen health inequality by adding to existing health issues in the area, most notably through emissions during Stage 2, 3 and 4 adding to existing high levels of pollution or through increasing congestion in areas within heavily congested areas.

#### Unconventional Oil and Gas

In a similar way to conventional oil and gas, Stages 2, 3 and 4 of unconventional oil and gas lifespan have the potential to increase health inequalities if a high proportion of sites were located in urban areas with existing health problems (most notably respiratory issues). The magnitude of impact would be greater for unconventional oil and gas given the greater scale of activity and the negative effects of hydraulic fracturing. However, given public perception of shale gas it is likely that unconventional oil and gas will be located in areas with lower population densities which tend to have lower existing air pollution. There is potential for payments to the local community under the community engagement charter in Stages 3 and 4 to be used to reduce deprivation in the local area which may address inequalities, however, this is highly uncertain as it depends on how the funds are spent.

#### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 1 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required. Generally, commercially viable VCBM tend to be shallower when compared to oil and gas, therefore it is expected that the duration of preparation and drilling will be less than under conventional and non-conventional oil and gas. In consequence, the duration and potential for negative impacts from generation of noise, vibration and air pollution is expected to be less.

#### Gas Storage

The greatest potential for negative effects from gas storage would be during the construction and installation of pipelines and facilities. However, given the small scale expected and the minor and temporary nature of negative impacts, this is not expected to have a major effect on health inequality.

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## 3.11.2 SEA Area 2: West Midlands, North West England and Southern Scotland

### Conventional Oil and Gas

Generally this area is experiencing improving trends in health and air quality. There is a potential for air emissions from Stages 2, 3 and 4 to impact on air quality trend, however, overall there should still be an improvement compared to present levels which may have an impact on respiratory health. Although population growth rates within these areas are expected to be lower than other areas of the UK it is still one of the more densely populated areas within the UK. Therefore, the likelihood of sensitive residential areas being within close proximity to site and therefore more likely to be affected by increasing noise, dust etc will be greater than several other regions within the UK.

### Unconventional Oil and Gas

Given the greater scale of activity expected and the potential for negative effects of hydraulic fracturing there is more potential for unconventional oil and gas to reverse the trend of improving air quality in the region which could prevent against improvements in respiratory health.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 2 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required. Generally, commercially viable VCBM tend to be shallower when compared to oil and gas, therefore it is expected that the duration of preparation and drilling will be less than under conventional and non-conventional oil and gas. In consequence, the duration and potential for negative impacts from generation of noise, vibration and air pollution is expected to be less.

### Gas Storage

The scale of activity expected for gas storage is expected to be a much lower scale than for unconventional oil and gas and therefore the potential for negative impact on respiratory health is expected to be considerably less.

## 3.11.3 SEA Area 3: East Midlands and Eastern England

### Conventional Oil and Gas

This area has the low population densities when compared to other areas within the UK. As a result the likelihood of conventional oil and gas being located within close proximity to residential and other areas sensitive to increases in noise, dust and air emissions will be lower than other. However, population projections expect this area will experience the greatest population growth outside of London which will decrease the gap in population density. This growth is expected to be predominantly within urban areas

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and is expected to put strain on congested road networks. Depending on where sites are located the additional vehicular transport to support the site (especially within Stage 3) may contribute to congestion and air pollution in these areas. However, this could be mitigated through diverting vehicular movements away from congested areas.

### Unconventional Oil and Gas

Given the greater scale of activity and the need for HGV movement to carry water and other materials for hydraulic fracturing there is more potential for unconventional oil and gas to have a negative impact on air quality which could have a negative impact on respiratory health.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 3 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required. Generally, commercially viable VCBM tend to be shallower when compared to oil and gas, therefore it is expected that the duration of preparation and drilling will be less than under conventional and non-conventional oil and gas. In consequence, the duration and potential for negative impacts from generation of noise, vibration and air pollution is expected to be less.

### Gas Storage

The scale of HGV movement expected for gas storage is expected to be a much lower scale than for unconventional oil and gas and therefore the potential for negative impact on respiratory health due to contributions to congestion is expected to be considerably less.

## 3.11.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

### Conventional Oil and Gas

Generally health and air quality in Wales is improving but health equalities (both within and between local areas) are increasing. In a similar way as SEA Area 1, if a high number of conventional oil and gas sites were to be located within close proximity to areas with existing issues they could worsen health inequality by adding to existing health issues in the area. most notably through emissions during Stage 2, 3 and 4 adding to existing high levels of pollution or through increasing congestion in areas within heavily congested areas. However, these issues are considered to be minor and in reality given the need to avoid sensitive sites, it is more likely that oil and gas sites will be located in more remote areas with lower population densities.

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### Unconventional Oil and Gas

In a similar way to conventional oil and gas, Stages 2, 3 and 4 of unconventional oil and gas lifespan have the potential to increase health inequalities if a high proportion of sites were located in urban areas with existing health problems (most notably respiratory issues). The magnitude of impact would be greater for unconventional oil and gas given the greater scale of activity and the negative effects of hydraulic fracturing. However, given public perception of shale gas it is likely that unconventional oil and gas will be located in areas with lower population densities which tend to have lower existing air pollution.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 4 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required. Generally, commercially viable VCBM tend to be shallower when compared to oil and gas, therefore it is expected that the duration of preparation and drilling will be less than under conventional and non-conventional oil and gas. In consequence, the duration and potential for negative impacts from generation of noise, vibration and air pollution is expected to be less.

### Gas Storage

The greatest potential for negative effects from gas storage would be during the construction and installation of pipelines and facilities. However, given the small scale expected and the minor and temporary nature of negative impacts, this is not expected to have a major impact on health inequality.

## 3.11.5 SEA Area 5: Southern and South West England

### Conventional Oil and Gas

The population density within this area is significantly larger than the national averages, which increases the likelihood of sites being within close proximity to residential areas or other areas sensitive to noise and air emissions. Population is expected to increase, especially within existing urban areas. This is likely to result in decreasing air quality in areas with existing AQMA's such as Reading, Slough, Brighton and Cambridge. There is potential for air emissions from conventional oil and gas sites to contribute to worsening air quality, if they are located in such areas, which could impact on respiratory health.

### Unconventional Oil and Gas

Given potential negative impacts from hydraulic fracturing and the greater scale of activity expected, there is more potential for unconventional oil and gas to contribute to worsening air quality. Furthermore, given the high number of sites expected (especially under the high activity scenario) it is more likely that a site could be positioning within close proximity to areas with existing high levels of air pollution which would be more sensitive to further increases in air pollution and impacts to respiratory health.

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## Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 5 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required. Generally, commercially viable VCBM tend to be shallower when compared to oil and gas, therefore it is expected that the duration of preparation and drilling will be less than under conventional and non-conventional oil and gas. In consequence, the duration and potential for negative impacts from generation of noise, vibration and air pollution is expected to be less.

## Gas Storage

The number of gas storage is small and therefore the likelihood for it to be positioned in a location with existing high air pollution levels should be low.

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# 4. Land Use, Geology and Soils

## 4.1 Introduction

The overview of plans and programmes and baseline information contained in this section provides the context for the assessment of potential effects of the Licensing Plan on land use, geology and soils. Information is presented at the UK, national and regional level.

Land use in this context is concerned with the effective use of land, i.e. by encouraging the reuse of land that has been previously developed (brownfield land) as well promoting sustainable patterns of land use, e.g. in relation to the protection of open spaces and green infrastructure. Geology and soils is concerned with important geological sites, the contamination of soils and high quality agricultural land.

There are links between the land use, geology and soil topic and other topics in the SEA, including material assets.

## 4.2 Review of Plans and Programmes

### 4.2.1 International/European

The ***European Thematic Strategy on Soil Protection (2006)*** sets out the European Commission's strategy on soils and includes a proposal for an EU wide ***Soils Directive***. The overall objective of the strategy is the protection and sustainable use of soil, based on the following guiding principles:

- preventing further soil degradation and preserving its functions;
- when soil is used and its functions are exploited, action has to be taken on soil use and management patterns;
- when soil acts as a sink/receptor of the effects of human activities or environmental phenomena, action has to be taken at source; and
- restoring degraded soils to a level of functionality consistent at least with current and intended use, thus also considering the cost implications of the restoration of soil.

The ***EU Integrated Pollution, Prevention and Control (IPPC) Directive 2008/1/EC*** defines the obligations to which industrial and agricultural activities with a high pollution potential must comply, through a single permitting process. It sets minimum requirements to be included in all permits, particularly in terms of pollutants released. The aim of the Directive is to prevent or reduce pollution being released to the atmosphere, water and soil, as well as reducing the quantities of waste arising from industry and agriculture. In order to gain an IPPC permit, operators must demonstrate that they

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have systematically developed proposals to apply the 'Best Available Techniques' (BAT) to pollution prevention and control and that they address other requirements relevant to local factors.

The European Commission reviewed European legislation on industrial emissions in order to ensure clearer environmental benefits, remove ambiguities, promotes cost-effectiveness and to encourage technological innovation. The review led to the commission proposing and adopting a recast ***Directive on Industrial Emissions (IED) 2010/75/EU*** which came into force on 06 January 2011.

A number of other European Directives contribute indirectly to soil protection including on ***Habitats 92/43/EEC***, ***Air 2008/50/EC***, ***Water 2000/60/EC*** and ***Nitrates 91/676/EEC***.

The ***World Summit on Sustainable Development (2002)*** in Johannesburg proposed broad-scale principles which should underlie sustainable development and growth including an objective on greater resource efficiency. Reusing previously developed land is a good example of resource efficiency of land.

The conservation of resources is one of the underlying objectives of the ***European Spatial Development Perspective (ESDP) (1999)*** the framework for policy guidance to improve cooperation among community sectoral policies. There also exists a range of legislation in relation to resources.

### 4.2.2 UK

The ***Environmental Protection Act 1990*** defines within England, Scotland and Wales the legal framework for duty of care for waste, contaminated land and statutory nuisance.

The ***Environment Act 1995*** seeks to protect and preserve the environment and guard against pollution to air, land or water. The Act adopts an integrated approach to environmental protection and outlines where authorisation is required from relevant authorities to carry out certain procedures as well as outlining the responsibilities of the relevant authorities. The Act also amends the Environmental Protection Act 1990 with regard compulsory remediation of contaminated land. The Environmental Protection Act 1990 was also modified in 2006 to cover radioactivity, and then a further modification was made in 2007 to cover land contaminated with radioactivity originating from nuclear installations.

The ***Wildlife and Countryside Act 1981*** allows the designation of SSSIs for sites with geological importance.

The ***Environmental Permitting Regulations (England and Wales) (2010)*** consolidates a range of previous permits required for processes which might cause pollution. It covers water discharges, groundwater activities, radioactive substances, waste, mining and installations. It requires operators to obtain permits for some facilities, to register others as exempt and provides for ongoing supervision by regulators. The aim of the Regime is to:

- protect the environment so that statutory and Government policy environmental targets and outcomes are achieved;

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- deliver permitting and compliance with permits and certain environmental targets effectively and efficiently in a way that provides increased clarity and minimises the administrative burden on both the regulator and the operators;
- encourage regulators to promote best practice in the operation of facilities; and
- continue to fully implement European legislation.

The ***Pollution Prevention and Control (England and Wales) Regulations 2000*** permit and regulate many industrial activities that may pollute our environment.

The ***Overarching National Policy Statement (NPS) for Energy (EN-1)*** sets out the Government's policy against which proposals for major energy projects will be assessed and decided on by the National Infrastructure Directorate (NID) within the Planning Inspectorate. The NPS identifies a range of generic impacts that may arise from energy development and associated policy including geological conservation and land use. The ***National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4)*** provides the primary basis for decisions on applications for gas supply infrastructure and gas and oil pipelines considered to be nationally significant in England and Wales.

The ***National Forest Inventory*** began in 2009 and will be completed in 2014. It will provide a record of key information about the Great Britain's forests and woodlands. This information is useful to many people and organisations involved in forestry and land management, as well as in the wider world of planning, policy development and business. National Forest Inventory Woodland Area Statistics for Great Britain highlight that the area of woodland in Great Britain at 31 March 2010 is estimated to be 2,982 thousand hectares, around 13.0% of the total land area in Great Britain and 225 thousand hectares more than previously estimated.

The ***Ancient Woodland Inventory*** identifies woodlands that have had a continuous woodland cover for centuries. Studies show that these woodlands are typically more ecologically diverse, and of higher nature conservation value, than those that have developed recently or those where woodland cover on the site has been intermittent. They may also be culturally important.

## England

In June 2011, the Government outlined its vision for England's soils in the ***Natural Environment White Paper (NEWP)***. This set a clear target that by 2030 all of England's soils will be managed sustainably and degradation threats tackled successfully, in order to improve the quality of soil and to safeguard its ability to provide essential ecosystem services and functions for future generations. As part of this vision, the Government committed to undertaking further research to explore how soil degradation can affect the soil's ability to support vital ecosystem services; and how best to manage lowland peatlands in a way that supports efforts to tackle climate change. This will inform our future policies and the direction of future action towards 2030.

The ***Contaminated Land (England) Regulations 2006*** sets out provisions relating to the identification and remediation of contaminated land. The ***Environmental Damage (Prevention and Remediation)***

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***Regulations 2009*** require action in response to the most significant cases of environmental damage including in respect of risks to human health from contamination of land.

The Government has reviewed the contaminated land regime in England for the first time since its introduction in 2000. Following the review, revised ***Statutory Guidance has now been issued under Part 2A of the Environmental Protection Act 1990***. This revised Statutory Guidance while still taking a precautionary approach, allows regulators to make quicker decisions about whether or not land is contaminated under Part 2A. It also offers better protection against potential health impacts by concentrating on the sites where action is actually needed.

In 2009, Defra published ***Safeguarding our Soils, A Strategy for England.*** The vision in this strategy is that by 2030, all England's soils will be managed sustainably and degradation threats will be tackled successfully. The overall aspiration is that this will improve the quality of England's soils and safeguard their ability to provide essential services for future generations.

The ***National Planning Policy Framework* (2012)** (NPPF) sets out the Government's planning policy for the use of land in England. With specific regard to geology and soils, it states that "*the planning system should contribute to, and enhance, the natural and local environment by protecting and enhancing valued landscapes, geological conservation interests and soils; preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil pollution or land instability; and remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate*" (paragraph 109). Local planning authorities should take into account the economic and other benefits of the best and most versatile agricultural land. Where significant development of agricultural land is demonstrated to be necessary, local planning authorities should seek to use areas of poorer quality land in preference to that of a higher quality (paragraph 112). The NPPF also states that planning policies should encourage the effective use of land by reusing land that has been previously developed, provided that it is not of high environmental value (paragraph 111).

***Planning Practice Guidance for Onshore Oil and Gas (2013)*** provides advice on the planning issues associated with the extraction of hydrocarbons. It will be kept under review and should be read alongside other planning guidance and the NPPF. The guidance identifies a range of issues that mineral planning authorities may need to address. Those particularly relevant to land use, geology and soils include:

- risk of contamination to land;
- soil resources;
- the impact on best and most versatile agricultural land;
- land stability/subsidence;
- nationally protected geological and geomorphological sites and features; and

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- site restoration and aftercare.

***Local Plans*** set out the policies for the use of land at the local level including in respect of minerals and waste and must be prepared in accordance with the NPPF. As at March 2013, there were 161 Local Authorities with adopted Local Plans under the ***Planning and Compulsory Purchase Act 2004.***

## Scotland

The main aim of the ***Scottish Soil Framework (2009)*** is to promote the sustainable management and protection of soils consistent with the economic, social and environmental needs of Scotland. The Framework identifies a wide range of activities that will contribute to 13 soil outcomes, including factors such as maintaining soil structure, reducing soil erosion and where possible remediating, maintaining and enhancing soil's productive capacity.

***Scottish Planning Policy (SPP) (2010)*** sets out the Scottish Government's policy on land use planning and includes objectives regarding safeguarding minerals. Consultation on the revised ***Draft Scottish Planning Policy (2013)*** commenced in April 2013. The Draft SPP states that the planning system should seek to protect soils from damage such as erosion or compaction and limits development on prime agricultural land. With regard to the extraction of resources, the Draft SPP sets outs that the planning system should:

- recognise the continuing role of indigenous coal, oil and gas in maintaining a diverse energy mix and improving energy security;
- safeguard workable resources and ensure that an adequate and steady supply is available to meet the needs of the construction, energy and other sectors;
- minimise the impacts of extraction on local communities, built and natural heritage, and the water environment; and
- secure the sustainable restoration of mineral sites to a relevant use after working has ceased.

The second ***National Planning Framework (NPF2)*** was published in June 2009 and sets the spatial strategy for Scotland's development to 2030, and designates 14 national developments of strategic importance to Scotland. The National Planning Framework is currently being reviewed with draft policy issued for consultation in April 2013.

***Planning Advice Note 33: Development of Contaminated Land (PAN33)*** provides advice on implications of the development of contaminated land and the approach to contaminated land in development plans.

Scotland's first land use strategy, ***Getting the Best from Our Land: A land use strategy for Scotland*** was published in March 2011. The Strategy takes a strategic approach to the challenges facing land use in Scotland and sets out the following vision: "*A Scotland where we fully recognise, understand and*

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*value the importance of our land resources, and where our plans and decisions about land use deliver improved and enduring benefits, enhancing the wellbeing of our nation*." This vision is underpinned by the following objectives:

- Land based businesses working with nature to contribute more to Scotland's prosperity;
- Responsible stewardship of Scotland's natural resources delivering more benefits to Scotland's people; and
- Urban and rural communities better connected to the land, with more people enjoying the land and positively influencing land use.

***Local Plans*** are prepared by local councils and set out more detailed policies and proposals to guide development. Additionally, in the four main cities (Aberdeen, Dundee, Edinburgh and Glasgow) and their surrounding areas the development plan also includes ***Strategic Development Plans***.

A scheme for remedying contaminated land is introduced in the ***Contaminated Land (Scotland) Regulations (2005).*** This scheme identifies special sites' enforced by SEPA, remediation notices and their contents, and sets out the information to be held on a contaminated land register maintained by local councils. The ***Pollution Prevention and Control (Scotland) Regulations 2012*** permit and regulate many industrial activities that may pollute our environment. The **Environmental Liability (Scotland) Regulations 2009** oblige operators of certain activities to take preventative measures where there is an imminent threat of environmental damage, and to remediate any environmental damage caused by their activities.

## Wales

***One Wales: One Planet (2009)*** sets out proposals to promote sustainable development, how the Welsh Government will make sustainable development a reality for people in Wales, and the benefits that people will see from this, particularly in less well-off communities. With specific regard to land-based resources, the strategy's aim is to 'meet the needs of current and future generations without depleting the resources provided by land upon which we all depend'.

***The Wales Spatial Plan (2008)*** provides the context and direction of travel for local development plans and the work of local service boards. The 2008 update brings the Wales Spatial Plan into line with One Wales, and gives status to the area work which has developed since 2006. The key themes of the update (and the Wales Spatial Plan before it) are set out below:

- Building Sustainable Communities;
- Promoting a Sustainable Economy;
- Valuing our Environment;
- Achieving Sustainable Accessibility; and

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- Respecting Distinctiveness.

***Planning Policy Wales (2012)*** contains current land use planning policy for Wales. It promotes a preference for the reuse of brownfield land and conservation of the best and most versatile agricultural land and geological assets. Chapter 13 deals with minimising and managing environmental risks and pollution including contaminated and unstable land and seeks to maximise environmental protection for people, natural and cultural resources, property and infrastructure and prevent or manage pollution and promote good environmental practice.

***Technical Advice Note 6: Agricultural and Rural Development (TAN6)*** stipulates that, in considering planning applications, local planning authorities should consider the quality of agricultural land and other agricultural factors and seek to minimise any adverse affects on the environment.

***Minerals Planning Policy Wales (2001)*** sets out planning policy guidance in relation to minerals extraction and related development in Wales, which includes all minerals and substances in, on or under land extracted either by underground or surface mining. The overriding objective is to provide a sustainable pattern of minerals extraction including by providing mineral resources to meet society's needs and to safeguard resources from sterilisation. ***Minerals Technical Advice Note 1: Aggregates (MTS1)*** main objective is to provide aggregate resources in a sustainable way to meet society's needs for construction materials.

***Local Development Plans*** (LDPs) set out local planning authority proposals and policies for future development and use of land in Wales. As at March 2013, seven authorities had an adopted LDP with the remainder relying on extant adopted and emerging Unitary Development Plans.

The ***Contaminated Land (Wales) Regulations 2006*** sets out provisions relating to the identification and remediation of contaminated land. The ***Environmental Damage (Prevention and Remediation) (Wales) Regulations 2009*** require action in response to the most significant cases of environmental damage including in respect of risks to human health from contamination of land.

***Woodlands for Wales (2009)*** is the Welsh Government's strategy for woodlands and trees. It sets out the following vision: "*Wales will be known for its high-quality woodlands that enhance the landscape, are appropriate to local conditions and have a diverse mixture of species and habitats*". To deliver this vision, Woodlands for Wales identifies a series of high level outcomes under the following strategic themes:

- Welsh woodlands and tress;
- Responding to climate change – coping with climate change, and helping to reduce our carbon footprint;
- Woodlands for people - serving local needs for health, education, and jobs;
- A competitive and integrated forest sector - innovative, skilled industries supplying renewable products from Wales; and

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- Environmental quality - making a positive contribution to biodiversity, landscapes and heritage, and reducing other environmental pressures.

The ***Woodlands for Wales Action Plan (2009)*** sets out what needs to happen over the next five years to make progress towards achieving the outcomes of Woodlands for Wales. Actions are linked to the outcomes identified in Woodlands for Wales

## 4.3 Overview of the Baseline

### 4.3.1 UK

#### Geology

The geology of the UK is diverse and has over 800 soil types. As a broad overview the following rock types exist in a progression from North West to South East (predominant rock types): Tertiary Volcanic Rocks; Crystalline Rock of Pre-Cambrian and later age; Lower Carboniferous to Cambrian; Triassic and Permian; Early Precambrian and Devonian; Jurassic; Cretaceous; Tertiary and Marine Pleistocene; and finally a return to Cretaceous [1].

The UK has a diversity of mountain ranges and flood plains. In England, the southern part of the country is predominantly lowland, with mountainous terrain north-west of the Tees-Exe line (the Lowland-Upland divide across England), which includes the Cumbrian Mountains of the Lake District, the Pennines and limestone hills of the Peak District, Exmoor and Dartmoor[2].

The Geological Conservation Review (GCR) was launched in 1977 in order to identify and describe the most important (nationally and internationally) geological sites in Britain, and to create a suite of descriptions which collectively catalogue and display the full range of the UK's earth heritage features. The full geological chronology from the Cambrian period to the Quaternary is covered in 3,000 sites spanning100 categories (or 'blocks'). The UK coverage of GCR sites which fall within the SEA Areas are shown in **Figure 4.1**. Although individual sites are indicated as points on this figure, in reality they may range from a single rock exposure to a stretch of cliff.

[1] England's geology, Natural England, http://www.naturalengland.org.uk/ourwork/conservation/geodiversity/englands/default.aspx
[2] State of the Environment Report 2008, Natural England, 2008, http://naturalengland.etraderstores.com/NaturalEnglandShop/NE85

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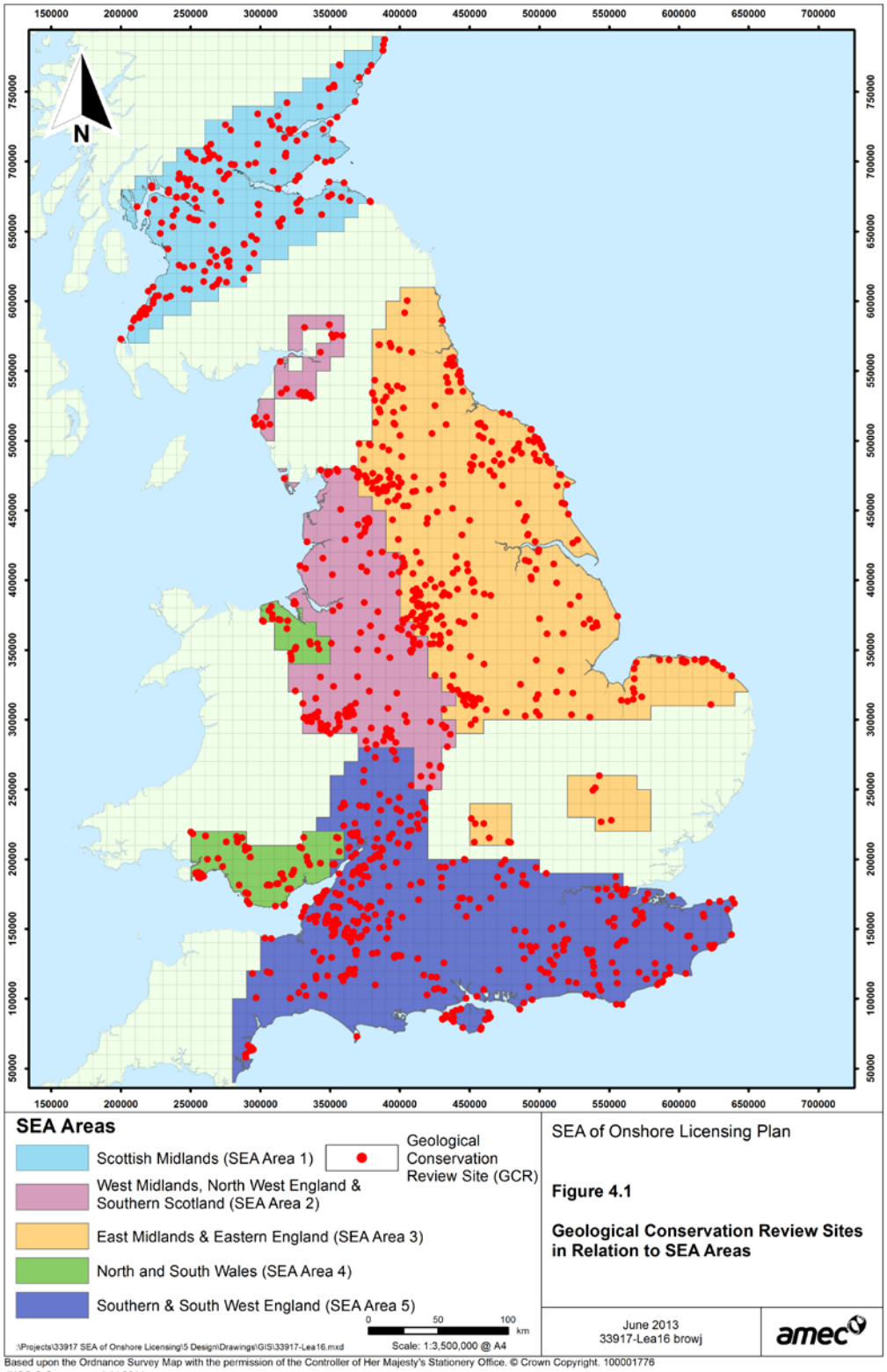
**Figure 4.1 Geological Conservation Review Sites in relation to SEA Areas**



There are an estimated 2,050 geological SSSIs in UK[3, 4, 5].

Across the UK there are also a number of non-statutory geological and geomorphological sites designated at a local level, i.e. often known as Local Geological Sites (formerly Regionally Important Geological and Geomorphological Sites (RIGS)).

## Land Use and Soils

The UK covers an area of 2,472,900 hectares (242,514km$^2$). England comprises the largest land area in the UK, covering an area of 13,028,100 hectares (130,281km$^2$). The smallest land area in the UK is Northern Ireland, which covers an area of 1,357,600 hectares (13,576km$^2$).

Average population density of the UK is 261 people per square kilometre[6].

**Table 4.1** shows land cover in the UK as it stood in 2007 and highlights that arable and horticulture and improved grassland are the most common land cover types, constituting 20.4% and 19.9% of total land area in the UK respectively.

**Table 4.1 Estimated Areas of Broad Habitats in the UK in 2007[7]**

| Land Type | '000 Hectares | % Land Area |
|---|---|---|
| Broadleaved, mixed and yew woodland | 1406 | 6.2 |
| Coniferous woodland | 1319 | 5.8 |
| Linear features | 496 | 2.2 |
| Arable and horticulture | 4608 | 20.4 |
| Improved grassland | 4494 | 19.9 |
| Neutral grassland | 2176 | 9.6 |
| Calcareous grassland | 57 | 0.3 |
| Acid grassland | 1589 | 7.0 |
| Bracken | 260 | 1.1 |
| Dwarf shrub heath | 1343 | 5.9 |

[3] Geoconservation Sites, http://www.geoconservation.com/sites/sssi.htm
[4] Natural England RIGS, http://www.naturalengland.org.uk/ourwork/conservation/designatedareas/lgs/default.aspx
[5] The Scottish Soil Framework, Scottish Government, May 2009, http://www.scotland.gov.uk/Publications/2009/05/20145602/13
[6] ONS (2013) Population and Household Estimates for the United Kingdom, March 2011, http://www.ons.gov.uk/ons/rel/census/2011-census/population-estimates-by-five-year-age-bands--and-household-estimates--for-local-authorities-in-the-united-kingdom/stb-population-and-household-estimates-for-the-united-kingdom-march-2011.html#tab-Population-density

[7] Countryside Survey (2009) http://www.countrysidesurvey.org.uk/ (accessed 23.05.13)

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| Land Type | '000 Hectares | % Land Area |
|---|---|---|
| Fen, Marsh, Swamp | 392 | 1.7 |
| Bog | 2232 | 9.9 |
| Standing open waters1 | 204 | 0.9 |
| Rivers and streams1 | 58 | 0.3 |
| Montane | 42 | 0,2 |
| Inland rock | 84 | 0.4 |
| Built-up areas and gardens | 1323 | 5.8 |
| Other land | 113 | 0.5 |
| Unsurveyed land2 | 522 | 2.3 |
| Total3 | 22627 | |

The quality of land across the UK varies, with the best and most versatile agricultural land generally situated in the lowland and valley areas of England. Due to the topography and terrain, much of Scotland and Wales is classified as lower grade land. An estimated 21% of all farmland in England is classified as Grade 1 and 2 land, with a similar percentage graded as Subgrade 3a land. These grades are the best and most versatile land grades as classified under the Agricultural Land Classification System [8].

In 2005 there was estimated to be around 413,906 hectares of land affected by industrial activity in England and Wales which may be contaminated, (around 2% of the land area in England and Wales)[9].

### 4.3.2 England

#### Geology

England's landscape is closely associated with its underlying geology. The topography of England is very varied. Lowland areas are generally found in the East of England. The North West is the most mountains area with other rugged areas found in the South West and central northern regions. There are a number of upland areas across England, such as the South Downs, Chilterns, Cotswolds and North York Moors.

Natural England (2008) report that there are 1,214 SSSIs designated for their geodiversity features covering 1,704 Geological Conservation Review (GCR) sites (which identified nationally important features of geological interest). Many SSSIs have more than one GCR feature and some GCR features extend over more than one SSSI, giving a total of 1,735 SSSI-GCR combinations, or 'geo-features'. The proportion of GCRs in favourable/recovering status varied between 76-94% depending on its category of GCR (each category is reported separately).

[8] Agricultural Land Classification, protecting the best and most versatile agricultural land, Natural England, January 2009.
[9] Indicators for Land Contamination, Science Report SC030039/SR, Environment Agency, August 2005.

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There are no formal international designations for geodiversity sites equivalent to the SPA and SAC designations for biological features, although the geodiversity of the Dorset and East Devon Coast is recognised through designation as a World Heritage site.

England contains two Geoparks: the English Riviera in Devon and the North Pennines AONB. These are areas considered by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) to be of international importance for geological heritage that should be safeguarded and sustainably managed and include strong local involvement. Two further areas in England (Abberley and Malvern Hills and the Cotswold Hills) identify themselves as Geoparks.

## Land Use and Soils

The average population density of England is 407 people per square kilometre[26].

**Table 4.2** shows land cover in England as it stood in 2007 and highlights arable and horticulture and improved grassland as the most common land use covers (covering 30.4% and 21.7% of total land in England respectively).

**Table 4.2 Land Cover in England in 2007[10]**

| England Land Cover 2007 | '000 ha | % Area |
|---|---|---|
| Broadleaved, Mixed and Yew Woodland | 981 | 7.4 |
| Coniferous Woodland | 257 | 1.9 |
| Boundary and Linear Features | 353 | 2.7 |
| Arable and Horticulture | 4,002 | 30.4 |
| Improved Grassland | 2,856 | 21.7 |
| Neutral Grassland | 1,453 | 11.0 |
| Calcareous Grassland | 30 | 0.2 |
| Acid Grassland | 396 | 3.0 |
| Bracken | 91 | 0.7 |
| Dwarf Shrub Heath | 331 | 2.5 |
| Fen, Marsh and Swamp | 117 | 0.9 |
| Bog | 140 | 1.1 |
| Standing Open Water and Canals | 97 | 0.7 |
| Rivers and Streams | 29 | 0.2 |
| Built-up Areas and Gardens | 1,038 | 7.9 |
| Other land | 580 | 4.4 |

[10] Countryside Survey (2009) http://www.countrysidesurvey.org.uk/ (accessed 23.05.13).

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| England Land Cover 2007 | '000 ha | % Area |
|---|---|---|
| Unsurveyed Urban Land | 428 | 3.5 |
| TOTAL | 13,180 | 100 |

The majority of land in England (around 72%) is in agricultural use. A further 8.6% is used for woodland and forestry. Whilst developed land accounts for around 10% of the total area, only a very small proportion of the land (1.14%) is occupied by domestic buildings (e.g. houses), with domestic gardens accounting for almost half of the 'developed area' (over 4% of the national land area). Roads account for around 2% and rail 0.14% of the total.

Within England, 87.7% of the land area is classed as agricultural land[11]. Of the remainder, 5% is non agricultural and 7.3% is urban. Of the 87.7% of land classed as agricultural, 65.1% is classed as moderate or better.

In England there was estimated to be 307,672 hectares of land that may be contaminated. A total of 659 sites had been determined as 'contaminated land' in England by the end of March 2007[12].

### 4.3.3 Scotland

#### Geology

As a broad overview the following rock types exist in a progression from North East to South West (predominant rock types): Pre-Cambrian (the Highlands); Carboniferous (Midland Valley area); and Ordovician and Silurian (Southern Uplands). Topographically, Scotland is divided into three main areas; the Highland region in the north, which includes the Cairngorm and Grampian mountain ranges; the Central Lowlands, which includes the major cities of Edinburgh and Glasgow; and the Southern Uplands, a pastoral upland area north of the English Border.

There are estimated to be 309 SSSIs with geological designation in Scotland[13].

Scotland has three Geoparks: North West Highlands Geopark, Lochaber Geopark and Shetland Geopark [14].

#### Land Use and Soils

The average population density of Scotland is 68 people per square kilometre[6].

[11] Agricultural land classification (ALC) Statistics from the digital 1:250,000 scale Provisional ALC map (www.magic.gov.uk).
[12] Dealing with contaminated land in England and Wales A review of progress from 2000-2007 with Part 2A of the Environmental Protection Act, Environment Agency, January 2009.
[13] The Scottish Soil Framework, Scottish Government, May 2009, http://www.scotland.gov.uk/Publications/2009/05/20145602/13
[14] Dealing with land contamination in Scotland: A review of progress 2000-2008, Scottish Environment Protection Agency, 2008, http://www.sepa.org.uk/land/land_publications.aspx

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**Table 4.3** shows land cover in Scotland as it stood in 2007 and highlights bog as the most common land use cover (covering 25.6% of total land in Scotland).

**Table 4.3 Land Cover in Scotland in 2007**[15]

| Scotland Land Cover 2007 | '000 ha | % Area |
|---|---|---|
| Broadleaved, Mixed and Yew Woodland | 251 | 3.1 |
| Coniferous Woodland | 956 | 11.9 |
| Boundary and Linear Features | 95 | 1.2 |
| Arable and Horticulture | 534 | 6.6 |
| Improved Grassland | 907 | 11.2 |
| Neutral Grassland | 461 | 5.8 |
| Calcareous Grassland | 26 | 0.3 |
| Acid Grassland | 983 | 12.3 |
| Bracken | 132 | 1.6 |
| Dwarf Shrub Heath | 894 | 11.1 |
| Fen, Marsh and Swamp | 239 | 3.0 |
| Bog | 2044 | 25.6 |
| Standing Open Water and Canals | 89 | 1.1 |
| Rivers and Streams | 21.3 | 0.3 |
| Montane | 38 | 0.5 |
| Inland Rock | 84 | 1.0 |
| Built-up Areas and Gardens | 153 | 1.9 |
| Other land | 74 | 0.9 |
| Unsurveyed Urban Land | 38 | 0.5 |
| TOTAL | 8012 | 100 |

Agricultural holdings in Scotland cover an area of over 6.2 million hectares. This represents about 80% of the total land area of Scotland (7.8 million hectares).

Scotland has a large variety of soils reflecting its geological and climatic diversity. Scotland's soil is predominantly carbon rich, with podzols, peat soils and gleys accounting for more than two-thirds. These soils are found throughout Scotland with the exception of the Central Valley, which is dominated by mineral soils. Soils in the north and west are more acidic on the whole and rich in organic matter.

[15] Countryside Survey (2009) http://www.countrysidesurvey.org.uk/ (accessed 23.05.13)

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Scotland contains a much higher proportion of organic soils than the rest of the UK[16].

The quality of land is highly variable with much of Scotland classified as Less Favoured Areas (suited only for improved grassland and rough grazing). Class 1 agricultural soils (suitable for a very wide range of crops) make up just 0.1% of the total land area according to the Land Capability for Agriculture classification scheme, which is distributed predominantly along the eastern coasts, and the Firths of Forth and Tay.

In 2005, there was estimated to be around 82,034 hectares of land affected by industrial activity in Scotland that may be contaminated. A total of 13 sites (equivalent to 53 hectares) had been determined as 'contaminated land' in Scotland by the end of 2008[17].

### 4.3.4 Wales

#### Geology

Sedimentary rocks underlie the majority of Wales, which are then overlain by a suite of acid soils, characterised by a peaty surface horizon. As a broad overview the following rock types exist in a progression from North West to South East (predominant rock types): Ordovician; Silurian; Devonian; and Carboniferous Peat covers 3% to 4% of Wales and is predominantly acid blanket peat, but with small areas of raised bog and fen peat scattered in lowland areas.[18]

Information obtained from CCW indicates that of the 1,019 SSSIs in Wales, 30% were notified for geological and geomorphological features (based on 2006 data). The Joint Nature Conservation Committee (JNCC) has reported the first six years of Common Standards Monitoring for Geological SSSIs in the UK but limited information is available for SSSIs in Wales in this respect. Cwm Dwythwch in North Wales is one of 68 SSSIs within Wales notified for its waters or water dependant species that has been identified by Environment Agency Wales as being at high/moderate risk from abstraction or flow to the water bodies that are coincident with the site[19].

There are 443 Geological Conservation Review (GCR) sites located in the Wales and three Geoparks (Fforest Fawr, Ynys Môn and Abberley - Malvern Hills also extends into Herefordshire).

#### Land Use and Soils

The average population density of Wales is 148 people per square kilometre[6].

[16] Land Use Strategy Strategic Environmental Assessment Screening and Scoping Report, Scottish Government, March 2010, http://www.scotland.gov.uk/Topics/Environment/Countryside/Landusestrategy/sea
[17] State of the Environment Soil Quality Report, Scottish Environment Protection Agency, 2001
[18] Farming and Countryside, Welsh Assembly Government, http://wales.gov.uk/topics/environmentcountryside/farmingandcountryside/maps/lfamap/?lang=en
[19] CCW (2006) Sites of Special Scientific Interest (SSSIs) in Wales Current state of knowledge Report for April 2005 – Mar 2006. Bangor, Countryside Council for Wales.

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**Table 4.4** shows land cover in Wales as it stood in 2007 and highlights improved grassland as the most common land use cover (covering 25.6% of total land in Scotland).

**Table 4.4 Land Cover in Wales in 2007**[20]

| Wales Land Cover 2007 | '000 ha | % Area |
|---|---|---|
| Broadleaved, Mixed and Yew Woodland | 174 | 8.2 |
| Coniferous Woodland | 106 | 5 |
| Boundary and Linear Features | 48 | 2.2 |
| Arable and Horticulture | 73 | 3.4 |
| Improved Grassland | 730 | 34.4 |
| Neutral Grassland | 263 | 12.4 |
| Calcareous Grassland | 1.2 | 0.1 |
| Acid Grassland | 211 | 9.9 |
| Bracken | 37 | 1.8 |
| Dwarf Shrub Heath | 117 | 5.5 |
| Fen, Marsh and Swamp | 36 | 1.7 |
| Bog | 48 | 2.3 |
| Standing Open Water and Canals | 5 | 0.3 |
| Rivers and Streams | 6 | 0.3 |
| Montane | 0.1 | 0.004 |
| Inland Rock | 8 | 0.4 |
| Built-up Areas and Gardens | 132 | 6.2 |
| Other land | 111 | 5.2 |
| Unsurveyed Urban Land | 15 | 0.7 |
| TOTAL | 2121 | 100 |

Land use in Wales is dominated by agricultural land under pasture and rough grazing (72.3%); a small proportion of the land in Wales is under crop or 'other' types of agriculture (4.2%) (urban land including land not otherwise specified accounts for 9.8% of land area in Wales compared to 19.2% in England). These characteristics reflect the climate, relief and soil type. Although the total proportion of land

[20] Countryside Survey (2009) http://www.countrysidesurvey.org.uk/ (accessed 23.05.13)

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classified as agricultural is similar in England there is a smaller proportion under pasture or rough grazing[21].

The proportion of land area classified as either Grade 1 ('Excellent') or Grade 2 ('Very Good') in Wales is significantly lower than in England (2.5% compared to 16.9%) whilst over 80% of land in Wales is classified as either Grade 4 ('Poor') or Grade 5 ('Very Poor'), significantly higher than in England (22.5%).

In 2005, there was estimated to be around 24,200 hectares of land affected by industrial activity in Wales that may be contaminated[22]. A total of 122 sites had been determined as 'contaminated land' in Wales by the end of March 2007.

## 4.4 Key Environmental Characteristics of those Areas most likely to be Significantly Affected

### 4.4.1 SEA Area 1 Scottish Midlands (including the Inner Forth)

#### Geology

The Midland Valley is fault-bounded by the Highland Boundary Fault to the north and the Southern Upland Fault to the south. Although well known for coal-bearing Carboniferous strata, older Silurian and Devonian sequences include terrestrial sandstone and volcanic lava and younger Permian and Triassic rocks include lava and desert dune sandstone. Volcanic intrusions have created small areas of hilly land such as the Bathgate Hills and the Campsie Fells. The conservation importance of the region's geology is reflected in the large number of GCR sites (200).

The strata in this area have been extensively mined and quarried for minerals, particularly coal and hardrock aggregate. The overlying Quaternary deposits have provided major resources of sand and gravel and brick clay. Legacy of both the minerals industry (coal and metals) and urban development include old mineworkings, contaminated land[23] and polluted groundwaters[24] although a number of spoil bings are now protected[25].

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[21] Environment Agency (2005). Land Use in England and Wales. Available at: www.environment-agency.gov.uk/research/library/data/34407.aspx [Accessed May 2013].

[22] Indicators for Land Contamination, Science Report SC030039/SR, Environment Agency, August 2005.

[23] Puri G and Gordon JE (1998). Soils and sustainability – a Natural Heritage Perspective. Contaminated Soil '98. Volume 1. Proceedings of the Sixth International FZK/TNO Conference on Contaminated Soil, Edinburgh, UK, 17-21 May 1998.

[24] Robins NS and Ball DF (2007). Groundwater Exploitation and Development: Some Current Issues in Scotland. *Water and Environment Journal* 12: 440-444.

[25] Scottish Natural Heritage (1996). Information and Advisory Note Number 50. The Natural Heritage Interest of Bings (Waste Tips) in Scotland. Scottish Natural Heritage. http://www.snh.org.uk/publications/on-line/advisorynotes/50/50.htm

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## Land Use and Soils

The cool, maritime climate of Scotland and resistant rock have led to the development of soils which are generally higher in organic content, more leached and wetter than those in most other European countries[26]. Podzols (infertile, non-productive soils), peat and gley soils (poorly draining, frequently anaerobic soils) cover a substantial proportion of the land area (23.7%, 22.5% and 20.6% respectively), and are found mostly in the north and west, contrasting markedly with the Midlands which contain a higher percentage of mineral soils. Twenty five percent of Scotland's land area is used for arable agriculture and this is mostly restricted to the east, with improved grassland having its greatest abundance in the south west. With the exception of forest (17% cover) much of Scotland is under moorland, blanket bog and montane habitat[26]. The Scottish Midlands has a cover of brown earths and humus-iron podzols in eastern parts with localised alluvial soil cover. In the west, surface water gleys cover much of the region with peaty podzols and peat soils present over upland areas. Broad soil categories and their distribution in Scotland are indicated in **Figure 4.2**.

[26] Towers W, Grieve IC, Hudson G, Campbell CD, Lilly A, Davidson DA, Bacon JR, Langan SJ and Hopkins DA (2006). Scotland's Soil Resource – Current State and Threats. The Macaulay Institute and University of Stirling. Environmental Research Report 2006/01, 181pp.

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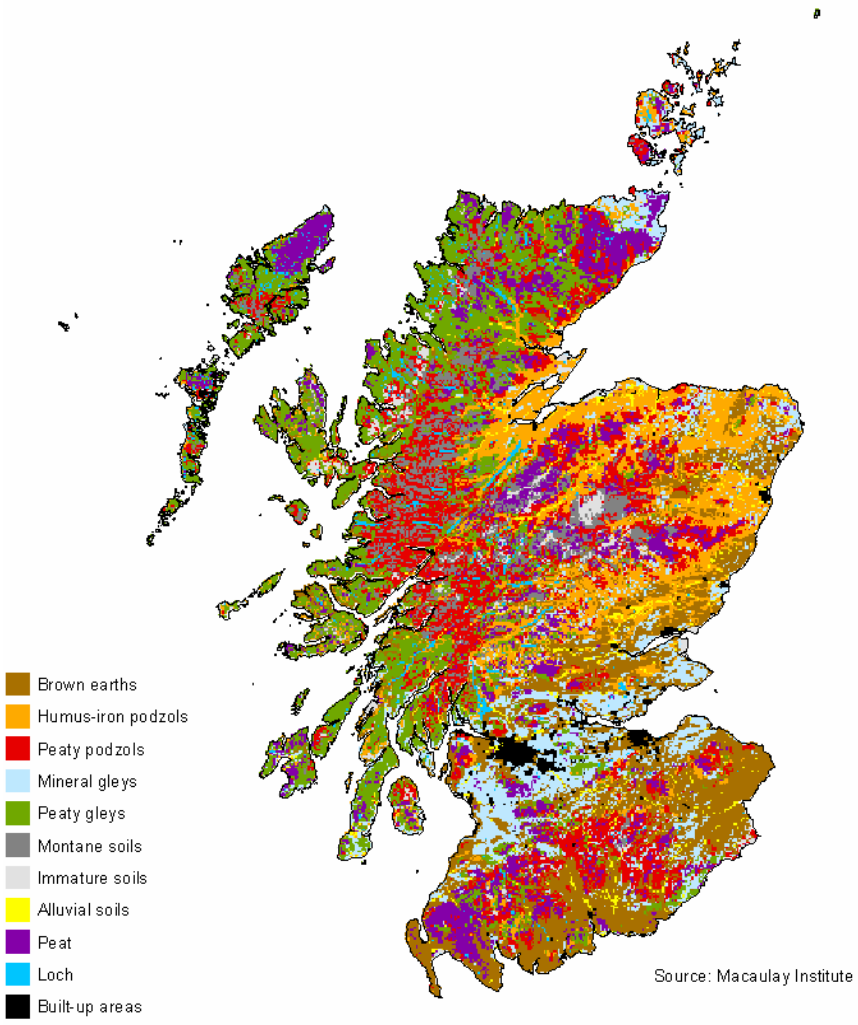
**Figure 4.2 Broad Soil Types and their Distribution in Scotland**




## 4.4.2 SEA Area 2 West Midlands, North West England and Southern Scotland

### Geology

Much of the West Midlands are underlain by predominantly soft reddish sandstone and clays. Jurassic Lias are found as an outlier to the west of Carlisle, and towards the South and East, Carboniferous limestones and shales are found. Carboniferous rocks underlie the region from Wolverhampton to Coventry, and around the Potteries and Telford. These include coal seams and other economically valuable deposits which have been responsible for much of the earlier industrial growth of the large urban centres[27]. To the North, Quaternary superficial deposits cover much of the region including the

[27] Silcock P, Swales V, Manley W, Jones J and Smith G (2003). A Long Term Policy Perspective for Sustainable Agriculture: The Potential Environmental Impacts of CAP Mid- Term Review Proposals. GFA-RACE Partners Limited in association with

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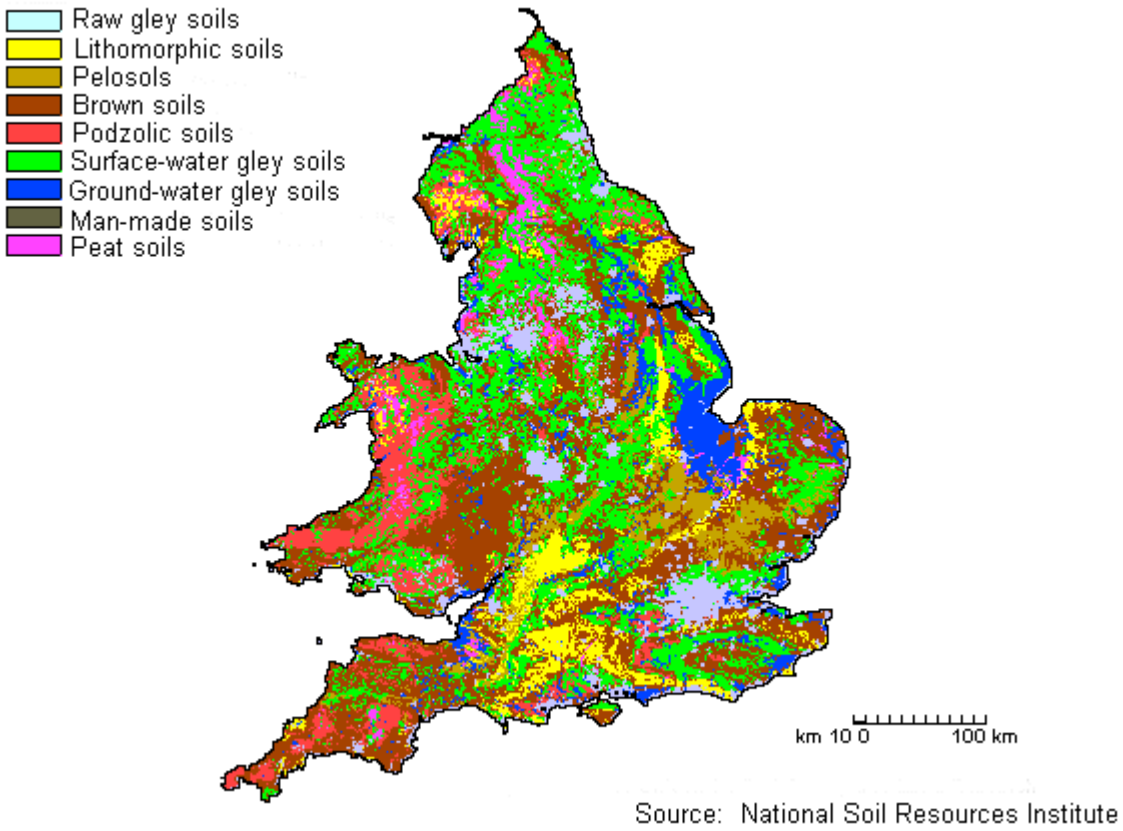
Carboniferous rocks of the Lancashire Coalfield and the sandstones that make up the surrounding Permo-Triassic basin. In contrast, moorland areas are dominated by Millstone Grit. The area of Walney Island is underlain by Triassic sandstones, and backed by Carboniferous limestones similar to the Solway and Borders area, though these are largely covered in glacial drift material. The area of Walney Island is noted for its coastal geomorphology which has been greatly influenced by glacial sedimentation, and is a designated GCR site.

The conservation importance of the region's geology is reflected in the large number of GCR sites (171).

## Land Use and Soils

For England and Wales, the National Soils Research Institute (NSRI), based at Cranfield University, has produced a simplified soils map for England and Wales at a scale of 1:250,000, created by merging some of the 300 soil associations generated for the National Soils Map (NATMAPVector) to just 27 categories. **Figure 4.3** shows a further simplified broad soil distribution map for England and Wales.

**Figure 4.3 Broad Soil Types and their Distribution in England and Wales**




IEEP, final report for Defra, 65pp.

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Urban areas including Birmingham, Manchester and Liverpool cover extensive tracts of land. Brown soils, surface-water gleys and localised podzolic soils cover much of the southern part of the region. To the north, upland areas are characterised by peat soils. Surface-water gleys cover much of the lowlands and groundwater gleys, lithomorphic and brown soils are also present.

### 4.4.3 SEA Area 3 East Midlands and Eastern England

#### Geology

The main geological features include the Carboniferous Limestones, sandstones and Millstone Grit of the Pennines, Northumberland moors and Yorkshire Dales, as well as the coal measures of the Northumberland, Durham and West Yorkshire coalfields. Sherwood Sandstone and mudstones occupy much of the Vale of York. Cretaceous Chalk extends through Humberside to the Wolds and Flamborough Head, and into north-east Norfolk. The conservation importance of the region's geology is reflected in the large number of GCR sites (399).

The industrial prosperity of the region was founded on the North East, Yorkshire–Nottinghamshire and Leicestershire coalfields. Current activities include some opencast and deep coal mining, extraction of limestone, hard-rock aggregate, sand and gravel, gypsum, oil and gas. Legacies of mining activities include hazards such as subsidence and contamination of ground and surface water sources by mining spoil or landfill. Other hazards include landslips, radon gas, ground 'heave' (swelling clays), and flooding.

#### Land Use and Soils

Surface-water gley soils cover much of the northern part of the region with peat soils over upland areas. Brown and lithomorphic (lime-rich soils over chalk or limestone) soils cover large tracts of land from Yorkshire through the East Midlands and Lincolnshire. Groundwater gley soils are extensive around the Humber, the Lincolnshire coast and the Wash. Brown, lithomorphic and surface water gley soils are prominent in Norfolk.

### 4.4.4 SEA Area 4 North and South Wales (including the Dee/Afon Dyfrdwy)

#### Geology

The region has a complex geology being underlain by rocks of Ordovician, Silurian, Devonian and Carboniferous age, in places covered by glacial and post-glacial deposits. These comprise shales, sandstones, limestone, coal, sands, gravels, boulder clay and peat, most of which have been exploited at some time. Carboniferous limestone and Coal Measures represent the most economically important mineral resources and the extensive coal fields of South Wales provided the stimulus for much of the region's industrial development. The conservation importance of the region's geology is reflected in the large number of GCR sites (80).

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### Land Use and Soils

Brown soils cover much of the Brecon Beacons and towards the English border. Podzolic soils and surface-water gleys cover much of South Wales, with brown soils and extensive urban areas near the coast. North Wales has a mixed cover of podzolic, brown, surface-water and groundwater gley soils. A legacy of past metal and coal mining activities has left some soils and river systems contaminated.

## 4.4.5 SEA Area 5 Southern and South West England

### Geology

The open rolling downs and heaths which characterise much of the region are underlain largely by chalk. Wealden Greensand forms a conspicuous ridge running east to west across Surrey and Kent terminating in coastal cliffs at Folkestone Warren. Further west, chalk downlands are intersected by Greensand hills and clay vales in Dorset and Wiltshire. Granite underlies much of Devon with sedimentary rocks, especially sandstone, limestone, shale and chalk occurring to the east. Past geological history has created conditions for oil and gas generation and entrapment for example at the Wytch Farm oil field in Dorset which in 1993 had an estimated 41.1 million tonnes of recoverable oil reserves, including an offshore extension[28]. The conservation importance of the region's geology is reflected in the large number of GCR sites (640). The Dorset and East Devon Coast World Heritage Site has been designated for its important fossil sites and coastal geomorphologic features.

### Land Use and Soils

Brown soils, lithomorphic, surface-water and groundwater gley soils cover much of Kent and Sussex. Lithomorphic soils dominate in central and western parts with brown, surface-water gley and podzolic soils also present. In Devon, brown and podzolic soils dominate, with groundwater gley soils along the coastal fringe of the Severn Estuary.

Some areas in the south west have a historic legacy of mine water polluted with heavy metals, contaminated land and the threat of subsidence.

## 4.5 Summary of Existing Problems Relevant to Onshore Oil and Gas Licensing

The following existing problems for land use, geology and soils have been identified.

[28] Crumpton CA, Goodwin MJ and Barne JH (1996). Oil and Gas Developments. In: Barne JH, Robson CF, Kaznowska SS, Doody JP and Davidson NC. Coasts and Seas of the United Kingdom. Region 9 Southern England: Hayling Island to Lyme Regis. Joint Nature Conservation Committee, Peterborough, pp. 210-211.

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## Geology

- Mining activities in all of the SEA Areas have left a legacy of hazards in some parts of the UK such as landslips, subsidence, contamination of ground and surface water sources from metals such as tin, copper and arsenic, and radon gas and flooding; and

- A report by AEA for the European Commission[29] on the potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe identifies that a key challenge is to ensure the correct identification and selection of geological sites, based on a risk assessment of specific geological features and of potential uncertainties associated with the long-term presence of hydraulic fracturing fluid in the underground, although risk of significant induced seismic activity was considered to be low.

## Land Use and Soils

- Significant areas across the UK carry a burden of contamination from industrial activity, although this is progressively being cleaned up as sites are redeveloped. Whilst contamination is remediated during redevelopment, the process can be expensive;

- Disturbance of contaminated sites carries the risk of pollution pathways being created or re-opened for any existing ground contamination;

- There is currently increasing pressure on rural and agricultural land from developers as urban areas expand. Future population growth leading to an increase in the need for housing and related urban development infrastructure will put more pressure on protected land including important geological sites;

- Soils in England continue to be degraded by human actions including intensive agriculture, historic levels of industrial pollution and urban development, making them vulnerable to erosion (by wind and water), compaction and loss of organic matter[30]. Effects include:

  - Soil erosion by wind and rain: erosion affects both the productivity of soils but also water quality and aquatic ecosystems;

  - Compaction of soil reduces agricultural productivity and water infiltration, and increases flood risk through higher levels of run-off;

  - Organic matter decline: the loss of soil organic matter reduces soil quality, affecting the supply of nutrients and making it more difficult for plants to grow, and increases emissions to the atmosphere; and

  - Impacts on soil carbon sequestration and the release of carbon to the atmosphere.

[29] AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed May 2013]

[30] http://www.defra.gov.uk/food-farm/land-manage/soil/

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- As the climate (including temperature and rainfall patterns) changes in the future, it is likely that soils have the potential to be further degraded, both as a result of the direct and indirect impacts of climate change, for example as land managers adapt their practices and the crops that they grow. Climate change and loss of organic matter are the most significant threats to Scottish soils[31]. The effect of industry, agricultural practices, forestry and climate change upon soils, particularly carbon rich peat soils, is also a key issue. Key pollutants include chemicals, oil or waste. Organic waste, including sewage sludge, is one of the main sources of heavy metal contamination of soils from humans;

- In Wales[81] the small proportion of land that is classified as 'best and most versatile' agricultural land needs to be conserved. There is also a need to protect soils in uplands and wetlands which contain high amounts of carbon and are vulnerable to acidification[32];

- Of UK land 5.6% is currently classed as 'built up.' Development pressure remains a constant factor in parts of the country, and it is not expected that previously-developed land will be able to fully deliver the UK's future needs. This will continue to place development pressures in rural areas and the urban fringe;

- When greenfield land is used for development, it is likely to result in the permanent loss of that land from other uses such as agriculture. There are similar pressures to build across each of the UK administrations, however the details differ slightly between each;

- The 2008 State of the Natural Environment report[33] noted that within rural England, the area of developed land had increased by about 4% since 1990, largely by using agricultural land and that between 1998 and 2003 substantial greenfield development has occurred near many urban areas, notably at key growth points, but also in former coalfield belts. It said the pace of development within England was increasing, particularly for housing in response to demand and a historic shortfall in housing provision and that this was expected to have a dramatic effect on a large part of central and southern England though the series of the then identified Growth Areas and Growth Points;

- With respect to woodlands, Woodlands for Wales (2009) identifies a need to ensure that:
  - more woodlands and trees are managed sustainably;
  - woodland ecosystems are healthy and resilient;
  - woodlands are better adapted to deliver a full range of benefits;
  - woodland cover in Wales increases;

[31] State of the environment and trends – Scotland, http://www.seaguidance.org.uk/11/State-of-the-Environment.aspx
[32] Environment Strategy for Wales, Welsh Assembly Government, 2006, http://wales.gov.uk/topics/environmentcountryside/epq/envstratforwales/strategy/?lang=en
[33] Natural England (2008) http://www.naturalengland.org.uk/publications/sone/default.aspx

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- the management of woodland and trees is more closely related to that of other land uses; and
- urban woodlands and trees deliver a full range of benefits.

- The AEA Report highlights that development associated with hydraulic fracturing potentially covers a wider area than is typical of conventional gas. Land use requirement is greatest during the actual hydraulic fracturing stage and lower during the production stage with surface installations requiring an area of approximately 3.6 hectares per pad for high volume hydraulic fracturing during the fracturing and completion phases; and
- The AEA Report also highlights that it may not be possible to fully restore sites in sensitive areas following well completion or abandonment, which could result in, inter alia, the loss of farmland.

## 4.6 Likely Evolution of the Baseline

### 4.6.1 UK

#### Geology

As part of the JNCC Common Standards Monitoring for designated sites, the features for which certain sites are designated were assessed to determine site condition. For geological sites, the principle designations are GCRs and SSSIs, many of which occupy the same or part of the same area of land. Site attribute condition was compared with its target value, the outcome of which resulted in a site being classified as favourable, unfavourable, unfavourable-recovering, or destroyed (in whole or in part). The overall results of the survey for broad geological features are indicated in **Table 4.5**, and the spatial distribution of sites and their condition in shown in **Figure 4.4**.

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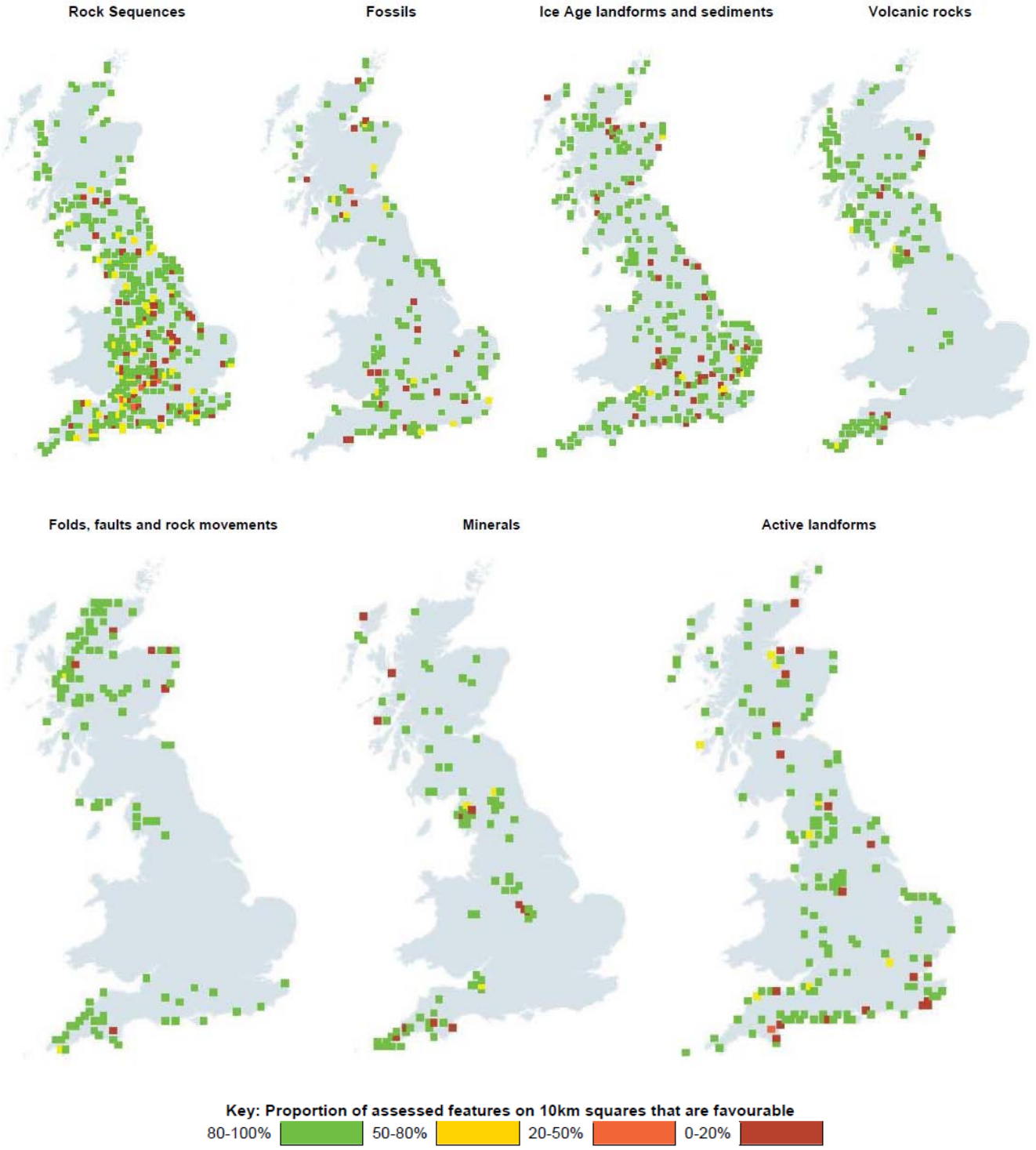
**Figure 4.4 Condition of SSSI Features (Where Unfavourable-Recovering is Counted as Unfavourable)**




Source: Williams, JM (ed.) (2006). Common Standards Monitoring for Designated Sites: First Six Year Report. Peterborough, JNCC.

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**Table 4.5 Condition of Geological Features**

| Category | No. of Assessments | % Favourable and Unfavourable-Recovering | % Destroyed (whole or part) |
|---|---|---|---|
| Rock sequences | 859 | 84.5 | 1 |
| Fossils | 274 | 87.6 | 1 |
| Ice Age landforms & sediments | 410 | 90.2 | 1 |
| Volcanic rocks | 215 | 95.3 | - |
| Folds, faults & rock movements | 139 | 93.5 | 1 |
| Minerals | 120 | 85.8 | 8 |
| Active landforms | 225 | 89.3 | 1 |
| Total | 2242 | 88.1 | 1.3 |

Source: Williams, JM (ed.) (2006). Common Standards Monitoring for Designated Sites: First Six Year Report. Peterborough, JNCC.

The main findings of arising from the results presented above are summarised below by category:

- **Rock Sequences**: The rock sequences category has the largest number of sites in any of the broad categories studied, with stratigraphic sequences representing the most abundant feature in this assessment (ca. 80%). A high number of sites (ca. 83%) are in favourable condition, and those which are not are principally so due to the feature being obscured. Management agreements are in place for many sites, which include measures to keep features exposed;

- **Fossils**: Williams (2006) accounts for ca. 75% of sites which have fossils indicated as a notified feature, 87% of which are in a favourable condition. Like many geological sites, many are considered unfavourable because features are obscured rather than damage inflicted as a result of fossil collectors;

- **Ice Age Landforms and Sediments**: About 75% of Quaternary features, which includes glacial landforms and sediments, have been accounted for in the JNCC Common Standard Monitoring assessment, 88% of which are reported as being in favourable condition. 1% of features are reporting as having being destroyed in whole or in part, with the remainder being unfavourable or recovering, mostly where sites are obscured;

- **Volcanic Rocks**: Of the 70% coverage of volcanic (igneous) rock sites assessed, 95% were regarded as favourable. Most igneous areas are robust and less likely to be affected by activities which may be damaging to soft rock or sedimentary landscapes. The unfavourable condition of most sites results from being obscured, probably by vegetation cover or scree;

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- **Folds, Faults and Rock Movements**: Only 40% of sites in this category were accounted for, and 94% were in favourable condition. Like volcanic rock areas, the robust nature of the rocks and features in this category makes them less susceptible to damage than soft-rock, sedimentary and more dynamic landscapes;
- **Minerals**: Just over 60% of sites are accounted for in the assessment, of which 86% are regarded as in favourable condition. There is a relatively large amount of partially or wholly destroyed sites (7.5%) compared with the other broad geological categories. Apart from being obscured, minerals have been the subject of anthropogenic exploitation and at some sites most or all of the features have been removed; and
- **Active Landforms**: Just over 60% of active landforms (including caves, karst features, fluvial and coastal geomorphology) have been accounted for in the assessment, 86% of which are in favourable condition. The data collected for this category is too sparse to detect any trends in the reasons for the condition of sites. Active landforms are often large and their dynamic, complex nature makes them particularly difficult to monitor.

The increase in public and policy awareness regarding geological SSSI sites and Geoparks may lead to an increase in the number of sites protected and managed. As quarries come to the end of their working lives there is potential for their identification and conservation as geologically important sites.

## Land Use and Soils

The estimated broad habitat type in the UK and how it has changed from 1984 to 2007 was calculated by the Office of National Statistics [34] and is shown in **Table 4.6**. It shows that the area of land cover under arable and horticulture has decreased by 9.1% between 1998 and 2007. The area of grassland land cover has generally increased with improved grassland increasing by 5.7%. Built-up areas and gardens have increased by 3.4% between 1998 and 2007.

**Table 4.6 Estimated Area ('000 ha) of Broad Habitats in the UK in 1984, 1990, 1998 and 2007**

| Land Type | 1984 | 1990 | 1998 | 2007 | % Change between 1998 and 2007 |
|---|---|---|---|---|---|
| Broadleaved, mixed and yew woodland | 1317 | 1343 | 1328 | 1406 | 5.9 |
| Coniferous woodland | 1243 | 1239 | 1386 | 1319 | -4.8 |
| Linear features | 491 | 581 | 511 | 496 | -2.9 |
| Arable and horticulture | 5283 | 5024 | 5067 | 4608 | -9.1 |
| Improved grassland | 5903 | 4619 | 4251 | 4494 | 5.7 |
| Neutral grassland | 467 | 1669 | 2007 | 2176 | 8.4 |

[34] http://www.statistics.gov.uk/STATBASE/Expodata/Spreadsheets/D5325.xls

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| Land Type | 1984 | 1990 | 1998 | 2007 | % Change between 1998 and 2007 |
|---|---|---|---|---|---|
| Calcareous grassland | 75 | 78 | 61 | 57 | -6.6 |
| Acid grassland | 1476 | 1821 | 1503 | 1589 | 5.7 |
| Bracken | 439 | 272 | 315 | 260 | -17.5 |
| Dwarf shrub heath | 1388 | 1436 | 1299 | 1343 | 3.4 |
| Fen, Marsh, Swamp | 428 | 427 | 426 | 392 | -8.0 |
| Bog | 2303 | 2050 | 2222 | 2232 | 0.5 |
| Standing open waters[1] | 284 | 200 | 196 | 204 | 4.1 |
| Rivers and streams[1] | 70 | 70 | 65 | 58 | -10.8 |
| Montane | 41 | n/a | 41 | 42 | 2.4 |
| Inland rock | 38 | 76 | 111 | 84 | -24.3 |
| Built-up areas and gardens | 1268 | 1266 | 1279 | 1323 | 3.4 |
| Other land | n/a | 57 | 107 | 113 | n/a |
| Unsurveyed land[2] | n/a | 522 | 522 | 522 | n/a |
| **Total[3]** | **22514** | **22632** | **22601** | **22627** | |

It is not known whether the decrease in arable and increase in improved grassland is likely to continue at the same rate in the future although it does seem likely that the extent of built up areas will continue to increase as some development will inevitably take place on greenfield land.

The total area of agricultural land across the UK has declined slightly over the last 27 years from 18,753 hectares in 1984 to 18,263 hectares in 2011 (a reduction of 2.6%)[35]. The clearest trend in land use change in the UK over the past quarter of a century has been the conversion of land from agriculture to forestry and woodland. Forestry Commission estimates of the area of forest and woodland cover in the UK imply an average annual net increase of 25,000 hectares since 1980, equivalent to 1.05% per year. There seems to have been some reduction in the rate of growth from 2000 to 2008 with the net increase in tree cover in this period being about 7,000 hectares per annum (or 0.24%). These recent patterns of woodland expansion continue a very clear upwards trend, which has led to a doubling of the area of UK woodland since World War II.

New planting has predominantly responded to subsidy and has involved the expansion of small broadleaved woodlands within agricultural holdings. The average annual increase in woodland on farms (14,500 hectares per annum) accounts for more than half of the net increase in the wooded area as a whole. The area of woodland within agricultural holdings has thus more than doubled since the early 1980s.

[35]Defra (2013) Agricultural Land Use, https://www.gov.uk/government/statistical-data-sets/agriculture-in-the-united-kingdom

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A number of threats to the UK soil resource have been recognised in England, Scotland and Wales including:

- loss of soil organic matter and erosion;
- climate change;
- loss of soil biodiversity;
- structural degradation and compaction;
- contamination;
- loss of soil to development (e.g. soil sealing), including urbanisation and agriculture; and
- threat to soil as a cultural resource (e.g. archaeological protection and UK environmental records).

UK soils store around 10 billion tonnes of carbon[36]. A study by the National Soil Inventory (NSI) found that between 1978 and 2003 there had been a loss in soil organic carbon of 0.6% per year for all soil types, though with higher losses (2% per year) in those which are particularly organic rich[37]. The loss of this carbon may also have climate change implications.

Compaction may result from a number of activities including intensive mechanised agriculture, poor timing of cultivation, over-stocking and overworking of land[36]. The result is a reduced plant yield, habitat loss for larger fauna, $NO_2$ losses, reduced water holding and soil infiltration capacity and an increased risk of flooding and erosion. The principle causes of accelerated erosion (i.e. that which exceeds background levels) in England, Wales and Scotland are:

- intensive cultivation - particularly where compacted by machinery and left open to rain;
- trampling by animals;
- poor forestry practice (e.g. during road construction and harvesting); and
- runoff from urban land surfaces.

Other causes include wind erosion, tillage losses and soil co-extracted with root vegetables[38].

[36] Environment Agency (2004). The State of Soils in England and Wales. Environment Agency, Bristol, 28pp.

[37] Bellamy PH, Loveland PJ, Bradley RI, Lark RM and Kirk GJD (2005). Carbon Losses from all Soils Across England and Wales 1978-2003. Nature 437: 245-248.

[38] Quine TA Van Oost K, Walling DE and Owens PN (2006). Development and Application of GIS-Based Models to Estimate National Rates of Soil Erosion by Tillage, Wind and Root Crop Harvest. University of Exeter Report to Defra, Project SP08007,

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There is still some uncertainty about the intensity and nature of any threats posed by climate change with regard to soil, though the following possibilities have been identified:

- A probable reduction in soil organic matter. Change is most critical in peat and organic-rich soils which are a major carbon store;
- A requirement for new management techniques - soils may become more susceptible to compaction;
- Biomass production may fall due to higher drought duration;
- Soil erosion may increase, particularly in peaty soils, if winters are to become wetter;
- Acidification and nutrient mobility will change with rainfall and temperature; and
- There may be more demand for irrigation, particularly in the south of England[26, 36]

As indicated above, UK soils store a substantial amount of carbon (~10 billion tonnes), and land use which allows the release of carbon accounts for ~5% of UK annual greenhouse gas emissions, offset by up to 2% by forestry and farming uptake[36].

Soil biodiversity is an emerging field of soil science and there is a low level of understanding and few relevant datasets [26], and it is not known what effects pollutants including metals and pesticides have on soil organisms important for maintaining soil quality[36]. Organisms include bacteria, fungi and invertebrates, 100 of which are regarded as BAP species, and like many other facets of the UK's natural environment, soil habitats are host to introduced species such as the predatory New Zealand flatworm[36].

Contaminated land may be the result of a legacy of old industrial practices or more recent incidents and is regarded as 'contaminated' in legislation (Part 2A of the Environmental Protection Act 1990) where there is a threat to the natural environment or public health. The area of contaminated land in the UK cannot be reliably estimated, though the Environment Agency estimates that ~325,000 sites covering 300,000 hectares (~2% of the area of England and Wales) are affected. The most common pollutants at sites identified by the Environment Agency were heavy metals and inorganic/organic compounds[39]. Other contamination results from pollutant deposition and direct application, leading to acidification and nutrient enrichment.

The soil of the UK has gradually built up since the end of the last Ice Age ~10,000 years ago during the current Holocene warm period, and even before in the case of palaeosols. Soils provide protection for a great deal of the UK's archaeological resource which remains covered, protecting it from redistribution, erosion, and in the case of peat, may provide exceptional preservational contexts. Undisturbed

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University of Exeter, UK, 59pp.

[39] Environment Agency (2009) Dealing with contaminated land in England and Wales, http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/geho0109bpha-e-e.pdf

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peatlands also preserve the environmental record of areas all over the UK pertaining to the Holocene which can be reconstructed using palaeo-archaeological methods (e.g. plant macrofossil, microfossil, entomological and sedimentary analyses). In many cases the soils themselves are a cultural construct such as the thickened soils of St Kilda[40 41], and the rig-and-furrow formations which are the most abundant archaeological feature in Scotland[42].

Land use including agriculture and building work have the potential to disturb archaeological contexts, which if not appropriately studied, could be damaged. Since the middle of the last century in England, 23,500 ancient monuments have been destroyed, with a total 10% destroyed and 30% damaged by agricultural practices[36]. Around 3,000 Scheduled Monuments are actively ploughed, and a third of all sites are on ploughed land, with 2% at high risk[36]. In Wales, 15% of scheduled ancient monuments have deteriorated due to natural, agricultural and other causes. In Scotland, there is a lack of monitoring with regard to issues relating to the preservation of archaeological features, and indeed the extent and distribution of cultural soils[26]. In addition, there is a general lack of data on changes in soil condition which may influence preservation conditions[26].

As there are now more stringent statutory controls on land contamination and remediation, increased areas of historic contamination are being remediated and fewer areas are being left in a contaminated state following decommissioning of commercial and industrial sites.

There are a number of European directives that are being implemented that may influence the way in which land contamination is managed in the future (i.e. the Environmental Liabilities, Soil, Water, Groundwater and the Waste Framework Directives). The implementation of these regimes into UK legislation is likely to affect how contaminated land is dealt with.

### 4.6.2 England

#### Geology

Natural England[43] has identified the following key threats to geology (which are also equally applicable to Scotland and Wales):

- inappropriate development;

[40] Meharg AA, Deacon C, Edwards KJ, Donaldson M, Davidson DA, Spring C, Schrimshaw C, Feldmann J, Raab A, Ellam R (2005). Ancient Manuring Practices Pollutes Arable Soil at the St Kilda World Heritage Site, Scottish North Atlantic. Chemosphere 64: 1818-1828.

[41] Donaldson MP, Edwards KJ, Meharg AA, Deacon C and Davidson D (2009). Land Use History of Village Bay, Hirta, St Kilda World Heritage Site: A Palynological Investigation of Plaggen Soils. Review of Palaeobotany and Palynology 153: 46-61.

[42] Halliday S. (2003), Rig-and-furrow in Scotland. In: Govan S (ed.) Medieval or Later Rural Settlement in Scotland: 10 years on. Historic Scotland, pp.69-81.

[43] See http://www.naturalengland.org.uk/ourwork/conservation/geodiversity/threats/default.aspx

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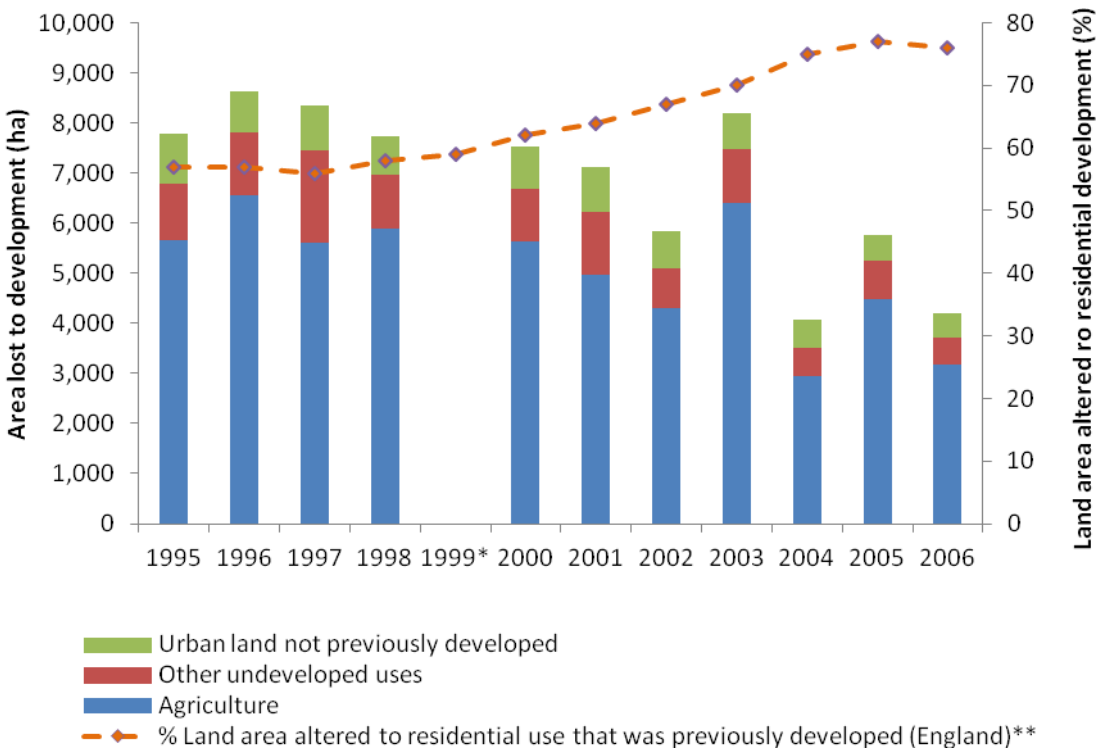
- natural degradation;
- irresponsible specimen collecting; and
- irresponsible recreational activities.

## Land Use and Soils

**Figure 4.5** shows the origin and amount of soil lost to development for each year from 1995 to 2006 for England and Wales. Overall, the amount of soil lost to development has gradually decreased from nearly 8,000 hectares in 1995 to 4,200 hectares in 2006. There was a noticeable increase in 2003 to over 8,000 hectares. In 2000, 10% of England and Wales was categorised as urban or suburban, predicted to rise to 12% by 2016.

**Figure 4.5 Soils Lost to Development (England and Wales)**




Source: Department for Communities and Local Government Land Use Change Statistics Webpage (http://www.communities.gov.uk/planningandbuilding/planningbuilding/planningstatistics/landusechange/)

In 2009, there was an estimated 61,920 hectares of previously developed land in England, down 2.9% from 63,750 hectares in 2008. An estimated 33,390 hectares of previously developed land were vacant or derelict, 54% of the total. The conversion of previously undeveloped land accounted for an average of 5,188 hectares per annum between 2000 and 2009 although the rate of development on undeveloped

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land decreased from 7,530 hectares in 2000 to 2,300 hectares in 2009. Of all greenfield land developed in 2009, 51% was for residential uses, 13% for minerals, landfill and defence, 12% for industrial, commercial and related activities, and the remaining 24% for other developed uses including transport and utilities[44].

There have also been changes in the changes to land use related to broad habitat types. Between 1998 and 2007 in England there was a significant increase in the area of Broadleaved Woodland (5.8%), Neutral Grassland (12.6%), Dwarf Shrub Heath (15.1%) and Standing Open Water and Canals (5.3%). The increase in the area of Dwarf Shrub Heath between 1998 and 2007 followed a decrease in area between 1990 and 1998. The increase in the area of Standing Open Water and Canals[6] recorded in England between 1998 and 2007 continued the increases recorded by Countryside Survey since 1990[45].

On the other hand, there was a significant decrease in the area of Arable and Horticulture Broad Habitat (8.8%) in England across the same period. No statistical change in extent was detected in the Coniferous Woodland, Improved Grassland, Bracken, Bog, Fen, Marsh and Swamp and Calcareous Grassland Broad Habitats in England between 1998 and 2007.

An estimated 25,000 inspections of land took place in England between 2000 and 2007[46].

The loss of organic matter from soils influences its structure and is linked to erosion and soil compaction, reduced agricultural productivity and soil biota diversity. Recent surveys in England and Wales as part of a programme for the National Soils Inventory reveal that the loss of organic matter is a series issue[26]. Since 1980 there has been an estimated average loss in organic matter of:

- 15% in arable soils and rotational grass soils;
- 16% in soils under permanently managed grassland; and
- 23% in agriculturally managed soils and semi-natural land[47].

17% of soils in England and Wales show signs of erosion which leads to a reduction in water retention and filtering, and the mobilisation of sediment (which may contain pesticides, nutrients and metals) to watercourses or floodplains[36].

In the 2012 Farm Practices Survey for England[48], 20% of farmers stated that they had experienced soil

[44] Defra (2013) NLUD PDL – Results and Analysis, http://www.homesandcommunities.co.uk/nlud-pdl-results-and-analysis.
[45] Countryside Survey for England (2007) http://www.countrysidesurvey.org.uk/sites/default/files/pdfs/reports2007/england2007/CS-England-Results2007-Chapter02.pdf
[46] Dealing with contaminated land in England and Wales A review of progress from 2000-2007 with Part 2A of the Environmental Protection Act, Environment Agency, January 2009
[47] Department for Environment, Food and Rural Affairs (2006). Sustainable Farming and Food Strategy – Indicator Data Sheet. Headline Indicator H5: Soil Quality – Soil Organic Matter. Department for Food and Rural Affairs, 2pp.

[48] Defra (2012) Farm Practices Survey 2012, https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs/series/farm-practices-survey

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compaction throughout the soil profile. For the 12 months leading up to August 2012, the Farm Practices Survey 2012 indicated that the most common actions taken to reduce compaction were removing compaction from headlands after harvest, enhancing drainage, using low pressure set-ups and crop rotation.

Key objectives and targets within the Soil Strategy for England include[49]:

- To undertake further research in areas including best practices to protect and enhance levels of soil organic matter, contribution of soil management to flood mitigation and best practices to prevent and remediate soil degradation;
- To significantly reduce the rate of loss of stored soil carbon by 2020;
- To halt the decline of soil organic matter caused by agricultural practices in vulnerable soils by 2025; and
- To introduce a reviewed Soil Protection Review to make it a more effective tool for soil management.

The Natural Environment White Paper (2011) established an ambition that by 2030 all of England's soils will be managed sustainably and degradation threats tackled successfully, in order to improve the quality of soils and to safeguard their ability to provide essential ecosystem services and functions for future generations.

### 4.6.3 Scotland

#### Geology

No further information has been identified beyond those issues identified in **Section 4.6.2**.

#### Land Use and Soils

In Scotland, most land is currently being lost to development in the central belt, with development in this area having doubled since the early 1980s and 1990s, though soil sealing in urban areas has not been accurately calculated as gardens, parks and other open spaces have not been accounted for[26].

Scotland's land cover has been studied in both the Countryside Survey and by the National Countryside Monitoring Scheme (NCMS). The latter study is arguably outdated, being based on aerial photography interpretation with the last dataset dating to 1988. The principal findings with regard to this section include:

- Built land increased by 46% mainly on grassland and farmland;

[49] Safeguarding our Soils: A Strategy for England, Defra, 2009, http://www.defra.gov.uk/environment/quality/land/soil/documents/soil-strategy.pdf

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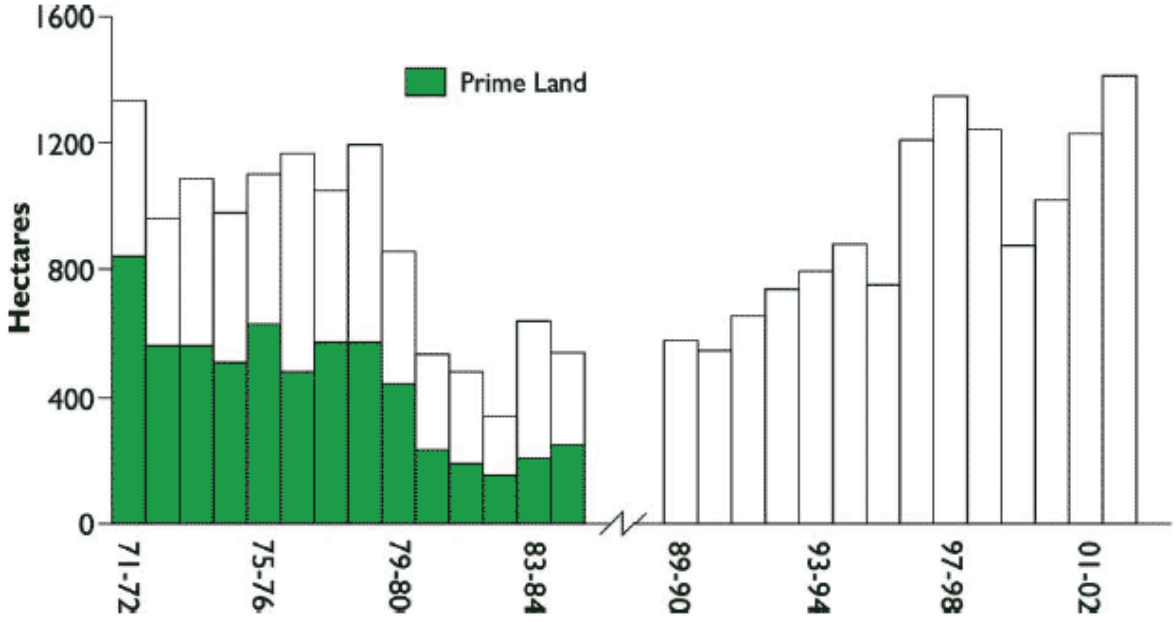
- Recreational land increased by 138%;
- Bare ground increased four-fold due to peat extraction and urban road development;
- Transport corridors increased by 22%; and
- Upland surfaced tracks increased by 29%.

**Figure 4.6** indicates the area of agricultural land in Scotland lost to development over the last 30 years, which unlike England and Wales, has been recently increasing.

**Figure 4.6 Conversion of Agricultural Land (Scotland)**




Source: Towers et al. (2006)

In Scotland, since 2006 there has been a 3% decrease in derelict and urban vacant land, from 11,282 hectares to 10,984 hectares in 2012. Since 2006, an average of 422 hectares of derelict and urban vacant land was brought back into use each year[50].

The area of Broadleaved Woodland, Improved Grassland and Acid Grassland Broad Habitats increased by 19.5% in Scotland between 1998 and 2007. There was a corresponding decrease of 7.1% in the area of Coniferous Woodland. The area of the Arable and Horticulture Broad Habitat decreased by 13.6% between 1998 and 2007. There was a corresponding increase of 9.1% in the area of Improved Grassland, but no significant increase in the area of Neutral Grassland across Scotland as a whole. The

[50]The Scottish Government (2012) Scottish Vacant and Derelict Land Survey 2012, http://www.scotland.gov.uk/Topics/Statistics/Browse/Planning/Publications/SVDLSTablesCharts

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changes in the areas of Broad Habitats in Scotland reflect short-term influences, such as agricultural economics, and medium term influences, such as woodland planting and harvesting[51].

Scotland's Land Use Strategy takes a strategic approach to the challenges facing land use in Scotland and sets out the following vision: "*A Scotland where we fully recognise, understand and value the importance of our land resources, and where our plans and decisions about land use deliver improved and enduring benefits, enhancing the wellbeing of our nation*."

In Scotland, an estimated 27,000 inspections of land with the potential to be contaminated have already been or are in the process of being undertaken (equating to an estimated 40% of all such sites). A total of 807 sites (equivalent to 1,864 hectares) of land that was affected by contamination have been remediated[52]

There is some evidence that soils are becoming slightly less acidic in some areas of Scotland due to reduced acid deposition. Ecological damage to soils caused by run-off from roads and urban areas is likely to increase. Agricultural land is being developed at twice the rate as in the 1990s. This development is likely to have occurred on some of Scotland's versatile and productive soils. There is some evidence that levels of organic matter may be declining[53].

Studies in Scotland indicate that land-use practices which leave bare soil during the winter months are particularly damaging, especially in lowland sandy/cultivated mineral soils, though single events may be confined to small areas. In the uplands, peat has been shown to be susceptible to erosion which has implications for carbon storage and erosion of any soil has implications for most soil 'functions'[26].

The Scottish Soil Framework (2009) aims to achieve 13 soil outcomes[54]:

- soil organic matter stock protected and enhanced where appropriate;
- soil erosion reduced and where possible remediated;
- soil structure maintained;
- greenhouse gas emission from soils reduced to optimum balance;
- soil biodiversity, as well as above ground biodiversity, protected;
- soils making a positive contribution to sustainable flood management;
- water quality enhanced through improved soil management;

[51] Countryside Survey 2007, http://www.countrysidesurvey.org.uk/reports2007.html
[52] Dealing with land contamination in Scotland: A review of progress 2000-2008, Scottish Environment Protection Agency, 2008, http://www.sepa.org.uk/land/land_publications.aspx
[53] State of the environment and trends – Scotland, http://www.seaguidance.org.uk/11/State-of-the-Environment.aspx
[54] Scottish Soil Framework (2009) http://www.scotland.gov.uk/Publications/2009/05/20145602/0

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- soil's productive capacity to produce food, timber and other biomass maintained and enhanced;
- soil contamination reduced;
- reduced pressure on soils by using brownfield sites in preference to greenfield;
- soils with significant historical and cultural features protected;
- knowledge and understanding of soils enhanced, evidence base for policy review and development strengthened; and
- effective co-ordination of all stakeholders' roles, responsibilities and actions.

## 4.6.4 Wales

### Geology

No further information has been identified beyond those issues identified in **Section 4.6.2**.

### Land Use and Soils

In Wales, between 1998 and 2007 the area of built land has increased by 12.5%. Most Broad Habitats did not change significantly in area between 1998 and 2007 when averaged across Wales as a whole. However, a number of statistically significant changes in area have been noted between 1998 and 2007. In the lowland zone of Wales Broadleaved, Mixed and Yew Woodland increased, and in the upland zone, Arable and Horticultural Land increased, Neutral Grassland decreased and Acid Grassland increased. The possible drivers of these changes are unknown and require further research.

No baseline data has been identified in relation to previously developed land in Wales and therefore trends could not be established. However, similar to national (UK) trends, it is expected that current trend in land use is generally towards increased development on previously developed land.

In Wales, an estimated 6,500 inspections of land with the potential to be contaminated have been completed between 2000 and 2007[55].

Included within the Environment Strategy for Wales is the objective to manage soil and to safeguard its ability to support plants and animals, store carbon and provide other important ecosystem services. Changes in soil carbon will be used as an indicator to measure progress of the objective and further indicators are to be selected when the UK Soil Indicator Consortium reports[56].

[55] Dealing with contaminated land in England and Wales A review of progress from 2000-2007 with Part 2A of the Environmental Protection Act, Environment Agency, January 2009
[56] Environment Strategy for Wales (2008) http://cymru.gov.uk/topics/environmentcountryside/epq/envstratforwales/strategy/;jsessionid=PQ2DN1rZNVdZ3pGhRYq4jRYlyc

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### 4.6.5 SEA Areas

#### Geology

There is little comparable data on the long term trends associated with geology at the regional scale. **Figure 4.3** above does serve to highlight that geological sites across the SEA areas are largely in favourable condition although there are pockets where the proportion of assets assessed as being in favourable condition is relatively low particularly within Southern and South West England and East Midlands and Eastern England.

#### Land Use and Soils

Similar to geology, there is also little comparable data on the long term trends associated with land use and soils at the regional scale.

## 4.7 Assessing Significance

The objectives and guide questions related to land use, geology and soils which have been identified for use in the appraisal of the effects of Licensing Plan proposals are set out in **Table 4.7**, together with reasons for their selection.

**Table 4.7 Approach to Assessing the Effects of the Licensing Plan on Land Use, Geology and Soils**

| Objective/Guide Question | Reasoning |
|---|---|
| **Objective: To conserve and enhance soil and geology and contribute to the sustainable use of land** | The SEA Directive requires that likely significant effects on soil and resources be taken into account in the Environmental Report.<br>National planning policy and legislation in England, Scotland and Wales and local development plans concern the contribution of spatial planning towards sustainable development including in respect of the best use of land and protection of geological assets. |
| Will the activities that follow the licensing round have an effect on soil quality/function, variety, extent and/or compaction levels? | Loss of soil quality, variety, extent or an increase in soil compaction will lead to degradation of soil.<br>The European Thematic Strategy on Soil Protection seeks the protection and sustainable use of soil preventing soil degradation and ensuring restoration of degraded soils. |
| Will the activities that follow the licensing round increase the risk of significant land contamination? | Environment Act 1995 seeks to protect and preserve environment against pollution to land.<br>The Soil Strategy for England and Scottish Soil Framework include objectives on reducing/preventing soil pollution and contamination. |
| Will the activities that follow the licensing round have an effect on any known and existing contamination? | Significant areas of the UK carry a burden of contamination from industrial activity. Disturbance of contaminated sites carry the risk of pollution pathways being created or re-opened for existing ground contamination. |



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| Objective/Guide Question | Reasoning |
|---|---|
| Will the activities that follow the licensing round protect and/or enhance Geological Conservation Sites, important geological features and geophysical processed and functions? | National planning policy in England, Scotland and Wales seeks to protect and enhance geological conservation interests. |
| Will the activities that follow the licensing round affect land stability? | Mining activities in all of the SEA regions have left a legacy of hazards such as landslips, subsidence.<br>The report by AEA for the European Commission identifies that a key challenge is to ensure the correct identification and selection of geological sites, based on a risk assessment of specific geological features and of potential uncertainties associated with the long-term presence of hydraulic fracturing fluid in the underground, although risk of significant induced seismic activity was considered to be low. |
| Will the activities that follow the licensing round change patterns of land use? | National and local planning policies set out that planning should make the best use of previously developed land.<br>Development associated with hydraulic fracturing is likely to require greater landtake than is typical of conventional gas. Further, it may not be possible fully to restore sites in sensitive areas following well completion or abandonment, which could result in the loss of farmland. |

**Table 4.8** sets out guidance that will be utilised during the assessment to help determine the relative significance of potential effects on the land use, geology and soils objective. It should not be viewed as definitive or prescriptive; merely illustrative of the factors that may be considered as part of the assessment process.

**Table 4.8 Illustrative Guidance for the Assessment of Significance for Land Use, Geology and Soils**

| Effect | Description | Illustrative Guidance |
|---|---|---|
| ++ | Significant positive | • Option would restore and significantly improve soil quality and land stability to conditions beyond current levels and remove all soil contamination so that soil functions and processes would be significantly improved in the long term;<br>• Option would minimise, and protect from irreversible damage high quality agricultural land;<br>• Option would have a significant and sustained positive impact on national designated geological sites;<br>• Option would seek to minimise use of any undeveloped land, and look to preferentially reclaim and redevelop significant areas of previously-developed or derelict land. |
| + | Minor Positive | • Option would generate minor improvements in soil quality and land stability and will remove some soil contamination so that soil functions and processes would be improved in the long term;<br>• Option would reduce any potential damage to high quality agricultural land;<br>• Option will reduce any potential hazard associated with existing soil contamination;<br>• Option would have a minor and temporary positive impact on a national designated geological site;<br>• Option would seek to preferentially make use of previously developed land; however, would allow for development of undeveloped. |

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| Effect | Description | Illustrative Guidance |
|---|---|---|
| 0 | No (neutral effects) | • Option would not significantly affect potential hazards associated with any existing contamination;<br>• Option would not cause damage or loss to soil such that soil function and processes will not be affected;<br>• Option would not affect land stability;<br>• Option would not involve significant loss of any undeveloped or developed land. |
| - | Minor Negative | • Option would lead to an increase in pollutant discharges to soil, however these would be less than permitted limits, such that there will be minor short term increases in land contamination;<br>• Option would cause minor increases in potential hazards associated with existing soil contamination;<br>• Option would cause minor increases in potential hazards associated with seismicity;<br>• Option would cause a temporary loss of soil so that soil function and processes would be negatively affected in the short/medium term;<br>• Option would cause minor short term negative effects on geological conservation sites/important geological features or soils of high importance;<br>• Option would lead to the majority of development using undeveloped land or land that has reverted to a 'wild' state. |
| -- | Significant negative | • Option would lead to a statutory limit being reached or exceeded in relation to land contamination, such that there would be a major and sustained increase in land contamination;<br>• Option would cause major and sustained increases in potential hazards associated with existing soil contamination;<br>• Option would cause major increases in potential hazards associated with seismicity;<br>• Option would cause considerable loss of soil quality, such that soil function and processes will be irreversibly and significantly affected;<br>• Option would cause a substantial and permanent loss of or damage to soil of high importance and/or designated geological conservation sites/important geological features;<br>• Option would not develop derelict or previously-developed land, but would lead to development of significant areas of undeveloped land/ land that has reverted to a 'wild' state. |
| ? | Uncertain | • From the level of information available the impact that the option would have on this objective is uncertain. |

This section comprises the assessment of the potential activities that could follow on from the licensing round on the land use, geology and soils objective. There are a total of six main stages of oil and gas exploration and production (including gas storage) that are the subject of the assessment. These are highlighted in **Table 4.9** for both conventional and unconventional oil and gas together with an overview of the associated key activities at each stage. Please note that Stages 1, 2 and 4 do not necessarily apply to gas storage, depending on the history of the particular site

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**Table 4.9 Oil and Gas Exploration and Production Lifecycle and Key Activities**

| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| 1. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. |
| 2. | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring.* | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. |
| 3. | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring* | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. |
| 4. | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring.* | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. |
| 5. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. |
| 6. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. |

Note: Exploration wells most usually move from Stage 2 to Stage 5, though some may be used for long-term production testing (which would require new consents including planning permission) and some may be retained and their sites redeveloped as a production project (this would also require new consents including planning permission). For the purposes of this assessment, the appraisal stage (a term commonly used in industry) spans Stages 2 and 3.

*Conventional oil and gas exploration and production activities (stages 2 to 4 above) can occasionally include hydraulic fracturing. However, the need to undertake hydraulic fracturing is relatively uncommon and has therefore not been considered in the assessment of conventional oil and gas activities as part of this SEA.

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### 4.7.1 Conventional Oil and Gas

The assessment of the six main stages of conventional oil and gas production is contained in **Table 4.10**. The first two columns describe the exploration and production stage. The third and fourth columns summarise the expected effects on the land use, geology and soils objective for both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report). The rationale for this relationship is explained in more detail in the final column and includes:

- the nature and scale of the potential effects on the land use, geology and soils objective;
- when the effect could occur (timing) and its degree of permanence;
- what mitigation measures might be appropriate for potentially significant negative effects on the land use, geology and soils objective;
- what options there are to enhance positive effects; and
- assumptions and uncertainties that underpin the assessment.

**Table 4.10 Assessment of Effects: Conventional Oil and Gas**

| **Objective 4: Land Use, Geology and Soils** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>Stage 1 of the oil and gas exploration and production lifecycle would comprise non-intrusive activities. Site identification, selection and characterisation and the securing of development and operation permits would be expected to be largely desk-based and in consequence, no effects on land use, geology or soils would be anticipated from these activities.<br>Vibroseis is the most common method of seismic survey and typically involves 3-5 large vibrator units which sub-sonically vibrate the ground while a number of support vehicles record the returning shock waves for analysis. As highlighted in the 2010 Environmental Report[57], surveys tend to be spatially restricted due to the requirement for roads or other hard surfaces accessible by vehicle. Where existing roads and/or hard surfaces are utilised, any effects on land use, geology or soils would be negligible and in this context, it should be noted that vibroseis would generally be regarded as permitted development. There may, however, be a requirement for the temporary construction of new roads to facilitate access to sites. This could result in the loss of greenfield land and soils and may obstruct the use of land (e.g. for agricultural use). Where soils are high agricultural quality these effects may be more severe. |

[57] DECC (2010) Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds: Environmental Report.

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| Objective 4: Land Use, Geology and Soils | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | There is also the potential for seismic surveys to affect geologically sensitive areas such Geological Conservation Review sites where activities are undertaken on or in close proximity to such sites. Notwithstanding, the area of land lost to development would be expected to be small and any adverse effects would be temporary with land restored following the completion of surveys.<br><br>Where shot-hole techniques are utilised (which involve the use of explosions as a source of seismic energy), the requirement for large vehicular access would be likely to be reduced whilst it would be expected that shot holes would be infilled after use.<br><br>Taking into account the fact that any adverse effects on land use or soils would be temporary and felt over a small area, this stage has been assessed as having a neutral effect on this objective.<br><br>**Low and High Activity Scenarios:**<br><br>As noted above, this stage of the oil and gas exploration and production lifecycle would comprise non-intrusive activities such that effects on land use, geology and soils are likely to be limited.<br><br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed). In consequence, the total volume of greenfield land that may be required to support new site access may be greater whilst adverse impacts on land uses may be more widespread. Further, there may be increased risk of loss of high quality agricultural land and/or development taking place on or in close proximity to geologically sensitive sites. However, given that any adverse effects associated with seismic surveys are likely to be minor, temporary and localised, there is not expected to be any substantial difference in the type and magnitude of effects between low and high activity scenarios. Further, it is anticipated that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible thus reducing the potential for adverse effects on this objective.<br><br>**Mitigation:**<br><br>• Sites selected should be of low agricultural/geological value.<br><br>**Assumptions:**<br><br>• It is assumed that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible.<br><br>• It is assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br><br>**Uncertainties:**<br><br>• None identified. |

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| Objective 4: Land Use, Geology and Soils | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 2 | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring. | - | - | **Assessment of Effects:**<br>Pad preparation and associated developments including provision of gravel access roads (if required) would require, on average, 1ha of land (as per Table 2.6 in the main report). Landtake associated with the exploration stage is likely to require the clearance of vegetation and loss of soil layers and compaction which may have a negative effect in terms of soil function and processes. However, it is anticipated that sites would be restored following either completion of exploration drilling or decommissioning of wells such that effects would be reduced in longer term (i.e. following exploratory drilling or beyond the site restoration stage, depending on whether a site is taken forward to the production stage). Where development is located on land that is of high agricultural quality (i.e. Agricultural Land Classification Grades 1, 2 or 3a), or in other sensitive areas, effects could be more significant and permanent particularly if the nature of the sensitive area inhibits full site restoration[58]. Notwithstanding, national planning policy such as the National Planning Policy Framework and Planning Policy Wales seeks to avoid development in areas that are sensitive including those of high agricultural land quality .<br>Pad preparation and the drilling of boreholes may affect land stability, geomorphology and/or soil erosion rates, on- or off-site. The type/magnitude of the effects will depend on the geology and physical nature of the area and effects may be particularly adverse where activities are undertaken within or in close proximity to sensitive areas such Geological Conservation Review sites. However, it is considered reasonable to assume that the risk of potential impacts on geologically sensitive sites/areas would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013). Further, the potential for significant negative effects would be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).<br>There is the potential for construction activities and exploratory drilling to cause disturbance to contaminated sites which could result in pollution pathways being created or re-opened for existing ground contamination. However, the risk of any such effect occurring cannot be fully established until such time that sites have been identified. Further, it is anticipated that ground contamination surveys would be undertaken prior to development in order to identify the potential risk of disturbance and appropriate mitigation, in accordance with the Contaminated Land Regulations and taking into account appropriate guidance.<br>There is a small risk of land contamination from, for example, accidental spillage. It would be expected that any potential contamination would be sufficiently mitigated by following best practice guidance and through the use of a |

[58] AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed May 2013].

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| Objective 4: Land Use, Geology and Soils | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Construction Environmental Management Plan (CEMP). However, it would not allow for accidental or unforeseen discharges.<br><br>A potential source of contamination is likely to be drilling wastes. Drilling wastes are covered under section 1, 'wastes resulting from exploration, mining, quarrying, and physical and chemical treatment of minerals' in schedule 1 of the List of Wastes (England) Regulations 2005, implemented following the adoption of the Waste Directive (67/548/EEC) and after the List of Wastes Decision (2000/532/EC). Those wastes in the list relevant to drill cuttings and which are considered hazardous include:<br><br>• oil-containing drilling muds and wastes (waste: 01 05 05);<br>• drilling muds and other drilling wastes containing dangerous substances (waste: 01 05 06).<br><br>Drilling muds and cuttings are the by-product of well drilling, and consist of a mixture of rock fragments and muds which may be oil or water-based. The latter usually contains biodegradable compounds whereas the former may contain compounds which resist degradation and would result in contamination if not appropriately managed (i.e. are hazardous wastes). Cuttings may be moved offsite and disposed of at a licensed landfill site or disposed of onsite if appropriate. The Environmental Protection (Duty of Care) Regulations will require operators to take suitable steps to manage such waste and provide appropriate information to any third party operator who may transport and/or dispose of the material elsewhere. The requirements of the Landfill Regulations 2002 (and subsequent amendments) will need to be met, including the waste acceptance criteria, and under the Water Framework Directive it would also need to be demonstrated that water resources could not be contaminated by disposal of mud and cuttings. Regulatory controls under existing legislation will therefore effectively minimise and mitigate potential effects.<br><br>Pad construction and associated landtake could affect both existing land uses on site (e.g. agriculture) and those adjacent/in close proximity, particularly where they are sensitive to construction activity (e.g. residential areas). Works may also have a positive effect on this aspect of the objective where development utilises previously developed land. At this stage it is not known whether development would take place on previously developed or greenfield land nor what land uses may be affected. Further, it is anticipated that sites would be restored following either completion of exploration drilling (which lasts between 12 and 25 weeks) or decommissioning of wells such that any adverse effects would be reduced in longer term (i.e. following exploratory drilling or beyond the site restoration stage, depending on whether a site is taken forward to the production stage).<br><br>Overall, it is considered that Stage 2 of the oil and gas exploration and production lifecycle would have a minor negative effect on this objective. This principally reflects the likelihood that there would be some (albeit small scale) loss of greenfield land associated with pad preparation and the assumption that, under normal operating conditions, the risk of land contamination would be low. |

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| Objective 4: Land Use, Geology and Soils | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Low and High Activity Scenarios:**<br><br>Landtake under a high activity scenario would be an estimated 30ha (assuming a total of 30 boreholes and average exploration well pad size of 1ha). This compares to a landtake requirement of 5ha under the low activity scenario. Commensurate with the increase in land required under the high activity scenario, it is expected that the potential for loss of soils would also increase. However, it is not considered that, in a UK context, the scale of landtake associated with the high activity scenario would be likely to generate a significant negative effect on this aspect of the objective, although this is dependent on the characteristics of the sites taken forward for development and their respective soil quality which is currently uncertain.<br><br>There is the potential for increased risk of adverse effects on geologically sensitive areas under the high activity scenario. However, as noted above, it is considered reasonable to assume that such risks would be fully considered as part of the planning application process and in accordance with national planning policy including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013). The potential for significant negative effects would also be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).<br><br>As noted above, there is not considered to be a substantial risk of land contamination associated with this stage. In consequence, effects in this regard are not expected to be significantly influenced by the quantum of activity.<br><br>The land use implications of low and high activity scenarios are largely unknown at this stage and would be dependent on individual site characteristics and the density of well pads in any one area. In this context, the magnitude of any negative effect associated with the high activity scenario may be increased relative to a low activity scenario if, for example, development resulted in the loss of a greater volume of greenfield, agricultural land. Conversely, the magnitude of positive effects could be enhanced if a large number of previously developed sites were taken forward for development.<br><br>**Mitigation:**<br><br>• Sites selected for exploratory drilling should be of low agricultural/geological value;<br><br>• Where necessary, sites should be carefully stripped of topsoils prior to construction works commencing to avoid damage. All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible. Soil excavation and mounds should avoid compaction where possible by making use of appropriate wide tracked vehicles and avoiding working on soil when it is wet. Appropriate drainage systems should be utilised on site to reduce soil erosion; |

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| Objective 4: Land Use, Geology and Soils | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Where possible, development should make best use of previously developed land;<br>• Careful consideration should be given during the site selection process to the avoidance of adverse impacts on sensitive land uses that may be affected by construction activity and drilling.<br>**Assumptions:**<br>• It is assumed that the risk of potential impacts on geologically sensitive sites would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013);<br>• It is assumed that works would be undertaken in accordance with relevant regulations and best practice so as to minimise the risk of land contamination;<br>• It is assumed that soil loss would be greater under the high activity scenario compared to the low activity scenario, commensurate with the total number of boreholes that would be drilled and total landtake.<br>**Uncertainties:**<br>• Individual site characteristics (e.g. in terms of agricultural land quality or the proximity of sensitive land uses) and the density of well pads in any one area are currently unknown. |
| 3 | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring. | - | - | **Assessment of Effects:**<br>The range and type of effects associated with Stage 3 of the oil and gas exploration and production lifecycle would be similar to those identified under Stage 2. However, the area of landtake required per well pad would be greater than that associated with the exploratory drilling stage (in the region of 2-3ha) reflecting the need for additional infrastructure such as storage tanks and on-site pipelines. Additional landtake may also be required for road connections and the installation of pipelines required to collect natural gas for transfer to the existing natural gas pipeline infrastructure. Works are likely to require further clearance of vegetation and loss of soil layers and compaction which may have a negative effect in terms of soil function and processes. However, it is anticipated that sites would be restored following decommissioning such that effects would be reduced in longer term. Additionally, following the completion of Stage 3, some land associated with development of the well pad and associated infrastructure (e.g. pipelines) may be returned to its previous use. Where development is located on land that is of high agricultural quality (i.e. Agricultural Land Classification Grades 1, 2 or 3a), or in other sensitive areas, effects could be more significant and permanent particularly if the nature of the sensitive area inhibits restoration[59]. Notwithstanding, national planning policy such as the National Planning Policy Framework and Planning Policy Wales seeks to avoid development in areas that are sensitive including those of high agricultural land quality . |

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| Objective 4: Land Use, Geology and Soils | | | | |
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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Overall, it is considered that Stage 3 of the conventional oil and gas exploration and production lifecycle would have a minor negative effect on this objective. Like Stage 2, this principally reflects the likelihood that there would be some loss of greenfield land associated with pad preparation and the assumption that, under normal operating conditions, the risk of land contamination would be low.<br><br>**Low and High Activity Scenarios:**<br><br>Landtake under the high activity scenario would be between 12-18ha (assuming a total of 6 well pads and an average well pad size of 2-3ha). This compares to a landtake requirement of 6-9ha under the low activity scenario. Commensurate with the increase in land required under the high activity scenario, it is expected that the potential for loss of soils would also increase. However, it is not considered that, in a UK context, landtake associated with the high activity scenario is of a scale that would be likely to generate a significant negative effect on this aspect of the objective, although this is dependent on the characteristics of the sites taken forward for development and their respective soil quality which is currently uncertain.<br><br>There is the potential for increased risk of adverse effects on geologically sensitive areas under the high activity scenario. However, as noted above, it is considered reasonable to assume that such risks would be fully considered as part of the planning application process and in accordance with national planning policy including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013). The potential for significant negative effects would also be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).<br><br>As noted above, there is not considered to be a substantial risk of land contamination associated with this stage. In consequence, effects in this regard are not expected to be significantly influenced by the quantum of activity.<br><br>The land use implications of low and high activity scenarios are largely unknown at this stage and would be dependent on individual site characteristics. In this context, the magnitude of any negative effect associated with the high activity scenario may be increased relative to the low activity scenario if, for example, development resulted in the loss of a greater volume of greenfield, agricultural land. Conversely, the magnitude of positive effects could be enhanced if a large number of previously developed sites were taken forward for development. The distance between well pad sites may also influence the magnitude of effects (i.e. cumulative effects) on other land uses and receptors. However, under both low and high activity scenarios the total number of well pads would be relatively low (between 3 and 6) and the minimum distance between well pad sites would be 5km (in the most densely developed areas). In consequence, it is not expected that effects on land uses would be significant.<br><br>**Mitigation:**<br><br>• Well pad sites should be located on land of low agricultural/geological value; |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Where necessary, sites should be carefully stripped of topsoils prior to construction works commencing to avoid damage. All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible. Soil excavation and mounds should avoid compaction where possible by making use of appropriate wide tracked vehicles and avoiding working on soil when it is wet. Appropriate drainage systems should be utilised on site to reduce soil erosion;<br>• Where possible, development should make best use of previously developed land;<br>• Careful consideration should be given during the site selection process to the avoidance of adverse impacts on sensitive land uses that may be affected by construction activity and drilling;<br>• Where possible, well pad infrastructure and associated development that is no longer required should be removed as soon as is reasonably practicable with land restored;<br>• Pipelines should be buried where possible with land restored following installation.<br>**Assumptions:**<br>• It is assumed that the risk of potential impacts on geologically sensitive sites would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013);<br>• It is assumed that works would be undertaken in accordance with relevant regulations and best practice so as to minimise the risk of land contamination;<br>• It is assumed that soil loss would be greater under the high activity scenario compared to the low activity scenario, commensurate with the total number of well pads total landtake.<br>**Uncertainties:**<br>• Individual site characteristics (e.g. in terms of agricultural land quality or the proximity of sensitive land uses) are currently unknown. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring; | **0** | **0** | **Assessment of Effects:**<br>It is assumed that no additional landtake would be required during the production, operation and maintenance stage and in consequence, associated effects on soils and land stability would be negligible.<br>During the production phase there is the potential for the accidental release of pollutants including oils and produced water that could result in land contamination. |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • Environmental monitoring and well integrity monitoring. | | | As highlighted under the assessment of Stages 2 and 3, it would be expected that any potential contamination would be sufficiently mitigated by following best practice guidance and through the use of a Construction Environmental Management Plan (CEMP). However, it would not allow for accidental or unforeseen discharges.<br>As there would be no additional landtake associated with this stage of the conventional oil and gas exploration and production lifecycle, it is anticipated that any effects on land use would be very minor and limited to disturbance to those uses that are in close proximity to well pad sites and potentially sensitive to impacts arising from operational activities (e.g. emissions to air, noise and vibration). These potential effects are considered elsewhere in this Appendix (see Chapters 3 and 6).<br>Based on the assumption that there would be no additional landtake during Stage 4 and that the risk of land contamination from operational activities would be low, this stage has been assessed as having a neutral effect on land use, geology and soils.<br>**Low and High Activity Scenarios:**<br>As noted above, this stage of the oil and gas exploration and production lifecycle would not involve any additional landtake and in consequence, effects on land use, geology and soils are likely to be limited.<br>There would be an increase in operational activity under the high activity scenario and as result, the risk of accidental spillage of pollutants could also increase (relative to the low activity scenario). However, given that the likelihood of accidental spillage occurring and resulting in land contamination is low, there is not expected to be any substantial difference in the type and magnitude of effects between low and high activity scenarios.<br>**Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• It is assumed that there would be no additional landtake during Stage 4 of the conventional oil and gas exploration and production lifecycle;<br>• It is assumed that works would be undertaken in accordance with relevant regulations and best practice so as to minimise the risk of land contamination.<br>**Uncertainties:**<br>• Individual site characteristics (in terms of the proximity of sensitive land uses) are currently unknown. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>Decommissioning will require additional machinery, and potentially, construction compounds to facilitate the removal of site equipment. Associated works may require clearance of vegetation and loss of soil layers and compaction, potentially generating a negative effect in terms of soil function and processes. However, it is not expected that the area of land required to undertake decommissioning activities (beyond existing well pads) would be significant. In this respect, the AEA (2012:69) report for the European Commission notes that there is generally little difference |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | between conventional and unconventional wells in the post-abandonment phase and that the consequences for landtake would be "*comparable with many other industrial and commercial land-uses, and are of no more than minor significance*". Notwithstanding, where development associated with decommissioning activities is located on land that is of high agricultural quality (i.e. Agricultural Land Classification Grades 1, 2 or 3a), or in other sensitive areas, effects could be more significant and permanent particularly if the nature of the sensitive area inhibits full site restoration[59], although national planning policy seeks to avoid development in areas that are sensitive including those of high agricultural land quality .<br><br>As with pad preparation (Stages 2 and 3), decommissioning may affect land stability, geomorphology and/or soil erosion rates, on- or off-site. The type/magnitude of the effects will depend on the geology and physical nature of the area and effects may be particularly adverse where activities are undertaken within close proximity to sensitive areas such Geological Conservation Review sites. However, it is considered reasonable to assume that the risk of potential impacts on geologically sensitive sites/areas would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013). Further, the potential for significant negative effects would be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).<br><br>There is the potential for the construction of buildings and infrastructure associated with decommissioning to cause disturbance to contaminated land where this development takes place on an existing contaminated site. However, the risk of any such effect occurring cannot be fully established until such time that sites have been identified. Further, it is anticipated that ground contamination surveys would be undertaken prior to decommissioning in order to identify the potential risk of disturbance and appropriate mitigation, in accordance with the Contaminated Land Regulations and taking into account appropriate guidance.<br><br>During the decommissioning stage, there continues to be a small risk of land contamination from, for example, accidental spillage. However, it would be expected that any potential contamination would be sufficiently mitigated by following best practice guidance and through the use of a Construction Environmental Management Plan (CEMP). It should also be noted that the decommissioning of onshore wells and associated installations would be addressed through conditions in planning consents and through PPC authorisation, which requires that the site of an installation be returned to a satisfactory state on closure. Permission to decommission onshore wells is also required from DECC under The Petroleum (Production) (Landward Areas) Regulations 1995 and would require submission and agreement in advance of a Cessation of Production (COP) report[57].<br><br>Decommissioning activities and associated landtake (beyond the existing well pad) could affect both existing land uses on decommissioning development sites (e.g. agriculture) and those adjacent/in close proximity, particularly where they are |

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| Objective 4: Land Use, Geology and Soils | | | | |
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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | sensitive to decommissioning activity (e.g. residential areas). However, disruption would be temporary (i.e. for the duration of decommissioning) with land expected to be restored on completion.<br><br>Overall, it is considered that Stage 5 of the conventional oil and gas exploration and production lifecycle would have a neutral effect on this objective.<br><br>**Low and High Activity Scenarios:**<br><br>Additional landtake and associated effects on soils related to the decommissioning stage under the high activity scenario would be potentially greater compared to the low activity scenario, commensurate with the number of well pad sites to be decommissioned. However, it is not expected that landtake requirements associated with the high activity scenario would be of a scale likely to generate a negative effect on this aspect of objective, although this is dependent on the characteristics of the sites taken forward for development and their respective soil quality which is currently uncertain.<br><br>There is the potential for increased risk of adverse effects on geologically sensitive areas under the high activity scenario. However, as noted above, it is considered reasonable to assume that such risks would be fully considered as part of the planning application process and in accordance with national planning policy including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013). The potential for significant negative effects would also be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).<br><br>As noted above, there is not considered to be a substantial risk of land contamination associated with this stage. In consequence, effects in this regard are not expected to be influenced significantly by the quantum of activity.<br><br>Taking into account the number of well pad sites that would be decommissioned under the high activity scenario and the expectation that any disruption would be temporary (i.e. for the duration of decommissioning), effects have been assessed as neutral.<br><br>**Mitigation:**<br><br>• Sites selected to accommodate development associated with decommissioning activities should be of low agricultural/geological value.<br><br>• Where necessary, sites should be carefully stripped of topsoils prior to construction works commencing to avoid damage. All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible. Soil excavation and mounds should avoid compaction where possible by making use of appropriate wide tracked vehicles and avoiding working on soil when it is wet. Appropriate drainage systems should be utilised on site to reduce soil erosion. |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Where possible, development should make best use of previously developed land;<br>• Careful consideration should be given during the site selection process to the avoidance of adverse impacts on sensitive land uses that may be affected by decommissioning activity.<br>**Assumptions:**<br>• It is assumed that the risk of potential impacts on geologically sensitive sites would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013);<br>• It is assumed that works would be undertaken in accordance with relevant regulations and best practice so as to minimise the risk of land contamination;<br>• It is assumed that soil loss would be greater under the high activity scenario compared to the low activity scenario, commensurate with the total number of well pad sites to be decommissioned.<br>**Uncertainties:**<br>• Individual site characteristics (e.g. in terms of agricultural land quality or the proximity of sensitive land uses) are currently unknown. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | + | + | **Assessment of Effects:**<br>For the purposes of this assessment it is assumed that all production facilities, infrastructure and hardstanding would be removed during the site restoration and relinquishment stage. Due to the need for invasive demolition techniques and land excavation there is the potential for adverse effects on land stability, geomorphology and/or soil erosion during this stage. Notwithstanding, it is anticipated that effects would be similar to site restoration associated with other forms of mineral extraction and would be unlikely to be significant.<br>It is expected that during site restoration work, land would be remediated and wells sealed thereby mitigating the potential long term risk of land contamination.<br>Long term effects (i.e. beyond site restoration) on land use, geology and soils associated with this stage will depend largely on the end use of well pad sites and future soil quality (this would be determined on a site-by-site basis following discussions between the operator and the minerals planning authority). However, paragraph 143 of the National Planning Policy Framework (DCLG 2012) promotes high quality restoration and aftercare "*including for agriculture (safeguarding the long term potential of best and most versatile agricultural land and conserving soil resources), geodiversity, biodiversity, native woodland, the historic environment and recreation*". In consequence, it is expected that this stage of the conventional oil and gas exploration and production lifecycle would have a positive effect on this objective by restoring, and potentially enhancing, soil quality and prospects for beneficial land use. |

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## Objective 4: Land Use, Geology and Soils

| *Stage* | *Description* | *Score* | | *Commentary* |
|---|---|---|---|---|
| | | *Low Activity Scenario* | *High Activity Scenario* | |
| | | | | It should be noted that the AEA (2012) report (albeit in relation to unconventional oil and gas) highlights that it may not be possible to return entire sites to beneficial use following decommissioning due to, for example, concerns regarding public safety. The report states(at page 69) that over a wider area "*this could result in a significant loss of land, and/or fragmentation of land area such as an amenity or recreational facility, valuable farmland, or valuable natural habitat*". However, in view of the total area covered by well pads (up to 18ha under the high activity scenario), the risk of such effects is considered to be negligible.<br><br>Overall, Stage 6 has been assessed as having a minor, long term positive effect on this objective. This reflects the expectation that well pad sites would be restored and soil quality enhanced through restoration activities.<br><br>**Low and High Activity Scenarios:**<br><br>There is the potential for increased risk of adverse effects on land stability, geomorphology and/or soil erosion under the high activity scenario, commensurate with the area of land to be restored relative to the low activity scenario. However, as noted above, it is anticipated that effects would be similar to site restoration associated with other forms of mineral extraction and would be unlikely to be significant.<br><br>No other notable differences between low and high activity scenarios have been identified.<br><br>**Mitigation:**<br><br>• None identified (beyond requirements contained in existing national planning policy).<br><br>**Assumptions:**<br><br>• It is assumed that all production facilities, infrastructure and hardstanding would be removed during the site restoration and relinquishment stage.<br><br>**Uncertainties:**<br><br>• Long term effects (i.e. beyond site restoration) on land use, geology and soils associated with the decommissioning phase will depend largely on the end use of well pad sites and future soil quality. This would be determined on a site-by-site basis following discussions between the operator and the minerals planning authority. |

### *Summary*

The assessment has not identified any significant positive or significant negative effects on land use, geology and soils associated with all six stages of the conventional oil and gas exploration and production lifecycle. Pad preparation and provision of associated infrastructure such as pipelines and road connections during Stage 2 (exploration drilling) and Stage 3 (production development) are likely to require the clearance of vegetation and loss of soil layers and compaction which may have a minor negative effect in terms of soil function and processes. These effects could be greater (although not significant) under the high activity scenario, commensurate with increased landtake. However, it is anticipated that sites would be restored following either completion of exploration drilling or decommissioning of wells such that effects would be reduced in longer term. Where development is located on land that is of high agricultural quality (i.e. Agricultural Land Classification Grades 1, 2 or 3a), or in other sensitive areas, effects could be more significant and permanent particularly if the nature of the sensitive area inhibits full site restoration. Notwithstanding, national planning policy such as the National Planning Policy Framework and Planning Policy Wales seeks to avoid development in areas that are sensitive including those of high agricultural land quality.

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| Objective 4: Land Use, Geology and Soils | | | | |
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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| Whilst long term effects (i.e. beyond site restoration) on land use, geology and soils associated with this stage will depend largely on the end use of well pad sites and future soil quality (this would be determined on a site-by-site basis following discussions between the operator and the minerals planning authority), paragraph 143 of the National Planning Policy Framework (DCLG 2012) promotes high quality restoration and aftercare "*including for agriculture (safeguarding the long term potential of best and most versatile agricultural land and conserving soil resources), geodiversity, biodiversity, native woodland, the historic environment and recreation*". In consequence, it is expected that site restoration and relinquishment (Stage 6) would have a minor positive effect on this objective by restoring, and potentially enhancing, soil quality and prospects for beneficial land use.<br><br>Stages 1, 4 and 5 have been assessed as having a neutral effect on land use, geology and soils. This reflects the fact these stages are unlikely to result in substantial (if any) additional landtake and, taking into account the implementation of appropriate mitigation, are unlikely to result in land contamination.<br><br>**Mitigation Summary**<br>• Well pad sites should be located on land of low agricultural/geological value.<br>• Where necessary, sites should be carefully stripped of topsoils prior to construction works commencing to avoid damage. All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible. Soil excavation and mounds should avoid compaction where possible by making use of appropriate wide tracked vehicles and avoiding working on soil when it is wet. Appropriate drainage systems should be utilised on site to reduce soil erosion.<br>• Where possible, development should make best use of previously developed land.<br>• Careful consideration should be given during the site selection process to the avoidance of adverse impacts on sensitive land uses that may be affected by construction activity and drilling.<br>• Where possible, well pad infrastructure and associated development that is no longer required should be removed as soon as is reasonably practicable with land restored.<br>• Pipelines should be buried where possible with land restored following installation. | | | | |

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 4.7.2 Unconventional Oil and Gas

The assessment of the six main stages of unconventional oil and gas production is contained in **Table 4.11** under both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report).

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**Table 4.11 Assessment of Effects: Unconventional Oil and Gas**

| Objective 4: Land Use, Geology and Soils | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>The type, scale and magnitude of effects associated with Stage 1 of the unconventional oil and gas exploration and production lifecycle are likely to be similar to those identified in respect of conventional oil and gas (see **Table 4.10**) and would comprise non-intrusive activities.<br>Site identification, selection and characterisation and the securing of development and operation permits would be expected to be largely desk-based and in consequence, no effects on land use, geology or soils would be anticipated from these activities.<br>Vibroseis is the most common method of seismic survey and typically involves 3-5 large vibrator units which sub-sonically vibrate the ground while a number of support vehicles record the returning shock waves for analysis. As highlighted in the 2010 Environmental Report[57], surveys tend to be spatially restricted due to the requirement for roads or other hard surfaces accessible by vehicle. Where existing roads and/or hard surfaces are utilised, any effects on land use, geology or soils would be negligible and in this context, it should be noted that vibroseis would generally be regarded as permitted development. There may, however, be a requirement for the temporary construction of new roads to facilitate access to sites. This could result in the loss of greenfield land and soils and may obstruct the use of land (e.g. for agricultural use). Where soils are high agricultural quality these effects may be more severe. There is also the potential for seismic surveys to affect geologically sensitive areas such Geological Conservation Review sites where activities are undertaken on or in close proximity to such sites. Notwithstanding, the area of land lost to development would be expected to be relatively small and any adverse effects would be temporary with land restored following the completion of surveys.<br>Where shot-hole techniques are utilised (which involve the use of explosions as a source of seismic energy), the requirement for large vehicular access would be likely to be reduced whilst it would be expected that shot holes would be infilled after use.<br>Taking into account the fact that any adverse effects on land use or soils would be temporary and felt over a small area, this stage has been assessed as having a neutral effect on this objective. In this context, it is noted that the AEA report[59] concerning the potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe identifies that there are no substantial risks associated with this stage of the lifecycle. |

[59] AEA (2012) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission.

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| Objective 4: Land Use, Geology and Soils | | | | |
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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Low and High Activity Scenarios:**<br>As noted above, this stage of the oil and gas exploration and production lifecycle would comprise non-intrusive activities such that effects on land use, geology and soils are likely to be limited.<br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed). In consequence, the total volume of greenfield land that may be required to support new site access may be greater whilst adverse impacts on land uses may be more widespread. Further, there may be increased risk of loss of high quality agricultural land and/or development taking place on or in close proximity to geologically sensitive sites. However, given that any adverse effects associated with seismic surveys are likely to be minor, temporary and localised, there is not expected to be any substantial difference in the type and magnitude of effects between low and high activity scenarios. Further, it is anticipated that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible thus reducing the potential for adverse effects on this objective.<br>**Mitigation:**<br>• Sites selected should be of low agricultural/geological value.<br>**Assumptions:**<br>• It is assumed that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible.<br>• It is assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>**Uncertainties:**<br>• None identified. |
| 2 | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. | - | -/-- | **Assessment of Effects:**<br>Pad preparation and associated developments including provision of gravel access roads (if required) would require, on average, 1ha of land (as per Table 2.7 in the main report). Landtake associated with the exploration stage is likely to require the clearance of vegetation and loss of soil layers and compaction which may have a negative effect in terms of soil function and processes. However, it is anticipated that sites would be restored following either completion of exploration drilling or decommissioning of wells such that effects would be reduced in the longer term (i.e. following exploratory drilling or beyond the site restoration stage, depending on whether a site is taken forward to the production stage). Where development is located on land that is of high agricultural quality (i.e. Agricultural Land Classification Grades 1, 2 or 3a), or in other sensitive areas, effects could be more significant and permanent particularly if the nature of the sensitive area inhibits full site restoration[59].<br>Notwithstanding, national planning policy such as the National Planning Policy Framework and Planning Policy Wales seeks to avoid development in areas that are sensitive including those of high agricultural land quality . |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Pad preparation and drilling may affect land stability, geomorphology and/or soil erosion rates, on- or off-site. The type/magnitude of the effects will depend on the geology and physical nature of the area and effects may be particularly adverse where activities are undertaken within or in close proximity to sensitive areas such Geological Conservation Review sites. However, it is considered reasonable to assume that the risk of potential impacts on geologically sensitive sites/areas would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013). Further, the potential for significant negative effects would be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).<br>For unconventional oil and gas this stage is likely to include some hydraulic fracturing to establish if hydrocarbons are present and to determine whether production would be commercially viable. Hydraulic fracturing is used to stimulate the production of gas by increasing the number of fractures in a rock formation, and therefore its permeability, through the injection of water under high pressure accompanied by (typically) sand which prevents the fractures closing[59].<br>On 1st April 2011, the Blackpool area in north west England experienced seismicity of magnitude 2.3 $M_L$ shortly after Cuadrilla Resources hydraulically fractured a well at its Preese Hall site. Seismicity of magnitude 1.5 $M_L$ occurred on 27th May 2011 following renewed fracturing of the same well. Hydraulic fracturing was subsequently suspended. Cuadrilla Resources commissioned a set of reports to investigate the cause of seismicity (de Pater and Baisch 2011). DECC subsequently commissioned an independent review of these reports, which was published for public comment (Green *et al* 2012). This research confirms that the observed seismicity was induced by hydraulic fracturing, most probably through the injection of fluid into a nearby but unidentified pre-stressed fault.<br>The independent review (Green *et al* , 2012) concluded, however, that the maximum magnitude of induced seismicity arising from hydraulic fracturing operations in that area would be not greater than $M_L$=3 which, according to the European Macroseismic Scale, would be equivalent to a passing truck, being felt by few people and resulting in negligible, if any, surface effects. In this context, Davies *et al* (2013) state that, when compared with other sources of induced seismicity such as mining and reservoir impoundment, "*hydraulic fracturing has been, to date, a relatively benign mechanism*" and that the risk of hydraulic fracturing causing felt seismicity (M>3) is "*very small*"[60]. Similarly, the AEA (2012) report for the European Commission on the potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe concludes (at page 54): |

[60] Davies, J.D. Foulgar, G., Bindley, A., Styles, P. (2013) *What size of earthquakes can be caused by fracking? DEI Briefing Note April 2013*. Durham University: Durham.

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| | | | | *"In view of these evaluations and the low frequency of reported incidents, it is judged that the frequency of significant seismic events is "rare" and the potential significance of this impact is "slight." Multiple development could increase the risk of seismic events due to one operation affecting the well integrity of a separate operation, although in view of the low frequency of the reported events and the established measures for monitoring well integrity, the risks are judged to remain low*".<br><br>In the context of the Preese Hall site, the independent review concluded that, with appropriate mitigation including geological surveys to characterise stresses and identify faults and use of sensitive fracture monitoring equipment and a DECC agreed "traffic light" control protocol for future operations, shale gas exploration activities could be allowed to restart. In his Written Ministerial Statement[61], the Secretary of State for Energy and Climate Change subsequently concluded that appropriate controls are available to mitigate the risks of undesirable seismic activity. The Government has accepted the recommendations of a review of the hazards of hydraulic fracturing for shale gas by The Royal Society and The Royal Academy of Engineering (2012 ). New controls announced in the Written Ministerial Statement that will be implemented and enforced by DECC include the requirement for operators to:<br><br>• conduct a prior review of information on seismic risks and the existence of faults;<br>• submit to DECC a hydraulic fracturing plan showing how any seismic risks are to be addressed;<br>• carry out seismic monitoring before, during and after hydraulic fracturing; and<br>• implement a "traffic light" system which will be used to identify unusual seismic activity requiring reassessment, or halting, of operations.<br><br>For the first few operations, DECC will also have an independent expert on site to observe the operator's conformance to the protocols established by DECC and to monitor the operator's interpretation of data. This will enable any lessons learned to be put into effect.<br><br>Taking into account the findings of research into the impacts of hydraulic fracturing and the measures proposed to reduce the risk of undesirable seismic activity, it considered that Stage 2 would not have a significant adverse effect in respect of seismicity.<br><br>There is the potential for construction activities and drilling to cause disturbance to contaminated sites which could result in pollution pathways being created or re-opened for existing ground contamination. However, the risk of any such effect occurring cannot be fully established until such time that sites have been identified. Further, it is anticipated that ground contamination surveys would be undertaken prior to development in order to identify the potential risk of disturbance and appropriate mitigation, in accordance with |

[61] Written Ministerial Statement by Edward Davey: '*Exploration for Shale Gas*'. 13 December 2012.

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| | | | | the Contaminated Land Regulations and taking into account appropriate guidance. There is also a small risk of land contamination from, for example, accidental spillage including of fracturing fluid or from well blow outs. However, The Royal Society and The Royal Academy of Engineering (2012) review of hydraulic fracturing highlights that the impact of spills could be mitigated using established best practices such as bunding and use of non-hazardous chemicals whilst the probability of well failure is low (further consideration of the potential effects of Stage 2 in respect of surface and groundwater pollution is presented in **Chapter 5** of this Appendix).<br><br>A further potential source of contamination is likely to be drilling wastes. Drilling wastes are covered under section 1, 'wastes resulting from exploration, mining, quarrying, and physical and chemical treatment of minerals' in schedule 1 of the List of Wastes (England) Regulations 2005, implemented following the adoption of the Waste Directive (67/548/EEC) and after the List of Wastes Decision (2000/532/EC). Those wastes in the list relevant to drill cuttings and which are considered hazardous include:<br>• oil-containing drilling muds and wastes (waste: 01 05 05);<br>• drilling muds and other drilling wastes containing dangerous substances (waste: 01 05 06).<br><br>Drilling muds and cuttings are the by-product of well drilling, and consist of a mixture of rock fragments and muds which may be oil or water-based. The latter usually contains biodegradable compounds whereas the former may contain compounds which resist degradation and would result in contamination if not appropriately managed (i.e. are hazardous wastes). Cuttings may be moved offsite and disposed of at a licensed landfill site or disposed of onsite if appropriate. The Environmental Protection (Duty of Care) Regulations will require operators to take suitable steps to manage such waste and provide appropriate information to any third party operator who may transport and/or dispose of the material elsewhere. The requirements of the Landfill Regulations 2002 (and subsequent amendments) will need to be met, including the waste acceptance criteria, and under the Water Framework Directive it would also need to be demonstrated that water resources could not be contaminated by disposal of mud and cuttings. Regulatory controls under existing legislation will therefore effectively minimise and mitigate potential effects.<br><br>Pad construction and associated landtake could affect both existing land uses on site (e.g. agriculture) and those adjacent/in close proximity, particularly where they are sensitive to construction activity (e.g. residential areas). Works may also have a positive effect on this aspect of the objective where development utilises previously developed land. At this stage it is not known whether development would take place on previously developed or greenfield land nor what land uses may be affected. Further, it is anticipated that sites would be restored following either the completion of Stage 2 or decommissioning of wells such that any adverse effects would be reduced in longer term (i.e. following drilling or beyond the site restoration stage, depending on whether a site is taken forward to the production stage). |

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| | | | | Overall, it is considered that Stage 2 of the unconventional oil and gas exploration and production lifecycle would have a minor negative effect on this objective. This principally reflects the likelihood that there would be some loss of greenfield land associated with pad preparation and the assumption that, under normal operating conditions, the risk of severe induced seismicity or land contamination would be low.<br>**Low and High Activity Scenarios:**<br>Landtake under the high activity scenario would be an estimated 240ha (assuming a total of 240 boreholes and average exploration well pad size of 1ha). This compares to a landtake requirement of 20ha under the low activity scenario. Commensurate with the increase in land required under the high activity scenario, it is expected that the potential for loss of soils would also increase and could be significant, depending on the physical characteristics of the site (e.g. if land was classified as high quality agricultural land), although this is currently uncertain.<br>There is the potential for increased risk of adverse effects on geologically sensitive areas under the high activity scenario. However, as noted above, it is considered reasonable to assume that such risks would be fully considered as part of the planning application process and in accordance with national planning policy including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013). The potential for significant negative effects would also be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).<br>As noted above, there is not considered to be a substantial risk of land contamination or induced seismicity associated with this stage. In consequence, effects in this regard are not expected to be significantly influenced by the quantum of activity.<br>The land use implications of low and high activity scenarios are largely unknown at this stage and would be dependent on individual site characteristics and the density of well pads in any one area. In this context, the magnitude of any negative effect associated with the high activity scenario may be increased relative to the low activity scenario and could be significant if, for example, development resulted in the loss of a greater volume of greenfield, agricultural land. Conversely, the magnitude of positive effects could be enhanced if a large number of previously developed sites were taken forward for development.<br>**Mitigation:**<br>• Reflecting the recommendations contained in the AEA (2012) report for the European Commission on the potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe, DECC should consider providing guidance in respect of:<br>o Using larger drilling pads for multiple wells, increasing the spacing between wells;<br>o Site selection including in respect of access and avoidance of sensitive areas such as areas of high agricultural land value;<br>o Limiting the use of impoundments; |

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| | | | | o Land restoration;<br>• Where necessary, sites should be carefully stripped of topsoils prior to construction works commencing to avoid damage. All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible. Soil excavation and mounds should avoid compaction where possible by making use of appropriate wide tracked vehicles and avoiding working on soil when it is wet. Appropriate drainage systems should be utilised on site to reduce soil erosion.<br>• Where possible, development should make best use of previously developed land.<br>• Careful consideration should be given during the site selection process to the avoidance of adverse impacts on sensitive land uses that may be affected by construction activity and drilling.<br>**Assumptions:**<br>• It is assumed that the risk of potential impacts on geologically sensitive sites would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013).<br>• It is assumed that works would be undertaken in accordance with relevant regulations and best practice so as to minimise the risk of land contamination.<br>• It is assumed that soil loss would be greater under the high activity scenario compared to the low activity scenario, commensurate with the total number of boreholes that would be drilled and total landtake.<br>**Uncertainties:**<br>• Individual site characteristics (e.g. in terms of agricultural land quality or the proximity of sensitive land uses) and the density of well pads in any one area are currently unknown. |
| 3 | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring; | - | -/-- | **Assessment of Effects:**<br>The range and type of effects associated with Stage 3 of the unconventional oil and gas exploration and production lifecycle would be similar to those identified under Stage 2. However, the area of landtake required per well pad would be greater than that associated with the exploratory drilling stage (in the region of 2-3ha) reflecting the need for additional infrastructure such as storage tanks and on-site pipelines. Additional landtake may also be required for road connections and the installation of pipelines required to collect natural gas for transfer to the existing natural gas pipeline infrastructure. Works are likely to require further clearance of vegetation and loss of soil layers and compaction which may have a negative effect in terms of soil function and processes. |

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| | • Provision of pipeline connections<br>• (Possibly) re-fracturing. | | | However, it is anticipated that sites would be restored following decommissioning such that effects would be reduced in longer term. Additionally, following the completion of Stage 3, some land associated with development of the well pad and associated infrastructure (e.g. pipelines) may be returned to its previous use. Where development is located on land that is of high agricultural quality (i.e. Agricultural Land Classification Grades 1, 2 or 3a), or in other sensitive areas, effects could be more significant and permanent particularly if the nature of the sensitive area inhibits restoration[59]. Notwithstanding, national planning policy such as the National Planning Policy Framework and Planning Policy Wales seeks to avoid development in areas that are sensitive including those of high agricultural land quality.<br><br>During Stage 3 there would be a need for further hydraulic fracturing to stimulate the production of gas. As highlighted under the assessment of Stage 2, this process has the potential to cause induced seismicity although the independent review by Green *et al* (2012) and research published by AEA (2012) and Davies *et el* (2013) in particular suggests that the risk of hydraulic fracturing causing felt seismicity (M>3) is very small.<br><br>As under Stage 2, well pad construction and associated landtake could affect both existing land uses on site (e.g. agriculture) and those adjacent/in close proximity, particularly where they are sensitive to construction activity (e.g. residential areas). Works may also have a positive effect on this aspect of the objective where development utilises previously developed land. At this stage it is not known whether development would take place on previously developed or greenfield land nor what land uses may be affected. Further, it is anticipated that sites would be restored following the decommissioning of wells such that any adverse effects would be reduced in longer term.<br><br>Overall, it is considered that Stage 3 of the unconventional oil and gas exploration and production lifecycle would have a minor negative effect on this objective. Like Stage 2, this principally reflects the likelihood that there would be some loss of greenfield land associated with pad preparation and the assumption that, under normal operating conditions, the risk of land contamination would be low.<br><br>**Low and High Activity Scenarios:**<br><br>Landtake under the high activity scenario would be between 240-360ha (assuming 30-120 well pad sites between 2 and 3ha in area and between 12 and 24 wells per pad). This compares to a landtake requirement of between 60 and 90ha under the low activity scenario. Commensurate with the increase in land required under the high activity scenario, it is expected that the potential for loss of soils would also increase and could be significant, depending on the physical characteristics of the site (e.g. if land was classified as high quality agricultural land), although this is currently uncertain.<br><br>There is the potential for increased risk of adverse effects on geologically sensitive areas under the high activity scenario. However, as noted above, it is considered reasonable to assume that such risks would be fully considered as part of the planning application process and in accordance with national planning policy including, for example, guidance |

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| | | | | contained in Planning practice guidance for onshore oil and gas (DCLG, 2013). The potential for significant negative effects would also be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).<br><br>As noted above, there is not considered to be a substantial risk of land contamination or induced seismicity associated with this stage. In consequence, effects in this regard are not expected to be significantly influenced by the quantum of activity.<br><br>The land use implications of low and high activity scenarios are largely unknown at this stage and would be dependent on individual site characteristics. In this context, the magnitude of any negative effect associated with the high activity scenario may be increased relative to the low activity scenario if, for example, development resulted in the loss of a greater volume of greenfield, agricultural land. Conversely, the magnitude of positive effects could be enhanced if a large number of previously developed sites were taken forward for development. The distance between well pad sites may also influence the magnitude of effects (i.e. cumulative effects) on other land uses and receptors. However, under both low and high activity scenarios the minimum distance between well pad sites would be 5km (in the most densely developed areas). Taking into account the total number of well pad sites (up to 130) it is not expected that effects on land uses would be significant.<br><br>**Mitigation:**<br><br>• Reflecting the recommendations contained in the AEA (2012) report for the European Commission on the potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe, DECC should consider providing guidance in respect of:<br>  o Using larger drilling pads for multiple wells, increasing the spacing between wells;<br>  o Site selection including in respect of access and avoidance of sensitive areas such as areas of high agricultural land value;<br>  o Limiting the use of impoundments;<br>  o Land restoration;<br>• Where necessary, sites should be carefully stripped of topsoils prior to construction works commencing to avoid damage. All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible. Soil excavation and mounds should avoid compaction where possible by making use of appropriate wide tracked vehicles and avoiding working on soil when it is wet. Appropriate drainage systems should be utilised on site to reduce soil erosion. |

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| | | | | • Where possible, development should make best use of previously developed land.<br>• Careful consideration should be given during the site selection process to the avoidance of adverse impacts on sensitive land uses that may be affected by construction activity and drilling.<br>• Where possible, well pad infrastructure and associated development that is no longer required should be removed as soon as is reasonably practicable with land restored.<br>• Pipelines should be buried where possible with land restored following installation.<br>**Assumptions:**<br>• It is assumed that the risk of potential impacts on geologically sensitive sites would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013).<br>• It is assumed that works would be undertaken in accordance with relevant regulations and best practice so as to minimise the risk of land contamination.<br>• It is assumed that soil loss would be greater under the high activity scenario compared to the low activity scenario, commensurate with the total number of well pads total landtake.<br>**Uncertainties:**<br>• Individual site characteristics (e.g. in terms of agricultural land quality or the proximity of sensitive land uses) are currently unknown. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>It is assumed that no additional landtake would be required during the production, operation and maintenance stage and in consequence, associated effects on soils would be negligible.<br>The AEA (2012) review highlights that an operator may choose to re-fracture a well during this stage in order to increase the rate of gas production, if this is considered worthwhile from a commercial perspective. Wells are likely to be re-fractured infrequently (either once every five to 10 years or not at all, based on US experience) and reflecting the findings of the AEA review, it has been assumed that each well would be re-fractured once during its operational lifetimes. Whilst this presents a risk of induced seismicity, as highlighted under the assessment of Stages 2 and 3, the independent review published by Green *et al* (2012) and research by AEA (2012) and Davies *et el* (2013) in particular suggests that the risk of hydraulic re-fracturing causing felt seismicity (M>3) is very small.<br>There is a small risk of land contamination from, for example, accidental spillage including of fracturing fluid or from well blow outs. |

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| | | | | However, as noted under Stages 2 and 3, The Royal Society and The Royal Academy of Engineering (2012) review of hydraulic fracturing highlights that the impact of spills could be mitigated using established best practices such as bunding and use of non-hazardous chemicals whilst the probability of well failure is low (further consideration of the potential effects of Stage 4 in respect of surface and groundwater pollution is presented in **Chapter 5** of this Appendix). Further, as noted in the AEA (2012) review, it is expected that monitoring of potential well failure would be undertaken during re-fracturing with measures implemented to address any issues identified.<br><br>As there would be no additional landtake associated with this stage of the unconventional oil and gas exploration and production lifecycle, it is anticipated that any effects on land use would be very minor and limited to disturbance to those uses that are in close proximity to well pad sites and potentially sensitive to impacts arising from operational activities (e.g. emissions to air, noise and vibration). These potential effects are considered elsewhere in this Appendix (see **Chapter 3 and 6**).<br><br>Based on the assumption that there would be no additional landtake during Stage 4 and that the risk of induced seismicity and land contamination from operational activities would be low, this stage has been assessed as having a neutral effect on land use, geology and soils.<br><br>**Low and High Activity Scenarios:**<br><br>As noted above, this stage of the oil and gas exploration and production lifecycle would not involve any additional landtake and in consequence, effects on land use, geology and soils are likely to be limited.<br><br>There would be an increase in operational activity under the high activity scenario and as result, the risk of accidental spillage of pollutants and induced seismicity could also increase relative to the low activity scenario. However, as there is not considered to be a substantial risk of land contamination or induced seismicity associated with this stage, effects in this regard are not expected to be substantially influenced by the quantum of activity.<br><br>**Mitigation:**<br><br>• None identified.<br><br>**Assumptions:**<br><br>• It is assumed that there would be no additional landtake during Stage 4 of the unconventional oil and gas exploration and production lifecycle.<br><br>• It is assumed that works would be undertaken in accordance with relevant regulations and best practice so as to minimise the risk of land contamination.<br><br>**Uncertainties:**<br><br>• Individual site characteristics (in terms of the proximity of sensitive land uses) are currently unknown. |

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| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **-** | **Assessment of Effects:**<br>The AEA (2012:69) report for the European Commission notes that there is generally little difference between conventional and unconventional wells in the post-abandonment phase. In consequence, the range and type effects associated with Stage 5 of the unconventional oil and gas production lifecycle are likely to be similar to those identified under conventional oil and gas production for this stage (see **Table 4.10**).<br>Decommissioning will require additional machinery, and potentially, construction compounds to facilitate the removal of site equipment. Associated works may require clearance of vegetation and loss of soil layers and compaction, potentially generating a negative effect in terms of soil function and processes. However, it is not expected that the area of land required to undertake decommissioning activities (beyond existing well pads) would be significant. In this respect, the AEA (2012:69) report for the European Commission states that the consequences for landtake would be "*comparable with many other industrial and commercial land-uses, and are of no more than minor significance*". However, where development associated with decommissioning activities is located on land that is of high agricultural quality (i.e. Agricultural Land Classification Grades 1, 2 or 3a), or in other sensitive areas, effects could be more significant and permanent particularly if the nature of the sensitive area inhibits full site restoration[59]. Notwithstanding, national planning policy such as the National Planning Policy Framework and Planning Policy Wales seeks to avoid development in areas that are sensitive including those of high agricultural land quality .<br>As with pad preparation (Stages 2 and 3), decommissioning may affect land stability, geomorphology and/or soil erosion rates, on- or off-site. The type/magnitude of the effects will depend on the geology and physical nature of the area and effects may be particularly adverse where activities are undertaken within on in close proximity to sensitive areas such Geological Conservation Review sites. However, it is considered reasonable to assume that the risk of potential impacts on geologically sensitive sites/areas would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013). Further, the potential for significant negative effects would be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).<br>There is the potential for the construction of buildings and infrastructure associated with decommissioning to cause disturbance to contaminated land where this development takes place on an existing contaminated site. However, the risk of any such effect occurring cannot be fully established until such time that sites have been identified. Further, it is anticipated that ground contamination surveys would be undertaken prior to decommissioning in order to identify the potential risk of disturbance and appropriate mitigation, in accordance with the Contaminated Land Regulations and taking into account appropriate guidance. |

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| | | | | During the decommissioning stage, there continues to be a small risk of land contamination from, for example, accidental spillage. However, it would be expected that any potential contamination would be sufficiently mitigated by following best practice guidance and through the use of a Construction Environmental Management Plan (CEMP). It should also be noted that the decommissioning of onshore wells and associated installations would be addressed through conditions in planning consents and through PPC authorisation, which requires that the site of an installation be returned to a satisfactory state on closure. Permission to decommission onshore wells is also required from DECC under The Petroleum (Production) (Landward Areas) Regulations 1995 and would require submission and agreement in advance of a Cessation of Production (COP) report[57].<br><br>Decommissioning activities and associated landtake (beyond the existing well pad) could affect both existing land uses on decommissioning development sites (e.g. agriculture) and those adjacent/in close proximity, particularly where they are sensitive to decommissioning activity (e.g. residential areas). However, disruption would be temporary (i.e. for the duration of decommissioning) with land expected to be restored on completion.<br><br>Overall, it is considered that Stage 5 of the unconventional oil and gas exploration and production lifecycle would have a neutral effect on this objective.<br><br>**Low and High Activity Scenarios:**<br><br>Additional landtake and associated effects on soils related to the decommissioning stage under the high activity scenario would be potentially greater compared to the low activity scenario, commensurate with the number of well pad sites/total area to be decommissioned. Taking into account the total area that could be covered by wells under the high activity scenario (between 240ha and 360ha) effects on this aspect of the objective have been assessed as negative. Effects may be more significant if development required to facilitate decommissioning takes place on sensitive sites.<br><br>There is the potential for increased risk of adverse effects on geologically sensitive areas under the high activity scenario. However, as noted above, it is considered reasonable to assume that such risks would be fully considered as part of the planning application process and in accordance with national planning policy including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013). The potential for significant negative effects would also be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).<br><br>As noted above, there is not considered to be a substantial risk of land contamination associated with this stage. In consequence, effects in this regard are not expected to be influenced significantly by the quantum of activity.<br><br>The land use implications of low and high activity scenarios are largely unknown at this stage and would be dependent on individual site characteristics. In this context, the magnitude of any negative effect associated with the high activity scenario may be increased relative to a low activity scenario if, for example, development resulted in the loss of a greater volume of greenfield, agricultural land. |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Taking into account the area of potential landtake required to support decommissioning activities, the high activity scenario has been assessed as having a minor negative effect on this objective. Reflecting the expectation that a much reduced area of land would be required to support decommissioning under the low activity scenario, effects on this objective have been assessed neutral.<br>**Mitigation:**<br>• Sites selected to accommodate development associated with decommissioning activities should be of low agricultural/geological value;<br>• Where necessary, sites should be carefully stripped of topsoils prior to construction works commencing to avoid damage. All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible. Soil excavation and mounds should avoid compaction where possible by making use of appropriate wide tracked vehicles and avoiding working on soil when it is wet. Appropriate drainage systems should be utilised on site to reduce soil erosion;<br>• Where possible, development should make best use of previously developed land;<br>• Careful consideration should be given during the site selection process to the avoidance of adverse impacts on sensitive land uses that may be affected by decommissioning activity.<br>**Assumptions:**<br>• It is assumed that the risk of potential impacts on geologically sensitive sites would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013);<br>• It is assumed that works would be undertaken in accordance with relevant regulations and best practice so as to minimise the risk of land contamination;<br>• It is assumed that soil loss would be greater under the high activity scenario compared to the low activity scenario, commensurate with the total number of well pad sites to be decommissioned.<br>**Uncertainties:**<br>• Individual site characteristics (e.g. in terms of agricultural land quality or the proximity of sensitive land uses) are currently unknown. |

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| Objective 4: Land Use, Geology and Soils | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | + | +/- | **Assessment of Effects:**<br>For the purposes of this assessment it is assumed that all production facilities, infrastructure and hardstanding would be removed during the site restoration and relinquishment stage. Due to the need for invasive demolition techniques and land excavation there is the potential for adverse effects on land stability, geomorphology and/or soil erosion during this stage. Notwithstanding, it is anticipated that effects would be similar to site restoration associated with other forms of mineral extraction and would be unlikely to be significant.<br>It is expected that during site restoration work, land would be remediated and wells sealed thereby mitigating the potential long term risk of land contamination.<br>Long term effects (i.e. beyond site restoration) on land use, geology and soils associated with the decommissioning phase will depend largely on the end use of well pad sites and future soil quality (this would be determined on a site-by-site basis following discussions between the operator and the minerals planning authority). However, paragraph 143 of the National Planning Policy Framework (DCLG 2012) promotes high quality restoration and aftercare "*including for agriculture (safeguarding the long term potential of best and most versatile agricultural land and conserving soil resources), geodiversity, biodiversity, native woodland, the historic environment and recreation*". In consequence, it is expected that this stage of the unconventional oil and gas exploration and production lifecycle would have a positive effect on this objective by restoring, and potentially enhancing, soil quality and prospects for beneficial land use.<br>It should be noted that the AEA (2012) report highlights that it may not be possible to return entire sites to beneficial use due to, for example, concerns regarding public safety. The report states(at page 69) that over a wider area "*this could result in a significant loss of land, and/or fragmentation of land area such as an amenity or recreational facility, valuable farmland, or valuable natural habitat*". This is considered further in respect of both low and high activity scenarios below.<br>Overall, Stage 6 has been assessed as having a minor, long term positive effect on this objective. This reflects the expectation that well pad sites would be restored and soil quality enhanced.<br>**Low and High Activity Scenarios:**<br>There is the potential for increased risk of adverse effects on land stability, geomorphology and/or soil erosion under the high activity scenario, commensurate with the area of land to be restored, relative to the low activity scenario. However, as noted above, it is anticipated that effects would be similar to site restoration associated with other forms of mineral extraction and would be unlikely to be significant.<br>As set out above, the AEA (2012) report highlights that it may not be possible to return entire sites to beneficial use due to, for example, concerns regarding public safety. The report states (at page 69) that over a wider area "*this could result in a significant loss of land, and/or fragmentation of land area such as an amenity or recreational facility,* |

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## Objective 4: Land Use, Geology and Soils

| *Stage* | *Description* | *Score* | | *Commentary* |
|---|---|---|---|---|
| | | *Low Activity Scenario* | *High Activity Scenario* | |
| | | | | *valuable farmland, or valuable natural habitat*". In view of the potentially large area of land that may be covered by well pad sites under the high activity scenario (between 240 and 360ha) it is considered that there is an increased risk of loss of/fragmentation to land uses which has been assessed as having a negative effect on this objective.<br>**Mitigation:**<br>• None identified (beyond requirements contained in existing national planning policy).<br>**Assumptions:**<br>• It is assumed that all production facilities, infrastructure and hardstanding would be removed during the site restoration and relinquishment stage.<br>**Uncertainties:**<br>• Long term effects (i.e. beyond site restoration) on land use, geology and soils associated with the decommissioning phase will depend largely on the end use of well pad sites and future soil quality. This would be determined on a site-by-site basis following discussions between the operator and the minerals planning authority. |

### *Summary*

The assessment has not identified any significant positive or significant negative effects on land use, geology and soils associated with all six stages of the unconventional oil and gas exploration and production lifecycle. Pad preparation and provision of associated infrastructure such as pipelines and road connections during Stage 2 (exploration drilling) and Stage 3 (production development) are likely to require the clearance of vegetation and loss of soil layers and compaction which may have a minor negative effect in terms of soil function and processes. These effects could be greater, and potentially significant, under the high activity scenario, commensurate with increased landtake. However, it is anticipated that sites would be restored following either completion of exploration drilling or decommissioning of wells such that effects would be reduced in longer term. Where development is located on land that is of high agricultural quality (i.e. Agricultural Land Classification Grades 1, 2 or 3a), or in other sensitive areas, effects could be more significant and permanent particularly if the nature of the sensitive area inhibits full site restoration. Notwithstanding, national planning policy such as the National Planning Policy Framework and Planning Policy Wales seeks to avoid development in areas that are sensitive including those of high agricultural land quality .

Whilst long term effects (i.e. beyond site restoration) on land use, geology and soils associated with this stage will depend largely on the end use of well pad sites and future soil quality (this would be determined on a site-by-site basis following discussions between the operator and the minerals planning authority), paragraph 143 of the National Planning Policy Framework (DCLG 2012) promotes high quality restoration and aftercare "*including for agriculture (safeguarding the long term potential of best and most versatile agricultural land and conserving soil resources), geodiversity, biodiversity, native woodland, the historic environment and recreation*". In consequence, it is expected that site restoration and relinquishment (Stage 6) would have a minor positive effect on this objective by restoring, and potentially enhancing, soil quality and prospects for beneficial land use.

Stages 1, 4 and 5 have broadly been assessed as having a neutral effect on land use, geology and soils. This reflects the fact these stages are unlikely to result in substantial (if any) additional landtake and, taking into account the implementation of appropriate mitigation, are unlikely to result in land contamination. However, under the high activity scenario additional landtake and associated effects on soils related to the decommissioning stage (Stage 5) would be potentially greater, commensurate with the number of well pad sites/total area to be decommissioned. Also reflecting the potentially large area of land that may be covered by well pad sites under the high activity scenario (between 240 and 360ha), it is considered that there is an increased risk of loss of/fragmentation to land uses which has been assessed as having a negative effect on this objective.

It should be noted that during Stages 2, 3 and 4 of the unconventional oil and gas exploration and production lifecycle there would be a need for hydraulic fracturing which has the potential to cause induced seismicity. Based on the findings of the independent review by Green *et al* (2012) and research published by AEA (2012) and Davies *et el* (2013) in particular, and taking into account the measures proposed by Government to reduce the risk of undesirable seismic activity, the assessment considers that the risk of hydraulic fracturing causing felt seismicity (M>3) is very small.

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| Objective 4: Land Use, Geology and Soils | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |

**Mitigation Summary**

- Reflecting the recommendations contained in the AEA (2012) report for the European Commission on the potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe, DECC should consider providing guidance in respect of:
  - Using larger drilling pads for multiple wells, increasing the spacing between wells;
  - Site selection including in respect of access and avoidance of sensitive areas such as areas of high agricultural land value;
  - Limiting the use of impoundments;
  - Land restoration;
- Where necessary, sites should be carefully stripped of topsoils prior to construction works commencing to avoid damage. All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible. Soil excavation and mounds should avoid compaction where possible by making use of appropriate wide tracked vehicles and avoiding working on soil when it is wet. Appropriate drainage systems should be utilised on site to reduce soil erosion.
- Where possible, development should make best use of previously developed land.
- Careful consideration should be given during the site selection process to the avoidance of adverse impacts on sensitive land uses that may be affected by construction activity and drilling.
- Where possible, well pad infrastructure and associated development that is no longer required should be removed as soon as is reasonably practicable with land restored.
- Pipelines should be buried where possible with land restored following installation.

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 4.8 Virgin Coalbed Methane

The effects of exploration and production activities associated with virgin coalbed methane (VCBM) are similar to those described in the assessment of effects of unconventional oil and gas (Stages 1-6) in **Table 4.11** above although hydraulic fracturing is not normally required. No attempt has been made to provide an indication of low and high levels of activity.

VCBM exploration drilling sites are usually smaller (around 0.25 hectare) than conventional and unconventional oil and gas drilling sites (1 hectare) [57] whilst production well pad sites are also likely to require less landtake. In consequence, the magnitude of negative effects associated with the clearance of vegetation and loss of soil layers and compaction is also likely to be less (although this is dependent on the characteristics of sites taken forward for development which is currently uncertain).

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During decommissioning (Stage 5), the removal of infrastructure associated with individual wells can be carried out relatively quickly (2-6 weeks). Removal of infrastructure associated with a multiwell development will likely be a gradual process over the lifetime of the development (up to 30 years). The spatial extent of physical disturbance effects associated with decommissioning is unlikely to exceed that of the construction and operation phases[57]. Effects associated with restoration, meanwhile, are expected to be similar to those identified in respect of conventional and unconventional oil and gas under Stages 5 and 6 (see **Table 4.10** and **Table 4.11**) with the potential for site restoration and relinquishment to have a minor positive effect on this objective by restoring, and potentially enhancing, soil quality and prospects for beneficial land use.

## 4.9 Gas Storage

The development of gas storage capacity is likely to entail the following activities:

1. Construction and Installation of Pipelines and Storage Facilities;
2. Storage operations; and
3. Decommissioning.

The likely effects of these activities are appraised in **Table 4.12**.

**Table 4.12 Assessment of Effects: Gas Storage**

| **Objective 7: Climate Change** | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| 1 | **Construction and Installation of Pipelines and Storage Facilities** | - | **Assessment of Effects:**<br>Gas storage projects under consideration in this SEA involve the use of depleted reservoirs, implying that some existing infrastructure is in place. Re-development as a storage facility will typically utilise an existing oil or gas infrastructure site (approximately 1ha) with additional gas processing plant increasing site size to around 2ha[62]. There is also likely to be a need for additional infrastructure including, in particular, new or enhanced road connections and pipeline construction.<br>The development of gas storage facilities including associated infrastructure, like pad preparation for conventional and unconventional oil and gas, may require the clearance of vegetation and loss of soil layers and compaction. However, in view of average site size (up to 2ha) and the likelihood that facilities would be located at an existing oil or gas infrastructure site, any negative effects on soil function and processes are likely to be minor. Notwithstanding, where development is located on land that is of high agricultural quality (i.e. Agricultural Land |

[62] DECC (2010) Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds: Environmental Report.

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| Objective 7: Climate Change | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| | | | Classification Grades 1, 2 or 3a), or in other sensitive areas, effects could be more significant and permanent particularly if the nature of the sensitive area inhibits full site restoration (although national planning policy such as the National Planning Policy Framework and Planning Policy Wales seeks to avoid development in areas that are sensitive including those of high agricultural land quality).<br><br>Construction activities may also affect land stability, geomorphology and/or soil erosion rates, on- or off-site. The type/magnitude of the effects will depend on the geology and physical nature of the area and effects may be particularly adverse where activities are undertaken within or in close proximity to sensitive areas such GCR sites. However, it is considered reasonable to assume that the risk of potential impacts on geologically sensitive sites/areas would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013). Further, the potential for significant negative effects would be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).<br><br>As with any construction activity, there is the potential for works to cause disturbance to contaminated sites which could result in pollution pathways being created or re-opened for existing ground contamination. However, the risk of any such effect occurring cannot be fully established until such time that sites have been identified. Further, it is anticipated that ground contamination surveys would be undertaken prior to development in order to identify the potential risk of disturbance and appropriate mitigation, in accordance with the Contaminated Land Regulations and taking into account appropriate guidance. There is also a small risk of land contamination from, for example, accidental spillage. It would be expected that any potential contamination would be sufficiently mitigated by following best practice guidance and through the use of a Construction Environmental Management Plan (CEMP). However, it would not allow for accidental or unforeseen discharges.<br><br>In view of the fact that gas storage facilities would be likely to be located at an existing oil or gas infrastructure site, it is considered unlikely that existing land uses would be substantially affected during construction. Further, there is strong potential to maximise the use of previously developed land which would have a positive effect on land use, geology and soils.<br><br>Overall, Stage 1 of the gas storage lifecycle has been assessed as having a minor negative effect on this objective.<br><br>**Mitigation:**<br><br>• Sites taken forward for development should be located on land of low agricultural/geological value;<br><br>• Where necessary, sites should be carefully stripped of topsoils prior to construction works commencing to avoid damage. All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible. Soil |

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| Objective 7: Climate Change | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| | | | excavation and mounds should avoid compaction where possible by making use of appropriate wide tracked vehicles and avoiding working on soil when it is wet. Appropriate drainage systems should be utilised on site to reduce soil erosion;<br>• Where possible, development should make best use of previously developed land;<br>• Careful consideration should be given during the site selection process to the avoidance of adverse impacts on sensitive land uses that may be affected by construction activity and drilling;<br>• Where possible, gas storage infrastructure and associated development that is no longer required should be removed as soon as is reasonably practicable with land restored;<br>• Pipelines should be buried where possible with land restored following installation.<br>**Assumptions:**<br>• It is assumed that the risk of potential impacts on geologically sensitive sites would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013).<br>• It is assumed that works would be undertaken in accordance with relevant regulations and best practice so as to minimise the risk of land contamination.<br>**Uncertainties:**<br>• Individual site characteristics (e.g. in terms of agricultural land quality or the proximity of sensitive land uses) are currently unknown. |
| 2 | **Storage Operations** | **0** | **Assessment of Effects:**<br>It is assumed that no additional landtake would be required during the storage stage and in consequence, associated effects on soils and land stability would be negligible.<br>During the storage stage there is the potential for the accidental release of pollutants including oils that could result in land contamination. However, it would be expected that any potential contamination would be sufficiently mitigated by following best practice guidance and through the use of a Construction Environmental Management Plan (CEMP). However, it would not allow for accidental or unforeseen discharges.<br>In view of the fact that gas storage facilities would be likely to be located at an existing oil or gas infrastructure site, it is considered unlikely that existing/adjacent land uses would be substantially affected during operation.<br>Based on the assumption that there would be no additional landtake during Stage 2 and that the risk of land contamination from operational activities would be low, this stage has been assessed as having a neutral effect on land use, geology and soils. |

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| Objective 7: Climate Change | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| | | | **Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• It is assumed that there would be no additional landtake during Stage 2;<br>• It is assumed that works would be undertaken in accordance with relevant regulations and best practice so as to minimise the risk of land contamination.<br>**Uncertainties:**<br>• Individual site characteristics (in terms of the proximity of sensitive land uses) are currently unknown. |
| 3 | **Decommissioning** | **0** | **Assessment of Effects:**<br>Removal of infrastructure associated with gas storage facilities can be carried out relatively quickly (2-6 weeks). Removal of transport infrastructure linking the facility with the national transmission system will have a duration and effect comparable to installation with the spatial extent of physical disturbance effects likely to be similar to construction[62].<br>Decommissioning will require additional machinery, and potentially, construction compounds to facilitate the removal of site equipment. Associated works may require clearance of vegetation and loss of soil layers and compaction, potentially generating a negative effect in terms of soil function and processes. However, it is not expected that the area of land required to undertake decommissioning activities (beyond the existing site) would be significant. Notwithstanding, where development associated with decommissioning activities is located on land that is of high agricultural quality (i.e. Agricultural Land Classification Grades 1, 2 or 3a), or in other sensitive areas, effects could be more significant and permanent particularly if the nature of the sensitive area inhibits full site restoration[59], although national planning policy seeks to avoid development in areas that are sensitive including those of high agricultural land quality.<br>As with construction (Stage1), decommissioning may affect land stability, geomorphology and/or soil erosion rates, on- or off-site. The type/magnitude of the effects will depend on the geology and physical nature of the area and effects may be particularly adverse where activities are undertaken within close proximity to sensitive areas such Geological Conservation Review sites. However, it is considered reasonable to assume that the risk of potential impacts on geologically sensitive sites/areas would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013). Further, the potential for significant negative effects would be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).<br>There is the potential for the construction of buildings and infrastructure associated with decommissioning to cause disturbance to contaminated land where this development takes place on an existing contaminated site. However, the risk of any such effect occurring cannot be fully established until such time that sites have been identified. |

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| Objective 7: Climate Change | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| | | | Further, it is anticipated that ground contamination surveys would be undertaken prior to decommissioning in order to identify the potential risk of disturbance and appropriate mitigation, in accordance with the Contaminated Land Regulations and taking into account appropriate guidance.<br>During the decommissioning stage, there continues to be a small risk of land contamination from, for example, accidental spillage. However, it would be expected that any potential contamination would be sufficiently mitigated by following best practice guidance and through the use of a Construction Environmental Management Plan (CEMP). It should also be noted that the decommissioning of onshore wells and associated installations would be addressed through conditions in planning consents and through PPC authorisation, which requires that the site of an installation be returned to a satisfactory state on closure. Permission to decommission onshore wells is also required from DECC under The Petroleum (Production) (Landward Areas) Regulations 1995 and would require submission and agreement in advance of a Cessation of Production (COP) report[57].<br>In view of the fact that gas storage facilities would be likely to be located at an existing oil or gas infrastructure site, it is considered unlikely that existing land uses would be substantially affected during decommissioning.<br>Overall, Stage 3 has been assessed as having a mixed positive and negative effect on this objective.<br>**Mitigation:**<br>• Sites selected to accommodate development associated with decommissioning activities should be of low agricultural/geological value.<br>• Where necessary, sites should be carefully stripped of topsoils prior to construction works commencing to avoid damage. All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible. Soil excavation and mounds should avoid compaction where possible by making use of appropriate wide tracked vehicles and avoiding working on soil when it is wet. Appropriate drainage systems should be utilised on site to reduce soil erosion.<br>• Where possible, development should make best use of previously developed land.<br>• Careful consideration should be given during the site selection process to the avoidance of adverse impacts on sensitive land uses that may be affected by decommissioning activity.<br>**Assumptions:**<br>• It is assumed that the risk of potential impacts on geologically sensitive sites would be fully considered as part of the planning application process and in accordance with national planning policy and guidance including, for example, guidance contained in Planning practice guidance for onshore oil and gas (DCLG, 2013). |

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## Objective 7: Climate Change

| *Stage* | *Description* | *Score* | *Commentary* |
|---|---|---|---|
| | | | • It is assumed that works would be undertaken in accordance with relevant regulations and best practice so as to minimise the risk of land contamination.<br>**Uncertainties:**<br>• Individual site characteristics (e.g. in terms of agricultural land quality or the proximity of sensitive land uses) are currently unknown. |

### *Summary*

The assessment has not identified any significant positive or significant negative effects on land use, geology and soils associated with all three stages of the gas storage lifecycle. The development of gas storage facilities including associated infrastructure (Stage 1) may require the clearance of vegetation and loss of soil layers and compaction. However, in view of average site size (up to 2ha) and the likelihood that facilities would be located at an existing oil or gas infrastructure site, any negative effects on soil function and processes are likely to be minor. Where development is located on land that is of high agricultural quality (i.e. Agricultural Land Classification Grades 1, 2 or 3a), or in other sensitive areas, effects could be more significant and permanent particularly if the nature of the sensitive area inhibits full site restoration. Notwithstanding, national planning policy such as the National Planning Policy Framework and Planning Policy Wales seeks to avoid development in areas that are sensitive including those of high agricultural land quality.

Stage 2 (Storage Operations) and Stage 3 (Decommissioning) have been assessed as having a neutral effect on land use, geology and soils. This reflects the fact these stages are unlikely to result in substantial additional landtake and, taking into account the implementation of appropriate mitigation, are unlikely to result in land contamination. Further, in view of the fact that gas storage facilities would be likely to be located at an existing oil or gas infrastructure site, it is considered unlikely that existing/adjacent land uses would be substantially affected during operation or decommissioning.

**Mitigation Summary:**

- Sites taken forward for development should be located on land of low agricultural/geological value.
- Where necessary, sites should be carefully stripped of topsoils prior to construction works commencing to avoid damage. All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible. Soil excavation and mounds should avoid compaction where possible by making use of appropriate wide tracked vehicles and avoiding working on soil when it is wet. Appropriate drainage systems should be utilised on site to reduce soil erosion.
- Where possible, development should make best use of previously developed land.
- Careful consideration should be given during the site selection process to the avoidance of adverse impacts on sensitive land uses that may be affected by construction activity and drilling.
- Where possible, gas storage infrastructure and associated development that is no longer required should be removed as soon as is reasonably practicable with land restored.
- Pipelines should be buried where possible with land restored following installation.

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

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## 4.10 SEA Areas

The following sections consider in-turn the potential effects of Licensing Plan activities on the land use, geology and soils objective in the five SEA Areas. The assessment draws on the findings presented in **Table 4.10** and **Table 4.11** above and takes account of the environmental characteristics of the areas as detailed in **Section 4.4**.

### 4.10.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

#### Conventional Oil and Gas

A large proportion of Scotland's land area is used for arable agriculture (25%). This is mostly restricted to the east which coincides with areas of prime agricultural land quality (Class 1 to Class 3.1) (see **Figure 4.7**).

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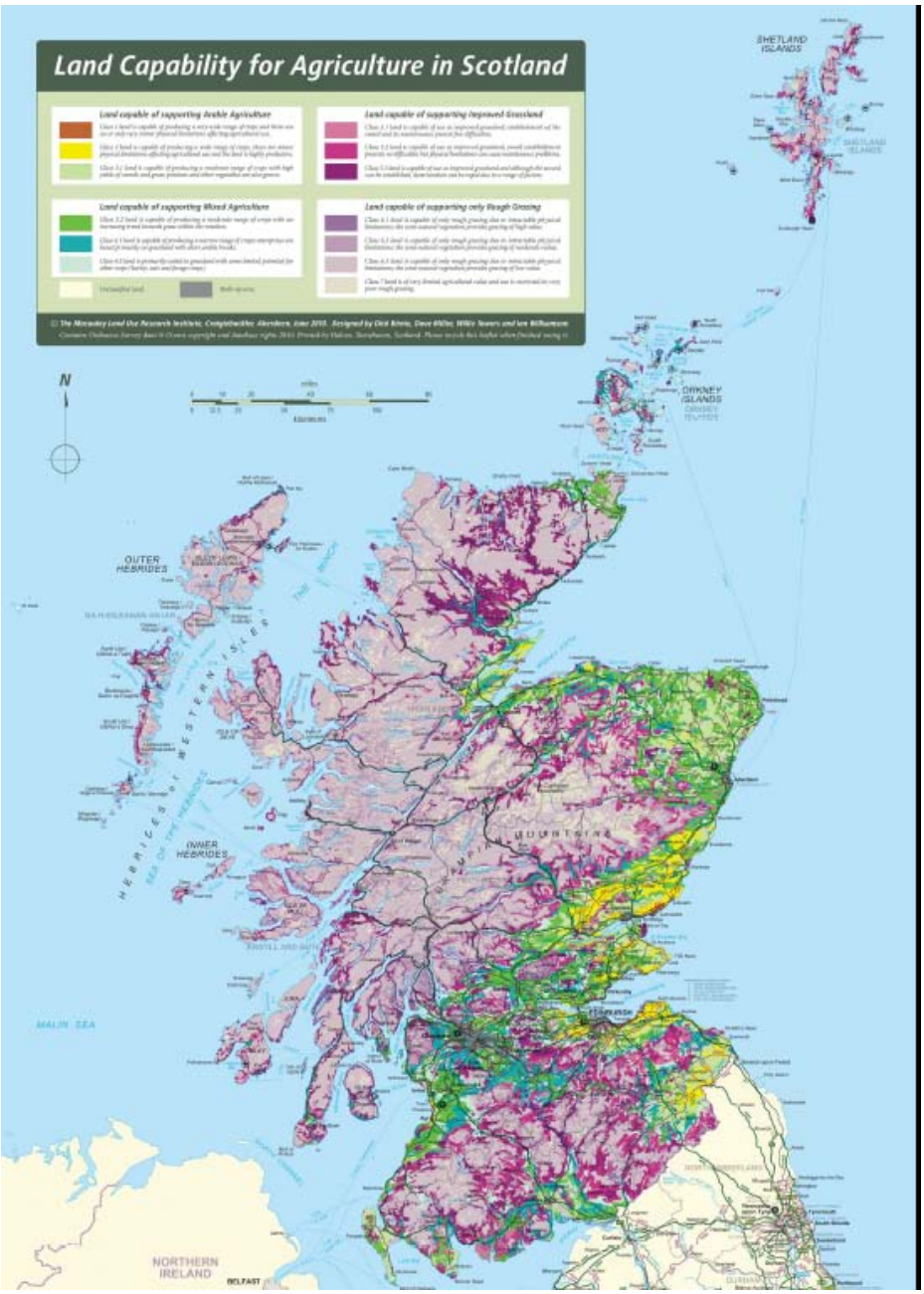
**Figure 4.7 Land Capability for Agriculture (Scotland)**




Source: http://www.macaulay.ac.uk/explorescotland/lca.html

Pad preparation and provision of associated infrastructure such as pipelines and road connections during Stage 2 (exploration drilling) and Stage 3 (production development) are likely to require the clearance of vegetation and loss of soil layers and compaction which may have a minor negative effect in terms of soil function and processes. Should development be located in agricultural areas towards the east then the potential for negative effects on soils (and agricultural land uses) may be greater. However, it is assumed that such land would be avoided, in accordance with the draft Scottish Planning Policy (Scottish Government, 2013).

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There are a large number of GCR sites in SEA Area 1 (200) which increases the potential for adverse effects on geology. However, it is considered reasonable to assume that the risk of potential impacts on geologically sensitive sites/areas would be fully considered as part of the planning application process and in accordance with national planning policy. Further, the potential for significant negative effects would be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).

SEA Area 1 has a legacy of both the minerals industry (coal and metals) and urban development including old mineworkings, contaminated land and polluted groundwaters. Should sites be taken forward in this SEA Area, it will therefore be important to ensure that appropriate remediation is undertaken in advance of construction activity.

### Unconventional Oil and Gas

The range and type of effects associated with the development of unconventional oil and gas in SEA Area 1 are likely to be similar to those identified in respect of conventional oil and gas exploration and production. Importantly, however, there is the potential that pressure on higher quality agricultural land and GCR sites could increase in view of the larger area of land that could be covered by well pad sites, particularly under the high activity scenario (up to 360 hectares). However, this is dependent on the quantum and distribution of development across the area which is currently uncertain.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 1 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production although in view of the reduced landtake associated with this resource, the potential magnitude of effects may be reduced.

### Gas Storage

The potential for negative effects on land use, geology and soil in SEA Area 1 is likely to be less than that associated with conventional and unconventional oil and gas exploration and production. This reflects the likelihood that facilities would be located at existing oil or gas infrastructure sites thereby reducing the requirement for the development of greenfield land.

## 4.10.2 SEA Area 2: West Midlands, North West England and Southern Scotland

### Conventional Oil and Gas

Agricultural land quality is varied across SEA Area 2 with poorer quality land (Grades 4 and 5) in upland areas and a relatively large proportion of land classified as urban. Higher quality agricultural land (Grades 1, 2 and 3a) is predominantly concentrated towards the West and South of the area. Should well pad sites be located in these areas there may be a higher risk of adverse effects on soil function and

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processes. Notwithstanding, the National Planning Policy Framework and draft Scottish Planning Policy seek to avoid development in areas that are sensitive including those of high agricultural land quality.

There are a large number of GCR sites in SEA Area 2 (171) which increases the potential for adverse impacts on geology. However, it is considered reasonable to assume that the risk of potential impacts on geologically sensitive sites/areas would be fully considered as part of the planning application process and in accordance with national planning policy. Further, the potential for significant negative effects would be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).

## Unconventional Oil and Gas

The range and type of effects associated with the development of unconventional oil and gas in SEA Area 2 are likely to be similar to those identified in respect of conventional oil and gas exploration and production. Importantly, however, there is the potential that pressure on higher quality agricultural land and GCR sites could increase in view of the larger area of land that could be covered by well pad sites, particularly under the high activity scenario (up to 360 hectares). This is dependent on the quantum and distribution of development across the area which is currently uncertain. However, it is noted that the BGS study [63] of the Carboniferous Bowland Shale gas resource indicates that areas of higher agricultural land quality coincide with those areas considered to be more prospective in the Bowland-Hodder study area (see **Figure 4.8**).

[63] Andrews, I.J. (2013) *The Carboniferous Bowland Shale gas study: geology and resource estimation*. British Geological Survey for Department of Energy and Climate Change, London, UK.

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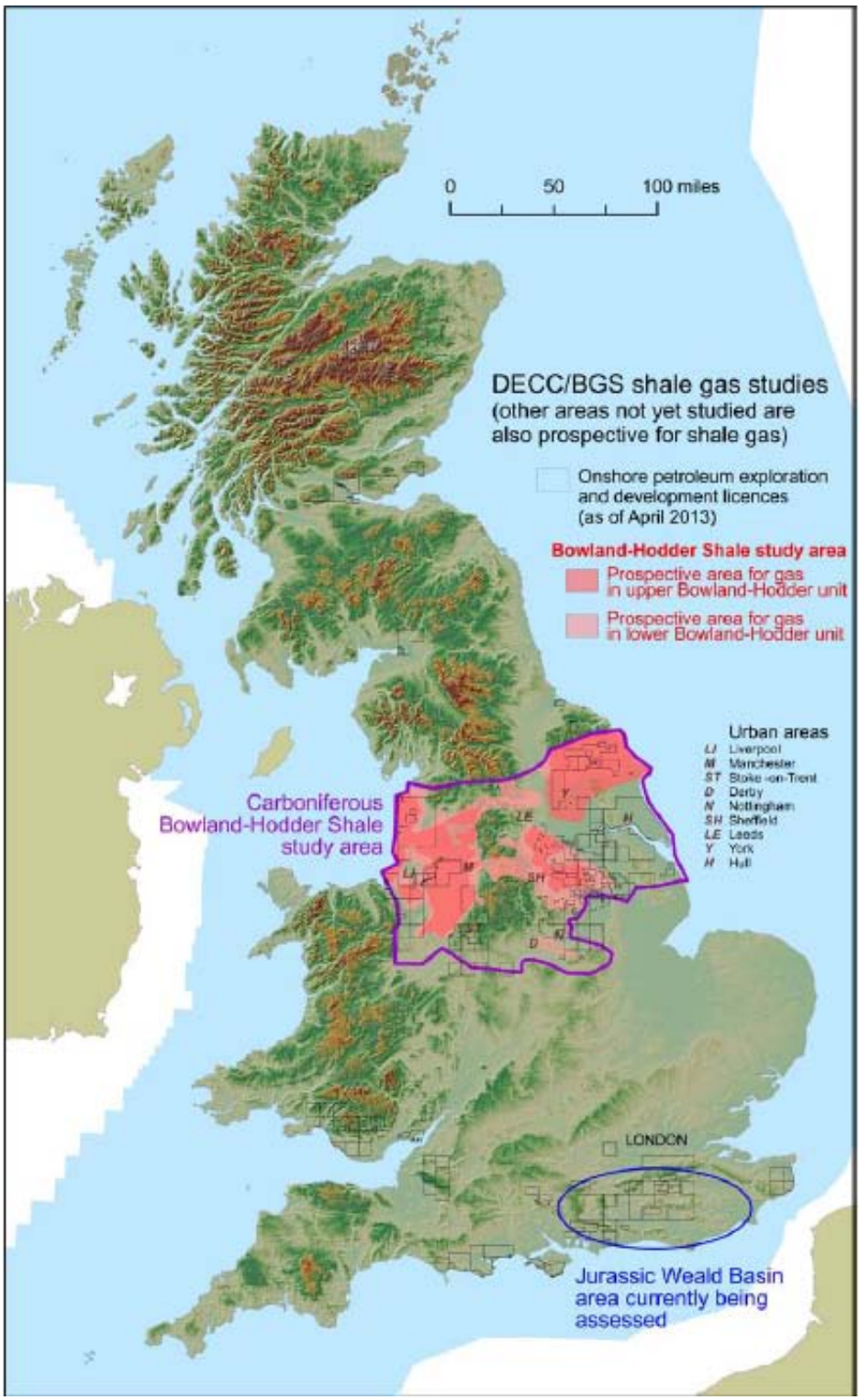
**Figure 4.8 Location of the BGS Study Area in Central Britain, together with Prospective Areas for Shale Gas, Currently Licensed Acreage and Selected Urban Areas**




Source: Andrews, I.J. (2013) *The Carboniferous Bowland Shale gas study: geology and resource estimation*. British Geological Survey for Department of Energy and Climate Change, London, UK.

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Prospective areas identified in the BGS study also include a number of urban areas such as Blackpool and Liverpool. In consequence, there is the potential for both the construction, operation and decommissioning of sites to affect sensitive land uses and impede the delivery of other types of development (e.g. housing and economic development) which could have a negative effect on this objective. However, opportunities may also exist to utilise previously developed sites which would generate a positive effect on this objective.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 2 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production although in view of the reduced landtake associated with this resource, the potential magnitude of effects may be reduced.

### Gas Storage

The potential for negative effects on land use, geology and soil in SEA Area 2 is likely to be less than that associated with conventional and unconventional oil and gas exploration and production. This reflects the likelihood that facilities would be located at existing oil or gas infrastructure sites thereby reducing the requirement for the development of greenfield land.

## 4.10.3 SEA Area 3: East Midlands and Eastern England

### Conventional Oil and Gas

SEA Area 3 is characterised by a large proportion of land classified as being of high agricultural quality (Grades 1, 2 and 3a) including areas deemed to be ‘excellent’ (Grade 1) toward the South. In consequence, there could be an increased risk of loss of higher quality agricultural land during Stage 2 (exploration drilling) and Stage 3 (production development) of the conventional oil and gas exploration and production lifecycle. Notwithstanding, the National Planning Policy Framework seeks to avoid development in areas that are sensitive including those of high agricultural land quality.

There are a large number of GCR sites in SEA Area 3 (399) which increases the potential for adverse impacts on geology. However, it is considered reasonable to assume that the risk of potential impacts on geologically sensitive sites/areas would be fully considered as part of the planning application process and in accordance with national planning policy. Further, the potential for significant negative effects would be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).

The industrial prosperity of the region was founded on the North East, Yorkshire–Nottinghamshire and Leicestershire coalfields. Current activities include some opencast and deep coal mining, extraction of limestone, hard-rock aggregate, sand and gravel, gypsum, oil and gas. Legacies of mining activities include hazards such as subsidence and contamination of ground and surface water sources by mining

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spoil or landfill. Other hazards include landslips, radon gas, ground 'heave' (swelling clays), and flooding. Should sites be taken forward in this SEA Area, it will therefore be important to ensure that appropriate remediation is undertaken in advance of construction activity.

### Unconventional Oil and Gas

The range and type of effects associated with the development of unconventional oil and gas in SEA Area 3 are likely to be similar to those identified in respect of conventional oil and gas exploration and production. Importantly, however, there is the potential that pressure on higher quality agricultural land and GCR sites could increase in view of the larger area of land that could be covered by well pad sites, particularly under the high activity scenario (up to 360 hectares). However, this is dependent on the distribution of development across the area which is currently uncertain.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 3 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production although in view of the reduced landtake associated with this resource, the potential magnitude of effects may be reduced.

### Gas Storage

The potential for negative effects on land use, geology and soil in SEA Area 3 is likely to be less than that associated with conventional and unconventional oil and gas exploration and production. This reflects the likelihood that facilities would be located at existing oil or gas infrastructure sites thereby reducing the requirement for the development of greenfield land.

## 4.10.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

### Conventional Oil and Gas

Within Wales, agricultural land quality is generally poorer in the north and south east. As a result, the potential risk of significant negative effects on soils during Stage 2 and 3 of the conventional oil and gas exploration and production lifecycle is potentially lower compared to the other SEA areas. Notwithstanding, the lack of higher quality agricultural land in these areas reinforces the need for its protection and in accordance with national planning policy set out in Planning Policy Wales (Welsh Government, 2012), the site selection process should seek to ensure that the best and most versatile agricultural land is avoided.

A legacy of past metal and coal mining activities in SEA Area 4 has left some soils and river systems contaminated. Should sites be taken forward in this SEA Area, it will therefore be important to ensure that appropriate remediation is undertaken in advance of construction activity.

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### Unconventional Oil and Gas

The range and type of effects associated with the development of unconventional oil and gas in SEA Area 4 are likely to be similar to those identified in respect of conventional oil and gas exploration and production.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 4 are likely to be similar to those identified in respect of conventional oil and gas exploration and production although in view of the reduced landtake associated with this resource, the potential magnitude of effects may be reduced.

### Gas Storage

The potential for negative effects on land use, geology and soil in SEA Area 4 is likely to be less than that associated with conventional and unconventional oil and gas exploration and production. This reflects the likelihood that facilities would be located at existing oil or gas infrastructure sites thereby reducing the requirement for the development of greenfield land.

## 4.10.5 SEA Area 5: Southern and South West England

A large proportion of SEA Area 5 is classified as Grade 3 agricultural land although there are some pockets of Grades 1, 2, 4 and 5 land. In consequence, there could be an increased risk of loss of higher quality agricultural land during Stage 2 (exploration drilling) and Stage 3 (production development) of the conventional oil and gas exploration and production lifecycle. Notwithstanding, the National Planning Policy Framework seeks to avoid development in areas that are sensitive including those of high agricultural land quality.

There are a large number of GCR sites in SEA Area 3 (640) which increases the potential for adverse impacts on geology. The Dorset and East Devon Coast World Heritage Site has also been designated for its important fossil sites and coastal geomorphologic features. However, it is considered reasonable to assume that the risk of potential impacts on geologically sensitive sites/areas would be fully considered as part of the planning application process and in accordance with national planning policy. Further, the potential for significant negative effects would be identified as part of the Environmental Impact Assessment (EIA) process (where appropriate).

Some areas in the south west have a historic legacy of mine water polluted with heavy metals, contaminated land and the threat of subsidence. Should sites be taken forward in this SEA Area, it will therefore be important to ensure that appropriate remediation is undertaken in advance of construction activity.

This SEA area contains a number of large urban areas including, for example, London, Bristol, Oxford, Southampton and Portsmouth. In consequence, there is the potential for both the construction,

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operation and decommissioning of sites to affect sensitive land uses and impede the delivery of other types of development (e.g. housing and economic development) which could have a negative effect on this objective. However, opportunities may also exist to utilise previously developed sites which would generate a positive effect on this objective.

## Unconventional Oil and Gas

The range and type of effects associated with the development of unconventional oil and gas in SEA Area 5 are likely to be similar to those identified in respect of conventional oil and gas exploration and production. Importantly, however, there is the potential that pressure on higher quality agricultural land and GCR sites could increase in view of the larger area of land that could be covered by well pad sites, particularly under the high activity scenario (up to 360 hectares). However, this is dependent on the distribution of development across the area which is currently uncertain.

## Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 5 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production although in view of the reduced landtake associated with this resource, the potential magnitude of effects may be reduced.

## Gas Storage

The potential for negative effects on land use, geology and soil in SEA Area 5 is likely to be less than that associated with conventional and unconventional oil and gas exploration and production. This reflects the likelihood that facilities would be located at existing oil or gas infrastructure sites thereby reducing the requirement for the development of greenfield land.

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# 5. Water and Flood Risk

## 5.1 Introduction

The overview of plans and programmes and baseline information contained in this section provides the context for the assessment of potential effects of Licensing Plan proposals on water quality, water resources and flood risk. Information is presented for both national and regional levels.

Water quality and resources within this context are defined as inland surface freshwater and groundwater resources, and inland surface freshwater, groundwater, estuarine, coastal and marine water quality.

There are links between the water quality/resources and flood risk topic and a number of other SEA topics, in particular the effects and interactions of water quality and resources on biodiversity, population and human health.

## 5.2 Review of Plans and Programmes

### 5.2.1 International/European

The ***Water Framework Directive*** (WFD) is the most substantial piece of EC water legislation to date and replaces a number of existing Directives including the Surface Water Abstraction Directive. It establishes a framework for the protection of inland surface waters, transitional waters, coastal water and groundwater and is designed to improve and integrate the way water bodies are managed, including encouraging the sustainable use of water resources. The key objectives at European level are general protection of the aquatic ecology, specific protection of unique and valuable habitats, protection of drinking water resources, and protection of bathing water.

In accordance with Article 4(1), the Directive objectives for surface water, groundwater, transitional and coastal water bodies are to:

- prevent deterioration;
- reduce pollution;
- protect, enhance and restore condition;
- achieve ‘good status’ by 2015, or an alternative objective where allowed; and
- comply with requirements for protected areas .

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Article 7.3 of the Directive notes that member states shall ensure the necessary protection for the bodies of water identified [for the purposes of providing human consumption for 50 persons or more] with the aim of avoiding deterioration in their quality in order to reduce the level of purification treatment required in the production of drinking water. In addition, member states may establish safeguard zones for those bodies of water.

The WFD adopts the 'polluters pays principle' in seeking to ensure that the costs and benefits of discharging pollutants to the water environment are appropriately valued, and that implementation of the Directive is achieved in a fair and proportionate way across all sectors.

The aim of the ***Marine Strategy Framework Directive 2008*** is to protect more effectively the marine environment across Europe. It aims to achieve good environmental status of the EU's marine waters by 2021 and to protect the resource base upon which marine-related economic and social activities depend.

With specific regard to coastal water quality, the ***Bathing Waters Directive 2006/7/EC*** sets standards for the quality of bathing waters in terms of:

- the physical, chemical and microbiological parameters;
- the mandatory limit values and indicative values for such parameters; and
- the minimum sampling frequency and method of analysis or inspection of such water.

The ***Floods Directive 2007/60/EC*** aims to provide a consistent approach to managing flood risk across Europe. The approach is based on a 6 year cycle of planning which includes the publication of Preliminary Flood Risk Assessments, hazard and risk maps and flood risk management plans. The Directive is transposed into English law by the Flood Risk Regulations 2009.

The ***Urban Waste Water Treatment Directive 91/271/EEC*** has the objective of protecting the environment from the adverse effects of untreated 'urban waste water' ('sewage'). The directive establishes minimum requirements for the treatment of significant sewage discharges. An important aspect of the directive is the protection of the water environment from nutrients, (specifically compounds of nitrogen and phosphorus), and/or nitrates present in waste water where these substances have adverse impacts on the ecology of the water environment or abstraction source waters. It was transposed into English law through the Urban Waste Water Treatment (England and Wales) Regulations 1994 (as amended).

In addition, the following European Directives have relevance to the protection of the water environment and resources:

- Dangerous Substances Directive 76/464/EEC;
- Quality of Shellfish Waters Directive 79/923/EEC;
- Directive on Priority Substances 2008/105/EC;

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- Groundwater Directive 2006/118/EC;
- Waste Framework Directive 2008/98/EC;
- Industrial Emissions Directive 2010/75/EU; and
- Drinking Water Directive 98/83/EC.

### 5.2.2 UK

The ***Flood and Water Management Act 2010*** makes provisions about water, including those related to water resources, including:

- To widen the list of uses of water that water companies can control during periods of water shortage, and enable Government to add to and remove uses from the list;
- To encourage the uptake of sustainable drainage systems by removing the automatic right to connect to sewers and providing for unitary and county councils to adopt SUDS for new developments and redevelopments;
- To reduce 'bad debt' in the water industry by amending the Water Industry Act 1991 to provide a named customer and clarify who is responsible for paying the water bill; and

To make it easier for water and sewerage companies to develop and implement social tariffs where companies consider there is a good cause to do so, and in light of guidance that will be issued by the Secretary of State following a full public consultation. The Flood and Water Management Act 2010 contains provisions for regional working and co-operation such as the establishment of regional flood and coastal committees and the bringing together of lead local flood authorities, who will have a duty to cooperate, to develop local strategies for managing local flood risk. In addition, the Flood Risk Regulations 2009 impose a duty on the Environment Agency and lead local flood authorities to take steps to identify and prepare for significant flood risk.

Shoreline Management Plans (SMPs), currently under revision by Coastal Groups and the Environment Agency, assess the risks to people, development, and the natural and historic environment from coastal processes. These plans (SPM2) will provide a route map for local authorities for the time period of the next 20 years, and leading up to the next 50-100 years. They will include an action plan of what is required to manage coastal processes and where, and will form the basis of decision making for such works.

The ***Marine and Coastal Access Act 2009*** sets out a number of measures including the establishment of Marine Conservation Zones (MCZs) and Marine Spatial Plans. The main objectives of the ***Marine Policy Statement (2011)*** are to enable an appropriate and consistent approach to marine planning across UK waters, and to ensure the sustainable use of marine resources and strategic management of marine activities from renewable energy to nature conservation, fishing, recreation and tourism.

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## 5.2.3 England

### Water Quality and Resources

In England, the implementation work related to the Water Framework Directive is undertaken by the Environment Agency, working in partnership with key partners. For these reason the majority of data and programmes regarding Water Quality and Resources cover both administrations and therefore England and Wales are considered collectively in this chapter.

There are 11 River Basin Districts in England and Wales which each require (under the Water Framework Directive) a ***River Basin Management Plan (RBMP)*** including objectives for surface water, groundwater, transitional and coastal water bodies.

The Government's 2011 White Paper '***Water for Life'*** sets out the Government's vision for future water management in which the water sector is resilient and which water is valued as a precious resource. The key reforms set out in the White Paper are:

- the introduction of a reformed water abstraction regime, as signalled in the Natural Environment White Paper changes to deal with the legacy of over-abstraction of our rivers;
- a new catchment approach to dealing with water quality and wider environmental issues;
- with the Environment Agency and Ofwat provide clearer guidance to water companies on planning for the long-term, and keeping demand down;
- consultation on the introduction of national standards and a new planning approval system for sustainable drainage; and
- collaboration with water companies, regulators and customers to raise awareness of the connection between how we use water and the quality of our rivers.

The Government's 2011 White Paper '***Water for Life'*** sets out the Government's vision for future water management in which the water sector is resilient and which water is valued as a precious resource. The key reforms set out in the White Paper are:

- the introduction of a reformed water abstraction regime, as signalled in the Natural Environment White Paper changes to deal with the legacy of over-abstraction of our rivers;
- a new catchment approach to dealing with water quality and wider environmental issues;
- with the Environment Agency and Ofwat provide clearer guidance to water companies on planning for the long-term, and keeping demand down;
- consultation on the introduction of national standards and a new planning approval system for sustainable drainage; and

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- collaboration with water companies, regulators and customers to raise awareness of the connection between how we use water and the quality of our rivers.

**Water for people and the environment - Water resources strategy for England and Wales** (2009) published by Environment Agency, includes the following objectives:

- enable habitats and species to adapt better to climate change;
- allow protection for the water environment to adjust flexibly to a changing climate;
- reduce pressure on the environment caused by water taken for human use;
- encourage options resilient to climate change to be chosen in the face of uncertainty;
- better protect vital water supply infrastructure;
- reduce greenhouse gas emissions from people using water, considering the whole life-cycle of use; and
- improve understanding of the risks and uncertainties of climate change.

Other relevant strategies include the Environment Agency's ***Catchment Abstraction Management Strategies*** (CAMS) which have identified a number of catchments in England and Wales which are designated as 'over-licensed' or 'over-abstracted'. That is, the current level of licensed abstraction could result in an unacceptable stress on the catchment's ecology (designated over-licensed) or possibly is resulting in an unacceptable effect (designated over-abstracted).

***National Policy Statements (2011 and 2012)*** brings together national government policy for nationally significant infrastructure projects (NSIPs) for energy, wastewater and ports infrastructure. The National Policy Statements set out the policy framework for decisions on major infrastructure projects that meet the NSIPs thresholds established in the Planning Act 2008.

The ***National Planning Policy Framework (NPPF) (2012)*** expects the planning system to contribute to conserving and enhancing the natural environment and reducing pollution, and take full account of flood risk. In particular, the planning system is expected to prevent new development from contributing to unacceptable levels of water pollution.

- Local planning authorities are expected to set out the strategic priorities for their area in the Local Plan including strategic policies to deliver the provision of infrastructure for water supply, wastewater, flood risk and coastal change management. In preparing the evidence base for their Local Plans, they are expected to work with other authorities and providers to assess the quality and capacity of the existing infrastructure and its ability to meet forecast demands. Public bodies have a duty to co-operate on planning issues that cross administrative boundaries particularly those which relate to strategic priorities; and

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- The Framework expects inappropriate development in areas of flood risk to be avoided and sets out how this should be achieved through the preparation of Local Plans and in determining planning applications. Supporting technical guidance has been provided to ensure the effective implementation of the policy.

Local plans are expected to take account of climate change over the longer term including factors such as flood risk, coastal change and water supply. New development should be planned to avoid increased vulnerability to the range of impacts arising from climate change.

***Planning Practice Guidance for Onshore Oil and Gas (2013)*** provides advice on the planning issues associated with the extraction of hydrocarbons. It will be kept under review and should be read alongside other planning guidance and the NPPF. The guidance identifies a range of issues that mineral planning authorities may need to address. Those particularly relevant to water include flood risk and internationally, nationally or locally designated wildlife sites, protected habitats and species, and ecological networks.

## Flood Risk

The 2011 ***National Flood and Coastal Erosion Risk Management Strategy for England*** [1] seeks to ensure that flooding and coastal erosion risks are well-managed and co-ordinated, so that their impacts are minimised through better understanding of the risks, management of the likelihood, helping people to manage their own risk, preventing inappropriate development and improving flood prediction and post-flood recovery.

To complement the above Strategy, risks associated with coastal change are being addressed through ***Shoreline Management Plans*** which are being developed across England and Wales, whilst information on the national risk from coast erosion has been collated. **Surface Water Management Plans** are being developed across England and Wales, with accompanying technical guidance [2].

The NPPF (paragraph 100) seeks to avoid inappropriate development in areas at risk of flooding by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere. Technical guidance on flood risk published alongside the NPPF sets out how this policy should be implemented, including the PPS25 Supplement on Development and Coastal Change. Local Plans should be supported by Strategic Flood Risk Assessment and develop policies to manage flood risk from all sources, taking account of advice from the Environment Agency and other relevant flood risk management bodies, such as lead local flood authorities and internal drainage boards. Local Plans should apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change. This includes applying a sequential test to

[1] http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/geho0711btze-e-e.pdf

[2] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69342/pb13546-swmp-guidance-100319.pdf

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steer new development to areas with the lowest probability of flooding.

When determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment (NPPF paragraph 103). A site-specific flood risk assessment is required for proposals of 1 hectare or greater in Flood Zone 1; all proposals for new development (including minor development and change of use) in Flood Zones 2 and 3, or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the Environment Agency); and where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding. Flood defence consents under the Land Drainage Act 1991 and the Water Resources Act 1991 (and associated byelaws) will be required if any of the following apply;

- works in, over, under, or within the byelaw margin of main rivers, or likely to affect the integrity of tidal defences;
- raising ground levels in the floodplain beside a main river; and
- constructing or altering a culvert or structure to control the flow of the river (such as a weir) on any ordinary watercourse.

### 5.2.4 Wales

Within the ***Environment Strategy for Wales (2006)*** there are a number of water related objectives; including:

- to manage water resources sustainably without causing environmental damage;
- to increase water efficiency and maintain water quality;
- to maintain and enhance quality of water sources; understand and manage diffuse pollution sources; and
- to minimise the risk posed by exposure to chemicals.

***Planning Policy Wales (2012) (Edition 5)*** sets out the land use planning policies of the Welsh Assembly Government. Regarding water resources, PPW seeks to protect and improve water resources through increased efficiency and demand management of water, particularly in those areas where additional water resources may not be available and ensure that appropriate sewerage facilities are provided to convey, treat and dispose of waste water in accordance with appropriate legislation and sustainability principles.

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## 5.2.5 Scotland

### Water Quality and Resources

The ***Water Environment and Water Services (Scotland) Act 2003*** makes provisions for the protection of the Scottish water environment, including a timetable for implementation of requirements of the Water Framework Directive up until 2015.

The ***Water Environment (Controlled Activities) (Scotland) Regulations (2005)*** sets out the process by which activities that have the potential to affect Scotland's water environment are regulated. Authorisation under the Controlled Activities Regulations (CAR) is required for discharging to waters, disposal of pollutants to land, abstractions, impoundments and engineering works affecting water bodies.

The Scottish Environment Protection Agency's ***River Basin Planning Strategy for the Scotland River Basin District (2005)*** describes planned actions within three key areas necessary for the development of effective river basin planning, namely: establishing administrative arrangements and working principles to support RBMP production; delivering opportunities for participation and consultation, and integrating and coordinating the RBMP with other plans and planning.

Other relevant strategies include the Scottish Executives ***Bathing Water Strategy for Scotland (2006)*** which sets out a framework for meeting the challenges associated with implementing the revised Bathing Water Directive. This revision requires stricter bacteriological standards to be met in the future and sets new requirements for the provision of information on water quality to the public, as well as for engaging public participation in matters relating to bathing waters.

The Scottish Executive Scottish Coastal Forum's ***A Strategy for Scotland's Coast and Inshore Waters (2004)*** which has goals that include: delivering integrated management for the whole Scottish coast; establishing an integrated system of spatial planning for Scotland's inshore marine area which combines with the terrestrial planning system; strategic and adequately resourced leadership for the management and sustainable use of coastal resources; safeguard the resources of Scotland's coast and inshore waters and to promote awareness; to achieve effective stakeholder participation at the appropriate geographical and administrative levels amongst others.

Policies aimed to provide a sustainable future for Scotland's groundwater resources by protecting legitimate uses of groundwater are included within the ***Groundwater Protection Policy for Scotland (2009).***

The ***draft Scottish Planning Policy (2013)*** places a duty on the planning system to protect and improve the water environment, including rivers, lochs, estuaries, wetlands, coastal waters and groundwater, in a sustainable and co-ordinated way.

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### Flood Risk

The ***Flood Risk Management (Scotland) Act 2009*** includes a duty placed upon Scottish Ministers, SEPA, local authorities, Scottish Water and other responsible authorities to exercise their functions with a view to managing and reducing flood risk and to promote sustainable flood risk management. As a means of identifying the highest risk areas, ***Surface Water Management Plans*** are being developed across the country, based on accompanying technical guidance[3].

***Scottish Planning Policy (SPP) (2010)*** sets out the Scottish Government's policy on land use planning. The key aims of SPP in relation to flooding are:

- to prevent developments which would be at significant risk of being affected by flooding;
- to prevent developments which would increase the probability of flooding elsewhere; and
- to provide a basis for planning decision making related to flood risk, the SPP provides a risk framework which divides flood risk into three categories and outlines an appropriate planning response.

With regard to flood risk, SPP states that developers and planning authorities should take a precautionary approach in taking decisions when flood risk is an issue and that development should not take place on land that could otherwise contribute to managing flood risk, for instance through managed coastal realignment, washland creation or as part of a scheme to manage flood risk. With respect to coastal issues, SPP states that planning authorities should take the likely effect of proposed development on the marine environment into account when preparing when making decisions on planning applications. The SPP also notes that the risks associated with rising sea levels and coastal flooding should be taken into account when identifying areas that are suitable for development.

## 5.3 Overview of the Baseline

### 5.3.1 UK

The UK has a diversity of inland and coastal waters (such as reservoirs, lakes, rivers, canals, estuaries, transitional waters, and coastal waters). Protected water features include waters designated for human consumption (including those abstracted from groundwater); areas designated for the protection of economically significant aquatic species (e.g. shellfish or freshwater fish); bathing waters (under the Bathing Waters Directive); nutrient-sensitive areas; and areas with waters important to protected habitats or species under the Habitats Directive or the Birds Directive.

There are 182 protected areas in UK inshore waters with a marine element, which includes 81 Special Protection Areas (SPAs) with marine habitats for birds, 98 Special Areas of Conservation (SACs) with

[3] http://www.scotland.gov.uk/Publications/2013/02/7909

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marine habitats or species and three Marine Nature Reserves. In total the area coverage of these sites exceeds 1.8 million hectares, or 2.2% of UK waters [4].

The principal aquifers of the UK are located in the lowlands of England. The most important are the Chalk, Permo-Triassic sandstones, the Jurassic limestones and the Lower Greensand. Around 81% of groundwater bodies in England are at risk of failing Water Framework Directive objectives because of diffuse pollution.

As the majority of data regarding water resources and quality is collected by the Environment Agency (covering both England and Wales), Scottish Environment Protection Agency and Northern Ireland's Department of Ireland, there is little available data on a UK level and therefore for this chapter the remainder of the baseline is considered by these divisions of administrations.

## 5.3.2 England

### Water Quality

Coastal water quality has improved over the last two decades, however current WFD draft classification results and maps produced by the Environment Agency indicate that there are still a large proportion of coastal waters in England (and Wales) that are classified as being of Moderate Ecological Status (see **Figure 5.1**), i.e. are failing to meet 'Good Ecological Status' (GES) on the basis of a number of physio-chemical and biological standards and are therefore in need of measures to achieve GES.

[4] http://www.defra.gov.uk/foodfarm/fisheries/documents/mpp2009-10info.pdf

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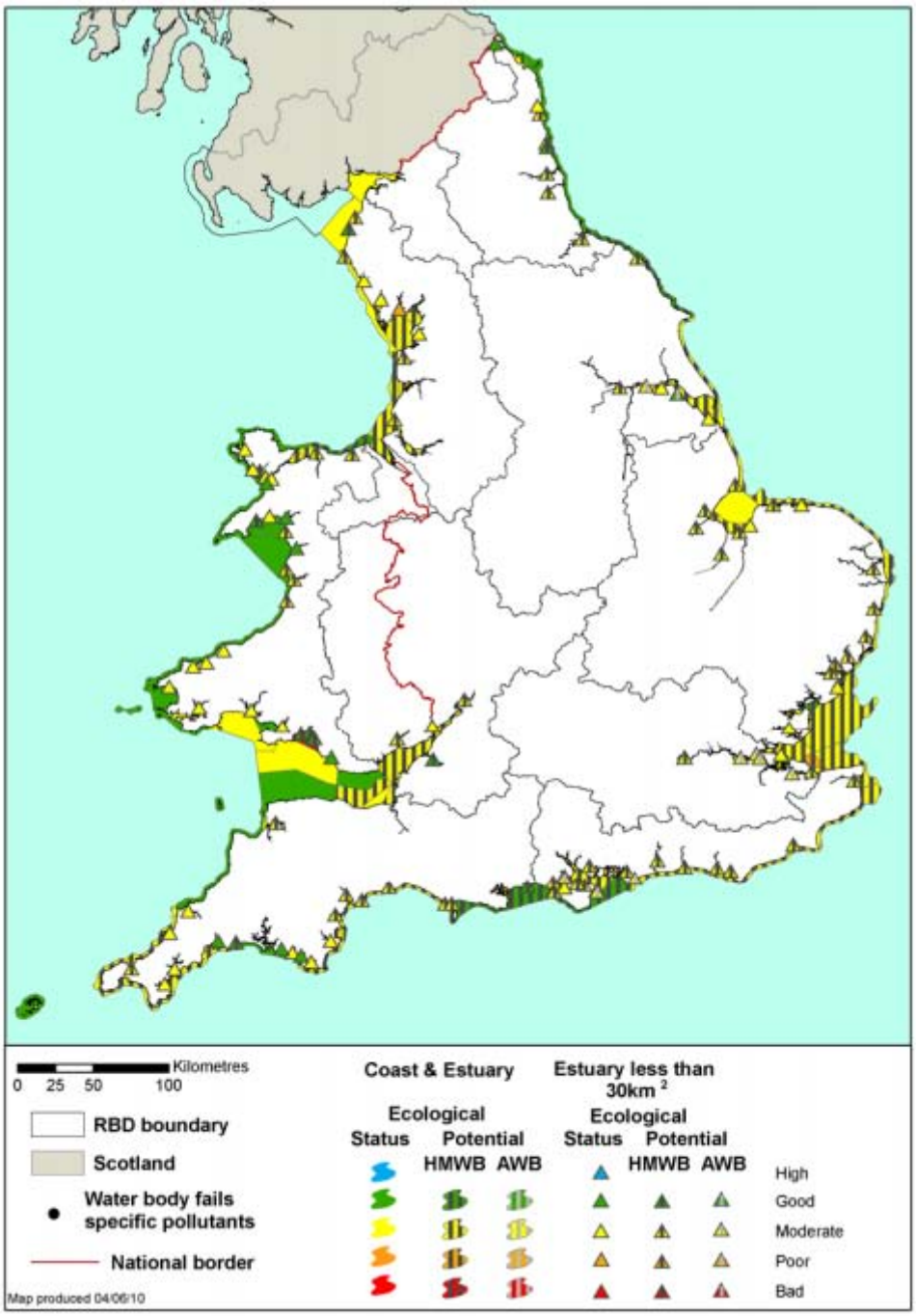
**Figure 5.1 Ecological Status/Potential of Estuaries and Coasts in England and Wales**




Source: *Framework Directive results and maps* available at http://www.environment-agency.gov.uk/research/library/data/97343.aspx (accessed 29/05/2013 )

River water quality in England has been steadily increasing since 1990 and in 2009, 73% of rivers were of good biological quality. Between 2006 and 2007, the percentage of rivers of 'good' chemical quality

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rose from 74% to 76% (based on the General Quality Assessment system[5] which is based on three determinands - dissolved oxygen, biochemical oxygen demand and ammoniacal nitrogen). In 2009, this rose to 80%. High levels of phosphorus can result in increased algal growth in freshwater and high levels of nitrate are of concern in relation to drinking water abstractions. Rivers with the highest concentrations of phosphate and nitrate are mainly in central and eastern England reflecting geology, agricultural inputs and higher population density.

Groundwater provides a third of drinking water in England, and up to 80% in some areas of southern England. The Environment Agency have defined Source Protection Zones (SPZs), for 2000 groundwater sources. These zones show the risk of contamination from any activities that might cause pollution in the area. The Environment Agency use the zones in conjunction with their Groundwater Protection Policy to set up pollution prevention measures in areas which are at a higher risk, and to monitor the activities of potential polluters nearby.

Groundwater Source Protection Zones are classified as either 'Inner Zone' (Zone 1), 'Outer Zone' (Zone 2), 'Total Catchment/Source Catchment' (Zone 3) and 'Special Interest' (Zone 4). The shape and size of a zone depends on the condition of the ground, how the groundwater is removed, and other environmental factors. A map which shows the contours of these zones for England and Wales can be viewed on the Environment Agency's website at:

http://maps.environmentagency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=groundwater

## Water Resources

The consumption of water abstracted from non-tidal surface and groundwater in England and Wales has fallen from an estimated 41.2 thousand megalitres/day in 2000 to 33.6 thousand megalitres/day in 2009.

The results from first cycle of Catchment Abstraction Management Strategies in 2008 showed that there is considerable pressure on water resources throughout England and Wales, but in particular in the South East and East of England [6].

[5] The GQA system is being superseded by the Water Framework Directive regime, however the transition is on-going.
[6] Environment Agency (2008) Water Resources in England and Wales- current state and future pressures (http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/geho1208bpas-e-e.pdf)

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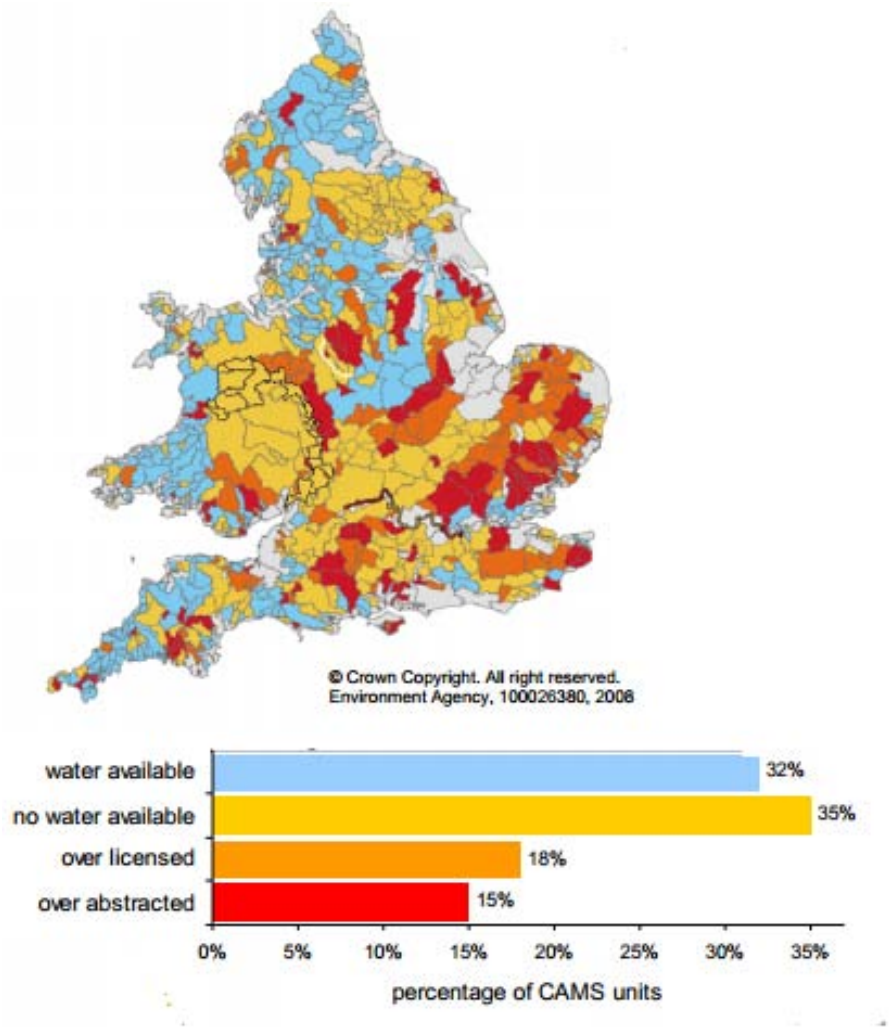
**Figure 5.2 Map of Water Available for Abstraction (surface water combined with groundwater)**




## Bathing Water

Coastal Bathing Water quality in England was lower than in other parts of the UK in 2012. Overall, 92% of sites met the mandatory standard [7]. On a regional level, Anglia and the South East both performed best, with 100% compliance, whereas the North West performed worst (with an 87% compliance rate). There was a decline in compliance compared with 2011 results and this has been attributed to above average rainfall in the summer months.

With regard to the more stringent standards, 59% of sites in England were compliant in 2012, down from 79% in 2011.

[7] Defra (2012) News release 6 November 2012, available at: http://archive.defra.gov.uk/environment/quality/water/waterquality/bathing/documents/bathing-waters-results-summary-2012.pdf

## Flood Risk

Flooding is associated with a range of sources: river, coastal, surface water, sewer, groundwater and reservoir[8]. In 2009, an estimated 2.7 million properties in England and Wales were in areas deemed to be at risk of flooding. Of these, some 580,000 were where the risk of flooding was greater than a 1 in 75 chance in any year ('risk' is the likelihood of flooding occurring given existing flood defences - not the extent to which flooding may cause damage)[9]. Coastal erosion is occurring along 30% of England's and 23% of Wales' coastline[10]. Of the regions in England, Yorkshire and Humber has the greatest proportion of coastal length which is eroding at 56% (203km). Coastal erosion is occurring along 30% to 32% of the South East, South West and East Midland's coastlines whilst 27% and 18% of the North East and North West coastlines respectively are eroding. The East Midlands has the smallest proportion of coastal length which is eroding at 9% or 21km[11].

Regionally, Greater London has the highest number of people at risk from flooding, with around 542,000 properties and one million people located in the floodplain. However, although London does have the largest number of people at risk, 84% are in areas with a low chance of flooding. This is mainly due to the major flood defences and flood defence structures in the Thames Estuary, including the Thames Barrier. The City of Kingston-upon-Hull and East Riding in Yorkshire are the two local authorities with the highest number of properties with a chance of flooding. However, other local authorities, such as Boston and North Somerset, have a higher share of properties in areas of significant flood risk. For instance, Boston has about two-thirds of its properties in areas with a significant chance of flooding [12].

### 5.3.3 Scotland

## Water Quality

Overall, Scotland's water environment is in a good condition but a wide range of problems exist at local levels. In most cases, the risks to water quality are declining, the exception being groundwater.

Scotland has two river basin districts: the Scotland river basin district which covers most of Scotland and the Solway Tweed river basin district in the south of the country. The Scotland river basin district has been sub-divided into eight Management Plan Areas which are administrated by eight regional 'Area Advisory Groups' (AAGs). These are: Argyll; Clyde; Forth; North East Scotland; North Highland; Orkney and Shetland; Tay and West Highland.

[8] http://www.environment-agency.gov.uk/homeandleisure/floods/31652.aspx
[9] Defra (2010) Measuring Progress - Sustainable Development Indicators 2010
[10] Marine Climate Change Partnerships website coastal erosion, http://www.mccip.org.uk/annual-report-card/2007-2008/marine-environment/coastal-erosion.aspx
11 Marine Climate Change Partnerships website coastal erosion http://www.mccip.org.uk/annual-report-card/2007-2008/marine environment/coastal-erosion.aspx
[12] Environment Agency, 2009, Flooding in England: A National Assessment of Flood Risk

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**Table 5.1** displays the percentage of water bodies in each class in Scotland for 2011[13]. **Figure 5.3** highlights the overall status of surface water in Scotland.

**Table 5.1 WFD Classification Results for Water Bodies in Scotland; Percentage of Water Bodies in each Class**

| Status<br><br>Category | High | Good | Moderate | Poor | Bad |
|---|---|---|---|---|---|
| River | 8 | 46 | 23 | 15 | 8 |
| Lochs | 19 | 44 | 23 | 11 | 4 |
| Estuaries | 36 | 50 | 12 | 2 | 0 |
| Coastal Waters | 29 | 68 | 4 | - | - |
| Groundwater | - | 80 | - | 20 | - |

[13] SEPA (2012) 2011 Aquatic Classification Results and comparison to previous years

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**Figure 5.3 Map of Overall Status for Surface Waters in Scotland**

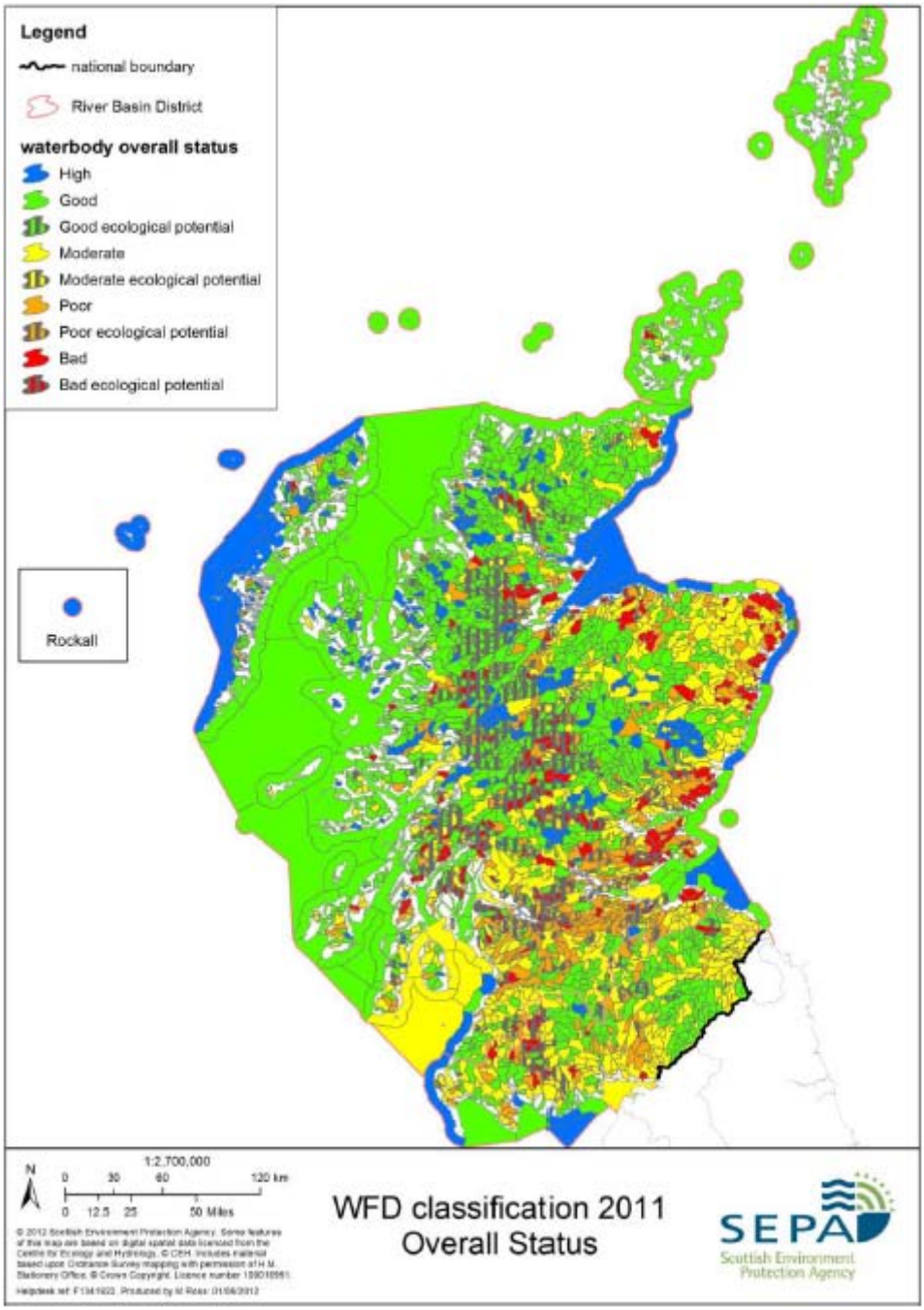
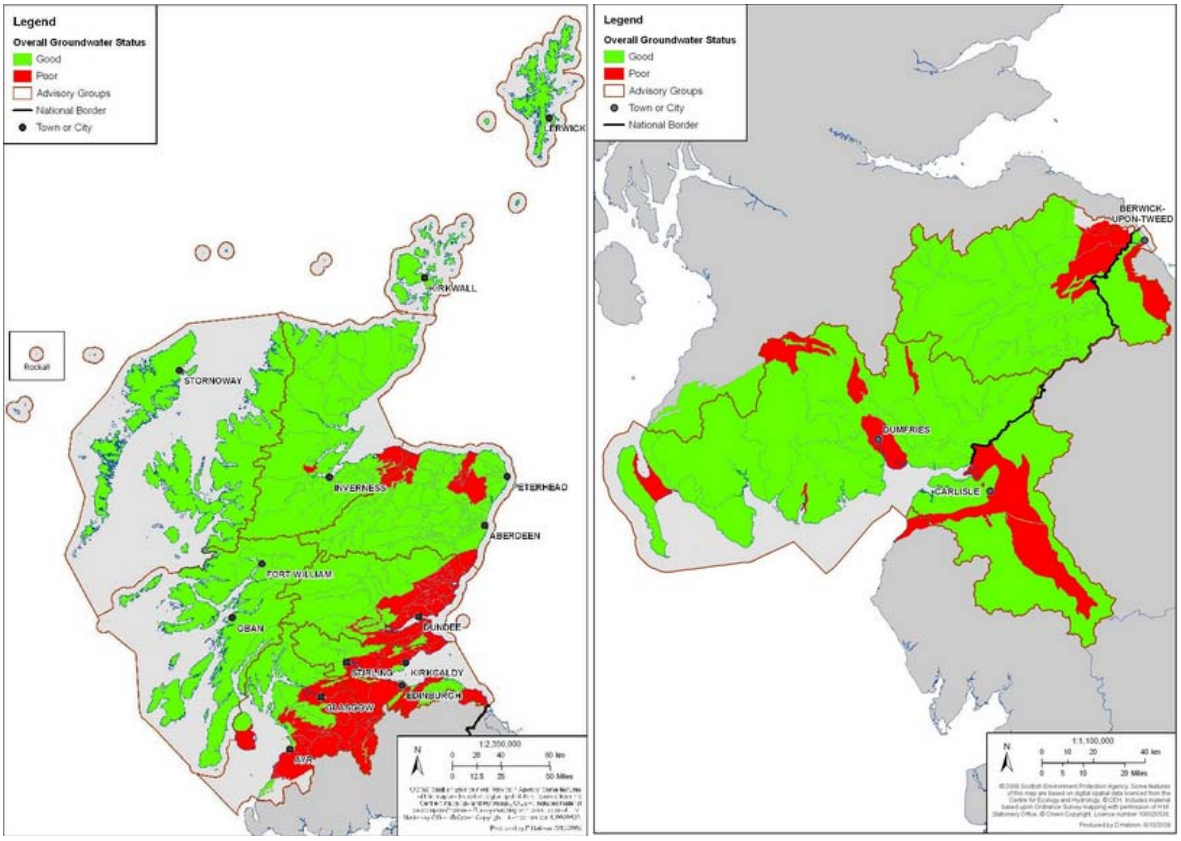



**Figure 5.4** displays groundwater quality in the Scotland and Solway Tweed RBDs.

**Figure 5.4 Map of Overall Status for Groundwater Classification for Scotland and Solway Tweed River Basin Districts 2008**




Source: SEPA, available at: http://www.sepa.org.uk/water/river_basin_planning/area_advisory_groups/forth/condition_and_objectives.aspx (accessed on 30/05/2013)

## Water Resources

Demand for water in Scotland rose by 4% between 1981 and 2006[14]. Demand in 2006 (2,344 Ml/d) was higher than average daily yield (3,094 Ml/d), despite an overall reduction in yield due to the rationalisation of treatment works throughout Scotland.

## Bathing Water

Despite an exceptionally wet summer in 2012 (most parts of Scotland received twice the long term monthly average), 98% of Scotland's 83 bathing waters achieved the mandatory standard for bathing water quality and two-fifths managed to achieve the more stringent guideline standard.

[14] Scottish Government, Statistics Online-Water Resource and Supply, accessed at http://www.scotland.gov.uk/seso/DatasetSearch.aspx?TID=83

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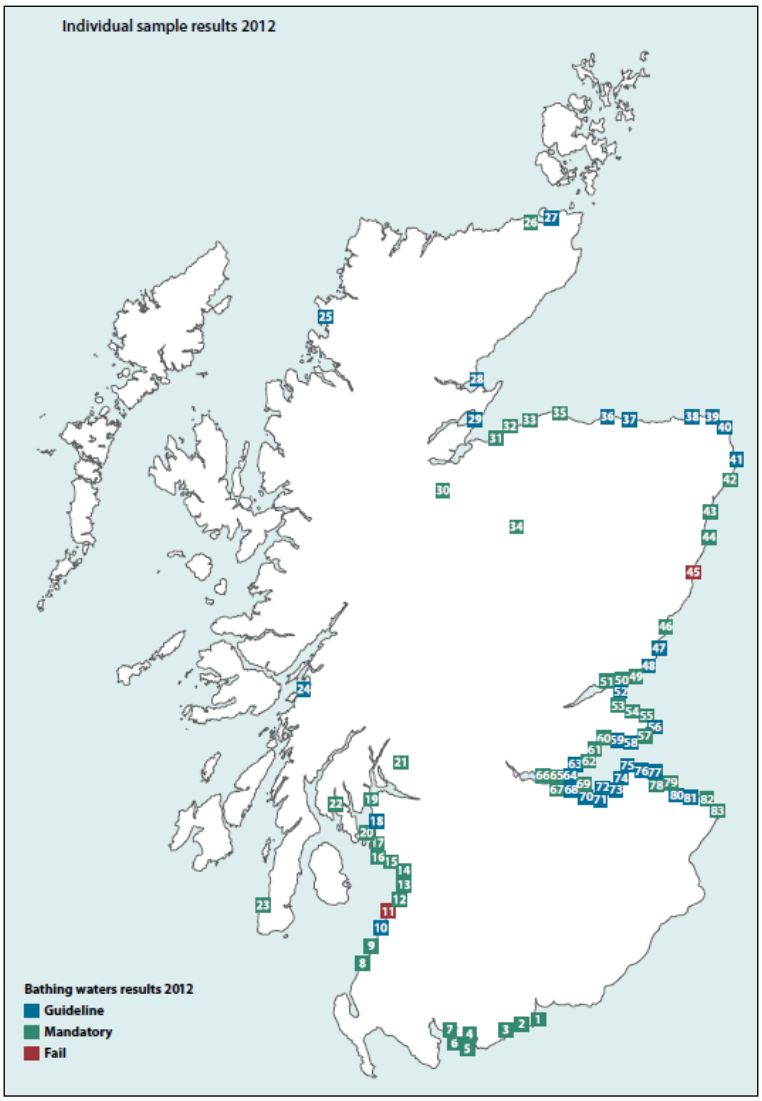
**Figure 5.5 Map of Bathing Water Results 2012 in Scotland**




Source: *SEPA (2013) Scottish Bathing Waters 2012-13*, available at http://www.sepa.org.uk/water/bathing_waters/bathing_water_reports.aspx (accessed 29/05/2013)

## Flood Risk

In Scotland, an estimated 99,000 properties (around 3.9% of all properties) lie in areas at high to medium risk of flooding (i.e. areas where the risk of flooding is greater than a 1 in 200 annual probability) with 26,000 at risk from the sea and 73,000 at risk from rivers[15]. SEPA has mapped a strategic national overview of flood risk in Scotland from rivers and the sea[16].

[15] Scottish Government, Flood Risk Responsibilities, http://www.scotland.gov.uk/Resource/Doc/921/0052798.doc
[16] http://www.sepa.org.uk/flooding/flood_extent_maps/view_the_map.aspx

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### 5.3.4 Wales

#### Water Quality

The percentage of river lengths in Wales of good chemical quality has been consistently above 90% since 1994, and has remained at around 95% for the last three monitored years (2006-08). The percentage of river length in Wales of good biological quality has steadily increased since 2000, peaking at 88% in 2008 [17]. In 2012, of the 100 EC-identified bathing waters monitored by Environment Agency Wales, 97% complied with the mandatory standards and 75% passed the tougher guideline standard. Both these figures were down on previous years due to above average rainfall[18].

#### Flood Risk Wales

Over 220,000 properties in Wales are at risk from river and sea flooding, of which 64,000 are at significant risk (greater than a one in 75 chance in any year). Across the local authorities in Wales, Cardiff has the highest numbers of properties at risk from flooding from rivers or the sea. However, many of these are at low risk (less than one in 200 chance in any given year), mainly because of the flood defence structures in place in Cardiff. Although Cardiff is well defended, if these defences were to be overtopped then the consequences could be severe. Conwy has the largest number of properties at significant risk (greater than a 1 in 75 chance in any given year). This is largely because of the coastal flood risk. Coastal flooding is also the cause of the significant risk to property in Gwynedd and Newport[19].

## 5.4 Environmental Characteristics of those Areas most likely to be Significantly Affected

**Tables 5.2 to 5.6** provide a high level summary of the main hydrological characteristics of each RBD/ DMPA relevant to the SEA Areas and the associated impacts and pressures in each.

[17] Sustainable Development Indicators for Wales (2010) http://wales.gov.uk/topics/statistics/publications/sustain2010/?lang=en
[18] Environment Agency Wales (2013) Wales Bathing Water Report 2012, http://www.environment-agency.gov.uk/static/documents/EAW_WSR_December_2012.pdf

[19] Environment Agency Wales, 2009, Flooding in Wales: A National Assessment of Flood Risk

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**Table 5.2 SEA Area 1- Scottish Midlands (including the Inner Forth)**

| RBD or DMPA | Environmental Characteristics | Water Resources | Principal Impacts and Pressures |
|---|---|---|---|
| Scotland: Clyde | There are 11 river catchments with just over 2,200km of river length which are recognised as supporting salmon and trout, in addition to a number of other small burns. The River Endrick also supports two rare species of lamprey.<br>Sea lochs are home to both international and national wildlife designations and busy port operations. The Firth of Clyde has an expanse of intertidal mudflats, sand and shingle interspersed with saltmarsh. Wintering wildfowl and waders of national and international importance are present around the Firth, and Ailsa Craig supports important numbers of gannet.<br>Most of the Loch Lomond and the Trossachs National Park is within the management area, and the loch itself is of recreational, scientific and economic importance, with ~2 million visitors per year.<br>The area has a strong industrial heritage which has spanned the last 200 years and has had a significant influence on the water environment. In addition to manufacturing, mining, quarrying, tourism and recreation, the rural lowlands support large areas of arable, livestock and mixed farming land. Continuing growth within the towns and cities means that developments have the potential to increase pressure on resources of the water environment. | **Surface waters:** 263 rivers and canals (2,846km), 27 lochs (107km$^2$), 22 coastal waters (3,153km$^2$), 9 estuaries (91km$^2$).<br>**Ground water bodies:** 44<br>**Freshwater fisheries:**<br>14 salmonid and 1 cyprinid catchment designated under the Freshwater Fish Directive.<br>**Shellfish waters:**<br>6 shellfish growing waters.<br>**Designated bathing areas:** 15<br>**Nutrient sensitive areas:** 20<br>**Protected drinking waters:** 108<br>**Natura 2000 sites:**<br>3 SACs and 4 SPAs dependent upon water resources. | **Physical modification: morphology:**<br>Almost all river catchments have modified sections. Changes to physical character affect 826km (38% of river length) and 561km can be regarded as being heavily modified. Structures prevent fish migration into 334km of river. Most lochs are of less than good status due to morphological changes.<br>**Abstraction and artificial flow:**<br>Changes to flow affect 232km (11%) of river length. Impacts on groundwater from abstraction are minimal, with 5% recorded as poor, and 95% recorded as good status.<br>**Chemical pollutants:**<br>156km (7%) of river length is at less than good status due to chemical pollution.<br>**Nitrate in surface/groundwater:**<br>20 nutrient sensitive areas are listed for this area, though no NVZs have been designated. Increased nutrients in the area come from a variety of sources, including sewerage network discharges, agriculture, industry and run-off from roads and urban areas. They can encourage attached algae and rooted plants, which in turn can affect habitat structure and DO levels. These particularly affect the estuaries of the Clyde and Gareloch and Garnock/Irvine Estuaries. |
| Scotland: Forth | The Forth RBMA covers over 4,900km$^2$ and contains 11 major river catchments in addition to estuarine and coastal waters.<br>Extensive industrialisation around the Forth has occurred over the last 200 years including mining, quarrying, glass container manufacture, oil production from oil shale, chemical manufacturing, paper manufacturing and distilling. Population | **Surface waters:** 160 rivers and canals (1,569km), 11 lochs (27km$^2$), 11 coastal waters (1,404km$^2$), 3 estuaries (40km$^2$)<br>**Ground water bodies:** 29 | **Nitrate in surface/groundwater:**<br>2 NVZs are present; Edinburgh, East Lothian and Borders, and Strathmore and Fife. A total of 27 nutrient sensitive areas are present in the RBD management area. 775km (~50%) of rivers are of less than good status due to water chemistry and species composition, much of which is due to excess nutrients. However |

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| RBD or DMPA | Environmental Characteristics | Water Resources | Principal Impacts and Pressures |
|---|---|---|---|
| | increases in the past and in the future have generated demands for greater levels of infrastructure which have, *inter alia*, effects for the water environment.<br>The economy of Edinburgh is largely based on the financial and business services sector, public administration, higher education, culture and tourism, though also supports the busiest port in Scotland as well as arable, livestock and mixed farming in more rural areas.<br>As a consequence of pollution from industrial development, many of the rivers, lochs, estuaries and coastal waters were severely affected. Significant improvements to the quality of these waters have been made over the last 40 years.<br>The significance of the water environment in the Forth is recognised internationally and nationally for many rare and significant habitats and species (e.g. sea, brook and river lamprey in the River Teith). 16 rivers are presently recognised for their importance in supporting migratory freshwater fish populations, and the Firth of Forth is a recognised Ramsar site due to its waterfowl community. | **Freshwater fisheries:**<br>14 salmonid and 1 cyprinid watercourse designations.<br>**Shellfish waters:**<br>3 areas are designated as shellfish growing waters.<br>**Designated bathing waters:** 22<br>**Nutrient sensitive areas:** 27<br>**Protected drinking water:** 59<br>**Natura 2000 sites:**<br>7 SPAs and 4 SACs dependent on water resources. | DO levels were found to be affected on only 63km of river.<br>**Physical modification: morphology:**<br>619km (39%) of river are of less than good quality due to morphological changes. 12 lochs (29km$^2$) have been heavily modified. 1 coastal and 2 estuarine water bodies have been designated as heavily modified.<br>**Abstraction and artificial flow:**<br>319km of river length is regarded as less than good due to poor flow conditions as a result of inappropriate abstraction levels. Changes to water flow are the main reason for lochs failing to meet good ecological potential. Impacts on groundwater from abstraction are minimal, with 5% recorded as poor, and 95% recorded as good.<br>**Chemical pollutants:**<br>175km (21%) of river length is of less than good status due to elevated iron levels from point or diffuse mine water discharges. Other metals and toxic substances affect 126km of river length. |
| Scotland: Tay | The Tay covers ~9,000km$^2$ and includes the eastern expanses of the Loch Lomond and the Trossachs National park, and the south eastern extremes of the Cairngorms National Park around Glen Clova and Glen Prosen. There are 7 major river catchments within the Tay DMPA, most of which are of high quality, supporting salmon populations.<br>Conservation sites including SACs and SPAs recognise the importance of flora and fauna such as the Tay and South Esk SACs for their salmon and freshwater pearl mussel populations respectively. The quality of the coast and estuaries of the area promotes tourism, and many of these waters are designated as SPAs. | **Surface waters:** 215 rivers and canals (2,556km), 10 lochs (39km$^2$), 6 coastal waters (640km$^2$), 5 estuaries (117km$^2$)<br>**Ground water bodies:** 46<br>**Designated bathing areas:** 7<br>**Freshwater fisheries:**<br>14 salmonid watercourse designations.<br>**Shellfish waters:**<br>3 areas designated as shellfish growing waters.<br>**Protected drinking waters:** 74<br>**Nutrient sensitive areas:** 16 | **Phosphorous/nitrate in surface/groundwater:**<br>Almost 30km$^2$ (77%) of lochs and around 600km (>20%) of rivers have high levels of phosphorus, located predominantly in the east of the area. Nitrogen levels exceed the standard required by the WFD in 12% of estuaries, though there is no evidence to suggest that this has lead to enhanced plant (algal) growth. Those groundwaters not achieving good chemical status are primarily failing due to nitrate levels.<br>**Physical modification: morphology:**<br>The condition of 30% of the river habitat (800km) is less than good status due to morphological alterations. Barriers to fish affect around 300km of river length. |

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| RBD or DMPA | Environmental Characteristics | Water Resources | Principal Impacts and Pressures |
|---|---|---|---|
| | The Tay supports a high level of agricultural activity including arable farming, potato and soft fruit growing and upland sheep farming. The uplands also support forestry, deer stalking, grouse shooting, angling and other outdoor pursuits.<br>The Tay and Earn catchments support large scale hydro power schemes managed by Scottish and Southern Energy, with a smaller scale scheme on the River Lyon. | **Natura 2000 sites:**<br>9 SPAs and 9 SACs dependent on water resources. | **Abstraction and artificial flow:**<br>Around 700km (>25%) of river length if affected by alterations to flow. A further 100km (15%) of heavily modified rivers fail potential ecological standards due to poor hydrological regime. 1,601km$^2$ (18%) do not meet good status due to reduced levels. |
| Solway Tweed (also partly in SEA area 2) | The Solway Tweed RBD crosses the border between Scotland and England, covering an area of ~17,500 km$^2$ (3,800 km$^2$ of which is in England). The landscape varies from rolling hills in the Southern Uplands to rocky shorelines and sandy beaches along the west coast. The Southern Uplands are drained by rivers in the west (the Nith, Annan and Esk) which discharge to the Solway Firth. The River Eden rises in the northern Pennines and eastern Lake District fells, and flows north to the Solway estuary. The River Tweed drains the eastern part of the District into the Tweed estuary. Land use in the district is mainly agriculture, forestry and woodland. Both the Tweed and Eden are also excellent salmon rivers in the district.<br>The rural nature of the District means that it supports important habitats and wildlife, including water-dependent SACs and SPAs, notably the River Eden and tributaries, and the Solway estuary. The District has a moderately high rainfall relative to the rest of the UK, being higher in the west than in the east. Around 90% of the water supply for the District comes from surface waters, the remainder from groundwaters. | **Surface waters:** 526 rivers and canals, 35 lakes/lochs, 8 coastal waters (1913km$^2$), 11 estuaries (390km$^2$).<br>**Ground water bodies:** 73<br>**Designated bathing waters:** 8<br>**Designated drinking waters:** 74<br>**Freshwater fisheries:**<br>252 salmonid and 4 cyprinid watercourse designations.<br>**Shellfish waters:**<br>4 areas are designated as shellfish growing waters.<br>**Natura 2000 sites:**<br>13 SPAs and 33 SACs dependent on water resources | **Water quality:** 32% of all water bodies are less than good due to water quality issues, including 28% of rivers and 40% of lakes. Though only 9% of estuaries are regarded as being of less than good status, by area these account for 78% of estuarine waters. 11% of groundwaters are less than good, mainly due to nitrate inputs from agriculture and mining impacts.<br>**Alterations to water flows and levels:**<br>13% of water bodies fail to achieve good status due to changes to water flows and levels, including 13% of rivers and 23% of lakes.<br>**Modification of bed, banks and shores:**<br>31% of lakes/lochs and 19% of rivers are modified sufficiently that they fail to achieve good status.<br>**Barriers to fish migration (Scotland only):**<br>20% of lakes/lochs and 9% of rivers pose barriers to fish that inhibit these water bodies achieving good status.<br>**Invasive non-native species (Scotland only):**<br>Only 1% of rivers and 3% of lakes/lochs fail to achieve good status due to the impact of these introduced species. |

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**Table 5.3 SEA Area 2 -West Midlands, North West England and Southern Scotland**

| RBD | Environmental Characteristics | Water Resources | Principal Impacts and Pressures |
|---|---|---|---|
| North West | The North West RBD covers an area of 13,140km$^2$ from Cheshire in the south to the Lake District in the North. The area contains the key cities of Manchester and Liverpool and many other major settlements. Agricultural land covers 80% of the area. A number of small settlements sit alongside protected areas including SACs and SPAs with water dependent features.<br><br>The area has a third of the poorest quality rivers in England and Wales. The reservoirs of the Pennine Fells and Lake District supply water for highly populated areas. There are a number of excellent salmon rivers, and coarse rivers to the south. Canals are important for tourism, transport and coarse fishing.<br><br>The RBD contains 38% of England's swamp and reed beds, extensive dune systems, shingle and coastal reef and mudflats. The area is the second most important site for wintering birds in the Western Palaearctic. Coastal habitats are affected by dredging, recreational pressures and pollution run off from land. Drainage and intensive farming have resulted in a 98% reduction in peat over 100 years, and what is left is fragmented and small in size. While there is restoration this is small in scale. | **Surface waters:** 547 rivers and canals (including surface water transfers), 164 lakes and reservoirs, 8 coastal waters, 12 estuaries. 41% of surface waters may be regarded as having been heavily modified.<br><br>**Ground water bodies:** 18<br><br>**Bathing waters:** 34<br><br>**Freshwater fisheries:** 830<br><br>**Shellfish waters:** 9<br><br>**Nitrate vulnerable zones:** 59<br><br>**Protected drinking waters:** 156<br><br>**Natura 2000 sites:**<br><br>7 SPAs and 20 SACs dependent on water resources. | **Phosphorous in rivers and standing waters:**<br><br>2,468km (41%) of river length is/probably at risk from point and diffuse pressures. 26 lakes at/probably at risk from diffuse or point phosphorous inputs. 57% of river length at/probably at risk from diffuse agricultural pollutants.<br><br>**Organic pollution (ammonia and BOD):**<br><br>1,446km (24%) of river length at/probably at risk of failing ammonia standards. 779km (13%) of river length at/probably at risk of failing BOD standards.<br><br>**Nitrate in surface and groundwaters:**<br><br>44% of groundwater bodies are at risk of failing environmental objectives as a result of nitrate<br><br>**Sediment:**<br><br>1,111km (18%) of river length is/probably at risk from direct effects of sediment.<br><br>**Pesticides:**<br><br>1,000km at/probably at risk from diffuse pesticides. 762km at/probably at risk from sheep dip. 1 groundwater body is probably at risk from pesticides.<br><br>**Faecal indicator organisms**<br><br>**Urban and transport pressures:**<br><br>158 rivers at/probably at risk from ammonia, 120 at/probably at risk from BOD levels.<br><br>**Chemicals including priority hazardous substances, priority substances and specific pollutants (excl. pesticides).** |

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| RBD | Environmental Characteristics | Water Resources | Principal Impacts and Pressures |
|---|---|---|---|
| | | | 16 rivers and 4 transitional water bodies either at/probably at risk of failing WFD dangerous substance objectives.<br>**Mines and mine waters:**<br>37 water bodies at risk from mines or mine waters.<br>**Physical modification: morphology:**<br>2,662km (44%) of river length, all coastal and 11 (92%) estuarine water bodies at risk from failing WFD 2015 objectives. 133 (81%) of lakes at/probably at risk from morphological pressures.<br>**Abstraction and other artificial flow pressures:**<br>609km (12%) of river length at/probably at risk from abstraction/flow regulation. |

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**Table 5.4 SEA Area 3- East Midlands and Eastern England**

| RBD | Environmental Characteristics | Water Resources | Principal Impacts and Pressures |
|---|---|---|---|
| Northumbria | The Northumbria RBD covers an area of 9,029km$^2$ from the Scottish Borders to just south of Guisborough, and from the Pennines, east to the North Sea. The landscape is highly variable, ranging from industrial urban areas to moors, hills and valleys of the Northumberland National Park and Pennine Area of Outstanding Natural Beauty.<br><br>Outside of urban areas, the rural landscape supports a range of agricultural activities including hill farming, arable production and forestry. Around 67% of the area is farmed, managed for moorland grouse or used for forestry. Blanket peat in the north Pennines and Cheviots form the headwaters of rivers which flow west to east.<br><br>Drainage has reduced the size of wetland isolating habitats and associated species even with schemes in the North Pennines to restore peatland. Eutrophication, alterations to catchment hydrology, reduced water quality and abstraction affected freshwater habitats. The North East Region has the only site in Britain with Baltic bog-moss, only one of two sites in Britain for water rock-bristle; and is home to one of the largest breeding colonies of grey seals.<br><br>Industrial neglect is found next to major rivers such as the Tees which are close to large centres of population and have the potential for environmental improvement. The river basin district contains internationally important river shingle habitat which is associated with previous metal ore mining along the Rivers Tyne and Allen, which support unique metal tolerant flora | **Surface waters:** 380 rivers and canals, 73 lakes or reservoirs, 7 coastal waters, 7 estuaries. 27% of surface waters may be regarded as having been heavily modified.<br><br>**Ground water bodies:** 9<br><br>**Bathing waters:** 33<br><br>**Freshwater fisheries:** 312<br><br>**Shellfish waters:** 1<br><br>**Nitrate vulnerable zones:** 48 (20% of RBD area)<br><br>**Protected drinking waters:** 34<br><br>**Natura 2000 sites:**<br><br>6 SPAs and 9 SACs dependent on water resources. | **Mines and mine waters:**<br><br>40 (12%) rivers at risk and 6 (67%) groundwater bodies at risk.<br><br>**Nitrate in surface and groundwater:**<br><br>404km (11%) of river length is at/probably at risk from oxidised nitrogen loading and 15% are at/probably at risk from phosphorous. 4 groundwater bodies are at risk of failing their nitrate objectives and a further 1 has failed its test with a significant and sustained increase in nitrate concentration.<br><br>**Physical modification: morphology:**<br><br>1,790km (51%) of river length is probably at risk of failing WFD 2015 objectives. 2 (29%) estuarine water bodies are at risk and 7 (100%) coastal waters at risk from failing WFD 2015 targets. Pressures include land reclamation, shoreline reinforcement, dredging and aggregate extraction.<br><br>**Urban and transport pressures:**<br><br>34 rivers at risk/probably at risk from urban diffuse pollution.<br><br>**Invasive non-native species:**<br><br>20 (5%) rivers probably at risk of failing WFD 2015 targets, and 2 out of 7 estuarine water bodies are probably at risk. |

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| RBD | Environmental Characteristics | Water Resources | Principal Impacts and Pressures |
|---|---|---|---|
| | Healthy populations of salmon and sea trout present in several rivers, including the River Tyne, which has the highest salmon rod catch in England and Wales. | | **Organic pollution (ammonia and BOD):**<br>423km (12%) of river length at/probably at risk from ammonia. 139km (3%) at/probably at risk from failing proposed BOD standards. 29% of the estuarine water bodies and no coastal water bodies have been assessed as at risk or probably at risk from point sources of organic pollution.<br>**Pesticides:**<br>1,243km of river at/probably at risk from pesticides. 46km at/probably at risk from sheep dip. No groundwaters at risk.<br>**Phosphorous in rivers and standing waters;**<br>52% of total river length is/probably is at risk from diffuse phosphorous pollution. There is no risk assessment for lakes at present.<br>**Sediment:**<br>1,332km (38%) of river length is/probably at risk from sediment effects. |
| Humber (also partly in SEA area 2) | The Humber RBD covers 26,109km$^2$ ranging from the North York Moors to Birmingham, the Pennines to the North Sea and Stoke-on-Trent to Rutland.<br>The key economic sectors include business services, health, wholesale and distribution and manufacturing (particularly metals). Mining for coal and other minerals has been historically important, but is now less so – a few deep coal mines still survive.<br>Outside of urban centres, land use is centred on arable floodplain agriculture and upland livestock grazing. The North Yorkshire Moors, Yorkshire Dales and High Peak are within the RBD and are an important component of the tourist economy. | **Surface waters:** 960 rivers and canals, 136 lakes or reservoirs, 1 coastal water, 8 estuaries. 36% of all surface waters may be regarded as modified.<br>**Ground water bodies:** 50<br>**Bathing waters:** 22<br>**Freshwater fisheries:** 1,273<br>**Shellfish waters:** 1<br>**Nitrate vulnerable zones:** 197 (81% of RBD)<br>**Protected drinking waters:** 167 | **Abstraction and other artificial flow pressures:**<br>1,901km (17%) of river length and 11km$^2$ lake is/probably at risk from abstraction and flow regulation. 9,922km2 (38%) of groundwaters at/probably at risk from abstraction and flow regulation.<br>**Mines and mine water:**<br>43 water bodies are at risk from mines and mine waters.<br>**Nitrate in surface and ground water:**<br>3,158km (28)% of river length is at risk of failing the 50mg/l threshold for nitrate. 14 (30%) groundwater bodies are at risk of failing objectives due to nitrate. In addition, 13 groundwater bodies in the |

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| RBD | Environmental Characteristics | Water Resources | Principal Impacts and Pressures |
|---|---|---|---|
| | Salmon and trout numbers are increasing across the district's rivers due to improved estuary water quality.<br><br>Land has been drained and reclaimed for agricultural production. As a result there has been a loss of wetland which has become both reduced in size and fragmented. Schemes seek to restore wetland but this is small in scale.<br><br>The area contains very important wetland habitats including intertidal mudflats and 11% of the nation's saline lagoon, which is located around the Humber Estuary and supports internationally important migratory birds and rare mammals. | **Natura 2000 sites:**<br><br>7 SPAs and 26 SACs dependent on water resources. | Humber River Basin District (26%) had a significant and sustained increase in nitrate concentration in groundwater.<br><br>**Physical modification: morphology:**<br><br>5,246km (46.93%) of river length and 7 (88%) estuarine water bodies are at/probably at risk of failing WFD 2015 objectives. 1 (100%) coastal water body and 97% of lakes are probably at risk from morphological pressures.<br><br>**Urban and transport pollution pressures:**<br><br>211 rivers at/probably at risk from urban and transport pressures.<br><br>**Organic pollution**<br><br>2,399km (21.47%) of river length at/probably at risk of failing the ammonia standards. 1,431km (12%) of river length are at risk of failing the biochemical oxygen demand (BOD) standards.<br><br>**Invasive non-native species:**<br><br>123 (12.7%) rivers are/probably at risk of failing WFD 2015 targets. 6 (4.4 %) lake, 1 coastal water body and 8 (37.5%) estuarine waters are at risk.<br><br>**Pesticides:**<br><br>5,869km of river is/probably at risk from diffuse pollutants. 83km is/probably at risk from sheep dip. 32 groundwater bodies in the Humber River Basin District are at risk from pesticides.<br><br>**Phosphorous in rivers and standing waters:**<br><br>53% of river length is/probably at risk of failing to meet standards for good ecological status. Over 61% of river length is/probably at risk from diffuse phosphorous from agriculture.<br><br>**Sediment:**<br><br>4,567km (40%) are/probably at risk from direct effects of sediment. |

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| RBD | Environmental Characteristics | Water Resources | Principal Impacts and Pressures |
|---|---|---|---|
| Anglian | The River Basin District covers 27,890 km$^2$ from Lincolnshire in the north to Essex in the south, and Northamptonshire in the west to the East Anglian coast. The landscape ranges from gentle chalk and limestone ridges to the extensive lowlands of the Fens and East Anglian coastal estuaries and marshes.<br>Over half of the landmass of the catchment is used for agriculture and horticulture, producing more than a quarter of the wheat and barley in England in addition to a diverse horticultural crop including peas, beans, potatoes, carrots, apples and salad crops.<br>The artificial landscape of the fens is a major arable region in the UK for grains and vegetables, with low water levels maintained by drainage banks and pumps which also provide flood alleviation for homes and infrastructure.<br>The Broads are ecologically important, supporting a number of rare plants and animals, and freshwater habitats in the RBD as a whole are important for wintering waterfowl and fisheries. Approximately 80% of England's lowland fen is located in the Anglian RBD, in addition to swamp, reedbed and carr woodland habitats.<br>The district has some of the finest coarse fishing and some of the most famous river-trout fisheries. Many of the chalk-fed rivers that flow into the Breckland, River Great Ouse and some Lincolnshire and Norfolk rivers support natural brown trout populations.<br>There are a number of internationally designated intertidal areas along the coast, representing 33% of the UK's saltmarsh.<br>Water bodies and wetland areas within the Anglian RBD support a number of priority species listed in the UK Biodiversity Action Plan, such as freshwater white-clawed crayfish (*Austropotamobius pallipes*) and bittern (*Botaurus stellaris).* | **Surface waters:** 758 rivers and canals, 49 lakes or reservoirs, 11 coastal waters and 18 estuaries. Note that 71% of these surface waters are regarded as having been modified or are man-made.<br>**Ground water bodies:** 31<br>**Bathing waters:** 38<br>**Protected drinking water areas:** 50<br>**Freshwater fisheries:** 426 **Shellfish waters:** 22<br>**Nitrate vulnerable zones:** 229<br>**Natura 2000 sites:**<br>23 SPAs and 24 SACs dependent on water resources. | **Abstraction and artificial flow:**<br>1,593km (21%) of river length is/probably at risk from abstraction and flow regulation. 24km$^2$ (18%) of lakes are/probably at risk from abstraction and flow regulation. 14,577km$^2$ (87%) of groundwaters are at/probably at risk from abstraction and flow regulation. 9 km$^2$ (3%) of estuaries are probably at risk from industrial abstraction and artificial flow pressures. 6,758 km$^2$ (40%) of groundwaters are at/probably at risk from Saline Intrusion.<br>**Invasive non-native species:**<br>248 rivers (33%) are probably at risk of failing WFD objectives by 2015 due to the effect of alien species. 8 (17%) lakes, 4 (36%) coastal water bodies and 8 (44%) estuarine waters are also probably at risk.<br>**Nitrate in surface/ground water:**<br>10 ground waters are at risk of failing objectives due to nitrate. 61% of river length is at risk of failing the 50mg/l threshold for nitrate. 6% of estuarine water bodies and 36% of coastal water bodies are potentially at risk from diffuse source nutrient nitrogen.<br>**Phosphorous in rivers/standing water:**<br>More than 72% of the total lengths of Anglian river water bodies are at risk from diffuse agricultural pollution.<br>**Physical modification: morphology:**<br>32 (65%) of lakes probably at risk. 6,013km (81%) rivers at risk of failing WFD 2015 targets, as are 18 (100%) estuarine water bodies. 8 (72%) coastal water bodies are at risk.<br>**Sediment (rivers and lakes):**<br>2,472km (33%) are/probably at risk from the direct effects of sediment. |

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**Table 5.5 SEA Area 4- North and South Wales (including the Dee/Afon Dyfrdwy)**

| RBD | Environmental Characteristics | Water Resources | Principal Impacts and Pressures[20] |
|---|---|---|---|
| Dee | The Dee RBD covers an area of 2,251km$^2$ of North East Wales, Cheshire, Shropshire and the Wirral, and encompasses the River Dee basin, tributaries and estuary. The area varies from the mountains of the Snowdonia National Park, through the Vale of Llangollen to the open Cheshire plains and the Dee estuary mudflats.<br><br>The dominant land uses, particularly in the upper reaches, are agriculture and forestry. Several major lakes and storage reservoirs are present in the upper reaches including Llyn Tegid, the largest natural lake in Wales. The Dee is one of the most regulated rivers in Europe, and supplies ~3 million people with water in North West England in addition to those in the Dee catchment. The strategic importance of the catchment for flood alleviation and water supply led to the lower Dee being categorised as the only Water Protection Zone in the UK in 1999.<br><br>The principal abstractions in the Dee are for water supply, manufacturing and agriculture, amounting to 700 Ml/d.<br><br>In the Dee River Basin District, land reclamation and commercial fishing are significant sources of morphological alteration in transitional waters. Game fish, including salmon and sea trout, can be found throughout the catchment. Coarse fish, including grayling, for which the River Dee is well-known, are present in the middle and lower reaches. Some salmon net-fishing takes place in the estuary under licence. The estuary is also home to important cockle beds, which provide a local industry. | **Surface waters:** 87 rivers and canals, 21 lakes or reservoirs, 1 estuary. 34% of all surface waters are designated as heavily modified.<br><br>**Ground water bodies:** 6<br><br>**Bathing waters:** 1<br><br>**Protected drinking water areas:** 25<br><br>**Freshwater fisheries:** 83<br><br>**Shellfish waters:** 2<br><br>**Nitrate vulnerable zones:** 3 (23% of RBD)<br><br>**Natura 2000 sites:**<br><br>3 SPAs and 7 SACs dependent on water resources. | **Physical Modifications:**<br><br>The Dee is one of the most modified catchments in the UK with extensive regulation of flows in the upper catchment, changes to the channel cross section, flood protection structures and pump drainage of some sections of the floodplain for agriculture. Saltmarsh erosion is extensive on the Welsh side of the Dee estuary as the estuary continues to adjust to historic intervention. Land reclamation has also caused localised loss of intertidal habitats<br><br>**Pollution from sewage and waste water:**<br><br>In the Dee River Basin District, eleven Water bodies are reported as failing for phosphorous due to significant contributions from Water Company. Increased nutrients caused by the discharge of sewage can lead to changes in water quality and the ecology of lakes, rivers and estuaries. The consequences of this can be severe, including excessive growth of algae, which can be poisonous; weeds choking navigable waterways; changes in fish populations, and a deterioration in the look of the area for those living close to, or visiting watercourses.<br><br>**Pollution from rural areas:**<br><br>Agricultural activity is the source of a range of pollutants including nutrients, sediments, faecal bacteria, chemicals and fuels. Forest operations can have an impact through sediment runoff and exacerbating the effects of acidification. Surface water runoff from roads can also add to the problem. Excessive nutrients, especially phosphate, are a particular problem in the lower tributaries such as the Pulford, Worthenbury and Dolechfas brooks. |

[20] Natural Resources Wales (2013) Dee River Basin District: Challenges and choices, Summary of significant water management issues (consultation draft)

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| RBD | Environmental Characteristics | Water Resources | Principal Impacts and Pressures[20] |
|---|---|---|---|
| | | | **Pollution from mines:**<br>The Dee River Basin District has a legacy of mining for coal and metals. Pollution from abandoned mines mainly comes from underground workings and the waste materials left on the surface of the mine (spoil). |
| Severn (also partly in SEA areas 2 and 5) | The Severn RBD covers an area of 21,590km$^2$, with one third in Wales and two thirds in England. In addition to the river Severn, the district covers the rivers Wye, Usk and Taff, and those of the counties of Avon and Somerset that drain into the Severn.<br>Much of the area is rural, with 80% being used for agriculture and forestry, though there are several large urban centres including Bristol, Cardiff and Coventry. The key economic sectors in the area include business services, wholesale and distribution, public administration and health. Transport equipment and metals are also important sectors.<br>The basin contains 29 SACs and 5 SPAs with features which are dependent on water resources. Past and present activities have put water resources under pressure from a number of sources, including diffuse pollutants from rural land management issues, sewerage discharges, urban runoff and the legacy of mining.<br>Otters are numerous in the upper Severn catchment and lamprey, salmon, allis and twaite shad spawn in the mid Severn. Freshwater pearl mussels are also present in the River Clun. Floating water plantain and grass-wrack pond weed occur in Montgomery canal which crosses the basin, and *Ranunculus* is a feature of the Wye and Usk catchments. The lower catchment is important for elvers. Associated wetlands include the Mosses and Meres of the upper catchment and the floodplain grassland hams of the lower Severn/Avon. | **Surface waters:** 791 rivers and canals, 75 lakes and reservoirs, 6 estuaries. 17% of surface waters may be regarded as having been heavily modified.<br>**Ground water bodies:** 40<br>**Bathing waters:** 4<br>**Freshwater fisheries:** 906<br>**Nitrate vulnerable zones:** 147 (44% of RBD)<br>**Protected drinking water:** 124<br>**Natura 2000 sites:**<br>5 SPAs and 28 SACs dependent on water resources. | **Abstraction and other artificial flow pressures:**<br>918km (11%) of river length is/probably at risk from abstraction/regulation. 3 (4%) of lakes and 8,179km$^2$ (40%) of groundwater are at risk or probably at risk from abstraction and flow regulation.<br>**Invasive non-native species:**<br>138 (17%) rivers are probably at risk of failing WFD 2015 objectives, and 1 (1%) lake is also probably at risk.<br>**Nitrate in surface and groundwaters:**<br>10 (25%) groundwater bodies are at risk of failing their environmental objectives. 1,995km (24%) of total river length are/probably at risk of failing the 50mg/l threshold for nitrate.<br>**Pesticides:**<br>2,940km (39%) of river is/probably at risk of diffuse pollution and 1,888 (25.3%) is/probably at risk from sheep dip. 18 groundwater bodies are probably at risk from diffuse pesticides.<br>**Phosphorous in rivers and standing waters:**<br>An estimated 56% of the length of river water bodies are/probably at risk from diffuse phosphorous pollution.<br>**Physical modification: morphology:**<br>6 (100%) of estuarine water bodies are at risk of failing WFD 2015 targets. 3,226km (39%) of rivers are at risk or probably at risk of failing WFD 2015 targets. 63 (84%) of lakes are probably at risk from morphological pressure. |

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| RBD | Environmental Characteristics | Water Resources | Principal Impacts and Pressures[20] |
|---|---|---|---|
| | The River Severn and its tributaries, (e.g. the Wye and Usk), have in the past been important salmon fisheries however over the past decade fish populations have been decreasing. In addition there were concerns that mixed stock salmon fishing was reducing the numbers of rare shad as by-catch. | | **Sediment:**<br>3,231 (39%) of rivers are/probably at risk.<br>**Urban and transport pressures:**<br>107 river water bodies are at/probably at risk for urban diffuse pollution. |
| West Wales | The West Wales RBD covers an area of 16,653km$^2$, extending from Vale of Glamorgan in the south to Denbighshire in the north and includes Anglesey off the north-west coast.<br>Lakes and rivers are excellent for game and coarse fishing, with many rivers supporting salmon, brown and sea trout, which bring significant revenue to the area. Welsh rivers account for more than half the sea trout caught in England and Wales, and in 2005 the Tywi and Teifi had the highest declared rod catch of sea trout in England and Wales.<br>Valuable cockle and mussel beds are present in the north and south, with mussel farming taking place in the Menai Strait. Coastal fisheries are dominated by lobster and crab potting, and dredging for scallops and other species.<br>The rural uplands are used for livestock (particularly sheep) farming, with the lower, milder Pembrokeshire area being used for significant arable agriculture.<br>The principal urban centres are Swansea, Bridgend and Neath in the south, Aberystwyth in the centre on the coast, and Bangor in the north. In the summer time, coastal tourism accounts for a significant increase in population in an otherwise sparsely populated area. | **Surface waters:** 676 rivers, 62 lakes or reservoirs, 27 estuaries, 24 coastal water bodies.<br>**Groundwater bodies:** 25<br>**Protected drinking waters:** 86<br>**Freshwater fisheries:** 498<br>**Shellfish waters:** 25<br>**Bathing waters:** 81<br>**Nitrate vulnerable zones:** 39 (2% of RBD)<br>**Natura 2000 sites:**<br>12 SPAs and 60 SACs dependent on water resources. | **Physical modification**:<br>Physical modifications are a widespread problem in Western Wales: 118 water bodies fail to reach good status because of them. Mainly due to barriers to fish migration such as weirs (57 water bodies), but also flood protection (4) and impoundments (16).<br>**Pollution from sewage and waste water:**<br>In the West Wales River Basin District, 22 Water bodies are reported as failing for phosphorus due to significant contributions from Water Company final sewage effluent discharges. There are also two estuarine water bodies failing due to diffuse nutrients.<br>**Pollution from town, cities and transport:**<br>**Pollution from rural areas:**<br>Diffuse pollution from rural areas causes failures in approximately 122 water bodies in the Western Wales River Basin District. Of these 84 failures are from farming and 40 are from forestry |

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**Table 5.6 SEA Area 5: Southern and South West England**

| RBD | Environmental Characteristics | Water Resources | Principal Impacts and Pressures |
|---|---|---|---|
| South East | The South East RBD covers over 10,000km$^2$, with a large proportion being dominated by the rural landscape of the South Downs. Major urban centres include Brighton and Hove, Southampton and Portsmouth. SPA and SAC designations with wetland features cover around 9% of the area.<br><br>The coastal region supports a variety of habitats including exposed chalk, reed-beds, natural harbours, mudflats, salt-marshes and lagoons. Migratory species of commercial and recreational interest (salmon, sea trout and eels) and of conservation importance (shad species) are present.<br><br>Many urban and rural rivers have been modified for flood defences or navigation, and there is a great amount of pressure on groundwater for public water supply. 72% of public water supply is from groundwater, which is also required to maintain river flows and wetlands which support a range of water dependent habitats.<br><br>Based on estimates of housing need, it is possible that around 200,000 new homes and associated infrastructure is to be built in the area by 2026 which will increase pressures on the water resources of this area. | **Surface waters:** 340 rivers and canals, 34 lakes or reservoirs, 17 coastal waters, 20 estuaries.<br><br>**Ground water bodies:** 81<br><br>**Protected drinking waters:** 46<br><br>**Freshwater fisheries:** 222<br><br>**Shellfish waters:** 26<br><br>**Bathing waters:** 81<br><br>**Nitrate vulnerable zones:** 112 (70% of RBD)<br><br>**Natura 2000 sites:**<br><br>8 SPAs and 13 SACs dependent on water resources. | **Abstraction and other artificial flow regulation:**<br><br>601km (24%) of total river length and 9 (9%) of lakes is/probably at risk. 5,180km$^2$ (82%) of groundwater area is/probably at risk.<br><br>**Nitrate in surface and groundwater:**<br><br>493 kilometres (20%) of total river length at risk of failing the 50mg/l threshold for nitrate. 22 groundwater bodies are at/probably at risk of failing their objectives as a result of nitrate.<br><br>**Organic pollution (ammonia and BOD):**<br><br>282km (11%) of river length are/probably at risk for failing ammonia standards. 300km (12%) is at risk of failing BOD standards.<br><br>**Pesticides:**<br><br>673km (29%) of river length is/probably at risk from diffuse pesticides. 197km (8%) of river length is/probably at risk from sheep dip.<br><br>**Phosphorus:**<br><br>55% of the rivers by length in the South East River Basin District are at risk from phosphorus enrichment.<br><br>**Physical modification morphology:**<br><br>1,470 (59%) of river length, 29 (85%) lakes, 15 (94%) coastal water bodies, and 18 (90%) estuarine water bodies are/probably at risk from being degraded due to changes to their morphology.<br><br>**Sediment:**<br><br>1,176km (47%) of river length is/probably at risk from the effects of sediment.<br><br>**Urban and transport pressures:**<br><br>52 river water bodies are at/probably at risk, from urban diffuse pollution. |

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| RBD | Environmental Characteristics | Water Resources | Principal Impacts and Pressures |
|---|---|---|---|
| South West | The South West RBD covers an area of 21,000km$^2$, and is predominantly rural while including the urban centres of Exeter, Plymouth, Torquay, Bournemouth and Poole. This RBD also covers the Isles of Scilly and Lundy.<br><br>The area encompasses two National Parks and 12 Areas of Outstanding Natural Beauty and England's only Marine Nature Reserve (Lundy). SACs and SPAs which are dependent on water resources are located in the RBD, as is England's only natural World Heritage Site, the Jurassic Coast of Devon and Dorset. The district supports nearly half of England's fishing operations and a half of all shellfish waters in England and Wales. However, because of the geology and historic mining activities some sediments in the Gannel, Hayle, Fal and Looe continue to suffer from significant metal pollution.<br><br>The economy is dominated by the service sector and tourism is also a significant contributor to the local economy. Public administration and defence are the largest economic sectors, followed by construction, wholesale and distribution, retail and health. Agriculture is less significant, though important to the rural environment, and a potential source of pressure on the water environment.<br><br>38,000 hectares of SSSI are considered to be in unfavourable condition, and many of these are rivers and streams. Salmon are an important indicator species, and only 3 rivers were expected to reach the Environment Agency's management objectives for Salmon by 2008. | **Surface waters:** 938 rivers and canals, 63 lakes or reservoirs, 25 coastal waters, 23 estuaries.<br><br>**Ground water bodies:** 44<br><br>**Protected drinking waters:** 130<br><br>**Freshwater fisheries:** 954<br><br>**Shellfish waters:** 33<br><br>**Bathing waters:** 187<br><br>**Nitrate vulnerable zones:** 97 (41% of RBD)<br><br>**Natura 2000 sites:**<br><br>9 SPAs and 40 SACs dependent on water resources. | **Sediment:**<br><br>3,550km (47%) of river length at/probably at risk from the direct effects of sediment.<br><br>**Physical modification: morphology:**<br><br>2,485km (33%) of river and 14 (61%) estuarine areas are at/probably at risk of failing to meet WFD 2015 objectives. 55 (87%) lakes and 16 (64%) coastal water bodies are at risk from morphological pressures.<br><br>**Nitrate in surface and groundwater:**<br><br>3 groundwater bodies at risk. In addition, nine groundwater bodies in the South West River Basin District (20.5%) had a significant and sustained increase in nitrate concentration in groundwater.<br><br>**Phosphorous in rivers and standing waters:**<br><br>61% of total river length at/probably at risk of diffuse phosphorous pollution.<br><br>**Invasive non-native species:**<br><br>213 (23%) river water bodies are probably at risk of failing WFD objectives in 2015. 6 (10%) of lakes are probably at risk, 15 out of 25 coastal water bodies (60%) and 13 out of 23 estuarine waters (57%) are also probably at risk.<br><br>**Phosphorus in rivers and standing waters:**<br><br>59% of the total length of river water bodies is at risk or probably at risk from diffuse phosphorus from agricultural pollution.<br><br>**Abstraction and other artificial flow pressures:**<br><br>880km (12%) of river length is at/probably at risk from abstraction and flow regulation. 12 (19%) of lakes and 3,885km$^2$ (24%) of groundwater bodies are at/probably at risk.<br><br>**Mines and mine water:**<br><br>106 rivers and 6 groundwater bodies are at/probably at risk from mines/mine water. |

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| RBD | Environmental Characteristics | Water Resources | Principal Impacts and Pressures |
|---|---|---|---|
| | | | **Pesticides:**<br>1,563km (21%) of river length is at/probably at risk from diffuse pesticides. 345km (5%) of river length at/probably at risk from sheep dip. 2% of river length at risk from pollution point sources.<br>**Urban and transport pressures:**<br>49 (5%) of our river water bodies are at risk, or probably at risk from urban diffuse pollution.<br>**Organic pollution:**<br>425km (6% of total length) of river water bodies are at/probably at risk of failing the ammonia standards. 340 km (5% of total length) of river water bodies are at risk of failing the biochemical oxygen demand standards. 4% of estuarine water bodies at risk or probably at risk from point sources of organic pollution.<br>**Chemicals including priority hazardous substances, priority substances and specific pollutants (excl. pesticides):**<br>40 (4%) of rivers and 10 (43%) estuarine water bodies are at/probably at risk from failing WFD objectives due to dangerous substance directive compliance.<br>**Other issues include:**<br>Endocrine Disrupters<br>Faecal Indicator Organisms<br>Commercial fisheries (estuaries and coastal waters) |
| Thames (also partly in SEA area 3) | The Thames Estuary RBD covers an area of 16,133km$^2$ from the river's source in Gloucestershire, through London to the North Sea. The eastern and northern parts of the basin are heavily urbanised, though considerable areas of rural land remain.<br>Rainfall levels are low, and the area is one of the driest in the UK. The Thames provides two thirds of London's drinking water, with most other abstraction in the RBD coming from groundwater sources, principally from chalk aquifers. | **Surface waters:** 483 rivers and canals, 76 lakes or reservoirs, 1 coastal water, 11 estuaries.<br>**Ground water bodies:** 46<br>**Protected drinking waters:** 116<br>**Freshwater fisheries:** 433<br>**Shellfish waters:** 3 | **Abstraction and other artificial flow pressures:**<br>1,121km (21%) of river length and 2km$^2$ (5%) is/probably at risk from abstraction and flow regulation. 8,660km$^2$ (85%) of groundwater are at risk or probably at risk.<br>**Invasive non-native species:**<br>246 (51%) of rivers are at risk of failing WFD objectives by 2015. 5 (7%) of lakes (though 46% are not assessed), and 3 transitional waters are also probably at risk. |

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| RBD | Environmental Characteristics | Water Resources | Principal Impacts and Pressures |
|---|---|---|---|
| | Business services account for about one fifth of the Thames economy. Transport, and the London and Medway ports are also of economic importance. Agriculture is minimal, but where it exists, animal husbandry and vegetable growing make up the greatest proportion of activities.<br>The Thames and its tributaries support a number of water related priority species listed on the UK Biodiversity Action Plan such as cod, freshwater white-clawed crayfish and depressed river mussels. Populations of water vole and salmon are falling below conservation limits in the RBD, and they could become extinct in some areas without intervention.<br>The status and condition of SSSIs are influenced by habitat fragmentation, poor agricultural management, spread of non-native species, increasing water abstraction pressures and impacts of drought – which also have wider reaching impacts. | **Bathing waters:** 15<br>**Nitrate vulnerable zones:** 114 (78% of RBD)<br>**Natura 2000 sites:**<br>5 SPAs and 11 SACs dependent on water resources. | **Nitrate in surface and ground waters:**<br>2,171km (40%) of total river length is at/probably at risk of failing the 50mg/l threshold for nitrate<br>14 groundwater bodies are at risk of failing environmental objectives due to nitrate.<br>**Pesticides:**<br>1,901km of river is/probably at risk from diffuse pesticides. No rivers are at risk from sheep dip.<br>**Phosphorous in rivers and standing waters:**<br>Over 71% of river length is/probably at risk from diffuse agricultural phosphorous pollution.<br>**Physical modification: morphology:**<br>2,371km (44%) of river length and 21 (28%) of transitional water bodies are at risk of failing 2015 WFD objectives for morphological pressures. 11 (100%) of estuarine waters and 1 (100%) coastal water is also at risk from similar pressures.<br>**Sediment:**<br>1,569km (29%) of river length is/probably at risk from the direct effects of sediment.<br>**Urban and transport pressures:**<br>120 river water bodies are at risk, or probably at risk for urban diffuse pollution<br>**Organic pollution:**<br>685km (13%) of total river length is at/probably at risk of failing the ammonia standards. 658km (12%) of total river is at risk or probably at risk of failing the biochemical oxygen demand standards.<br>**Faecal indicator organisms** |

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## 5.5 Summary of Existing Problems Relevant to Onshore Oil and Gas Licensing

The following existing problems for water quality and resources have been identified:

- There is considerable pressure on water resources in many parts of the UK. In addition, water supplies are not available in all locations and water required for onshore oil and gas exploration/developed may need to be transported or delivered to sites;
- There is a legacy of groundwater pollution in the UK from historical mining and other industrial activities;
- A large percentage of surface waters currently do not meet biological status due to a wide range of pressures such as over-abstraction, eutrophication and morphological alterations;
- Climate change is expected to have significant impacts on the water environment. Areas where the underlying geology is generally impermeable are expected to be particularly affected as river flows would be likely to fall to low levels in drier periods and quickly react to rainfall episodes; and
- Existing waste water treatment works may not have the capacity or technology to treat wastewater from unconventional gas exploration and production.

The following existing problems for flood risk have been identified:

- Significant proportions of the UK population are at risk from flooding, around 10% of properties in England and Wales and 4% in Scotland, although the degree of risk varies;
- The Flood Directive (2007/60/EC) was transposed into UK law in the form of the Flood and Water Management Act 2010 (England & Wales) and the Flood Risk Management (Scotland) Act 2009. The Directive requires the production of flood hazard maps and flood management plans;
- The Environment Agency has completed consulting on Catchment Flood Management Plans (CFMPs) in England and Wales. At the local authority level, Strategic Flood Risk Assessments are being completed;
- Shoreline Management Plans (in England and Wales) are taking a long term view of coastal issues by identifying sustainable management approaches for up to the next 100 years; and
- Flood risk presents a significant planning issue in the development of major infrastructure projects, both in terms of potential direct impacts on the project itself and indirect impacts associated with works (such as increased run-off).

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## 5.6 Likely Evolution of the Baseline

### 5.6.1 UK

The current trend in water condition is generally towards increased water quality across natural environments, drinking water and bathing waters [21]. Current climate change predictions indicate that rainfall patterns will become increasingly seasonal, with lower amounts of flow in the summer. This will lead to lower summer river flows, especially in those catchments with a low groundwater component. This could lead to increased abstraction pressure, increased stress on sensitive hydrological systems and a decrease in dilution potential leading to a failure against water quality targets. Increased flooding and storm events also have the potential to increase runoff of pollutants into controlled waters, thus reducing water quality. Population pressures are predicted to increase in certain parts of Great Britain, for example in the south-east. Increased population density will result in an increased pressure on natural resources and could exacerbate current problems or cause new ones.

The Marine and Coastal Access Act (2009) allows for the creation of Marine Conservation Zones (MCZs) in Great Britain (Northern Ireland MCZs will be introduced through separate legislation). MCZs will protect nationally important marine wildlife, habitats, geology and geomorphology. Sites will be selected to protect the range of marine wildlife [22]. This should lead to greater protection and improvement of marine habitats in the future.

In the United Kingdom, 93.7% of coastal bathing waters met the mandatory water quality in 2012. This is a decrease of 3.7% compared to the previous year. The rate of compliance with the guide values decreased from 83.3% to 58.8% [23]. Under the revised Bathing Water Directive all bathing waters will be required to achieve at least 'sufficient' quality by 2015, which is twice as stringent as the current mandatory standard. The overall quality of bathing waters is therefore likely to increase as water quality is improved to meet the increased standards [24].

### 5.6.2 England

The Environment Agency's Catchment Abstraction Management Strategies (CAMS) have identified a number of catchments in England which are designated as Over-Licensed or Over-Abstracted. Climate change is likely to result in lower summer rainfalls and more frequent/sever winter flood events. Such changes are likely to increase pressure on summer freshwater water availability and increase pollutant runoff into controlled waters during flood events. Unsustainable groundwater and surface water

[21] Defra, Sustainable Development Indicators, 2009, http://www.defra.gov.uk/sustainable/government/progress/documents/SDIYP2009_a9.pdf
[22] Natural England. http://www.naturalengland.org.uk/ourwork/marine/protectandmanage/mpa/mcz/default.aspx
[23] European Environment Agency, United Kingdom Bathing Water Results 2012, http://www.eea.europa.eu/themes/water/status-and-monitoring/state-of-bathing-water/country-reports-2012-bathing-season/united-kingdom-2012/view

[24] Environment Agency http://www.environment-agency.gov.uk/research/library/data/112170.aspx

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abstraction may contribute to environmental damage of rivers and wetlands at 500 sites in England and Wales, important conservation sites, including sites of national and international conservation importance.

The Environment Agency aims that by 2030 water use per person in England should fall by 130 litres/ day[25].

The objectives of the river basin management plans, required by the Water Framework Directive and referenced earlier in this section are required to be achieved by 2015. Those objectives are to:

- prevent deterioration, enhance and restore bodies of surface water, achieve good chemical and ecological status of such water and reduce pollution from discharges and emissions of hazardous substances;
- protect, enhance and restore all bodies of groundwater, prevent the pollution and deterioration of groundwater, and ensure a balance between groundwater abstraction and replenishment; and
- preserve protected areas.

Defra aims that by 2030, at the latest, England has improved the quality of our water environment and the ecology which it supports, and continued to provide high levels of drinking water quality from its taps; sustainably manage risks from flooding and coastal erosion, with greater understanding and more effective management of surface water; ensure a sustainable use of water resources, and implement fair, affordable and cost reflective water charges; cut greenhouse gas emissions; and embed continuous adaptation to climate change and other pressures across the water industry and water users.

Environment Agency aims to enhance water supply by up to 1,100Ml/d above present levels by the improvement of existing schemes and the development of some new resources[26].

There is a trend of improving quality of rivers within England; between 1990 and 2008 the percentage of rivers of good biological quality in England rose from 63 to 72%. Over the same time period the percentage of rivers of good chemical quality rose from 55 to 79%[27].

[25] Defra (2008) Future Water, the Government's Water Strategy for England, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69346/pb13562-future-water-080204.pdf

[26] EA (2009) Water Resources for the Future: A Strategy for England and Wales

[27] Defra, Sustainable Development Indicators (2010) http://sd.defra.gov.uk/2010/07/measuring-progress-sustainable-development-indicators-2010/

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### 5.6.3 Scotland

**Table 5.7** demonstrates that the overall percentage of water bodies which were at good or high status between 2007 and 2011 was broadly similar for all water categories, except estuaries. In most cases the risks to water quality are steady or declining, the exception being groundwater.

**Table 5.7 WFD Classification Results for Water Bodies in Scotland; Percentage of Water Bodies in each Class for 2007 and 2011**

| Status<br>Category | High | Good | Moderate | Poor | Bad |
|---|---|---|---|---|---|
| River (2007 Classification) | 8 | 40 | 31 | 16 | 5 |
| River (2011 Classification) | 8 | 46 | 23 | 15 | 8 |
| Lochs (2007 Classification) | 26 | 35 | 15 | 22 | 2 |
| Lochs (2011 Classification) | 19 | 44 | 23 | 11 | 4 |
| Estuaries (2007 Classification) | 28 | 16 | 44 | 4 | 8 |
| Estuaries (2011 Classification) | 36 | 50 | 12 | 2 | 0 |
| Coastal Waters (2007 Classification) | 57 | 34 | 9 | 0 | 0 |
| Coastal Waters (2011 Classification) | 29 | 68 | 4 | 0 | 0 |
| Groundwater (2007 Classification) | - | 76 | - | 24 | 76 |
| Groundwater (2011 Classification) | - | 80 | - | 20 | 80 |

Another important trend is the sources of effects. In general, environmental effects from industry are declining, whereas effects from urban development and intensification are increasing[28].

The Scotland river basin district objective is to improve water quality such that 98% of surface water bodies and 94% of ground water bodies will be of good or better condition by 2027[29]. By 2027 the objective for the Solway Tweed river basin district is for 92% of surface water bodies and 93% of

[28] SNIFFER, Current environmental baseline and trends for Water –SCOTLAND, accessed at http://www.seaguidance.org.uk/Upload/Documents/102210CurrentstateandtrendsforWATERSCOT.pdf

[29] Scottish Government (2009) The river basin management plan for the Scotland river basin district 2009–2015

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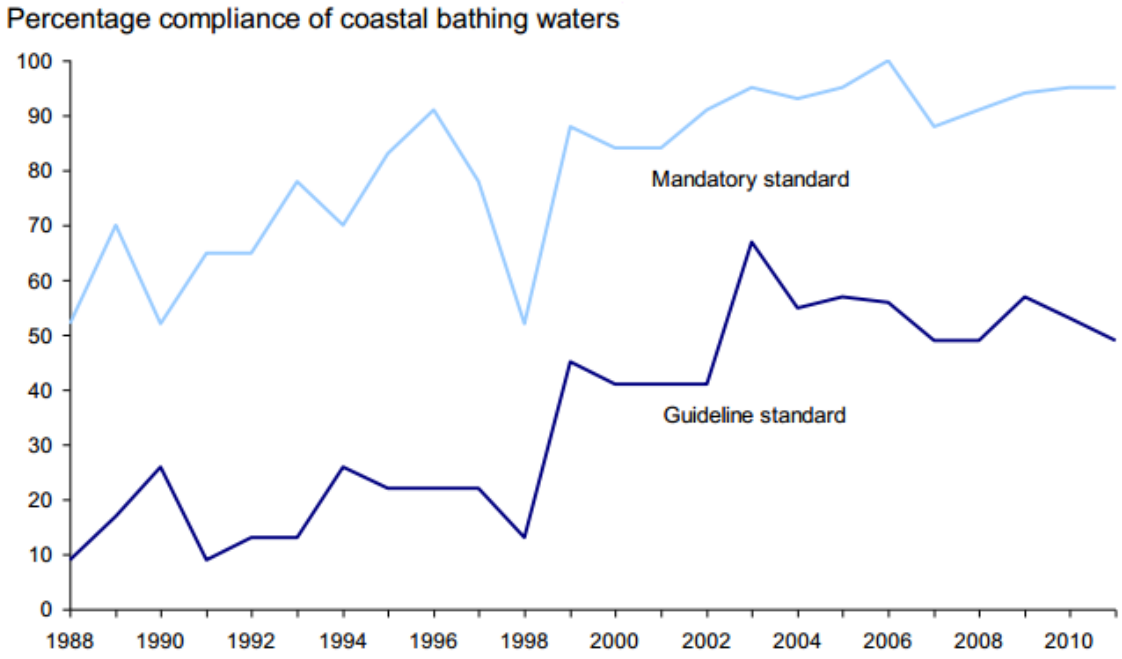
groundwater bodies to be of good or better quality[30].

As illustrated in **Figure 5.6**, the quality of bathing water has been improving since 1988. However, the results from recent years suggest that there are still challenges to ensure full compliance with the standards set out in the directive. Higher rainfall in summer and more intensive rainfall, as expected in most climate change projections, would be likely to pose significant hurdles to achieve full compliance with the standards.

**Figure 5.6 Percentage Compliance of Coastal Waters with the EC Bathing Water Directive 1988-2011**




Source: Scottish Government (2012) Key Environmental Statistics 2012, available at http://www.scotland.gov.uk/Resource/0040/00400677.pdf (accessed on 31.05.2013)

### 5.6.4 Wales

Population increase estimates are lower for Wales than for many other parts of the UK. However, the percentage of households metered across Wales is also lower than most other parts of the UK, save for the North East. Water companies in Wales expect to increase the overall number of properties that are metered to about 80%, in line with UK trends.

Climate change is expected to have significant effects on river flows in Wales, with most major watercourses experiencing 10-15% increase in mean monthly winter flows and 50-80% decreases in

[30] Scottish Government and Environment Agency (2009) The river basin management plan for the Solway Tweed river basin district 2009–2015

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summer flows. These predictions are generally more pronounced than in England, primarily due to the lack of groundwater storage capacity in Wales.

The Environment Agency believe that achieving good status in all water bodies in the Western Wales, Severn and Dee RBDs by 2027 will not be possible using only current technologies. Furthermore, the Agency predict that even achieving 75% good status will require marked changes in land use and water infrastructure, such as a major programme to separate foul and surface water sewers across most of the river basin district and by current standards, such changes are extremely unlikely to be economically or socially acceptable[31].

## 5.6.5 SEA Areas

### SEA Area 1: Scottish Midlands (including the Inner Forth)

The Clyde advisory group area has an ambitious target to meet good status by 2027. The overall goal is to improve 91% of water bodies. However, for 22 water bodies, good status will not be achieved. The reasons for these water bodies not reaching good status vary, and include:

- nine groundwater bodies are adversely affected from pollution arising from past mining events;
- 11 water bodies are affected by acid deposition and the natural recovery time is difficult to predict; and
- The Alt Fionn water body is affected by a hydropower generation plant.

Similar challenges face the Forth advisory group area. The overall objective is to ensure that 96% of waterbodies are at good or high ecological but it is expected that 11 water bodies will not meet good status. The reasons for this include: invasive species (Tiel Burn), acidification associated with forestry (Duchray River) and reservoir dams (such as the Gartmorn Dam).

### SEA Area 2: West Midlands, North West England and Southern Scotland

Water resources availability is set to decrease in the North West and 10% of the resource management units are already at risk of over abstraction. However, United Utilities plan to increase the resource base in the region in order to ensure demand is met. Most parts of the West Midlands suffer moderate levels of water stress.

It is expected that the water quality and groundwater quality will continue to improve in line with the legal requirements.

[31] Environment Agency Wales (2009) River Basin Management Plan, Western Wales River Basin District.

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## SEA Area 3: East Midlands and Eastern England

Climate change will affect the amount and distribution of rainfall impacting on flows and water levels. The Environment Agency has assessed how changes in rainfall could affect average river flows in the England by 2050 and found that on average river flows will be higher in the winter before flows become lower that at present during the spring and summer. Regional groundwater resources used for domestic, industrial and agricultural supply could be susceptible to long term reduction with a lowering of groundwater levels induced by lower recharge rates. Further, the greater concentration of rainfall intense events is likely to result in an increase ratio of run-off to recharge, leading to further reductions in recharge rates. Increasing demand for water abstraction due to hotter summers may also lead to further pressures on already strained groundwater resources. The increased winter rainfall is likely to cause increased run off due to soil saturation, it may also cause contaminated industrial material leaching from the ground into adjacent rivers causing water pollution. Increased rainfall may also impact on the number of mine water landscapes.

Public water supplies are generally good in the region, particularly in the north-east. However some regions further south (such as Lincolnshire and Cambridgeshire) are currently below their target headroom.

New housing throughout the region is likely to be concentrated in existing urban areas and it is probable that this will contribute to additional diffuse source pollution and/or an increase in phosphate levels from sewage plant discharges.

Groundwater protection is an important issue in the East of England as a significant proportion of public water supply in this region comes from groundwater resources. Changes to rainfall patterns may affect the re-charge of resources or cause pollution of groundwater sources to increase.

## SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

Dee Valley Water expects that over 80% of customers will have a metered water supply by 2035 and that the Company's licenced abstractions are unlikely to be affected by any sustainability reductions in the near future. [32].

There has been a significant downward trend in non-household demand by Dee Valley Water customers, from 23Ml/d in 1999 to 20.5 Ml/d in 2008. This is primarily due to a shift from manufacturing services to the services sector in the region. In addition, some strategic customers (such as Kellogs) have initiated water efficiency programmes.

Welsh Water predict that several water resources zones (WRZs) will be in deficit within a 25 year period. These WRZs cover most of south east Wales. In 2012, Welsh Water set out a number of objectives to help secure water resources in their operation area. These include:

[32] Dee Valley Water (2012) Dee Valley Water Final Water Resources Management Plan 2012.

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- a reduction in regional leakage from 190 Ml/d in 2011 to 184Ml/d in 2015; and
- the installation of water meters in all new properties and those households who opt to be metered as part of the free meter option.

A number of challenges were also identified by Welsh Water which may affect the delivery of water in the region. Climate change predictions are uncertain and it is difficult to build accurate future predictions as a result. Welsh Water has also accepted that river quality investigations under the Water Framework Directive may lead to modifications to operations.

With regard to water quality, despite the pressure that climate change and a population growth will result in, it is likely that overall water quality will improve in line with the statutory requirements.

### SEA Area 5: Southern and South West England

It is forecast that by 2020, 78% of all households in the South East will have a water meter. This can be compared against 2004, when only 22% of all households had a meter. People living in metered households in England tend to consume less water than unmetered households. The metering of households in the South East should help reduce actual per person water consumption from 156 litres a day (2008) to the Government aspiration of 130 litres a day by 2030. Despite this reduction in consumption, the scale of growth that is expected to occur in the South East will place significant pressures on water resources. The Environment Agency predict that the Q95 flows in some rivers could be reduced by at least 35%[33].

Similar to the South East, reductions in per person consumption over the coming years will largely eroded by population growth, with an overall increase in household demand of 1.4% by the 2020's. In addition, non-household consumption will increase by 3.2%[34].

Water quality in the South West is likely to deteriorate in more urban areas or catchments where growth is expected to occur.

## 5.7 Assessing Significance

The objectives and guide questions related to water quality and resources which have been identified for use in the appraisal of the effects of Licensing Plan proposals are set out in **Table 5.8,** together with reasons for their selection.

[33] Environment Agency (2010) State of the Environment- South East England

[34] South West Water (2007) Strategic Direction Statement (http://www.southwestwater.co.uk/media/pdf/a/3/SWWSDS.pdf)

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**Table 5.8 Approach to Assessing the Effects of the Licensing Plan Proposals on Water Quality and Resources**

| Objective/Guide Question | Reasoning |
|---|---|
| **Objective: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive.** | The SEA Directive requires that likely significant effects on water be taken into account in the Environmental Report. |
| *Will the activities that follow the licensing round affect demand for water resources (availability)?* | The Water Framework Directive encourages the sustainable use of water resources.<br>Government strategies including the Future Water (2008) for England, and the Environment Strategy for Wales (2006) promote the sustainable use of water. Some parts of the country have abstraction above a sustainable level which could result in water shortages in some areas in the future. |
| *Will the activities that follow the licensing round affect the amount of pollution arising from waste water and surface runoff produced?* | Surface runoff and waste water may affect water quality if it reaches water receptors. Water Framework Directive requires all inland, coastal and groundwater to reach a 'good' chemical and ecological status by 2015. Under Water Environment Regulations (Controlled Activities) (Scotland) (2005) authorisation is required for discharges to water. |
| *Will the activities that follow the licensing round protect and enhance the ecological status/ ecological potential* quality of surface, groundwater, estuarine and coastal waters quality?* | Water Framework Directive requires all inland, coastal and groundwater to reach a 'good' chemical and ecological status by 2015.<br>Government strategies, such as Future Water (2008) and Environment Strategy for Wales (2006) include objectives to protect quality of water. |
| *Will the activities that follow the licensing round protect the geological/hydrological connection between prospective shale gas sequences and UK geothermal and mineral springs?* | |
| **Objective: To minimise the risks of coastal change and flooding to people, property and communities** | The SEA Directive requires that likely significant effects on water be taken into account in the Environmental Report. |
| *Will the activities that follow the licensing round be at risk of flooding or be affected by flooding, if it occurred?* | The NPPF seeks to provide inappropriate development in areas of flood risk should be avoided. In addition, the National Flood and Coastal Erosion Risk Management Strategy for England seeks to ensure that flooding risks are well managed so that their impacts are minimised through better understanding of the risk |
| *Will the activities that follow the licensing round have the potential to cause or exacerbate flooding?* | As with all major construction projects there is a potential to contribute to flood risk. Consideration of location is important as inappropriate siting of a development (e.g. – on a floodplain) may result in flooding of the development and other developed areas if it displaces flooding. |
| *Will the activities that follow the licensing round have the potential to help alleviate flooding?* | The consumption of water resources may help reduce flood risk in the wider catchment. |
| *Will the activities that follow the licensing round have the potential to affect coastal processes and/or erosion rates?* | Climate change is likely to exacerbate erosion and coastal flooding as a result of sea level rise together with the potential increase in the intensity, severity and frequency of coastal storms over the next 100 years. |

**Table 5.9** sets out guidance that will be utilised during the assessment to help determine the relative significance of potential effects on the population objective. It should not be viewed as definitive or prescriptive; merely illustrative of the factors that may be considered as part of the assessment process.

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**Table 5.9 Illustrative Guidance for the Assessment of Significance for Water Quality and Resources**

| Effect | Description | Illustrative Guidance |
|---|---|---|
| ++ | Significant Positive | • Proposal would lead to a major reduction in water use compared to prior to development such that the risk of water shortages in the area is significantly decreased and abstraction is at a sustainable level in the long term;<br>• Proposal would significantly decrease the amount of waste water, surface runoff and pollutant discharges so that the quality of that water receptors (including groundwater, surface water, sea water or drinking receptors) will be significantly improved and sustained and that all water targets (including those relevant to chemical and ecological condition) are reached and exceeded;<br>• The option would result in decrease in people or property at risk or affected by flooding, coastal inundation or sea level rise. |
| + | Minor Positive | • Proposal would lead to a minor reduction in water use compared to prior to development such that the risk of water shortages in the area is decreased in the short term and abstraction is closer to sustainable levels than prior to development;<br>• Proposal would lead to minor decreases in the amount of waste water, surface runoff and/or pollutant discharges so that the quality of water receptors (including groundwater, surface water, sea water or drinking receptors) may be improved to some level temporarily and that some water targets (including those relevant to chemical and ecological condition) will be reached/exceeded;<br>• The option may result in decrease in people or property at risk or affected by flooding, coastal inundation or sea level rise. |
| 0 | Neutral | • Proposal would not significantly affect water demand and abstraction levels will not be altered;<br>• Proposal would not change amount of waste water, surface runoff and/or pollutant discharges so that the quality of water receptors will not be affected;<br>• Proposal would not result in any change to the amount of people or properties that are at risk by flooding, coastal inundation or seal level rise. |
| - | Minor Negative | • Proposal would lead to a minor increase in water use compared to prior to development such that the risk of water shortages in the area is increased to some level in the short term, particularly in periods of low flow and abstraction is considered beyond sustainable levels;<br>• Proposal would lead to minor increases in the amount of waste water, surface runoff and/or pollutant discharges so that the quality of water receptors (including groundwater, surface water, sea water or drinking receptors) may be decreased to some level temporarily and it may prevent some water targets (including those relevant to chemical and ecological condition) from being achieved;<br>• The option may result in increase in people or property at risk or affected by flooding, coastal inundation or sea level rise. |
| -- | Significant Negative | • Proposal would lead to major increases in water use compared to prior to development such that the risk of water shortages in the area is significantly increased and abstraction is significantly beyond sustainable levels;<br>• Proposal would lead to an exceedence of an abstraction license limit;<br>• Proposal would lead to major increases in the amount of waste water, surface runoff and/or pollutant discharges so that the quality of water receptors (including groundwater, surface water, sea water or drinking receptors) will be considerably increased and will prevent some or all water targets (including those relevant to chemical and ecological condition) from being achieved;<br>• Alternative would result in increase in significant number of people or property affected by flooding, coastal inundation or sea level rise. |

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| Effect | Description | Illustrative Guidance |
|---|---|---|
| ? | Uncertain | • From the level of information available the impact that the option would have on this objective is uncertain. |

## 5.8 Assessment of Effects

This section comprises the assessment of the potential activities that could follow on from the licensing round on the water and flood risk objectives. There are a total of six main stages of oil and gas exploration and production (including gas storage) that are the subject of the assessment. These are highlighted in **Table 5.10** for both conventional and unconventional oil and gas together with an overview of the associated key activities at each stage. Please note that Stages 1, 2 and 4 do not necessarily apply to gas storage, depending on the development history of the particular site.

**Table 5.10 Oil and Gas Exploration and Production Lifecycle and Key Activities**

| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| 1. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. |
| 2. | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring.* | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. |
| 3. | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring* | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. |
| 4. | **Production/operation/maintenance,** including:<br>• Gas/oil production; | **Production/operation/maintenance,** including:<br>• Gas/oil production; |

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| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| | • Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring.* | • Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. |
| 5. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. |
| 6. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. |

Note: Exploration wells most usually move from Stage 2 to Stage 5, though some may be used for long-term production testing (which would require new consents including planning permission) and some may be retained and their sites redeveloped as a production project (this would also require new consents including planning permission). For the purposes of this assessment, the appraisal stage (a term commonly used in industry) spans Stages 2 and 3.

*Conventional oil and gas exploration and production activities (stages 2 to 4 above) can occasionally include hydraulic fracturing. However, the need to undertake hydraulic fracturing is relatively uncommon and has therefore not been considered in the assessment of conventional oil and gas activities as part of this SEA.

### 5.8.1 Conventional Oil and Gas

The assessment of the six main stages of conventional oil and gas production is contained in **Table 5.11** and **Table 5.12**. The first two columns of each table describe the exploration and production stage. The third and fourth columns summarise the expected effects on the water and flood risk objectives for both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report). The rationale for this relationship is explained in more detail in the final column and includes:

- the nature and scale of the potential effects on the water and flood risk objectives;
- when the effect could occur (timing) and its degree of permanence;
- what mitigation measures might be appropriate for potentially significant negative effects on the water and flood risk objective;
- what options there are to enhance positive effects; and
- assumptions and uncertainties that underpin the assessment.

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**Table 5.11 Assessment of Effects: Conventional Oil and Gas (Objective 5)**

| **Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>Stage 1of the oil and gas exploration and production lifecycle would comprise of non-intrusive activities. Site identification, site selection and the securing of development and operation permits would be largely desk-based and in consequence, no effects on water quality or resources are anticipated.<br>Vibroseis is the most commonly used method of seismic survey and involves the employment of large vibrator unit vehicles as well as support vehicles for data recording. Construction of temporary tracks/roads may be required to facilitate site access. Temporary access roads may lead to a loss of permeability on site and increase surface water run-off. In general, the volume of surface runoff would be negligible. The runoff has the potential to pick up contaminants that may have been disposed of or spilt on access roads. Typical contaminants would likely include: oil; fuels; and lubricating fluids. As the exploration works would be short term, and not involve significant vehicle trips, the risk of spillages is low.<br>In some cases, shot-hole survey techniques may be used. This involves the drilling of a hole with a small diameter for the insertion of explosives which are infilled after use. It is unlikely that shot-hole survey techniques would be carried out in close proximity to surface water bodies and therefore would not impact on water quality.<br>Overall, the risk posed to water quality (both surface and groundwater) are negligible. In addition, no activities at this stage would be expected to result in the consumption of water resources and therefore demand for water resources would be unchanged.<br>Consequently, a neutral effect is expected on the water objective at this stage.<br>**Low and High Activity Scenarios:**<br>Although it is reasonable to assume that more surveys would be carried out under the high activity scenario, the risks posed to water quality would still not be of a scale to result in any discernible adverse effects occurring. A neutral effect is therefore also expected under the high activity scenario.<br>**Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• It is assumed that shot-hole techniques would not take place in close proximity to waterbodies.<br>• It is assumed that shot-hole techniques would result in the deposition of contaminants or hazardous materials in the soil. |

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| Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Uncertainties:**<br>• The depth of the drill required for shot-hole techniques is unknown. |
| 2 | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring. | **0** | **0** | **Assessment of Effects:**<br>Pad preparation would involve the removal of vegetation and general groundworks to a site of approximately 1 hectare. During this early construction work, there is a risk of runoff contaminated with hydraulic oil, nutrient phosphorous, nitrogen, fuels and lubricating oils entering water bodies, streams and groundwater.[35] These risks are generally shared with other large greenfield construction sites and the extent of the effect will depend on construction practices and rainfall events.<br>Off the pad, additional works would be required which may cause runoff. These works include access roads and utility corridors.<br>Surface water can be managed in a number of ways:<br>- Clean surface water run-off (for example from a road, pathway or clean hardstanding area) does not require a permit from the Environmental Agency to be discharged to a watercourse.<br>- However if surface water runoff does become contaminated an environmental permit is required to discharge the water. The Agency has indicated[36] that a permit will only be issued if it is not feasible to stop the contamination at source and the contamination will not pollute the receiving water.<br>- If a permit is not issued, alternative options (such as onsite treatment or removal by tankers) would have to be considered.<br>- Finally, discharge to a public foul sewer does not need a permit.<br>It is likely that the pad site will be lined with an impermeable liner/layer once groundworks have been completed. Surface water run-off is therefore likely to be captured in drainage channels surrounding the site and would be managed according to the options set out above. Windblown dust may affect the turbidity of nearby surface water bodies.<br>The causes of groundwater contamination associated with well design, drilling, casing and cementing generally relate to the quality of the well structure.[37] ‘ |

[35] New York Department of Environment (2011) *Revised Draft Supplemental Generic Environmental Impact Statement On The Oil, Gas and Solution Mining Regulatory Program*, available from http://www.dec.ny.gov/data/dmn/rdsgeisfull0911.pdf [Accessed June 2013]

[36] Environment Agency (2013) Onshore oil and gas exploratory operations: technical guidance (Consultation Draft).

[37] AEA (2012) Support to the identification of potential risks for the environment and human health arising from hydrocarbon

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| Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Well integrity' refers to preventing hydrocarbons from leaking out of the well by isolating it from other subsurface formations. The Royal Academy of Engineering[38] note that well failure may arise from poor well integrity resulting from:<br>-Blowout: a blowout is any sudden and uncontrolled escape of fluids from a well to the surface.<br>-Annular leak: poor cementation allows contaminants to move vertically through the well either between casings or between casings and rock formations.<br>-Radial leak: casing failure allow fluid to move horizontally out of the well and migrate into the surrounding rock formations.<br>The Secretary for Energy Advisory Board[39] in the US noted that where there is a large depth separation between drinking water sources and the producing zone for shale gas production, the chances of contamination reaching drinking water is remote in a properly constructed well. As shale gas drilling is typically similar to conventional oil and gas drilling (save for the hydraulic fracturing stage), it is highly likely that this assumption is applicable to drilling in conventional activities.<br>The Environment Agency have adopted the following Policy in their Groundwater Protection Principles and Practice document (which also applies to Wales):<br>"*We will object to [oil and conventional gas exploration and extraction] within Source Protection Zones 1 (SPZ1)[40]. Outside SPZ1, we will also object when the activity would have an unacceptable effect on groundwater.*<br>*Where development does proceed, we expect BAT to protect groundwater to be applied where any associated drilling or operation of the boreholes passes through a groundwater resource. Elsewhere, established good practice for pollution prevention should be followed*".<br>The Agency should also be informed if any activity could involve the discharge of pollutants into groundwater. In the case of well stimulation, this is likely to be considered 'a groundwater activity' and would be subject to the permitting process. Well stimulation may lead to the movement of pollutants into adjacent groundwater that would not |

operations involving hydraulic fracturing in Europe.

[38] Royal Academy of Engineering (2012) Shale Gas in the UK, A Review of Hydraulic Fracturing.

[39] Secretary of Energy Advisory Board (2011) Shale gas production sub-committee: 90 day report.

[40] The Environment Agency has defined Source Protection Zones (SPZs) for 2000 groundwater sources. These zones show the risk of contamination from any activities that might cause pollution in the area. The closer the activity, the greater the risk. There are three main zones (inner, outer and total catchment) and a fourth zone of special interest. SPZ 1 constitutes the inner protection zone and is defined as the 50 day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres.

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| Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | otherwise have received them. Pollutants may include substances introduced by operations (i.e. well stimulation fluids) or by the mobilisation of natural substances from the target formation. A permit application will be required to include:<br>-a conceptual model showing the hydrogeological relationship between the zone of interest and any overlapping or adjacent aquifers<br>-the method of well construction, including details of the casing and grouting<br>-information on how the integrity of the casing is to be tested<br>-information on where the well stimulation fluid is expected to travel<br>-details of the liquids to be injected, water use and disposal of effluents.<br>The Scottish Environment Protection Agency (SEPA) is the principal regulator of discharges to groundwater in Scotland. Exploration would be likely to require a permit from SEPA under The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) regime. For example, application for a CAR complex licence would be required to allow a deep borehole (>200m) to be constructed and condition any maintenance or monitoring required to ensure that the borehole does not result in contamination of groundwater. The application would need to be accompanied by a risk assessment and details of chemicals in drilling fluids.[41]<br>Overall, assuming that well integrity is ensured and best practice is following, the risks of groundwater contamination associated with drilling are low.<br>Drilling muds and cuttings which have been produced during the drilling stage are a possible source of surface water contamination, depending on how they are manage and treated.<br>The AEA (2012) report for the European Commission on the potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing[42] has identified the possibility of such an event occurring as 'rare' and note that established procedures are in place for management of waste from hydrocarbon extraction activity.<br>Water consumption at this stage would be negligible and generally restricted to providing water for drilling muds. |

[41] SEPA (2012) *Regulatory Guidance: Coal bed methane and shale gas*. Available from http://www.sepa.org.uk/customer_information/energy_industry.aspx [Accessed September 2013]

[42] AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2011.* Available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed May 2013]

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| **Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Low and High Activity Scenario:**<br>Under the high activity scenario, more wells would be drilled and therefore the risk of a polluting event would be higher. However as outlined above, assuming regulatory requirements are followed, supplemented by best practice, existing measures are in place to ensure that the risks of groundwater contamination are low and therefore neutral effects are expected on the water objective.<br>**Mitigation:**<br>• Surface water runoff should be managed so as to ensure it stays clean and uncontaminated. An appropriate monitoring regime should be adopted.<br>**Assumptions:**<br>• It is presumed that pads would be developed on greenfield sites<br>• It is assumed that a blowout preventer would be placed at the top of the well during drilling to automatically shut down fluid flow in the wellbore should there be any sudden or uncontrolled escape of fluids<br>• It is assumed formation pressure tests will be carried out immediately after the drilling of each casing.<br>• It is presumed that produced water would not flow to the surface during this stage. Should it do so, it will need to be treated or handled as set out in the assessment of Stage 4.<br>**Uncertainties**<br>• The location and density of drilling pads is unknown, as is the depth of wells drilled and specific geologically formations that will be the subject of exploration. . |
| 3 | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring. | **0** | **0** | **Assessment of Effects:**<br>Activities which may result in a deterioration of the quality of groundwater and surface water bodies at this stage include:<br>-Construction works to prepare the pad site<br>-Construction works to build above ground infrastructure and facilities<br>-Drilling Operations<br>-Extraction and handling of drilling related wastes<br>-Well completion and stimulation<br>These activities could have on effect on water quality. Effects on both groundwater and surface water have been described above for Stage 2 and would not differ at this stage. It should be noted however that it is assumed each pad would have 2 wells and therefore the likelihood of an incident which results in unacceptable levels of pollutants reaching groundwater or surface water bodies would be higher (although still very low).<br>**Low and High Activity Scenario:**<br>Under the high activity scenario, more wells would be drilled and therefore the risk of a polluting event would be higher (12 for the higher activity scenario as opposed to 6). However as outlined above, assuming regulatory |

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| Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | requirements are followed, supplemented by best practice, existing measures are in place to ensure that the risks of groundwater contamination is low and therefore neutral effects are expected on the water objective.<br>**Mitigation:**<br>• Surface water runoff should be managed so as to ensure it stays clean and uncontaminated. An appropriate monitoring regime should be adopted.<br>**Assumptions:**<br>• It is presumed that pads would be developed on greenfield sites.<br>• It is assumed that a blowout preventer would be placed at the top of the well during drilling to automatically shut down fluid flow in the wellbore should there be any sudden or uncontrolled escape of fluids.<br>• It is assumed formation pressure tests will be carried out immediately after the drilling of each casing.<br>• It is presumed that produced water would not flow to the surface during this stage. Should it do so, it will need to be treated or handled as set out in the assessment of Stage 4.<br>**Uncertainties**<br>• The location and density of drilling pads is unknown, as is the depth of wells drilled and specific geologically formations that will be the subject of exploration. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>Once the production is operational, the primary issue with regards to water will be the collection and disposal of produced water. 'Produced Water' is any water that is "produced" to the surface from an oil or gas reservoir along with the oil or gas. This water may come from the following sources:<br>(i) Connate water present in the reservoir prior to production<br>(ii) Condensed water which is condensed out of the produced gas in the production tubing<br>(iii) Injected water which has broken through from the injection wells to the producers.<br>The major substances found in produced water typically include: hydrocarbons, sands, dissolved salts and iron, metals and Naturally Occurring Radioactive Minerals.<br>The management of produced water will be an important step in reducing risks of surface water or groundwater contamination. Inadequate well cementing could result in produced water escaping into adjacent aquifers. Poorly designed tanks or capturing methods could also result in the produced water leaking, spilling or overwhelming pipes and tanks on the pad site and therefore draining into the soil (and eventually groundwater) or reaching rivers, lakes or other surface water bodies. Accidental releases can arise as a result of tank ruptures, equipment failure, overfills, vandalism, fires or improper operations. |

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| **Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Produced water is normally re-injected into a geological formation. This may be the hydrocarbon reservoir where it was produced from, or it may be re-injected into a separate formation.<br>Assuming that well cementing is not compromised, and produced water is managed in a way which reduces the risk of spillages occurring, there would be a neutral effect on the water objective at this stage.<br>**Low and High Activity Scenario:**<br>Although more wells would be in production under the high activity scenario, a neutral effect is expected as the risks of a water polluting event occurring are low and would be considered an abnormal event.<br>**Mitigation**:<br>• BAT should be considered in choosing options to collect, store and treat/dispose produced waters<br>• In the event of a spillage, bunding should be designed to capture escaped liquids<br>**Assumptions**<br>• It is assumed that well casing would be constructed to the appropriate standards<br>**Uncertainties**<br>• None identified. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>The inadequate sealing of wells could result in subsurface pathways for contaminant migration leading to groundwater pollution and potentially surface water pollution[41]. However as well decommissioning requires regulatory approval from DECC, it is highly likely all steps will be taken to ensure permanent isolation of subsurface formations and groundwater.<br>The construction activities at this stage may require water (i.e. for cement etc) but this would not be of a scale to result in any effects on local water demand and availability.<br>**Low and High Activity Scenario:**<br>Although more wells will have to be capped and sealed under the high activity scenario, the risks of groundwater and surface water pollution are low and therefore neutral effects would be expected under both scenarios.<br>**Mitigation**:<br>• Liquid tanks should be kept in bunded areas.<br>**Assumptions:**<br>• It is presumed that wells would be decommissioned in line with current regulation and best practices.<br>• It is assumed that no spillages or leakages of pollutants would occur during the removal of site equipment. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection; | **0** | **0** | **Assessment of Effects:**<br>Site restoration activities pose a low risk to water quality. The generation of dust may however increase the turbidity of nearby surface water bodies. |

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| Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • Site restoration and reclamation. | | | **Low and High Activity Scenario:**<br>Although more wells will have to be capped and sealed under the high activity scenario, the risks of groundwater and surface water pollution are low and therefore neutral effects would be expected under both scenarios.<br>**Mitigation:**<br>• Plant and vehicles involved in this work should be checked regularly to ensure they are in good condition and not leaking fuels.<br>• If any contaminants are identified, they should be handled appropriately to ensure they are not spilt or liable to reach ground/surface waters<br>• Soil re-profiling should take permeability into consideration so as to ensure surface water runoff rates are similar to baseline conditions.<br>• Hardstanding which is to remain in situ should be kept to a minimum<br>**Assumptions:**<br>• None identified.<br>**Uncertainties**:<br>• None identified. |

***Summary***

No positive effects would be expected on the water objective during any of the Stages of conventional oil and gas exploration and production. Overall, a score of neutral has been expected for all the stages. Some stages (Stage 1, Stage 6) involve construction works which may affect surface water quality. However these works would be typical for large construction projects and would be easily mitigated against. For other stages, which involve more technical activities (such as drilling, well completion, production, etc), there is the potential of water contamination occurring. However the strong regulatory system in place actively seeks to reduce these risks of such effects and any likelihood of them occurring and therefore it can be reasonably assumed that under normal operations, water quality would not be compromised.

**Mitigation Summary**

- Surface water runoff should be managed so as to ensure it stays clean and uncontaminated. An appropriate monitoring regime should be adopted.
- BAT should be considered in choosing options to collect, store and treat/dispose produced waters.
- In the event of a spillage, bunding should be designed to capture escaped liquids.
- Liquid tanks should be kept in bunded areas.
- Plant and vehicles involved in this work should be checked regularly to ensure they are in good condition and not leaking fuels.
- If any contaminants are identified, they should be handled appropriately to ensure they are not spilt or liable to reach ground/surface waters.
- Soil re-profiling should take permeability into consideration so as to ensure surface water runoff rates are similar to baseline conditions.
- Hardstanding which is to remain in situ should be kept to a minimum.

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

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**Table 5.12 Assessment of Effects: Conventional Oil and Gas (Objective 6)**

| **Objective 6: To minimise the risks of coastal change and flooding to people, property and communities** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection; characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>Stage 1of the oil and gas exploration and production lifecycle would comprise of non-intrusive activities. Site identification, site selection and the securing of development and operation permits would be largely desk-based and in consequence, no effects on water quality or resources are anticipated.<br>Vibroseis is the most commonly used method of seismic survey and involves the employment of large vibrator unit vehicles as well as support vehicles for data recording. Construction of temporary tracks/roads may be required to facilitate site access. Temporary access roads may lead to a loss of permeability on site and increase surface water run-off. In general, the volume of surface runoff would be negligible and would not be likely to increase the risk of flooding elsewhere.<br>Surveys may be at risk from flooding. However as they would be short term in duration and not involve the installation of immovable equipment, the risk that such flooding would entail would be negligible.<br>**Low and High Activity Scenarios:**<br>Although it is reasonable to assume that more surveys would be carried out under the high activity scenario, any additional flood risks posed would still not be of a scale to result in any discernible adverse effects occurring. A neutral effect is therefore also expected under the high activity scenario.<br>**Mitigation:**<br>• The Environment Agency's Flood Maps and Flood Alerts should be consulted before carrying out site surveys<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• None identified. |
| 2 | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring. | **0/?** | **0/?** | **Assessment of Effects:**<br>Pad preparation would involve the removal of vegetation and general groundworks to a site of approximately 1 hectare. The preparation of the pad site would also likely involve the laying of an impermeable surface to reduce the risk of contaminants leaking into soil/groundwater. This surface would change the natural drainage patterns of the site. This could result in the increase of flooding off site as runoff rates may be faster and the natural water storage the site provides would be lost. However these effects would be easily mitigated against.<br>As the exact location of particular drilling sites is uncertain, it is not possible to ascertain whether pad sites would be at risk from flooding. However should sites be developed that are in Flood Zones, the following potential risks may arise: |

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| Objective 6: To minimise the risks of coastal change and flooding to people, property and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | -The well may become inundated with flood water and disrupt drilling or cause damage to the casing.<br>-Plant and equipment may be damaged.<br>-Storage tanks may become damaged or suffer a loss of power and may release contaminants into the flood water.<br>-Hydrocarbons may be released and cause pollution or lead to explosions or fires.<br>As a result, it is likely that flood risk will be given due consideration at the consent stage (as part of the planning consent process) in order to reduce the likelihood of adverse effects occurring.<br>For the purpose of this assessment, a neutral effect is given as any effects on likely flood risk of sites adjacent to the drill pads will be minimised. However, it is uncertain whether there would be risk of flooding to the pad site as this would depend on the location and flood risk associated with the site selected.<br>**Low and High Activity Scenario:**<br>As flood risk would be considered on a site by site basis in line with the particular risk to each site, effects under the low and high activity scenarios would be consistent.<br>**Mitigation:**<br>• Flood Risk Assessments should identify all the key types of flood risk for drilling sites and ensure all appropriate mitigation measures are adopted;<br>• Surface water runoff should be managed by standard control methods such as drainage channels. These should be designed to slow down runoff.<br>**Assumptions:**<br>• It is assumed that the water abstracted for fracturing fluid would not reduce the risk of flooding elsewhere as the causal link between the two aspects is generally weak;<br>• It is assumed that all fracturing fluid would be injected into the shale rock formation and would not be split during injection or discharged from the site prior to usage.<br>**Uncertainties:**<br>• As outlined above, the flood risk cannot be ascertained on a site-specific basis as the drilling sites are unknown. |
| 3 | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation; | **0/?** | **0/?** | **Assessment of Effects:**<br>The determination of the risk of flooding occurring on the pad site is the same at this stage as set out in Stage 2.<br>With regard to increasing flood risk off the site, it is assumed that production sites would be 2-3ha in size at this stage, compared with 1 ha at Stage 2. |

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| Objective 6: To minimise the risks of coastal change and flooding to people, property and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring. | | | This is not expected to result in an increase of flood risk off the site as it is likely mitigation measures (drainage channels, etc) would be scaled up to met the requirements of the larger site. There is a residual uncertainty related to siting.<br>**Low and High Activity Scenario:**<br>As flood risk would be considered on a site by site basis in line with the particular risk to each site, effects under the low and high activity scenarios would be consistent.<br>**Mitigation:**<br>• Flood Risk Assessments should identify all the key types of flood risk for drilling sites and ensure all appropriate mitigation measures are adopted.<br>• Surface water runoff should be managed by standard control methods such as drainage channels. These should be designed to slow down runoff.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties**<br>• As outlined above, the flood risk cannot be ascertained on a site-specific basis as the drilling sites are unknown. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | **0/?** | **0/?** | **Assessment of Effects:**<br>Surface water runoff and flood risk aspects would be the same as those identified at Stage 3.<br>Once the production is operational, the primary issue with regards to water will be the collection and disposal of produced water. 'Produced Water' is any water that is "produced" to the surface from an oil or gas reservoir along with the oil or gas. The management of produced water for conventional oil and gas operations usually involves re-injection into other oil/gas formations. The collection and transportation of this water may involve a risk of accidental spillage. However as this is likely to be a rare occurrence, it would not be expected to result in flooding on or off the site. Once the produced water is re-injected, it would not pose a flood risk.<br>**Low and High Activity Scenario:**<br>As flood risk would be considered on a site by site basis in line with the particular risk to each site, effects under the low and high activity scenarios would be consistent<br>**Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• As outlined above, the flood risk cannot be ascertained on a site-specific basis as sites are unknown. |

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| Objective 6: To minimise the risks of coastal change and flooding to people, property and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0/?** | **0/?** | **Assessment of Effects:**<br>During the decommissioning of the wells and the pad site, there would be no change in the risk of increased surface water runoff than expected for Stages 2 to 4.<br>The site would still however be at risk from flooding and this flooding would be likely to have adverse effects. However as the site locations are not determined, it is not possible to ascertain the flood risk for each production site.<br>As a result, a score of neutral/uncertain has been given.<br>**Low and High Activity Scenario:**<br>As flood risk would be considered on a site by site basis in line with the particular risk to each site, effects under the low and high activity scenarios would be consistent.<br>**Mitigation**:<br>• Liquid tanks should be kept in areas which benefit from bunding.<br>**Assumptions:**<br>• It is presumed that wells would be decommissioned in line with current regulation and best practices.<br>• It is assumed that no spillages or leakages of pollutants would occur during the removal of site equipment.<br>**Uncertainties:**<br>• As outlined above, the flood risk cannot be ascertained on a site-specific basis as sites are unknown. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>Site restoration activities would involve construction works of short term duration. These works would not be expected to increase the risk of surface water runoff.<br>Although the site may be at risk from flooding, the adverse effects of such flooding would be lower than under other stages as the equipment will have been removed and the wells plugged. Therefore a neutral effect is expected on the flood risk objective during this stage.<br>**Low and High Activity Scenario:**<br>As flood risk would be considered on a site by site basis in line with the particular risk to each site, effects under the low and high activity scenarios would be consistent.<br>**Mitigation:**<br>• Soil re-profiling should take permeability into consideration so as to ensure surface water runoff rates are similar to baseline conditions.<br>• Hardstanding which is to remain in situ should be kept to a minimum<br>**Assumptions:**<br>• It is assumed that the site would be restored to a degree whereby baseline drainage and runoff levels are restored.<br>• It is assumed that any installations which are to be left on site long term would not pose issues should the site be flooded in the future. |

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| Objective 6: To minimise the risks of coastal change and flooding to people, property and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Uncertainties**:<br>• None identified. |

***Summary***

No positive effects are expected on the flood risk objective at any of the stages for unconventional oil and gas production. In general, the effects predicted fall into the neutral and uncertain category. Neutral effects have been predicted for Stages 1 (Non intrusive exploration) and 6 (Site restoration and relinquishment) as there would be no increased risk of flooding elsewhere due to activities to be carried out during these stages.

However for all other Stages (2, 3, 4, 5), should the exploration/production site become flooded, adverse effects could occur. As a result, there is the potential for a negative score to be assigned to these stages. However it is not possible to ascertain the probability of flooding occurring on these sites as their locations have not been chosen.

Accordingly, a combined neutral and uncertain score has been provided.

**Mitigation Summary:**

- The Environment Agency's Flood Maps and Flood Alerts should be consulted before carrying out site surveys in order to ascertain flood risk.
- Flood Risk Assessments should identify all the key types of flood risk for sites and ensure all appropriate mitigation measures are adopted.
- Surface water runoff should be managed by standard control methods such as drainage channels. These should be designed to slow down runoff.
- Soil re-profiling should take permeability into consideration so as to ensure surface water runoff rates are similar to baseline conditions.
- Hardstanding which is to remain in situ should be kept to a minimum.

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 5.8.2 Unconventional Oil and Gas

The assessment of the six main stages of unconventional oil and gas production is contained in **Table 5.13 and Table 5.14** under both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report).

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**Table 5.13 Assessment of Effects: Unconventional Oil and Gas (Objective 5)**

| **Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>Stage 1of the oil and gas exploration and production lifecycle would comprise of non-intrusive activities. Site identification, site selection and the securing of development and operation permits would be largely desk-based and in consequence, no effects on water quality or resources are anticipated.<br>Vibroseis is the most commonly used method of seismic survey and involves the employment of large vibrator unit vehicles as well as support vehicles for data recording. Construction of temporary tracks/roads may be required to facilitate site access. Temporary access roads may lead to a loss of permeability on site and increase surface water run-off. In general, the volume of surface runoff would be negligible. The runoff has the potential to pick up contaminants that may have been disposed of or spilt on access roads. Typical contaminants would likely include: oil; fuels; and lubricating fluids. As the exploration works would be short term, and not involve significant vehicle trips, the risk of spillages is very low.<br>In some cases, shot-hole survey techniques may be used. This involves the drilling of a hole with a small diameter for the insertion of explosives which are infilled after use. It is unlikely that shot-hole survey techniques would be carried out in close proximity to surface water bodies and therefore would not impact on water quality.<br>Overall, the risk posed to water quality (both surface and groundwater) are negligible. In addition, no activities at this stage would be expected to result in the consumption of water resources and therefore demand for water resources would be unchanged.<br>Consequently, a neutral effect is expected on the water objective at this stage.<br>**Low and High Activity Scenarios:**<br>Although it is reasonable to assume that more surveys would be carried out under the high activity scenario, the risks posed to water quality would still not be of a scale to result in any discernible adverse effects occurring. A neutral effect is therefore also expected under the high activity scenario.<br>**Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• It is assumed that shot-hole techniques would not take place in close proximity to waterbodies.<br>• It is assumed that shot-hole techniques would result in the deposition of contaminants or hazardous materials in the soil. |

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| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Uncertainties:**<br>• The depth of the drill required for shot-hole techniques is unknown. |
| 2 | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. | **-/--** | **-/--** | **Assessment of Effects:**<br><u>Surface water</u><br>Pad preparation would involve the removal of vegetation and general groundworks to a site of approximately 1 hectare. During this early construction work, there is a risk of runoff contaminated with hydraulic oil, nutrient phosphorous, nitrogen, fuels and lubricating oils entering water bodies, streams and groundwater.[43] These risks are generally shared with other large greenfield construction sites and the extent of the effect will depend on construction practices and rainfall events.<br>Off the pad, additional works would be required which may cause runoff. These works include access roads and utility corridors.<br>Surface water can be managed in a number of ways:<br>- Clean surface water run-off (for example from a road, pathway or clean hardstanding area) does not require a permit from the Environmental Agency to be discharged to a watercourse.<br>- However if surface water runoff does become contaminated an environmental permit is required to discharge the water. The Agency has indicated that permit will only be issued if it is not feasible to stop the contamination at source and the contamination will not pollute the receiving water.[44]<br>- If a permit is not issued, alternative options (such as onsite treatment or removal by tankers) would have to be considered.<br>- Finally, discharge to a public foul sewer does not need a permit.<br>It is likely that the pad site will be lined with an impermeable liner/layer once groundworks have been completed. Surface water run-off is therefore likely to be captured in drainage channels surrounding the site and would be managed according to the options set out above. Windblown dust may affect the turbidity of nearby surface water bodies.<br>Surface spills of fracturing fluid have been reported by some as posing a greater risk of contamination than the fracturing itself[45]. |
| | | | | |

[43] New York Department of Environment (2011) *Revised Draft Supplemental Generic Environmental Impact Statement On The Oil, Gas and Solution Mining Regulatory Program*, available from http://www.dec.ny.gov/data/dmn/rdsgeisfull0911.pdf [Accessed June 2013]

[44] Environment Agency (2013) Onshore oil and gas exploratory operations: technical guidance (Consultation Draft)

[45] Groat and Grimshaw (2012), Fact-based regulation for environmental protection in shale gas development, Energy Institute, University of Texas: Austin. Available from: http://cewc.colostate.edu/wp content/uploads/2012/02/ei_shale_gas_regulation120215.pdf (accessed on 08.09.2013)

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| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Other activities which could potentially result in surface water contamination include: wellbore leakage; accidental surface spills; and vehicle accidents. However, all fluids stored on site would be expected to be in double skinned bunded tanks, with spill management measures in place to ensure containment and capture.<br><u>Groundwater</u><br>The Secretary for Energy Advisory Board in the US noted that where there is a large depth separation between drinking water sources and the producing zone for shale gas production, the chances of contamination reaching drinking water is remote in a properly constructed well. [46]<br>During hydraulic fracturing, fracturing fluid is injected into the well. Evidence from the US suggests that up to 750 chemicals have been used between 2005 and 2009 in shale gas drilling throughout the United States.<br>Typically, fracturing fluid includes[47]:<br>-Water: about 98-99% of total volume<br>-Proppant: about 1-1.9% of total volume, usually sand or ceramic particles<br>-Friction reducer: about 0.025% of total volume, usually polyacrylamide<br>-Disinfectant: about 0.005% to 0.05%, usually glutaraldehyde, quaternary amine or tetrakis hydroxymethyl phosphonium sulphate<br>-Surfactants: 0.05-0.2%<br>-Gelation chemicals (thickeners): usually guar gum or cellulose polymers<br>-Scale inhibitors: phosphate esters or phosphonates<br>-Hydrochloric acid may be used in some cases to reduce fracture initiation pressure<br>-Corrosion inhibitor, used at 0.2% to 0.5% of acid volumes, and only used if acid is used.<br>Cuadrilla has released details on the composition of fracturing fluid[48]. Results from the Preese Hall-1 Well show that over 6 fracturing episodes, the following volumes of substances were used as fracturing fluid:<br>1) 8,399m$^3$ of fresh water sourced from United Utilities;<br>2) 462 metric tons of sand sourced from Sibelo UK;<br>3) 3.7m$^3$of friction reducer (polyacrylamide emulsion in hydrocarbon oil); and<br>4) 4,252 grams of chemical tracer (consisting of water and sodium salt). |

[46] Secretary of Energy Advisory Board (2011) Shale gas production sub-committee: 90 day report

[47] King (2012) 'Hydraulic Fracturing 101' Journal of Petroleum Technology, April 2012 p34-42

[48] Cuadrilla (2013) Composition of Components in Bowland Shale Fracturing Fluid for Preese Hall-1 Well

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| | | | | The Environment Agency has indicated that operators will not be able to use chemicals unless the Agency considers them acceptable for use. In addition, the Agency point out that allowing the use of a chemical at one site does not automatically mean it will be allowed to be used elsewhere as the environmental risks may be different, for example, due to local geological conditions.<br>Once the fluid has been pumped into the well at high pressures, it will cause fractures in the rock. The length of some fractures has been reported as high as 588 meters, although the majority of fractures are less than 100 meters[49].<br>It is assumed that 30-75% of the fracturing fluid will be returned to the surface as flowback fluid over a period of several days to two weeks.<br>The main risk of groundwater contamination is principally due to leakages of fracturing liquid as a result of inadequacies in well cementing or due to the movement of contaminants through existing faults or porous rocks to groundwater resources (although the latter has not been observed in practice). In addition, other substances (trace elements, NORM and organic material) may be contained in flowback water which, if not controlled, could cause contamination.<br>The causes of groundwater contamination associated with well design, drilling, casing and cementing generally relate to the quality of the well structure.[50] 'Well integrity' refers to preventing hydrocarbons from leaking out of the well by isolating it from other subsurface formations. The Royal Academy of Engineering[51] note that well failure may arise from poor well integrity resulting from:<br>-Blowout: a blowout is any sudden and uncontrolled escape of fluids from a well to the surface.<br>-Annular leak: poor cementation allows contaminants to move vertically through the well either between casings or between casings and rock formations.<br>-Radial leak: casing failure allow fluid to move horizontally out of the well and migrate into the surrounding rock formations.<br>The pollution of groundwater associated with unconventional oil and gas exploration and production has been reported by the US Environmental Protection Agency; [52] however, subsequent investigation has not confirmed contamination |

[49] Davies RJ, Mathias S, Moss J, Hustoft S and Newport L (2012), "Hydraulic fractures: How far can they Go?," Marine and Petroleum Geology in press.

[50] AEA (2012) Support to the identification of potential risks for the environment and human health arising from hydrocarbon operations involving hydraulic fracturing in Europe.

[51] Royal Academy of Engineering (2012) Shale Gas in the UK, A Review of Hydraulic Fracturing

[52] US EPA (2011c), "Investigation of Ground Contamination near Pavillion, Wyoming: DRAFT", available via http://www.epa.gov/ord

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| | | | | by fracture fluids. The migration of methane into aquifers has also been reported[53] due to unsatisfactory cementing of wells. Although methane can be present in shallow aquifers naturally, the introduction of methane into aquifers induced by oil/gas production would be likely to be considered a contamination event.<br>The Environment Agency have adopted the following Policy in their Groundwater Protection Principles and Practice document:<br>"We will object to [oil and conventional gas exploration and extraction] within SPZ1. Outside SPZ1, we will also object when the activity would have an unacceptable effect on groundwater.<br>Where development does proceed, we expect BAT to protect groundwater to be applied where any associated drilling or operation of the boreholes passes through a groundwater resource. Elsewhere, established good practice for pollution prevention should be followed".<br>The Agency should also be informed if any activity could involve the discharge of pollutants into groundwater. A permit application will be required to include:<br>-a conceptual model showing the hydrogeological relationship between the zone of interest and any overlapping or adjacent aquifers<br>-the method of well construction, including details of the casing and grouting<br>-information on how the integrity of the casing is to be tested<br>-information on where the well stimulation fluid is expected to travel<br>-details of the liquids to be injected, water use and disposal of effluents.<br>The Scottish Environment Protection Agency (SEPA) is the principal regulator of discharges to groundwater in Scotland. Exploration would be likely to require a permit from SEPA under The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) regime. For example, application for a CAR complex licence would be required to allow a deep borehole (>200m) to be constructed and condition any maintenance or monitoring required to ensure that the borehole does not result in contamination of groundwater. The application would need to be accompanied by a risk assessment and details of chemicals in drilling fluids.[54]<br>Talking all of this into consideration, it is reasonable to suggest that although exploratory drilling and the associated hydraulic fracturing has the potential to cause damage to water bodies, it is expected that the regulatory conditions in place will reduce these risks to very low levels. These processes should ensure that effects are restricted to abnormal events. However, in light of the risk of such events |

[53] Secretary of Energy Advisory Board (2011a), "Shale gas production sub-committee: 90 day report", Report to US Department of Energy, 18 August 2011, available via http://www.shalegas.energy.gov/
[54] SEPA (2012) *Regulatory Guidance: Coal bed methane and shale gas*. Available from http://www.sepa.org.uk/customer_information/energy_industry.aspx [Accessed September 2013]

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| | | | | occurring, coupled with the magnitude of damage they could cause, the potential for negative effects has been identified, although the likelihood remains exceptionally low.<br><u>Water Consumption</u><br>Hydraulic fracturing is a water intensive process. It has been assumed that between 10,000 and 25,000m$^3$ of water would be required per well.<br>The potential impacts of this water consumption will depend from where water is sourced. The AEA report (2012) notes some of the following effects[55]:<br>• Reduced stream flow affecting the availability of resources for downstream use, such as for public water supply.<br>• Adverse impacts on aquatic habitats and ecosystems from affects such as degradation of water quality, reduced water quantity, changes to water temperature, oxygenation and flow characteristics, including the effects of sediment and erosion under altered responses to stormwater runoff.<br>• Interplay with downstream dischargers, affecting their ability to discharge where limits are related to stream flow rate, or the overall concentration of pollutants where discharge rates remain unaffected.<br>• Impacts on water quality, affecting the use which can be made of surface waters<br>Water would typically be sourced from either a mains water supply or an abstraction from groundwater or surface water. Should water be supplied from a mains supply (either nearby to the site or tankered from a supply nearby), it will be the responsibility of the utility company to ensure that the extra demand fits in with the conditions of their water resource plans and abstraction licences. In considering any licensed abstraction application, the responsible statutory body will consider the effects on flows, the effects on other water users, the impacts on biota, and demands during low flow periods. Licenses will only be granted where such effects are acceptable to the regulator.<br>Private abstractions of more than 20m$^3$ will require an abstraction licence from the Environment Agency, SEPA or NRW. They will consider what the potential impacts on water levels, wetlands, river flows, the aquatic environment and other users would be.<br>Comparisons of water consumption between unconventional oil and gas production and other users have been made. Water consumption of 19,000m$^3$ has been described as the same amount of water needed: to water a golf course or a month; to run a 1GW coal fired power plant for 12 hrs; or the amount lost to leaks in United Utilities region every hour. [56] |

[55] AEA (2012) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe

[56] Moore (2012) Gas Works? Shale gas and its policy implications, The Policy Exchange, available from http://www.policyexchange.org.uk/images/publications/gas%20works%20-%20feb%2012.pdf (accessed on 08.09.2013)

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| | | | | Overall, the energy, water and waste sectors use approximately 48.5 million cubic metres of mains water annually.[57]<br>Several factors would need to be taken into consideration in order to determine the significance of the effect that the consumption of water would have on ensuring that water abstraction levels would be sustainable. These include:<br>-The timing of the consumption of the water (i.e. summer, winter, etc)<br>-The possibility of cumulative effects occurring either as a result of multi well pads or several pads in one area<br>-Existing water resources and the volume of water presently extracted by existing users in that area<br>-The volume of waste water than can be recycled and used as fresh injection fluid.<br>Overall, the total volume of water associated with hydraulic fracturing activities during this stage would be expected to be significant when compared to mains water use by the existing energy sector. However, the potential for consequential effects on water resource availability and biodiversity is more uncertain, although the risk of significant adverse effects is considered to be low given regulatory requirements and in particular the requirement for associated abstraction to be licensed. Further, Water UK, which represents the water industry, and UKOOG have also signed a Memorandum of Understanding (MoU) which ensures their respective members will cooperate throughout the shale gas exploration and extraction process in order minimise adverse effects on water resources and the environment. Under the MoU, members of UKOOG and Water UK will undertake timely consultation and discussion in order to identify and resolve risks around water or wastewater. Discussions will focus on:<br>• Baseline monitoring requirements to assess impacts of onshore oil and gas development on the quality and quantity of local water resources;<br>• Plans relating to site water management, especially water reuse, to improve understanding of local impacts;<br>• Onshore oil and gas company development plans, including scenarios for expansion of exploration and development within a local area and what this means for short and long-term demand for water at specific locations;<br>• The expected volumes and chemical and biological composition of wastewater as well as preferred disposal routes.<br>It is also noteworthy that the industry is not expected to be at substantial scale before the 2020s. This will allow time for any necessary new investment in water supply infrastructure. In consequence, Stage 2 has been assessed as having a minor negative effect on this objective, although it is recognised that there is the potential for effects to be |

[57] WRAP (2011) *Freshwater availability and use in the United Kingdom. A review of freshwater availability and non-household (consumptive) use in the UK*

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| | | | | significant, when considered against the existing energy sector mains water consumptions.<br>**Low and High Activity Scenarios:**<br>Under the high activity scenario, there would be up to 240 boreholes. Accordingly, the risk of water pollution would be more likely compared to the low activity scenario (under which there would be up to 20 boreholes).<br>Total water consumption under the high activity scenario would also be substantially greater (between 2,400,000 $m^3$ and 6,000,000 $m^3$ compared to between 200,000 $m^3$ and 500,000 $m^3$ under the low activity scenario). Demand for water could also be substantially reduced if it could be met from recycling and reuse of flowback water (the fractured fluid injected into the shale rock during hydraulic fracturing which returns to the surface through the drilled well). Notwithstanding, as noted above, the potential for consequential effects on water resource availability and biodiversity is uncertain, although the risk of significant adverse effects is considered to be low given regulatory requirements, and in particular the requirement for associated abstraction to be licensed, in addition to the expected cooperation between water companies and operators under the Water UK and UKOOG MoU.<br>**Mitigation:**<br>• A closed loop system should be used to contain drilling muds and reduce the risk of spillages.<br>• Fuel tanks should be bunded.<br>• Wastewater tanks should be stored in vessels which are designed to ensure their safe storage in light of the unique properties of this liquid (salinity, low-level radioactivity, etc).<br>• Water consumption should be considered in light of local climatic conditions so as to reduce the risk of abstractions occurring during low flow periods.<br>• Options to consider the treatment and re-use of flowback back should be considered as part of an overall Water Management Plan.<br>**Assumptions:**<br>• It has been assumed that between 10,000 and 25,000$m^3$ of water would be required per well.<br>• It is assumed that 50% of wells would access to water from the mains<br>• It is assumed that 30-75% of the fracturing fluid will be returned to the surface as flowback fluid over a period of several days to two weeks.<br>• It is assumed that operators will be compliant with the relevant regulations as detailed in guidance by the Environment Agency (EA)[58] and Scottish Environmental Protection Agency (SEPA).[59] |

[58] Environment Agency (2013) Guidance note: Regulation of exploratory shale gas operations. Available at: http://www.groundwateruk.org/downloads/EA_ShaleGasRegulation.pdf [Accessed October 2013]

[59] Scottish Environmental Protection Agency (2013) Regulatory guidance: Coal bed methane and shale gas. Available at

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| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Uncertainties:**<br>• Concern has been expressed regarding the potential effects of repeated pressure treatments (induced by hydraulic fracturing) on well construction components60. |
| 3 | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. | **-/--** | **-/--** | **Assessment of Effects:**<br>During production, the risk to groundwater and surface water bodies would be similar to those at Stage 2.<br>However, there would be considerably more drilling during production development and therefore it is plausible to suggest that the risk of inadequate well design or accidents occurring would be higher.<br>Water consumption at this stage would also be considerably higher. Between an estimated 10,000m$^3$ to 25,000m$^3$ of water would be required per well and as each pad would be expected to have between 6-12 (low activity scenario) or 12-24 (high activity scenario) wells per pad, there would be a potentially substantial cumulative effect on water resources. However, the potential for consequential effects on water resource availability and biodiversity is more uncertain, although the risk of significant adverse effects is considered to be low given regulatory requirements ,and in particular the requirement for associated abstraction to be licensed, in addition to the expected cooperation between water companies and operators under the Water UK and UKOOG MoU. There may also be opportunities during this stage to recycle flowback water for reinjection (following treatment) which would serve to reduce water consumption. Demand for water could also be substantially reduced if it could be met from recycling and reuse of flowback water (the fractured fluid injected into the shale rock during hydraulic fracturing which returns to the surface through the drilled well). Reported recycling rates in the US vary between 10% and 77%[61]. However, given the likely increase in activity under Stage 3, and the associated volumes of water required, this Stage has been assessed as having a minor negative/significant negative effect on this objective.<br>**Low and High Activity Scenarios:**<br>Under the high activity scenario, there would be up to 2,640 wells. Accordingly, the risk of water pollution would be more likely compared to the low activity scenario (under which there would be up to 340 wells). |

http://www.sepa.org.uk/customer_information/idoc.ashx?docid=c684b401-ad28-4d30-a4cb-1467f395c100&version=-1 [Accessed October 2013]

[60]US EPA (2011a) Office of Research and Development, "Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources," November 2011, available via http://www.epa.gov/hfstudy/

[61] AEA *et al* (2012) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe Report for European Commission DG Environment (pp 16) which noted studies identifying fresh water as comprising 80-90% of the water used as well as studies reporting up to 77% of wastewater generated from the Pennsylvania Marcellus Shale being recycled.

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| | | | | Total water consumption under the high activity scenario would also be substantially greater (between 26,400,000 $m^3$ and 66,000,000 $m^3$ assuming 2,640 wells) compared to the low activity scenario (between 3,400,000 $m^3$ and 8,500,000 $m^3$, assuming up to 340 wells). Notwithstanding, as noted above, the potential for consequential effects on water resource availability and biodiversity is uncertain, although the risk of significant adverse effects is considered to be low given regulatory requirements and in particular the requirement for associated abstraction to be licensed.<br>**Mitigation**:<br>• A closed loop system should be used to contain drilling muds and reduce the risk of spillages.<br>• Fuel tanks should be bunded.<br>• Wastewater tanks should be stored in vessels which are designed to ensure their safe storage in light of the unique properties of this liquid (salinity, low-level radioactivity, etc).<br>• Water consumption should be considered in light of local climatic conditions so as to reduce the risk of abstractions occurring during low flow periods.<br>• Options to consider the treatment and re-use of flowback back should be considered as part of an overall Water Management Plan.<br>**Assumptions:**<br>• It has been assumed that between 10,000 and 25,000$m^3$ of water would be required per well.<br>• It is assumed that 90% of wells would access to water from the mains.<br>• It is assumed that 30-75% of the fracturing fluid will be returned to the surface as flowback fluid over a period of several days to two weeks.<br>**Uncertainties:**<br>• Concern has been expressed regarding the potential effects of repeated pressure treatments (induced by hydraulic fracturing) on well construction components[62].<br>• The Environment Agency considers that the recycling of treated flowback by blending it with fresh water would be the preferred and sustainable option for water management[63]. It is not certain what % of the flowback water could be recycled. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions; | **-/--** | **-/--** | **Assessment of Effects:**<br>Once wells are operational, the primary issue with regards to water will be the collection and disposal of produced water. 'Produced Water' is any water that is "produced" to the surface from an oil or gas reservoir along with the oil or gas. This water may come from the following sources: |

[62] US EPA (2011a) Office of Research and Development, "Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources," November 2011, available via http://www.epa.gov/hfstudy/

[63] EA (2013) Onshore oil and gas exploratory operations: technical guidance. Available via http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT_7983_3b53c2.pdf [Accessed September 2013]

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| | • Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | | | (i) Connate water present in the reservoir prior to production<br>(ii) Condensed water which is condensed out of the produced gas in the production tubing<br>(iii) Injected water which has broken through from the injection wells to the producers.<br>The major substances found in produced water typically include: hydrocarbons, sands, dissolved salts and iron, metals and Naturally Occurring Radioactive Minerals. . However, the low permeability of shale means that it contains a very low water content and does not permit any flow and so produced water is not anticipated to arise from unconventional wells in the UK.<br>It has been assumed that each well would be re-fractured once during production to stimulate the flow of shale gas. As a result, an additional 10,000m$^3$ to 25,000m$^3$ of water would be required per well. In addition, the fracturing process would generate the likelihood of contamination associated with fracturing (identified and discussed in the assessment of Stage 3).<br>As a result of the water consumption and potential risks to water quality associated with hydraulic fracturing, a mixed score of minor negative/significantly negative is expected.<br>**Low and High Activity Scenario:**<br>Under the high activity scenario, there would be up to 2,880 wells. Accordingly, the risk of water pollution would be more likely compared to the low activity scenario (under which there would be up to 360 wells).<br>Total water consumption under the high activity scenario would also be substantially greater (between 28,800,000 m$^3$ and 72,000,000 m$^3$, assuming 2,880 wells) compared to the low activity scenario (between 3,600,000 m$^3$ and 9,000,000 m$^3$, assuming up to 360 wells). Demand for water could also be substantially reduced if it could be met from recycling and reuse of flowback water (the fractured fluid injected into the shale rock during hydraulic fracturing which returns to the surface through the drilled well). Notwithstanding, as noted above, the potential for consequential effects on water resource availability and biodiversity is uncertain, although the risk of significant adverse effects is considered to be low given regulatory requirements, and in particular the requirement for associated abstraction to be licensed, in addition to the expected cooperation between water companies and operators under the Water UK and UKOOG MoU. There may also be opportunities during this stage to recycle flowback water for reinjection (following treatment) which would serve to reduce water consumption.<br>**Mitigation**:<br>• A closed loop system should be used to contain drilling muds and reduce the risk of spillages.<br>• Fuel tanks should be bunded.<br>• Wastewater tanks should be stored in vessels which are designed to ensure their safe storage in light of the unique properties of this liquid (salinity, low-level radioactivity, etc). |

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| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Water consumption should be considered in light of local climatic conditions so as to reduce the risk of abstractions occurring during low flow periods.<br>• Options to consider the treatment and re-use of flowback back should be considered as part of an overall Water Management Plan.<br>**Assumptions:**<br>• It has been assumed that between10,000m$^3$ and 25,000 m$^3$ of water would be required per well.<br>• It is assumed that 90% of wells would access to water from the mains.<br>• It is assumed that 30-75% of the fracturing fluid will be returned to the surface as flowback fluid.<br>**Uncertainties:**<br>• Concern has been expressed regarding the potential effects of repeated pressure treatments (induced by hydraulic fracturing) on well construction components[64].<br>• The Environment Agency considers that the recycling of treated flowback by blending it with fresh water would be the preferred and sustainable option for water management[65]. It is not certain what % of the flowback water could be recycled. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>The inadequate sealing of wells could result in subsurface pathways for contaminant migration leading to groundwater pollution and potentially surface water pollution (AEA). However as well decommissioning requires regulatory approval from DECC, it would be anticipated that all steps would be taken to ensure permanent isolation of subsurface formations and groundwater.<br>The construction activities at this stage may require water (i.e. for cement etc) but this would not be of a scale to result in any effects on local water demand and availability.<br>**Low and High Activity Scenario:**<br>Although more wells will have to be capped and sealed under the high activity scenario, the risks of groundwater and surface water pollution are low and therefore neutral effects would be expected under both scenarios.<br>**Mitigation**:<br>• Liquid tanks should be kept in areas which benefit from bunding.<br>**Assumptions:**<br>• It is presumed that wells would be decommissioned in line with current regulation and best practices. |

[64]US EPA (2011a) Office of Research and Development, "Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources," November 2011, available via http://www.epa.gov/hfstudy/

[65] EA (2013) Onshore oil and gas exploratory operations: technical guidance. Available via http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT_7983_3b53c2.pdf [Accessed September 2013]

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| Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • It is assumed that no spillages or leakages of pollutants would occur during the removal of site equipment.<br>**Uncertainties:**<br>• None identified. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>Site restoration activities pose a low risk to water quality. The generation of dust may however increase the turbidity of nearby surface water bodies.<br>**Low and High Activity Scenario:**<br>Although more wells will have to be capped and sealed under the high activity scenario, the risks of groundwater and surface water pollution are low and therefore neutral effects would be expected under both scenarios.<br>**Mitigation:**<br>• Plant and vehicles involved in this work should be checked regularly to ensure they are in good condition and not leaking fuels.<br>• If any contaminants are identified, they should be handled appropriately to ensure they are not spilt or liable to reach ground/surface waters<br>• Soil re-profiling should take permeability into consideration so as to ensure surface water runoff rates are similar to baseline conditions.<br>• Hardstanding which is to remain in situ should be kept to a minimum.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties**:<br>• None identified. |

***Summary***

The assessment has identified that there is potential for some of negative effects to be significant. Stage 2 (exploration drilling), Stage 3 (production development) and Stage 4 (production) would require substantial volumes of water. This principally reflects water consumption associated with hydraulic fracturing (it has been assumed that between 10,000m$^3$ and 25,000m$^3$ of water would be required per well).

The assessment has identified that under the high activity scenario, total water consumption across Stages 2, 3 and 4 could be between 57,600,000 m$^3$ and 144,000,000 m$^3$ (assuming that a total of 240 boreholes during Stage 2, 2640 wells during Stage 3 and 2,880 wells during Stage 4 would require hydraulic fracturing) compared to between 7,000,000 m$^3$ and 18,000,000 m$^3$ under the low activity scenario (assuming a total of 20 boreholes and 360 wells). Under the high activity scenario annual water consumption could be up to 9,000,000 m$^3$ (assuming the exploration and production of 360 wells at peak and water use per well of 25,000 m$^3$), an increase of nearly 18.5% on the approximate 48.5 million cubic metres of mains water supplied to the energy, water and waste sectors annually. This level of water consumption has been assessed significant at the sector level. However, the potential impacts this could have on, for example, water resource availability, aquatic habitats and ecosystems and water quality is more uncertain. It is recognised that there is the potential for negative effects to be significant depending on:

- the timing of the consumption of the water (i.e. summer, winter, etc);
- the possibility of cumulative effects occurring either as a result of multi well pads or several pads in one area;
- the availability of existing water resources and the volume of water presently extracted by existing users in that area;
- the volume of waste water than can be recycled and used as fresh injection fluid.

Notwithstanding, water would typically be sourced from either a mains water supply or an abstraction from groundwater or surface water and would require an abstraction license that would only be granted where effects are acceptable to the regulator. In consequence, the risk of significant adverse effects is considered to be low. In addition, it is also that cooperation between water companies and operators under the

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| **Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| Water UK and UKOOG MoU will help to address any potentially locally significant issues. Demand for water could also be substantially reduced if it could be met from recycling and reuse of flowback water. Reported recycling rates in the US vary between 10% and 77% which if applied to the high activity scenario, could lower demand for water to between 13.2 million and 33.1 million cubic metres during stages 2, 3 and 4.<br>There is a risk of hydraulic fracturing causing groundwater contamination, principally due to leakages of fracturing liquid as a result of inadequacies in well cementing or due to the movement of contaminants through existing faults or porous rocks to groundwater resources (although the latter has not been observed in practice and would be unlikely). In addition, other substances (trace elements, NORM and organic material) may be contained in flowback water which, if not controlled, could cause contamination. However, while the possibilities of contamination exist, taking into account the requirements for discharge consents/permits and Environment Agency/SEPA policy in respect of groundwater protection, it is considered reasonable to conclude that these risks will be reduced to very low levels.<br>With regard to surface water, construction activities during Stage 2 and Stage 3 could result in the run off of contaminants although it would be expected that appropriate surface water management would be put in place to reduce the likelihood of contamination occurring.<br>Stage 5 (decommissioning) and Stage 6 (site restoration) have been assessed as having a neutral effect on this objective. This reflects the low risk posed to water quality during these stages and relatively small volumes of water required to support associated works.<br>**Mitigation Summary:**<br>• A Water Management Plan should be developed for all stages of well development.<br>• A closed loop system should be used to contain drilling muds and reduce the risk of spillages.<br>• Fuel tanks should be bunded.<br>• Wastewater tanks should be stored in vessels which are designed to ensure their safe storage in light of the unique properties of this liquid (salinity, low-level radioactivity, etc).<br>• Water consumption should be considered in light of local climatic conditions so as to reduce the risk of abstractions occurring during low flow periods.<br>• Options to consider the treatment and re-use of flowback back should be considered as part of an overall Water Management Plan.<br>• Plant and vehicles should be checked regularly to ensure they are in good condition and not leaking fuels.<br>• If any contaminants are identified, they should be handled appropriately to ensure they are not spilt or liable to reach ground/surface waters.<br>• Soil re-profiling should take permeability into consideration so as to ensure surface water runoff rates are similar to baseline conditions.<br>• Hardstanding which is to remain in situ should be kept to a minimum. | | | | |

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

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**Table 5.14 Assessment of Effects: Unconventional Oil and Gas (Objective 6)**

| **Objective 6: To minimise the risks of coastal change and flooding to people, property and communities** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>Stage 1of the oil and gas exploration and production lifecycle would comprise of non-intrusive activities. Site identification, site selection and the securing of development and operation permits would be largely desk-based and in consequence, no effects on water quality or resources are anticipated.<br>Vibroseis is the most commonly used method of seismic survey and involves the employment of large vibrator unit vehicles as well as support vehicles for data recording. Construction of temporary tracks/roads may be required to facilitate site access. Temporary access roads may lead to a loss of permeability on site and increase surface water run-off. In general, the volume of surface runoff would be negligible and would not be likely to increase the risk of flooding elsewhere.<br>Surveys may be at risk from flooding. However as they would be short term in duration and not involve the installation of immovable equipment, the risk that such flooding would entail would be negligible.<br>**Low and High Activity Scenarios:**<br>Although it is reasonable to assume that more surveys would be carried out under the high activity scenario, the risks posed to water quality would still not be of a scale to result in any discernible adverse effects occurring. A neutral effect is therefore also expected under the high activity scenario.<br>**Mitigation:**<br>• The Environment Agency's Flood Maps and Flood Alerts should be consulted before carrying out site surveys.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• None identified. |
| 2 | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. | **?** | **?** | **Assessment of Effects:**<br>Pad preparation would involve the removal of vegetation and general groundworks to a site of approximately 1 hectare. The preparation of the pad site would also likely involve the laying of an impermeable surface to reduce the risk of contaminants leaking into soil/groundwater. This surface would change the natural drainage patterns of the site. This could result in the increase of flooding off site as runoff rates may be faster and the natural water storage the site provides would be lost. However these effects would be easily mitigated against.<br>As the exact location of particular drilling sites is uncertain, it is not possible to ascertain whether pad sites would be at risk from flooding. However should sites be developed that are in Flood Zones, the following potential risks may arise: |

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| Objective 6: To minimise the risks of coastal change and flooding to people, property and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | -The well may become inundated with flood water and disrupt drilling or cause damage to the casing;<br>-Plant and equipment may be damaged;<br>-Storage tanks may become damaged or suffer a loss of power and may release contaminants into the flood water;<br>-Hydrocarbons may be released and cause pollution or lead to explosions or fires.<br>As a result, it is likely that flood risk will be given due consideration at the consent stage (probably by the Town and Country Planning regime) in order to reduce the likelihood of adverse effects occurring.<br>As it is currently unknown whether there would be risk of flooding on the pad site, effects associated with this stage have been assessed as uncertain.<br>**Low and High Activity Scenario:**<br>As flood risk would be considered on a site by site basis in line with the particular risk to each site, effects under the low and high activity scenarios would be consistent.<br>**Mitigation:**<br>• Flood Risk Assessments should identify all the key types of flood risk for drilling sites and ensure all appropriate mitigation measures are adopted.<br>• Surface water runoff should be managed by standard control methods such as drainage channels. These should be designed to slow down runoff.<br>**Assumptions:**<br>• It is assumed that the water abstracted for fracturing fluid would not reduce the risk of flooding elsewhere as the causal link between the two aspects is generally weak.<br>• It is assumed that all fracturing fluid would be injected into the shale rock formation and would not be split during injection or discharged from the site prior to usage.<br>**Uncertainties:**<br>• As outlined above, the flood risk cannot be ascertained on a site-specific basis as the drilling sites are unknown. |
| 3 | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion; | **?** | **?** | **Assessment of Effects:**<br>The determination of the risk of flooding occurring on the pad site is the same at this stage as set out in Stage 2.<br>With regard to increasing flood risk off the site, it is assumed that production sites would be 2-3ha in size at this stage, compared with 1 ha at Stage 2.<br>This is not expected to result in an increase of flood risk off the site as it is likely mitigation measures (drainage channels, etc) would be scaled up to met the requirements of the larger site. |

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| Objective 6: To minimise the risks of coastal change and flooding to people, property and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. | | | Overall, an uncertain effect is predicted.<br>**Low and High Activity Scenario:**<br>As flood risk would be considered on a site by site basis in line with the particular risk to each site, effects under the low and high activity scenarios would be consistent.<br>**Mitigation:**<br>• Flood Risk Assessments should identify all the key types of flood risk for drilling sites and ensure all appropriate mitigation measures are adopted.<br>• Surface water runoff should be managed by standard control methods such as drainage channels. These should be designed to slow down runoff.<br>**Assumptions:**<br>• It is assumed that the water abstracted for fracturing fluid would not reduce the risk of flooding elsewhere as the causal link between the two aspects is generally weak.<br>• It is assumed that all fracturing fluid would be injected into the shale rock formation and would not be split during injection or discharged from the site prior to usage.<br>**Uncertainties:**<br>• As outlined above, the flood risk cannot be ascertained on a site-specific basis as the drilling sites are unknown. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | **?** | **?** | **Assessment of Effects:**<br>Surface water runoff and flood risk aspects would be the same as those identified at Stage 3.<br>**Low and High Activity Scenario:**<br>As flood risk would be considered on a site by site basis in line with the particular risk to each site, effects under the low and high activity scenarios would be consistent.<br>**Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• It is assumed that the water abstracted for fracturing fluid would not reduce the risk of flooding elsewhere as the causal link between the two aspects is generally weak.<br>• It is assumed that all fracturing fluid would be injected into the shale rock formation and would not be split during injection or discharged from the site prior to usage.<br>**Uncertainties:**<br>• As outlined above, the flood risk cannot be ascertained on a site-specific basis as the drilling sites are unknown. |

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| Objective 6: To minimise the risks of coastal change and flooding to people, property and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **?** | **?** | **Assessment of Effects:**<br>During the decommissioning of the wells and the pad site, there would be no change in the risk of increased surface water runoff than expected for Stages 2 to 4.<br>The site would still however be at risk from flooding and this flooding would be likely to have adverse effects. However as the site locations are not determined, it is not possible to ascertain the flood risk for each production site.<br>As a result, a score of uncertain has been given.<br>**Low and High Activity Scenario:**<br>As flood risk would be considered on a site by site basis in line with the particular risk to each site, effects under the low and high activity scenarios would be consistent.<br>**Mitigation**:<br>• None identified.<br>**Assumptions:**<br>• It is presumed that wells would be decommissioned in line with current regulation and best practices.<br>• It is assumed that no spillages or leakages of pollutants would occur during the removal of site equipment.<br>**Uncertainties:**<br>• As outlined above, the flood risk cannot be ascertained on a site-specific basis as the drilling sites are unknown. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>Site restoration activities would involve construction works of short term duration. These works would not be expected to increase the risk of surface water runoff.<br>Although the site may be at risk from flooding, the adverse effects of such flooding would be lower than under other stages as the equipment will have been removed and the wells plugged. Therefore a neutral effect is expected on the flood risk objective during this stage.<br>**Low and High Activity Scenario:**<br>As flood risk would be considered on a site by site basis in line with the particular risk to each site, effects under the low and high activity scenarios would be consistent.<br>**Mitigation:**<br>• Soil re-profiling should take permeability into consideration so as to ensure surface water runoff rates are similar to baseline conditions.<br>• Hardstanding which is to remain in situ should be kept to a minimum<br>**Assumptions:**<br>• It is assumed that the site would be restored to a degree whereby baseline drainage and runoff levels are restored.<br>• It is assumed that any installations which are to be left on site long term would not pose issues should the site be flooded in the future. |

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| Objective 6: To minimise the risks of coastal change and flooding to people, property and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Uncertainties**:<br>• None identified. |

***Summary***

No positive effects are expected on the flood risk objective at any of the stages for unconventional oil and gas production. In general, the effects predicted fall into the neutral and uncertain category. Neutral effects have been predicted for Stages 1 (Non intrusive exploration) and 6 (Site restoration and relinquishment) as there would be no increased risk of flooding elsewhere due to activities to be carried out during these stages. In addition, should the production sites be subject to flooding, the adverse effects of such flooding would be negligible.

However for all other Stages (2, 3, 4, 5), should the exploration/production site become flooded, adverse effects would be likely to occur. As a result, there is the potential for a negative score to be assigned to these stages. However it is not possible to ascertain the probability of flooding occurring on these sites as their locations have not been chosen. Accordingly, an uncertain score has been provided.

**Mitigation Summary**

- The Environment Agency's Flood Maps and Flood Alerts should be consulted before carrying out site surveys in order to ascertain flood risk.
- Flood Risk Assessments should identify all the key types of flood risk for sites and ensure all appropriate mitigation measures are adopted.
- Surface water runoff should be managed by standard control methods such as drainage channels. These should be designed to slow down runoff.
- Soil re-profiling should take permeability into consideration so as to ensure surface water runoff rates are similar to baseline conditions.
- Hardstanding which is to remain in situ should be kept to a minimum.

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 5.9 Virgin Coalbed Methane

The effects of exploration and production activities associated with virgin coalbed methane (VCBM) are similar to those described in the assessment of effects of unconventional oil and gas (Stages 1-6) in **Table 5.13** and **Table 5.14** above although fracturing is not normally required. No attempt has been made to provide an indication of low and high levels of activity.

As in most cases hydraulic fracturing is unlikely to be required to stimulate the production of gas, it can be reasonably assumed that the volume of water that is required during Stages 2-4 would be reduced relative to unconventional oil and gas exploration and production. However, during well stimulation large volumes of water may be produced as a result of de-watering of the coal seam which may continue throughout the productive life of the well. Produced water may be saline and/or contain high

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concentrations of metals and other contaminants that might require treatment prior to discharge[66]. At Airth field, for example, the produced formation water was put into road tankers and disposed of in the nearby Firth of Forth. Total dissolved solids is about 20000 mg/l at Airth, and iron has to be removed prior to disposal. Drinking water should be less than 500 TDS [67]. However, taking into account the requirements for discharge consents/permits to be obtained from regulators (the EA, SEPA or Natural Resources Wales) prior to works commencing, it is considered reasonable to assume that any potential adverse effects would be appropriately managed.

There is a risk of surface or ground water contamination as a result of, for example, drilling or the accidental spillage of produced water. However, it is assumed that appropriate on-site management measures would be put in place to minimise such risk.

## 5.10 Gas Storage

The development of gas storage capacity is likely to entail the following activities:

1. Construction and Installation of Pipelines and Storage Facilities;
2. Storage operations; and
3. Decommissioning.

The likely effects of these activities are appraised in **Table 5.15**.

**Table 5.15 Assessment of Effects: Gas Storage (Objective 5)**

| **Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive** | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| 1 | **Construction and Installation of Pipelines and Storage Facilities** | **0** | **Assessment of Effects:**<br>The re-development of the storage facility would require construction works which have the potential to have adverse effects on surface water bodies. These would be generally limited in scale and would be short-term in duration. A neutral effect is therefore predicted. |

[66] Communities and Local Government (2011) *Mineral Planning Factsheet: Alternative Fossil Fuels*. Available from www.bgs.ac.uk/downloads/start.cfm?id=2085 [Accessed September 2013]

[67] DECC (2010) *The Unconventional Hydrocarbon Resources of Britain's Onshore Basins - Coalbed Methane*. Available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66171/promote-uk-cbm.pdf [Accessed September 2013]

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| Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| | | | **Mitigation:**<br>• Standard best practices should be adopted during the construction stage to reduce the risk of pollutants and silt entering into waterbodies.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• None identified. |
| 2 | **Storage Operations** | **0** | **Assessment of Effects:**<br>The primary risk to water quality during this stage would be related to the transportation and injection of the hydrocarbons. It is assumed that transport vehicles would not leak fuels, oils other contaminants which would be likely to reduce the quality or waterbodies.<br>A neutral effect is therefore predicted.<br>**Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• It is assumed that if liquids or fluids need to be stored on site they would be contained in safe and secure vessels that benefit from bunding.<br>**Uncertainties:**<br>• None identified. |
| 3 | **Decommissioning** | **0** | **Assessment of Effects:**<br>The removal and decommissioning of the installation/facility would have the potential to result in the release of contaminants from vehicles and equipment. However at the risk of such event occurring is low, and the magnitude of the effect is not considered high, a neutral effect has been given.<br>**Mitigation:**<br>• Vehicles should be checked for signs of damage or leaks on a regular basis.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• None identified. |

***Summary***

No positive or negative effects are expected on the water objective. Although there is a risk of water contamination occurring during all stages of Gas Storage, since the magnitude and probability of this effect would be low, a neutral effect has been predicted.

**Mitigation Summary:**

- Standard best practices should be adopted during the construction stage to reduce the risk of pollutants and silt entering into waterbodies;

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| Objective 5: To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Stage*** | ***Description*** | | | | ***Score*** | | | | ***Commentary*** | |
| • Fluids or liquids that require storage should be stored in safe and secure vessels;<br>• Vehicles should be checked for signs of damage or leaks on a regular basis | | | | | | | | | | |
| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
| *NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where the scores are both positive and negative, the boxes are deliberately not coloured. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.* | | | | | | | | | | |
| *S – short term (less than 6 years), M – medium term (between 7 and 12 years) and L – long term (> 12 years)* | | | | | | | | | | |

**Table 5.16 Assessment of Effects: Gas Storage (Objective 6)**

| Objective 6: To minimise the risks of coastal change and flooding to people, property and communities | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| 1 | **Construction and Installation of Pipelines and Storage Facilities** | **?** | **Assessment of Effects:**<br>The re-development of the storage facility would require construction works. It is not likely that considerable amounts of additional hardstanding would be required and the construction of the facilities is therefore not likely to increase the risk of flooding elsewhere.<br>During construction, the site may be at risk from flooding and should flooding occur, damage would be caused to plant, machinery and the facility. As the precise location of the Gas Storage facilities is unknown, an uncertain effect is predicted.<br>**Mitigation:**<br>• A Flood Risk Assessment should be carried out to determine the precise risk of flooding for the Gas Storage facility site.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• The development sites are unknown. |
| 2 | **Storage Operations** | **?** | **Assessment of Effects:**<br>During the operational stage, the facility may be at risk from flooding and as in the Stage 1, an uncertain effect is predicted.<br>**Mitigation:**<br>• None identified. |

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| Objective 6: To minimise the risks of coastal change and flooding to people, property and communities | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| | | | **Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• The development sites are unknown. |
| 3 | **Decommissioning** | **0** | **Assessment of Effects:**<br>During the decommissioning of the facility, the risk would be at risk from flooding. However as these works would be short term in duration, the risk would be negligible. Once the site is decommissioned, it is expected that the site would be restored t and that it would not be a vulnerable development with regards to flood risk<br>A neutral effect is therefore expected on the flood risk objective.<br>**Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• None identified. |

***Summary***

No positive or negative effects are expected on the water objective. As flooding would have an adverse effect during the construction and operation of the facility, negative effects have the possibility of occurring. However as it cannot be ascertained at this stage, whether the facilities would be located in areas at risk from flooding, an uncertain effect has been predicted.

During decommissioning, the vulnerable components of the facility would be dismantled/removed and therefore the risks of flooding have adverse effects would be considerably lower. A neutral effect is therefore expected.

**Mitigation Summary:**

- A Flood Risk Assessment should be carried out to determine the precise risk of flooding for the Gas Storage facility site and identify appropriate site-specific mitigation measures.

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where the scores are both positive and negative, the boxes are deliberately not coloured. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (less than 6 years), M – medium term (between 7 and 12 years) and L – long term (> 12 years)*

## 5.11 SEA Areas

The following sections consider in-turn the potential effects of Licensing Plan activities on water and flood risk in the five SEA Areas. The assessment draws on the findings presented in Tables 5.11-5.16 above and takes account of the environmental characteristics of the areas as detailed in **Section 5.4**.

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### 5.11.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

#### Conventional Oil and Gas

Scottish Water reported in 2010[68] that as a result of significant investment, only 65,000 of its customers in 33 water resource zones (WRZs) would be in supply demand balance deficit. In addition, nearly all WRZs in SEA Area 1 (save for some WRZs to the west of Glasgow) would be in surplus. Water consumption associated with conventional oil and gas operations is unlikely to be substantial and therefore significant demands on water resources in SEA Area 1 are not expected.

Water quality in SEA Area 1 has been adversely affected historically by industrial activities and mining operations although significant improvements have been made in recent years. As the potential for adverse effects on water quality associated with the conventional oil and gas exploration and production lifecycle is considered unlikely (due to the anticipated implementation of appropriate mitigation on sites and the requirements for consents under the regulatory regime), no major decreases in water quality are expected in SEA Area 1. However, abnormal events may result in the local deterioration of water quality.

#### Unconventional Oil and Gas

Unconventional oil and gas exploration and production would place increased demand on water resources in some areas. Although Scottish Water predict that most WRZs in SEA Area 1 will not be in deficit by 2014, the cumulative effect of several pads (each supporting up to 24 wells consuming between 10,000m$^3$ and 25,000m$^3$ per well) in certain WRZs could push some zones into a supply deficit. If, for instance, four pads were drilled for production in SEA Area 1, and each had 24 wells (as per the high activity scenario), up to 2.4 million m$^3$ (2,400 Ml) of water would be required. Average daily demand in the Central Scotland Megazone (which is of comparable size to SEA Area 1) is 1,254Ml although it is likely that the development of pads and hydraulic fracturing would be phased (hydraulic fracturing could occur over a two year period, assuming that a well is drilled every four weeks) and in consequence associated daily water requirements would constitute a small proportion of the total volume of water required. Further, if the water were abstracted from a surface or groundwater source, it would require an abstraction licence from the Scottish Environment Protection Agency (SEPA), which would only be granted if abstraction was considered to be sustainable.

The potential for adverse effects on water quality associated with the unconventional oil and gas exploration and production lifecycle is considered unlikely (due to the anticipated implementation of appropriate mitigation on sites and the requirements for consents under the regulatory regime). In consequence, no major decreases in water quality are expected in SEA Area 1. However, abnormal events may result in the local deterioration of water quality.

[68] Scottish Water (2010) *Water Resource Plan 2009*. Available from http://www.scottishwater.co.uk/assets/about%20us/files/key%20publications/adoptedwrp09summarydoc.pdf [Accessed September 2013]

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### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 1 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production although in view of the reduced water requirement associated with the extraction of this resource, the potential magnitude of effects may be reduced.

### Gas Storage

Reflecting the findings of the assessment of the gas storage lifecycle (see **Table 5.16**), no adverse effects in respect of water resource use or quality in SEA Area 1 are anticipated.

## 5.11.2 SEA Area 2: West Midlands, North West England and Southern Scotland

### Conventional Oil and Gas

United Utilities' Draft Water Resources Management Plan 2013[69] identifies that the West Cumbria WRZ is forecast to be in deficit by 2020/2021, principally due to the requirement for sustainability reductions. As highlighted in **Section 5.6.5**, most parts of the West Midlands suffer moderate levels of water stress. Severn Trent Water's Draft Water Resources Management Plan 2013[70] sets out that without new investment, the Strategic Grid and Nottinghamshire WRZs face some significant supply shortfalls in the long term as a result of the need to reduce abstraction from unsustainable sources and the potential impacts of climate change. However, both United Utilities and Severn Trent Water have proposed measures to address these deficits and given that water consumption associated with conventional oil and gas operations is unlikely to be substantial, it is not expected to be significant effects on water resources SEA Area 2.

A total of 2,468km (41%) of river length is/probably at risk from point and diffuse pollution in the North West River Basin District (see **Table 5.3**). Notwithstanding, as the potential for adverse effects on water quality associated with the conventional oil and gas exploration and production lifecycle is considered unlikely (due to the anticipated implementation of appropriate mitigation on sites and the requirements for consents under the regulatory regime), no major decreases in water quality are expected in SEA Area 2. However, abnormal events may result in the local deterioration of water quality.

[69] Available from http://corporate.unitedutilities.com/documents/Draft_Water_Resources_Management_Plan_2013_Final_Plan.pdf [Accessed September 2013]

[70] Available from http://www.severntrent.com/future/plans-and-strategy/water-resources-management-plan [Accessed September 2013]

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### Unconventional Oil and Gas

Unconventional oil and gas exploration and production would place a potentially significant demand on water resources in some areas within SEA Area 2. The cumulative effects of several pads (each supporting up to 24 wells consuming between 10,000m$^3$ and 25,000m$^3$ per well) could be particularly significant in those WRZ that are forecast to be supply-demand deficit. If, for instance, four pads were drilled for production in the West Cumbria WRZ, and each had 24 wells (as per the high activity scenario), up to 2.4 million m$^3$ (2,400 Ml) of water would be required. Average daily demand in the West Cumbria Zone is 51.7Ml although it is likely that the development of pads and hydraulic fracturing would be phased (hydraulic fracturing could occur over a two year period, assuming that a well is drilled every four weeks) and in consequence associated daily water requirements would constitute a small proportion of the total volume of water required. Further, if the water were abstracted from a surface or groundwater source, it would require an abstraction licence from the Environment Agency, which would only be granted if abstraction was considered to be sustainable.

The potential for adverse effects on water quality associated with the unconventional oil and gas exploration and production lifecycle is considered unlikely (due to the anticipated implementation of appropriate mitigation on sites and the requirements for consents under the regulatory regime). In consequence, no major decreases in water quality are expected in SEA Area 2. However, abnormal events may result in the local deterioration of water quality.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 2 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production although in view of the reduced water requirement associated with the extraction of this resource, the potential magnitude of effects may be reduced.

### Gas Storage

Reflecting the findings of the assessment of the gas storage lifecycle (see **Table 5.16**), no adverse effects in respect of water resource use or quality in SEA Area 2 are anticipated.

## 5.11.3 SEA Area 3: East Midlands and Eastern England

### Conventional Oil and Gas

Eastern England includes some of the driest parts of the UK and is expected to accommodate significant growth. This places particular constraints on water resource availability in SEA Area 3. In the Anglian River Basin District, for example, 21% of river length, 18% of lakes and 87% of groundwaters are/ probably are at risk of abstraction and flow regulation (see **Table 5.4**). There are a number of WRZs in SEA Area 3 that are forecast to be in deficit. These include the Grid Surface Water Zone (SWZ) in the Yorkshire Water supply area and Fenland WRZ in the Anglian Water supply area (there are no forecast

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deficits in the Northumbrian Water supply area)[71]. However, given that water consumption associated with conventional oil and gas operations is unlikely to be substantial, effects on water resources in SEA Area 3 are not expected to be significant.

As highlighted in **Section 5.6.5,** groundwater protection is an important issue in the East of England as a significant proportion of public water supply in this region comes from groundwater resources. Changes to rainfall patterns may affect the re-charge of resources or cause pollution of groundwater sources to increase. Notwithstanding, the potential for adverse effects on water quality associated with the conventional oil and gas exploration and production lifecycle is considered unlikely (due to the anticipated implementation of appropriate mitigation on sites and the requirements for consents under the regulatory regime) and therefore no major decreases in water quality are expected in SEA Area 3. However, abnormal events may result in the local deterioration of water quality.

## Unconventional Oil and Gas

Taking into account existing water resource issues in some parts of SEA Area 3, there is the potential for unconventional oil and gas exploration and production to have a significant effect on water resource availability. The cumulative effects of several pads (each supporting up to 24 wells consuming between 10,000m$^3$ and 25,000m$^3$ per well) could be particularly significant in those WRZs that are forecast to be deficit. If, for instance, four pads were drilled for production in the Anglian Water supply area, and each had 24 wells (as per the high activity scenario), up to 2.4 million m$^3$ (2,400 Ml) of water would be required. Average daily demand in the Anglian Water supply area is 1,209Ml/d although it is likely that the development of pads and hydraulic fracturing would be phased (hydraulic fracturing could occur over a two year period, assuming that a well is drilled every four weeks) and in consequence associated daily water requirements would constitute a small proportion of the total volume of water required. Average daily demand in the West Cumbria Zone is 51.7Ml although it is likely that the development of pads and hydraulic fracturing would be phased (hydraulic fracturing could occur over a two year period, assuming that a well is drilled every four weeks) and in consequence associated daily water requirements would constitute a small proportion of the total volume of water required. Further, if the water were abstracted from a surface or groundwater source, it would require an abstraction licence from the Environment Agency, which would only be granted if abstraction was considered to be sustainable.

The potential for adverse effects on water quality associated with the unconventional oil and gas exploration and production lifecycle is considered unlikely (due to the anticipated implementation of appropriate mitigation on sites and the requirements for consents under the regulatory regime). In consequence, no major decreases in water quality are expected in SEA Area 3. However, abnormal events may result in the local deterioration of water quality.

[71] See: Yorkshire Water (2013) *Draft Water Resources Management Plan*, available from http://www.yorkshirewater.com/our-environment/water-resources/managing-water-resources.aspx [Accessed September 2013]; Anglian Water (2013) D*raft 2015 Water Resources Management Plan*, available from http://www.anglianwater.co.uk/_assets/media/DraftWRMP_Jun13.pdf [Accessed September 2013]; Northumbrian Water (2013) *Draft Water Resources Management Plan*, available from http://www.nwl.co.uk/_assets/documents/Draft_NW_PR14_WRMP_Report_Final_for_Web.pdf [Accessed September 2013];

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### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 3 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production although in view of the reduced water requirement associated with the extraction of this resource, the potential magnitude of effects may be reduced.

### Gas Storage

Reflecting the findings of the assessment of the gas storage lifecycle (see **Table 5.16**), no adverse effects in respect of water resource use or quality in SEA Area 3 are anticipated.

## 5.11.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

### Conventional Oil and Gas

Dee Valley Water does not forecast any of its WRZs to be in deficit to 2039-40[72]. Welsh Water, meanwhile, forecasts there to be six of 24 WRZs that may be in deficit by 2040, although these WRZs do not fall within SEA Area 4. Given that water consumption associated with conventional oil and gas operations is unlikely to be substantial, in consequence there is not expected to be significant effects on water resources SEA Area 4.

The potential for adverse effects on water quality associated with the conventional oil and gas exploration and production lifecycle is considered unlikely (due to the anticipated implementation of appropriate mitigation on sites and the requirements for consents under the regulatory regime). In consequence, no major decreases in water quality are expected in SEA Area 4. However, abnormal events may result in the local deterioration of water quality.

### Unconventional Oil and Gas

As highlighted above, none of the WRZs in SEA Area 4 are forecast to be in deficit to 2040. Notwithstanding, there is the potential that the cumulative effect of several pads (each supporting up to 24 wells consuming between 10,000m$^3$ and 25,000m$^3$ per well) in certain WRZs could push some zones into a supply deficit. If, for instance, four pads were drilled for production in the SEWCUS and Tywl Gower WRZs (which together include a large proportion of the South Wales component of SEA Area 4), and each had 24 wells (as per the high activity scenario) up to 2.4 million m$^3$ (2,400 Ml) of water would be required. Average daily demand in both the SEWCUS and Tywl Gower WRZs is approximately 600Ml although it is likely that the development of pads and hydraulic fracturing would be phased (hydraulic fracturing could occur over a two year period, assuming that a well is drilled every four weeks)

[72] Dee Valley Water (2013) *Draft Water Resources Management Plan*. Available from http://www.deevalleywater.co.uk/article_files/129/english/dee-valley-water-wrp-draft.pdf [Accessed September 2013]

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and in consequence associated daily water requirements would constitute a small proportion of the total volume of water required. Further, if the water were abstracted from a surface or groundwater source, it would require an abstraction licence from the Environment Agency, which would only be granted if abstraction was considered to be sustainable.

The potential for adverse effects on water quality associated with the unconventional oil and gas exploration and production lifecycle is considered unlikely (due to the anticipated implementation of appropriate mitigation on sites and the requirements for consents under the regulatory regime). In consequence, no major decreases in water quality are expected in SEA Area 4. However, abnormal events may result in the local deterioration of water quality.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 4 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production although in view of the reduced water requirement associated with the extraction of this resource, the potential magnitude of effects may be reduced.

### Gas Storage

Reflecting the findings of the assessment of the gas storage lifecycle (see **Table 5.16**), no adverse effects in respect of water resource use or quality in SEA Area 4 are anticipated.

## 5.11.5 SEA Area 5: Southern and South West England

### Conventional Oil and Gas

As highlighted in **Section 5.6.5**, the scale of growth envisaged in the South East in particular will place significant pressures on water resource availability. In the South East River Basin District, for example, 24% of river length, 9% of lakes and 82% of groundwaters are/probably are at risk of abstraction and flow regulation (see **Table 5.6**).

Thames Water[73] forecasts a significant deficit in water supply (from 125 Ml per day in 2020 to 367 Ml by 2040) with the deficit in the London zone set to increase from 35 to 367 Ml per day by 2040 and the Swindon and Oxfordshire WRZ predicted to have a deficit of 14 Ml per day at times of highest demand over the same period. Several WRZs in the Southern Water supply area, meanwhile, are also forecast to be in deficit[74] including the Weald of Kent. Whilst water consumption associated with conventional oil

[73] Thames Water (2013) *Draft Water Resources Management Plan 2015-2040*. Available from http://www.thameswater.co.uk/tw/common/downloads/wrmp/WRMP_A4_36_page_WEB.pdf [Accessed September 2013]

[74] Southern Water (2013) *Water Resoruces Management Plan Consultation*. Available from http://swhaveyoursay.co.uk/wrmp/our-plans/#consultation-document [Accessed September 2013]

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and gas operations is unlikely to be substantial, in view of water resource issues in SEA Area 5 there would be a need to consider carefully water resource requirements associated with conventional oil and gas exploration and production once site locations are known.

The potential for adverse effects on water quality associated with the conventional oil and gas exploration and production lifecycle is considered unlikely (due to the anticipated implementation of appropriate mitigation on sites and the requirements for consents under the regulatory regime). In consequence, no major decreases in water quality are expected in SEA Area 5. However abnormal events may result in the local deterioration of water quality.

## Unconventional Oil and Gas

Reflecting the existing/forecast water resource issues in the South East in particular, there is the potential for unconventional oil and gas exploration and production to have a significant effect on water resource availability in SEA Area 5. Adverse effects could be more pronounced should several pads be taken forward. For example, if four pads were drilled for production and each had 24 wells (as per the high activity scenario), up to 2.4 million $m^3$ (2,400 Ml) of water would be required. Given forecast deficits in some WRZs (as noted above), effects could be significant, although it is likely that the development of pads and hydraulic fracturing would be phased (hydraulic fracturing could occur over a two year period, assuming that a well is drilled every four weeks) and in consequence associated daily water requirements would constitute a small proportion of the total volume of water required. However, in parts of the Weald Basin, water resource zones are smaller and the ability to meet any demand from shale gas operators is likely to be more constrained.

Further, if the water were abstracted from a surface or groundwater source, it would require an abstraction licence from the Environment Agency, which would only be granted if abstraction was considered to be sustainable.

The potential for adverse effects on water quality associated with the unconventional oil and gas exploration and production lifecycle is considered unlikely (due to the anticipated implementation of appropriate mitigation on sites and the requirements for consents under the regulatory regime). In consequence, no major decreases in water quality are expected in SEA Area 5. However, abnormal events may result in the local deterioration of water quality.

## Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 5 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production although in view of the reduced water requirement associated with the extraction of this resource, the potential magnitude of effects may be reduced.

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## Gas Storage

Reflecting the findings of the assessment of the gas storage lifecycle (see **Table 5.16**), no adverse effects in respect of water resource use or quality in SEA Area 5 are anticipated.

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# 6. Air

## 6.1 Introduction

The overview of plans and programmes and baseline information contained in this section provides the context for the assessment of potential effects of Licensing Plan proposals on air quality. Information is presented for both national and regional levels.

Air quality within this context concerns the levels of pollutants emitted into the air and their significance, in terms of the risk of adverse effects on the environment and/or human health. Carbon dioxide and other greenhouse gas emissions are excluded from the air quality topic and are reported under the climate change and adaptation topic.

There are links between the air quality topic and other topics in the SEA, specifically population, human health, climate change and material assets.

## 6.2 Review of Plans and Programmes

### 6.2.1 International/European

The ***Air Quality Framework Directive*** 96/62/EC and its Daughter Directives set a framework for monitoring and reporting levels of air pollutants across EU member states, setting limits or reductions for certain air pollutants.

The ***Ambient Air Quality and Cleaner Air for Europe Directive*** 2008/50/EC consolidated earlier air quality directives and also defines and establishes objectives and targets for ambient air quality to avoid, prevent or reduce harmful effects on human health and the environment as a whole. It sets legally binding limits for concentrations in outdoor air of major air pollutants that impact on public health such as particulate matter ($PM_{10}$ and $PM_{2.5}$) and nitrogen dioxide ($NO_2$). The 2008 directive replaced nearly all the previous EU air quality legislation and was made law in England through the ***Air Quality Standards Regulations 2010***, which also incorporates the 4$^{th}$ air quality daughter directive 2004/107/EC that sets targets for levels in outdoor air of certain toxic heavy metals and polycyclic aromatic hydrocarbons. Equivalent regulations exist in Scotland, Wales and Northern Ireland.

The UK monitors and models air quality to assess compliance with the air quality limit and target values set out in the EU legislation above. The results of the assessment are reported to the Commission on an annual basis. Air quality monitoring is also carried out by local authorities to meet local air quality management objectives.

In early 2011, the European Commission began a review of EU air quality policy which will culminate with the publication of new proposals on ambient air quality and emissions ceilings in 2013. On 30 June

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2011, the Commission launched a public consultation inviting views on the best way to improve the EU's air quality legislation. The consultation closed in October 2011.

The ***EU Thematic Strategy on Air Quality (2005)*** identifies that despite significant improvements in air quality across the EU, a number of serious air quality issues still persist. The strategy promotes an approach, which focuses upon the most serious pollutants, and that more is done to integrate environmental concerns into other policies and programmes. The objective of the strategy is to attain levels of air quality that do not give rise to significant negative impacts on and risks to human health and the environment. The strategy emphasises the need for a shift towards less polluting modes of transport and the better use of natural resources to help reduce harmful emissions.

The ***Industrial Emissions Directive (IED) 2010/75/EU*** combines seven existing air pollution directives, including the Large Combustion Plant Directive and the Integrated Pollution Prevention and Control (IPPC) Directive. As with previous directives aimed at minimising emission release, part of the benefit of the Industrial Emissions Directive is that it includes several new industrial processes, sets new minimum emission limit values (ELVs) for large combustion plant and addresses some of the implementation issues of the IPPC.

The ***National Emissions Ceilings Directive 2001/81/EC*** came into force in 2001, and Member States were required to transpose it into their national legislation by November 2002. This Directive sets 'ceilings' (maximum values to be achieved by 2010) for total national emissions of four pollutants: sulphur dioxide; oxides of nitrogen; volatile organic compounds; and ammonia. These four pollutants contribute to acidification, eutrophication, and formation of ground level ozone.

### 6.2.2 UK

The ***Air Quality Standards Regulations 2010*** transpose into UK law Directive 2008/50/EC on ambient air quality and cleaner air for Europe and Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclicaromatic hydrocarbons in ambient air. The objective of the Regulations is to improve air quality by reducing the impact of air pollution on human health and ecosystems. The standards set out air quality objectives, limit values and target values for pollutants, namely benzene, 1,3 butadiene, carbon monoxide, lead, nitrogen dioxide, $PM_{10}$, sulphur dioxide and $PM_{25}$.

The ***Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007)*** sets out a way forward for work and planning on air quality issues.

The ***Environment Act 1995*** was enacted to protect and preserve the environment and guard against pollution to air, land or water. It requires local authorities to undertake local air quality management (LAQM) assessments against the standards and objectives prescribed in regulations. Where any of these objectives are not being achieved, local authorities must designate air quality management areas and prepare and implement remedial action plans to tackle the problem.

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The ***Ozone-Depleting Substances (Qualifications) Regulations 2009*** introduces controls on the production, use and emissions from equipment of a large number of 'controlled substances' that deplete the ozone layer.

### 6.2.3 England

The ***National Planning Policy Framework (NPPF) (2012)*** expects the planning system to prevent new development from contributing to unacceptable levels of air pollution. Planning policies and decisions are therefore expected to ensure that new development is appropriate for its location and take into account "*The effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the potential sensitivity of the area or proposed development to adverse effects from pollution*" (paragraph 120).

The Framework expects planning policies to "*sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan*" (paragraph 124). In doing so, local planning authorities are expected to focus on whether the development itself is an acceptable use of the land, and the impact of the use, rather than the control of processes or emissions themselves where these are subject to approval under pollution control regimes.

***Planning Practice Guidance for Onshore Oil and Gas (2013)*** provides advice on the planning issues associated with the extraction of hydrocarbons. It will be kept under review and should be read alongside other planning guidance and the NPPF. The guidance identifies a range of issues that mineral planning authorities may need to address. Those particularly relevant to air quality include: dust; air quality; and traffic.

### 6.2.4 Scotland

***Scottish Planning Policy (SPP) (2010)*** places a requirement on mineral extraction operators to provide sufficient information to enable a full assessment to be made of the likely effects of the development. SPP also notes that when deciding planning applications for extraction, planning authorities should consider, inter alia, potential pollution of air.

The draft Scottish Planning Policy (2013) highlights the important role that planning has in realising sustainable development and protecting natural heritage, including air.

### 6.2.5 Wales

***Planning Policy Wales: (Edition 5) (2012***). Planning Policy Wales (PPW) sets out the land use planning policies of the Welsh Assembly Government. Regarding air quality, PPW sets out potential

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material planning considerations in relation to: location and site selection; impact on health and amenity; the risk and impact of potential pollution from the development as well as the effect of the surrounding environment, the prevention of nuisance and the impact on the road and other transport networks.

## 6.3 Overview of the Baseline

### 6.3.1 England

England is divided into 31 zones and agglomerations for ambient air quality reporting. In 2011, all zones and agglomerations complied with the limit values for 1-hour mean and 24-hour mean $SO_2$ concentration. Two areas (Greater London Urban Area and the South East) had locations which failed the short term limit for $NO_2$. Only in one area in England (Blackpool Urban Area) did all the measurement locations in the area meet the annual limit for $NO_2$. All areas in England complied with the annual limit for $PM_{10}$. The London Urban area failed to meet the short term limit or $PM_{10}$.[1]

Within England, in June 2012, there were 219 local authorities with AQMAs, 33 of which were within London. Most Air Quality Management Areas in the UK are in urban areas and result from traffic emissions of nitrogen dioxide or $PM_{10}$. Emissions from transport (road and other types) are the main source in 97% of the AQMAs declared for $NO_2$; only a few have been declared as a result of other sources, such as industrial or domestic emissions.

### 6.3.2 Scotland

The Scottish Air Quality Database contains monitoring data for a total of 86 sites. The data captured by these monitoring stations in 2011 suggests that air quality is generally good in Scotland, save for some urban locations[2].

Two sites (both in Glasgow) exceeded the AQS objective of not more than 18 exceedences of 200 µg $m^{-3}$ for the hourly mean for $NO_2$. A further 13 sites exceeded the AQS objective for $NO_2$ mean (40 µg $m^{-3}$). Similarly, 25 sites failed to reach the annual objective for $PM_{10}$ and eight failed to reach the daily objective. Two sites in Grangemouth failed to meet the AQS objective for number of exceedencess of the 15 minute mean for $SO_2$.

By the end of 2011, there were a total of 26 Air Quality Management Areas (AQMAs) in 13 local authorities in Scotland.

[1] Defra (2012) Air Pollution in the UK 2011 (http://uk-air.defra.gov.uk/library/annualreport/viewonline?year=2011_issue_2)

[2] Scottish Government (2012) Scottish Air Quality Database Annual Report 2011, http://www.scottishairquality.co.uk/documents/reports2/462130114_Scottish_Air_Quality_Database_Annual_Report_2011_V3.pdf

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### 6.3.3 Wales

Air quality in Wales continues to improve year on year and both emissions and ambient concentrations of key pollutants are decreasing, though annual average concentrations across the country have started to level out in recent years. Urban air quality in Wales is generally worse than in rural areas. The main causes of pollution at urban sites are fine particles ($PM_{10}$) and ozone. The main cause of pollution in rural areas is the variation in ozone levels, which is affected by the weather. In 2008, the number of days when air pollution was moderate or higher was 26 in Cardiff and in 2008 was 104 in Port Talbot Margam. The South East Wales region has the worst air quality, followed by parts of North East Wales. Moderate levels of ozone were recorded on 115 days during the year at one or more sites, and $PM_{10}$ levels were moderate or high on 47 days[3].

The Swansea Urban Area and South Wales Zone contained locations which breached the target value for nickel and benzopyrene in 2011.

As of 2012, there were 34 Air Quality Management Areas in Wales[4]. There are 26,353 people living in AQMAs in Wales. This represents 0.9% of the total population of Wales.

## 6.4 Environmental Characteristics of those Areas most likely to be Significantly Affected

### 6.4.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

As expected (given the concentration of development in this Area) it has the highest levels of air pollution in Scotland. Accordingly, 62 of the 86 automatic monitoring stations that feature in the Scottish Air Quality Database are in SEA Area 1 and of the 13 local authorities in Scotland that have declared an Air Quality Management Area in Scotland, 12 are in SEA Area 1[5].

The Glasgow Urban Area contains locations which exceeded the 1-hour limit value (200 µg $m^{-3}$) for $NO_2$ on more than the permitted 18 occasions in 2011. The Glasgow Urban Area, along with the Edinburgh Urban Area and the Central Scotland zone, also contained locations which breached the annual mean limit value for $NO_2$. Again, the Glasgow Urban Area also breached the annual mean limit for $PM_{2.5,}$ the only zone outside of London in the UK to do so.

[3] http://www.welshairquality.co.uk/documents//news/322100927_AQ_Wales_15_English_web.pdf
[4] Welsh Government (2012) State of the Environment Report http://wales.gov.uk/docs/statistics/2012/120725stateofenvironment12en.pdf

[5] These local authorities are: Perth and Kinross; Dundee; Fife; Stirling; Falkirk; Edinburgh; Midlothian; North Lanarkshire; Renfrewshire; Glasgow; East Dunbartonshire; and South Lanarkshire.

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### 6.4.2 SEA Area 2: West Midlands, North West England and Southern Scotland

There are seven agglomerations (West Midlands Urban Area, Coventry/Bedworth, the Potteries, Birkenhead Urban Area, Liverpool Urban Area, Greater Manchester Urban Area, Blackpool Urban Area) and three zones (West Midlands, North West and Merseyside, Scottish Borders) in SEA Area 2 for Ambient Air Quality Reporting in the UK.

Four of these zones and agglomerations had locations which measured or modelled annual mean $NO_2$ concentrations higher than the annual mean limit. However, only three zones (out of 43 in total) in the UK met the annual limit value in 2011 and two where in SEA Area 2; Blackpool Urban Area and Scottish Borders.

Prior to the subtraction of natural sources[6], the West Midlands agglomeration exceeded the 24-hour $PM_{10}$ limit value on more than 35 occasions in 2011.

According to the latest State of the Environment Report from the Environment Agency, 23 local authorities in the West Midlands have declared Air Quality Management Areas. All of these have declared $NO_2$ as a pollutant, with four local authorities also declaring PM10 as a pollutant[7].

### 6.4.3 SEA Area 3: East Midlands and Eastern England

Within the East Midlands, 17 Local Authorities have declared AQMAs. The spatial distribution of local authorities with AQMAS is generally focused in the Derby-Nottingham-Leicester area. Sixteen of these local authorities have declared $NO_2$ as a pollutant. The main source of air pollutants in the region are industry and road transport. The region's industries produce roughly 26% of national nitrogen oxide emissions.

Fifteen local authorities in Yorkshire and Humber have designated AQMAs. Similar to the East Midlands, the main pollutant in the region is $NO_2$ and most AQMAs are located around motorways and A-roads. There are also some AQMAs which identify $PM_{10}$ and $SO_2$ as pollutants, primarily due to heavy industries in the region (such as the Scunthorpe steelworks and Immingham docks).

### 6.4.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

There is a total of 31 AQMAs in SEA Area 4. Powys, Swansea, Neath Port Talbot, and Caerphilly all have one AQMA in their boundaries while there are two in Monmouthshire, nine in Newport and 13 in Rhondda-Cynon Taff.

[6] 'Natural Sources' for particulate matter include wind-blown dust, sea salt, pollens, fungal spores and soil particles.

[7] Environment Agency, West Midlands State of the Environment- Regulated Businesses, accessed on 18.05.2013, http://www.environment-agency.gov.uk/static/documents/Research/MIDS_SOE_West_Reg_Bus.pdf

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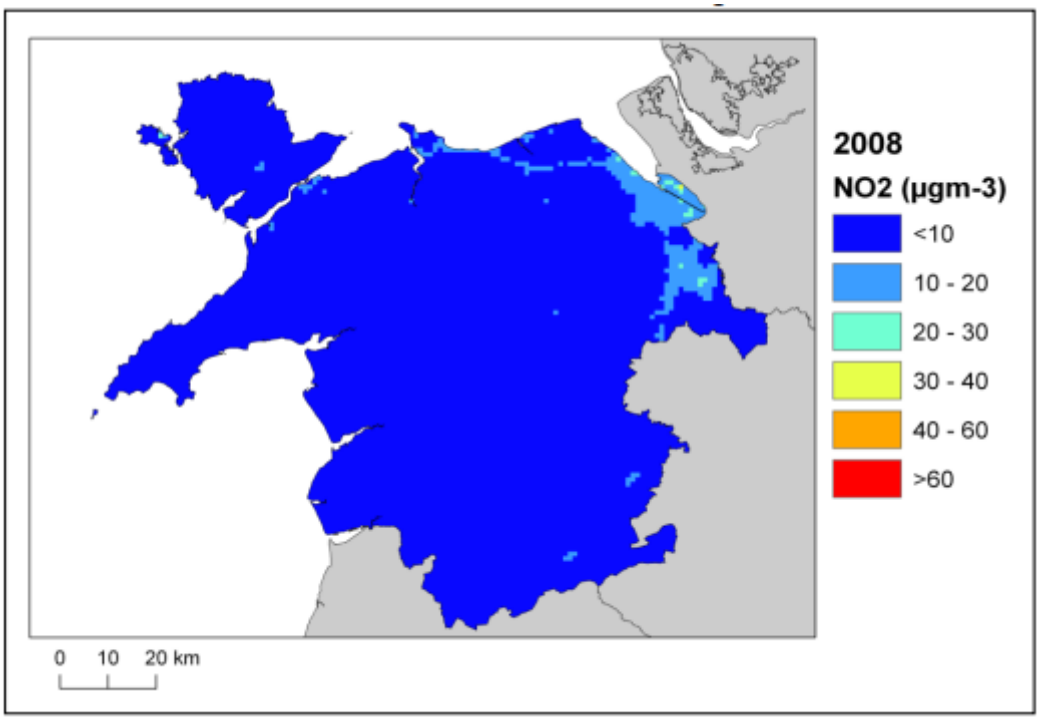
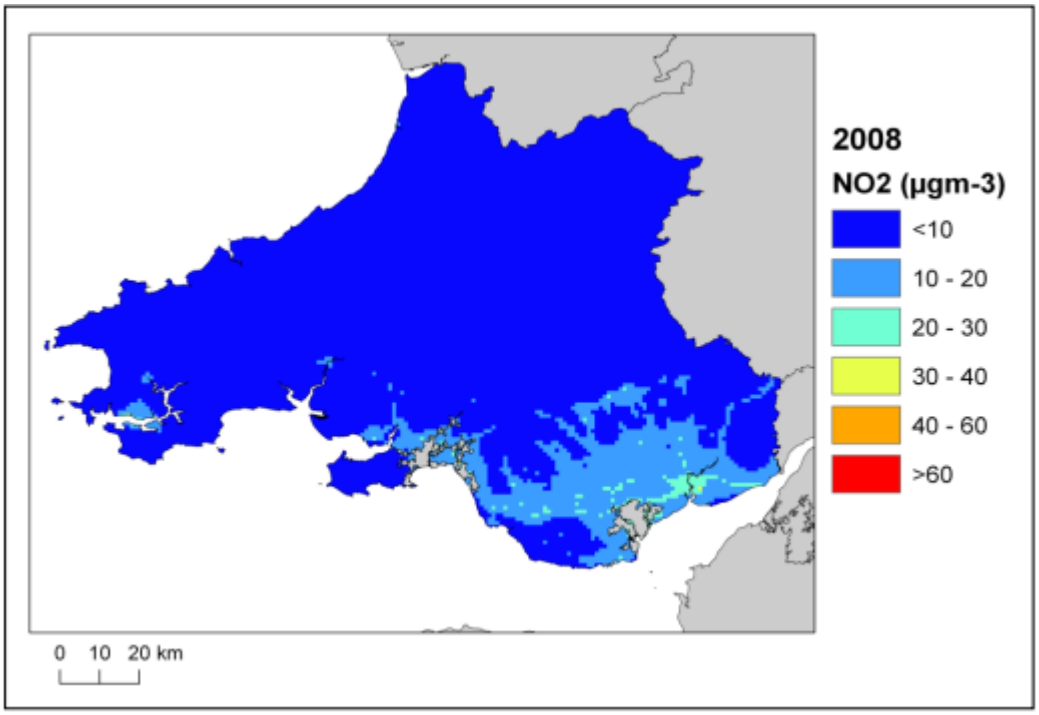
Modelling of annual $NO_2$ background levels suggests that the eastern fringes of North Wales and the Cardiff-Newport corridor suffer the highest concentrations (see **Figure 6.1**). This is unsurprising given the overall levels of urban areas in these locations and associated transport infrastructure.

**Figure 6.1 Annual NO2 Background Levels (North and South Wales)**

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### 6.4.5 SEA Area 5: Southern and South West England

Generally speaking, air quality has improved in the South East over the last decade as heavy polluting industries in the region have declined. The principal risk to good air quality now in the region is emissions associated with vehicular transport. There are 44 local authorities in the South East that have declared AQMAs. The vast majority of these AQMAs have been declared due to elevated $NO_2$ levels associated with vehicle emissions.

Every local authority in London has declared at least one AQMA. Locations in the Greater London Urban Area exceeded a number of air quality standards in 2011 including: the 1-hour limit values for $NO_2$; annual mean limit values for $NO_2$; and daily mean for $PM_{10.}$ Data collected by Defra [8] apportions 43% of $NO_2$ levels to road traffic sources in London, with a further 28% to commercial/residential sources and 9% to industry. Overall, in London there is almost 11km$^2$ of background area exceeding annual mean $NO_2$ limits.

Poor air quality in the South West is typically experienced in urban areas with good ambient air quality in more rural locations.

## 6.5 Summary of Existing Problems Relevant to Onshore Oil and Gas Licensing

The following existing problems for air quality have been identified:

- Poor air quality is generally associated with urban/industrial areas and major road infrastructure. A relatively large number of Air Quality Management Areas are located in each SEA area, particularly in urban areas, many of which have been designated due to high $NO_2$ and $PM_{10}$ levels; and
- Historical emissions have resulted in high levels of sulphur and nitrogen deposits in wetter parts of the UK such as northern England and the Welsh uplands. This has resulted in acidification and nitrogen eutrophication in some areas. Around a third of the UK land area is sensitive to acid deposition and a third to eutrophication. By 2005, the percentage of sensitive habitat area where acid deposited exceeded critical load was 58%. Similarly, 61% of sensitive habitat area exceeded the critical load as a result of nitrogen.

## 6.6 Likely Evolution of the Baseline

### 6.6.1 England

$PM_{10}$ pollution overall has been decreasing in recent years and this is predicted to continue in the future.

[8] Defra (2011) Air Quality Plan for the achievement of EU air quality limit values for nitrogen dioxide in Greater London Urban Area (http://uk-air.defra.gov.uk/library/no2ten/documents/UK0001.pdf)

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By 2015, 71.7km of main urban road is predicted to be in exceedance of 31.5µg/m$^3$ (roughly equivalent to the Stage 1 $PM_{10}$ 24-hour limit value and objective), this is a 96.7% decrease compared to the 2003 baseline[9].

Concentrations of $NO_2$ have been declining on average, although London Marylebone Road (the site with the highest $NO_2$ levels in England) and several other sites, are showing increasing concentrations in the most recent years. By 2015, 1,331km of main urban road is predicted to be in exceedance of the annual mean objective of 40µg m$^{-3}$, this is an 80.2% decrease compared to the 2003 baseline.

### 6.6.2 Scotland

There is a downward trend in air pollution in Scotland in recent years. For instance[10]:

- Annual mean $PM_{10}$ concentration at urban background sites at eight sites in Scotland shows a general decrease in levels since the 1990's although some sites show considerable fluctuation year on year;
- Annual mean $PM_{10}$ concentrations at traffic related urban sites are decreasing, although this is far less pronounced than in the case of urban background sites; and
- The average $NO_X$ concentration based on data from three long running sites (Aberdeen, Edinburgh St Leonards and Grangemouth) indicate a long term improvement through the 1990's but relatively stable levels since 2004.

### 6.6.3 Wales

There is a 'clear improvement' in the following Welsh air quality indicators: sulphur dioxide; nitrogen oxides; fine particulates; Non Methane Volatile Organic Compounds (NMVOC); carbon monoxide; and ammonia. There has also been an improvement in the area of natural and semi-natural habitat where deposition of acid exceeds critical loads.

The following indicators were rated 'stable' or they showed no clear trend[11]:

- number of days when air pollution is moderate or higher in rural zones and urban agglomerations;
- air concentrations of Heavy Metals; and
- area of natural and semi-natural habitat where deposition of nitrogen compounds exceeds critical loads.

[9] Defra (2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, /www.official-documents.gov.uk/document/cm71/7169/7169_i.asp

[10] Scottish Government (2012) Scottish Air Quality Database Annual Report 2011

[11] http://www.welshairquality.co.uk/documents//news/322100927_AQ_Wales_15_English_web.pdf

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### 6.6.4 SEA Areas

#### SEA Area 1: Scottish Midlands (including the Inner Forth)

Air Quality in urban areas of SEA Area 1, particular in Glasgow and Edinburgh city centres, is likely to continue to fail to meet all of the AQS objectives.

Glasgow City Council expect that concentrations of $NO_2$ are likely to continue to exceed annual national AQS mean objectives at several locations within existing Air Quality Management Areas[12]. Similar predictions have been made for the Glasgow Kerbside monitoring station with respect to the 1-hour mean objective for $NO_2$. Although the Council does not recognise any new development in the City that could impact on air quality, it is likely that future growth in the City over the next 25 years could result in increased congestion on the road network and more emissions from vehicles. A shift towards more sustainable forms of transport in the city (such as walking, cycling, trains and buses) or investment in the road network may prevent an increase in congestion in urban areas.

#### SEA Area 2: West Midlands, North West England and Southern Scotland

In line with national trends, key air pollutants are likely to decline in most parts of SEA Area 2. However, high levels are likely to persist in key urban areas and along transport corridors. Figures from Defra suggest that maximum modelled concentration levels of $NO_2$ will fall to roughly a third of current levels by 2020 in four zones Coventry/Bedworth, The Potteries, West Midlands Urban Area and West Midlands non-agglomeration)[13]. However, the achievement of these reductions is highly dependent on the implementation of measures, including a Low Emissions Zone.

#### SEA Area 3: East Midlands and Eastern England

Background air quality is expected to improve in SEA Area 3 as a result of tightening EU emission standards for cars and lorries and a shift towards cleaner electricity generation. However, growth in urban areas is expected to result in additional pressure on road networks and thus a corresponding decrease in air quality in urban areas or along transport corridors is expected.

Climate change is expected to bring higher temperatures to eastern regions of England and this would generally amplify the negative effects of poor air quality.

#### SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

Projections for background annual mean $NO_2$ concentrations in South Wales indicate a decrease in concentrations for a large area of South Wales (see **Figure 6.2**).

[12] Glasgow City Council (2012) 2012 Air Quality Updating and Screening Assessment for Glasgow City Council

[13] Defra (2011) Air Quality Plan for the achievement of EU air quality limit values for nitrogen dioxide in West Midlands.

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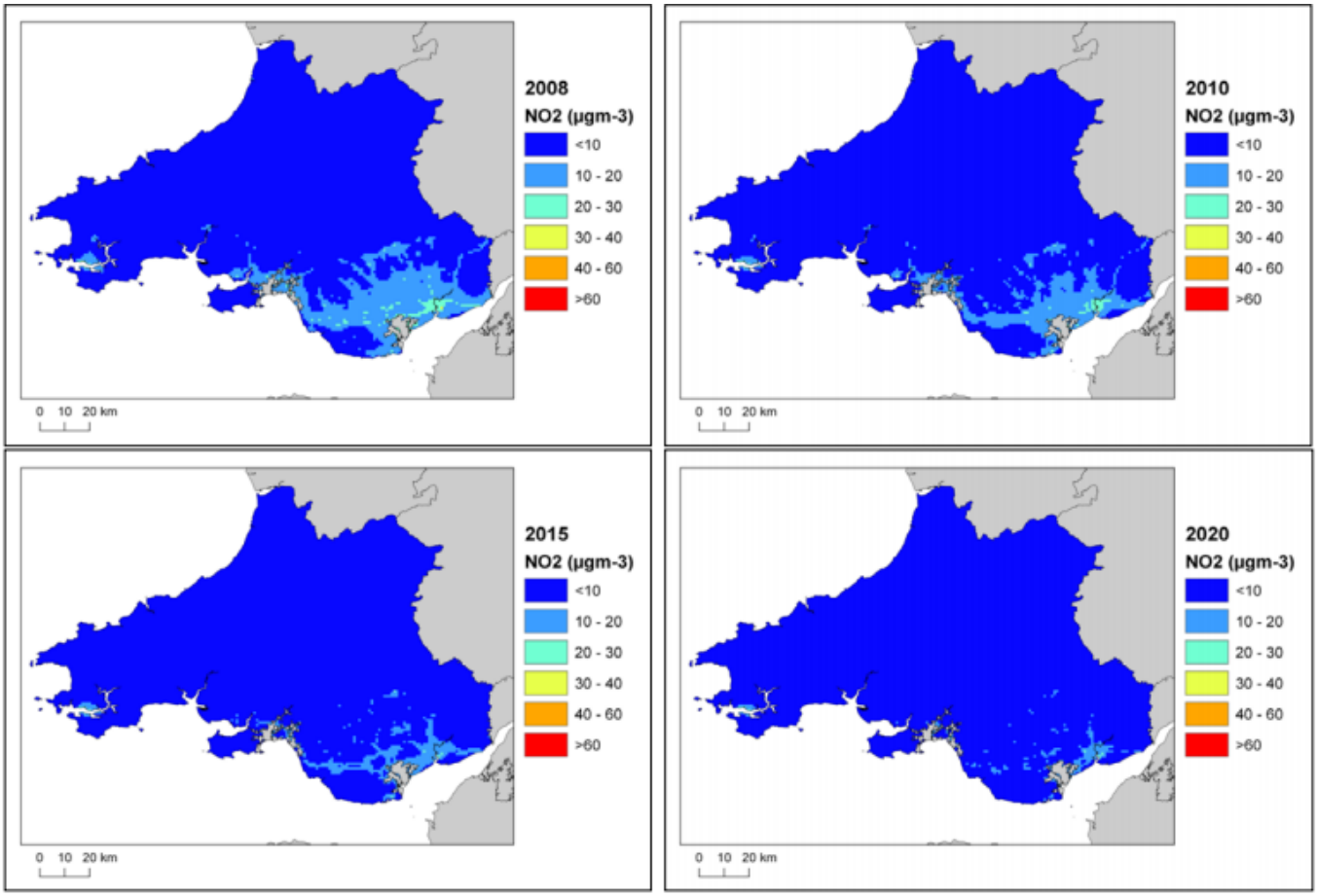
**Figure 6.2 Background Baseline Projections of Annual Mean $NO_2$ Concentrations – South Wales**[14]




Records from stations in North Wales (Aston Hill and Wrexham) show a steady decrease in annual mean $NO_2$ concentrations from 2002 to 2009.

As is the case in South Wales, projections for North Wales show a marked decrease in predicted annual mean $NO_2$ concentrations (see **Figure 6.3**).

[14] Defra (2011) Air Quality Plan for the achievement of EU air quality limit values for nitrogen dioxide in South Wales.

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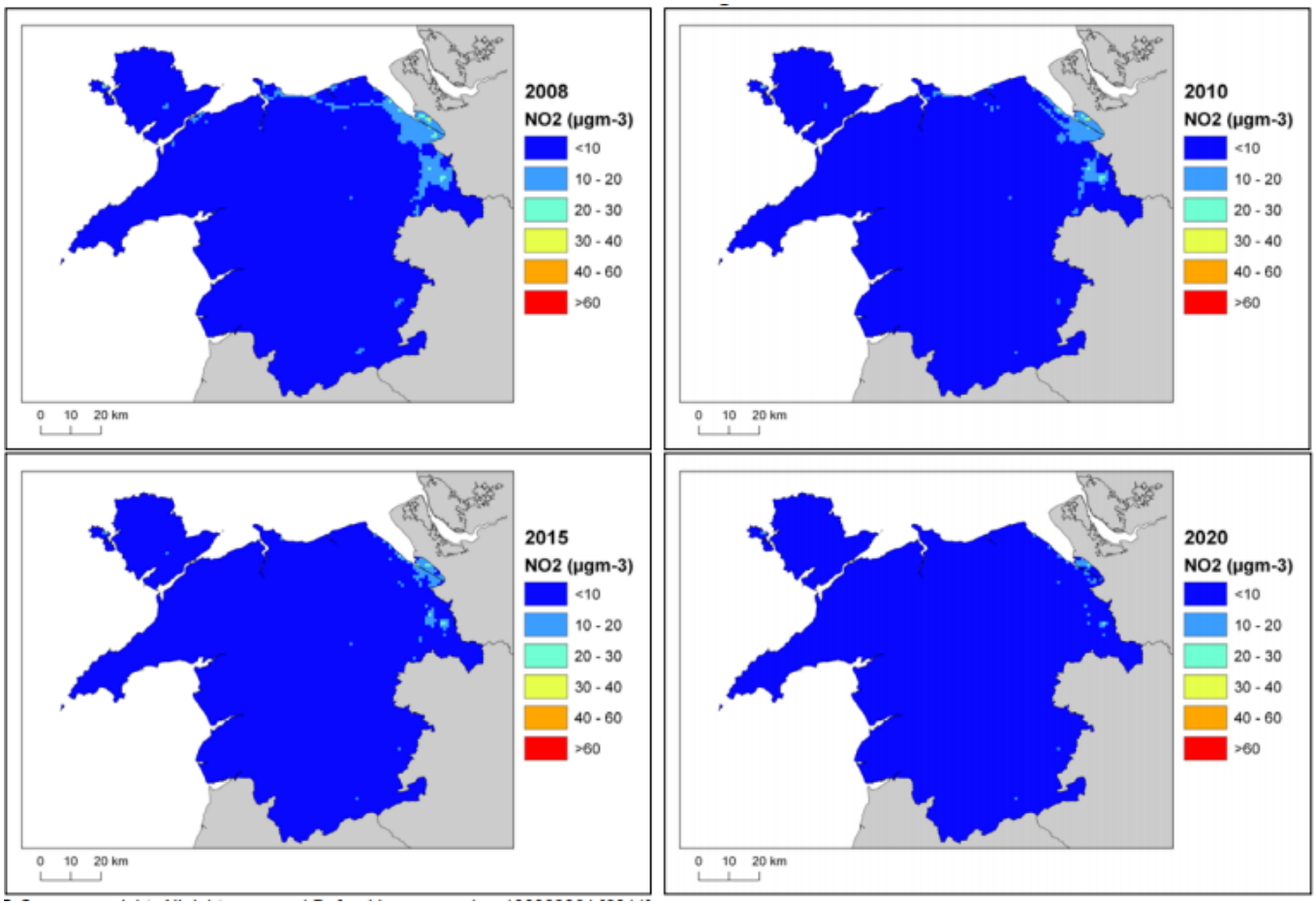
**Figure 6.3 Background Baseline Projections of Annual Mean NO2 Concentrations - North Wales** [15]




## SEA Area 5: Southern and South West England

Measures to improve air quality in London are planned on a European, National, Regional and Local level. On the regional level, the measures to be undertaken are set out in the Mayor's Air Quality Strategy[16]. These measures include: the Low Emission Zone; Bus emissions programme; Spatial Planning; and encouraging electric vehicles.

Modelling for annual mean expected $NO_2$ values predicts that the km of road that exceeds value limits will fall from 943km in 2010 to 341km in 2020 and 33km in 2020. It is also predicted that there will be a reduction in the background area exceeding limits from 25km$^2$ in 2010 to 0km$^2$ in 2020.

[15] Defra (2011) Air Quality Plan for the achievement of EU air quality limit values for nitrogen dioxide in North Wales.

[16] Greater London Authority (2010) Cleaning the Air, The Mayor's Air Quality Strategy (http://www.london.gov.uk/sites/default/files/Air_Quality_Strategy_v3.pdf)

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Outside of London, the majority of new growth is expected to occur in existing urban areas. This is likely to result in further decreases in air quality in areas which currently have AQMAs such as Reading, Slough, Brighton and Cambridge. New development in areas which suffer poor air quality as a result of transport or industry infrastructure (such as the area in the vicinity of Gatwick Airport and Dover Port) is also expected to lead to additional pressures.

## 6.7 Assessing Significance

The objectives and guide questions related to air quality which have been identified for use in the appraisal of the effects of Licensing Plan proposals are set out in **Table 6.1**, together with reasons for their selection.

**Table 6.1 Approach to Assessing the Effects of the Licensing Plan on Air Quality**

| Objective/Guide Question | Reasoning |
|---|---|
| **Objective: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality and Ambient Air Quality and Cleaner Air for Europe Directives.** | The SEA Directive requires that likely significant effects on air quality be taken into account in the Environmental Report. |
| Will the activities that follow the licensing round affect air quality? | Ambient Air Quality and Cleaner Air for Europe Directive aims to avoid the harmful effects on human health and environment from air pollution and includes objectives and targets for ambient air quality. This is transposed into UK law by Air Quality Standards. |
| Will the activities that follow the licensing round create a nuisance for people or wildlife (for example from dust or odours)? | Emissions to air may create dust or odours that have the potential to affect air quality or to be classed as a statutory nuisance (as under Environmental Protection Act 1990). |

**Table 6.2** sets out guidance that will be utilised during the assessment to help determine the relative significance of potential effects on the air quality objective. It should not be viewed as definitive or prescriptive; merely illustrative of the factors that may be considered as part of the assessment process.

**Table 6.2 Illustrative Guidance for the Assessment of Significance for Air Quality**

| Effect | Description | Illustrative Guidance |
|---|---|---|
| ++ | Significant Positive | • Option would significantly improve local air quality through a sustained reduction in concentrations of pollutants identified in the national air quality objectives. |

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| Effect | Description | Illustrative Guidance |
|---|---|---|
| + | Minor Positive | • Option would lead to a minor improvement in local air quality from a reduction in concentrations of pollutants identified in the national air quality objectives. |
| 0 | Neutral | • Option would not affect local air quality. |
| - | Minor Negative | • Option would result in a minor decrease in local air quality;<br>• Option has a negative effect on local communities and biodiversity adjacent to licensed construction and production transport routes due to an increase in air and odour pollution and particulate deposition. |
| -- | Significant Negative | • Option would cause a significant decrease in local air quality (e.g. leading to an exceedence of air Quality Objectives for designated pollutants and the designation of a new Air Quality Management Area);<br>• Option has a strong and sustained negative effect on local communities and biodiversity licensed construction and production due to significant increase in air and odour pollution and particulate deposition. |
| ? | Uncertain | • From the level of information available the effects the impact that the option would have on this objective is uncertain. |

## 6.8 Assessment of Effects

This section comprises the assessment of the potential activities that could follow on from the licensing round on the air quality objective. There are a total of six main stages of oil and gas exploration and production (including gas storage) that are the subject of the assessment. These are highlighted in **Table 6.3** for both conventional and unconventional oil and gas together with an overview of the

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associated key activities at each stage. Please note that Stages 1, 2 and 4 do not necessarily apply to gas storage, depending on the history of the particular site.

**Table 6.3 Oil and Gas Exploration and Production Lifecycle and Key Activities**

| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| 1. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. |
| 2. | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring.* | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. |
| 3. | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring* | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. |
| 4. | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring.* | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. |
| 5. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. |
| 6. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. |

Note: Exploration wells most usually move from Stage 2 to Stage 5, though some may be used for long-term production testing (which would require new consents including planning permission) and some may be retained and their sites redeveloped as a production project (this would also require new consents including planning permission). For the purposes of this assessment, the appraisal stage (a term commonly used in industry) spans Stages 2 and 3.

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*Conventional oil and gas exploration and production activities (stages 2 to 4 above) can occasionally include hydraulic fracturing. However, the need to undertake hydraulic fracturing is relatively uncommon and has therefore not been considered in the assessment of conventional oil and gas activities as part of this SEA.

### 6.8.1 Conventional Oil and Gas

The assessment of the six main stages of conventional oil and gas production is contained in **Table 6.4**. The first two columns describe the exploration and production stage. The third and fourth columns summarise the expected effects on the air quality objective for both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report). The rationale for this relationship is explained in more detail in the final column and includes:

- the nature and scale of the potential effects on the air quality objective;
- when the effect could occur (timing) and its degree of permanence;
- what mitigation measures might be appropriate for potentially significant negative effects on the air quality objective;
- what options there are to enhance positive effects; and
- assumptions and uncertainties that underpin the assessment.

**Table 6.4 Assessment of Effects: Conventional Oil and Gas**

| **Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>On site non-intrusive exploration surveys would result in emissions from vehicles and machinery. Due to the minor scale of works required and the short term duration of these surveys, the effect of the emissions would be negligible.<br>**Low and High Activity Scenarios:**<br>It can be reasonably assumed that under the high activity scenario, there would be more on site survey work and therefore emissions from vehicles and machinery would be higher than under the low scenario. However the effect of these emissions would be short term and of a minor scale and therefore a neutral effect would be expected on the objective under both scenarios.<br>**Mitigation:**<br>• Vehicles and machinery could shut down their engines when stationery or not in use to reduce emissions;<br>• Transport Plans could reduce the amount of trips made or the mileage that vehicles need to complete; |

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| Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Low Emissions Vehicles should be used where possible.<br>**Assumptions:**<br>• None.<br>**Uncertainties:**<br>• None. |
| 2 | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring. | **0** | **0** | **Assessment of Effects:**<br>The preparation of the pad site would generally involve the removal of vegetation and topsoil for an area of approximately 1 hectare over a 4 week period. Heavy machinery used for the site preparation would give rise to exhaust emissions. The exact scale of works required to clear and prepare the site will depend on local factors such as geology, habitat and hydrology.<br>The pad preparation would also give rise to dust, particularly during periods of low rainfall.<br>Vehicular movements will be required to transport materials to and from the site during each of the activities under this stage. It is estimated that this would be of the scale 6-7 vehicle movements a day which will result in emissions along the transport routes to and from pad sites. However, given the short term nature of the work (7-8 weeks), the effect is not expected to be significant. Although particular attention would need to be paid to any local designations of an Air Quality Management Area.<br>The drilling of the borehole and exploratory wells would be over a 24 hr basis for approximately 4-5 weeks. Diesel generators would be used to power the drilling rigs. These generators emit a number of pollutants including NOx, hydrocarbons, CO, and PM. Simultaneously to drilling operations, there will be on site movement of vehicles to and from the site.<br>Wastes produced during the drilling operations will need to be transported off the site for recycling or disposal.<br>Wells that encounter commercial quantities of hydrocarbons will generally carry out production testing. This may result in the flaring of some gas. Flaring would primarily result in the production of $CO_2$ but also $NO_X$, $SO_2$, CO, and Particulate Matter.[17]<br>Overall, the emissions at this stage would not be expected to affect air quality. However, there may be specific circumstances where there may be short term effects depending on local topography, weather conditions and ambient air quality.<br>**Low and High Activity Scenarios:**<br>The volume of pollutants emitted during this stage would be higher for the High Activity Scenario. However, the scale of activity is unlikely to have a negative effect. Given the assumed distance between pads, it is unlikely that there |

[17] See http://www.epa.gov/ttnchie1/ap42/ch13/final/c13s05.pdf [Accessed September 2013]

| **Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | would be any cumulative effects from more than one site being drilled in a local area. There may however be short term effects depending on local topography, weather conditions and ambient air quality.<br>**Mitigation:**<br>• Air emission specifications should be considered during all equipment selection and procurement;<br>• Vehicles and machinery could shut down their engines when stationery or not in use to reduce emissions;<br>• If flaring is the only option available for the disposal of test gases, only the minimum volume of hydrocarbons required for the test should be flowed and well test durations should be reduced to the extent practical. Volumes of hydrocarbons flared should be recorded. The Environment Agency consider an enclosed flare to be BAT but will consider other options to ensure waste gas is oxidised. In order to reduce air pollution, the type method of flaring to be selected should seek to minimise incomplete combustion, black smoke and hydrocarbon fallout;<br>• A Dust Suppression Plan could reduce the levels of dust that are caused by ground works. The scale of the management plan would generally be dependent on local conditions and the presence of sensitive receptors.<br>**Assumptions:**<br>• It is assumed that all waste gas will be flared and no venting will occur;<br>• It is assumed that drilling operations will be powered by diesel engines;<br>• It is estimated that stage 2 will generate approximately 6-7 vehicle movements over a 7-8 week period[18].<br>**Uncertainties:**<br>• The extent to which HGVs will met euro IV standard, or are fitted with catalytic convertors and particulate traps;<br>• The pollutant content from the gas mix from testing. |
| 3 | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion; | **0** | **0/-** | **Assessment of Effects:**<br>The preparation of the pad site would involve similar activities as under Stage 2 but as the average area covered by the well pad is larger (2-3ha), the scale of the effects would be more pronounced. Emissions from heavy machinery would be expected along with dust due to soil disturbance.<br>There would be, on average, 2 wells per pad and therefore it is likely that multiple activities (drilling, flaring, vehicle movements to and from the site) would occur simultaneously. This would result in higher emissions than expected during the exploratory drilling stage. |

[18] For information on the calculation of vehicle movements refer to Table 4.7 in Main Report.

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| Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • Provision of pipeline connections.<br>• Well testing, possibly including flaring. | | | Vehicular movements will be required to transport materials to and from the site during each of the activities under this stage. It is estimated stage 3 would generate some 5-6 vehicle movements a day. However, given the short term nature of the work (7-8 weeks), the effect on air quality is not expected to be significant. Although particular attention would need to be paid to any local designations of an Air Quality Management Area.<br>Overall, however it is expected that effects would be neutral at this Stage.<br>**Low and High Activity Scenarios:**<br>Under the high level scenario, there would be a total of 12 wells in the UK. While this is double the low activity scenario, cumulative effects would be unlikely to result in localised significant effects unless the majority of production focuses on specific locations, although it may on occasion cause localised negative effects.<br>**Mitigation:**<br>• Air Quality Monitoring should be carried out on a continuous basis during this stage. While this will not prevent air pollution per se, it will allow for early identification of any potential significant effects;<br>• Air emission specifications should be considered during all equipment selection and procurement;<br>• Vehicles and machinery could shut down their engines when stationery or not in use to reduce emissions;<br>• A Dust Suppression Plan could reduce the levels of dust that are caused by ground works. The scale of the management plan would generally be dependent on local conditions and the presence of sensitive receptors.<br>**Assumptions:**<br>• It is assumed that drilling operations will be powered by diesel engines;<br>• It is estimated that stage 2 will generate approximately 5-6 vehicle movements over a 7-8 week period.[19]<br>**Uncertainties:**<br>• The extent to which HGVs will met euro IV standard, or are fitted with catalytic convertors and particulate traps. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions; | **0** | **0/-** | **Assessment of Effects:**<br>The production of oil/gas normally requires energy in order to: drive pumps to extract the hydrocarbons and re-inject water; heat the output to separate the oil, gas and water; power compressors and pumps to transport the oil/gas from the site. |

[19] For information on the calculation of vehicle movements refer to Table 4.9 in the main report.

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| **Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | | | The amount of energy required will often depend on reservoir conditions and the power needed to bring the hydrocarbons to the surface. The extent to which this energy consumption can be met by electricity will determine the level of emissions from the operations on site.<br>Production sites which cannot be connected to the electricity grid would require internal combustion engines to power activities on site. These engines would cause emissions which would not be of a significant scale but would be long term.<br>It can be reasonably assumed that sites where generators would be required are in more remote rural areas and therefore the likelihood of significant effects occurring is lower as ambient air quality levels would be expected to be good. However, the long term deposition of pollutants may have localised effects on sensitive habitats.<br>There would be HGV movements to and from the site but these would be significantly less than during Stage 2.<br>Fugitive emissions of methane from the production wells typically occur during production. This has been assumed to be 50,000m$^3$ per well. Evidence from the US also suggests that gases such as methane could leak from the well during production due to loss of well integrity.[20] However, there is insufficient evidence to conclude the likelihood or quantities of gases that may be released (although it is expected to be minor). Furthermore, it is assumed that regular well integrity testing will prevent/mitigate against any loss of well integrity.<br>**Low and High Activity Scenarios:**<br>Additional activities associated with the higher number of pad site and wells under the high activity scenario may result in minor negative effects on air quality related to emissions from combustion engines and HGV movements.<br>**Mitigation**:<br>• Air emission specifications should be considered during all equipment selection and procurement;<br>• Vehicles and machinery could shut down their engines when stationery or not in use to reduce emissions;<br>• Due to the uncertainty of emissions to air during production it is suggest that Air Quality Monitoring should be carried out on a continuous basis during this stage. While this will not prevent air pollution per se, it will allow for early identification of any leakages/ loss of well integrity.<br>**Assumptions:**<br>• It is assumed that no additional drilling would be completed at this stage. |

[20] Ingraffea, A. (2012). Fluid Migration Mechanisms Due to Faulty Well Design and/or Construction: An overview and Recent Experiences in the Pennsylvania and Marcellus Play. *PSE.*

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|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Uncertainties:**<br>• The scale of energy required to keep the well in operation is unknown. In addition, it is unknown whether the consumption of energy required to power the site could be met by electricity. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>Well plugging would involve small scale construction activities on site that would be of a short duration.<br>The removal of the site equipment would involve HGV movements to and from the site and other specialised equipment transporters.<br>Evidence from the US suggests that gases such as methane could leak from the well after production due to loss of well integrity[21] However, there is insufficient evidence to conclude the likelihood or quantities of gases that may be released (although it is expected to be minimal, if at all). Furthermore, it is assumed that regular well integrity testing will prevent/mitigate against any loss of well integrity.<br>Overall, these activities are unlikely to give rise to air quality issues, save for sites located in areas with existing air quality issues. A neutral effect is therefore expected.<br>**Low and High Activity Scenarios:**<br>Additional sites would need to be decommissioned under the high activity scenario but as outlined above; these would not be likely in most instances to have considerable effects on air quality.<br>**Mitigation**:<br>• Transport Plans should be adopted to reduce vehicle movements to and from the site to a minimum;<br>• Low Emission Vehicles should be used if possible;<br>• Due to the uncertainty of emissions to air it is suggests that Air Quality Monitoring should be carried out. While this will not prevent air pollution per se, it will allow for early identification of any leakages/ loss of well integrity.<br>**Assumptions:**<br>• It is assumed that the well would be sealed adequately to prevent fugitive emissions.<br>**Uncertainties:**<br>• None identified. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection; | **0** | **0** | **Assessment of Effects:**<br>The restoration of the site would involve a similar level of activity required to prepare the pad site. Large plant and machinery would be expected to be on site for a period of 2-4 weeks and there would be movements of earth and soil. |

[21] Ingraffea, A. (2012). Fluid Migration Mechanisms Due to Faulty Well Design and/or Construction: An overview and Recent Experiences in the Pennsylvania and Marcellus Play. *PSE.*

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|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • Site restoration and reclamation. | | | This may give rise to dust depending on ground conditions, soil types and recent rainfall patterns. This would have a negligible effect on the air quality objective.<br>**Low and High Activity Scenarios:**<br>Under the high activity scenario, there would be more pads sites to restore. However as the scale of works required to complete his activity is minor, any effects on air quality would be short term and unlikely to lead to a decreases in local air quality.<br>**Mitigation:**<br>• Dust suppressions practices should be adopted where necessary.<br>**Assumptions:**<br>• None.<br>**Uncertainties:**<br>• None identified. |

***Summary***

No positive effects are expected on the air quality objectives during any of the six stages of conventional oil and gas production. Neutral effects are expected for the stages that are associated with ancillary or minor scopes of works, such as those in Stage 1 and 6. A mixed score of neutral/minor negative is expected for Stages 3 and 4 under the high activity scenario. The activities associated with these stages would result in the emission of pollutants and gases that are known to have adverse effects on the environment and for which there are national objectives to reduce their levels. However, the likelihood of a negative effect will depend on a number of factors, including weather conditions and existing ambient air quality. The adverse effects identified in Stage3 would generally be short term but long term effects may occur under Stage 4.

**Mitigation Summary**

- Air Quality Monitoring should be carried out on a continuous basis during Stage 3. While this will not prevent air pollution, per se, it will allow for early identification of any potential significant effects.
- Air emission specifications should be considered during all equipment selection and procurement.
- Vehicles and Machinery could shut down their engines when stationery or not in use to reduce emissions.
- Best practice in flaring management and technique
- Dust suppression management
- Low Emission Vehicles
- Where possible, low or 'zero' sulphur fuels should be used for the engines of drilling rigs and other equipment.

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

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## 6.8.2 Unconventional Oil and Gas

The assessment of the six main stages of unconventional oil and gas production is contained in **Table 6.5** under both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report).

**Table 6.5 Assessment of Effects: Unconventional Oil and Gas**

| **Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>On site non-intrusive exploration surveys would result in emissions from vehicles and machinery. Due to the minor scale of works required and the short term duration of these surveys, the effect of the emissions would be negligible and a neutral effect is expected on the objective.<br>**Low and High Activity Scenarios:**<br>It can be reasonable assumed that under the high activity scenario, there would be more on site survey work and therefore emissions from vehicles and machinery would be higher than under the low scenario. However the effect of these emissions would not be of a scale to result in any discernible effects on local air quality.<br>**Mitigation:**<br>• Vehicles and machinery could shut down their engines when stationery or not in use to reduce emissions;<br>• Transport Plans could reduce the amount of trips made or the mileage that vehicles need to complete;<br>• Low Emissions Vehicles should be used where possible.<br>**Assumptions:**<br>• None.<br>**Uncertainties:**<br>None. |
| 2 | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. | **-** | **-/--** | **Assessment of Effects:**<br>The preparation of the pad site would generally involve the removal of vegetation and topsoil for an area of approximately 1 hectare over a 4 week period. Heavy machinery used for the site preparation would give rise to exhaust emissions. The exact scale of works required to clear and prepare the site will depend on local factors such as geology, habitat and hydrology.<br>The pad preparation would also give rise to dust, particularly during periods of low rainfall<br>HGV movements will be required to transport materials to and from the site during each of the activities under this stage, especially related to the provision of water for hydraulic fracturing. |

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| Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | It is estimated stage 2 will generate approximately 14-36 vehicle movements a day over a 12-13 week period. This scale may have a negative effect on local air quality due to emissions from vehicles along the transport route. However, given the temporary nature of this work, this is not expected to be significant.<br>The drilling of the borehole would be over a 24 hr basis for approximately 4-5 weeks. Diesel generators will be used to power the drilling rigs. These generators emit a number of pollutants including NOx, hydrocarbons, CO, and PM. Simultaneously to drilling operations, it is expected that there would be movements of vehicles to and from the site.<br>During the hydraulic fracturing, diesel fumes would be emitted from the pumps that push the fracturing fluid into the well. In addition, it is expected that dust would be generated by the on-site handling (conveying and blending) the proppant (which is normally sand based)<br>Unconventional gas wells typically produce more cuttings per well than conventional wells. It is assumed that each well will generate 270m$^3$ of cuttings. These cuttings will need to be transported off site for treatment and/or recycling.<br>The quantification table 2.7 in the main report notes that the estimated emissions from flaring per well are 500,000m$^3$. Flaring is regulated by DECC as part of a licence condition and it is DECC's established policy that flaring should be reduced to the economic minimum. Flaring would primarily result in the production of $CO_2$ but also $NO_X$, $SO_2$, CO, and Particulate Matter.<br>Overall, negative effects would be expected during this stage on the air quality objective although this would be affected by the level of activity.<br>**Low and High Activity Scenarios:**<br>It has been assumed that the high activity scenario would be expected to result in up to 240 boreholes being drilling. This scale may lead to cumulative effects occurring in some areas which would be likely to exacerbate air quality and could lead to significant negative effects occurring in some areas. However, this is dependent on the sitting of pads and the existing levels of air pollution. Notwithstanding, it can be anticipated that regulatory controls through the Town and Country planning system and subsequent environmental permitting will ensure that these effects are not unacceptable. In this respect, Public Health England has recently published a review of the available evidence on potential public health impacts[22]. While noting that caution is required in extrapolating evidence from overseas into the UK context, they consider that the potential risks to public health from emissions to air are low if the operations are properly run and regulated. |

[22] Public Health England (2013) *Review of the Potential Public Health Impacts of Exposures to Chemical and Radioactive Pollutants as a Result of Shale Gas Extraction: Draft for Comment*, available from http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317140158707 [Accessed November 2013]

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| **Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Mitigation:**<br>• Air emission specifications should be considered during all equipment selection and procurement;<br>• Where possible, low or 'zero' sulphur fuels should be used for the engines of drilling rigs and fracturing equipment;<br>• Vehicles and machinery could shut down their engines when stationery or not in use to reduce emissions;<br>• If flaring is the only option available for the disposal of test gases, only the minimum volume of hydrocarbons required for the test should be flowed and well test durations should be reduced to the extent practical. Volumes of hydrocarbons flared should be recorded. The Environment Agency consider an enclosed flare to be BAT but will consider other options to ensure waste gas is oxidised. In order to reduce air pollution, the type method of flaring to be selected should seek to minimise incomplete combustion, black smoke and hydrocarbon fallout;<br>• A Dust Suppression Plan could reduce the levels of dust that are caused by ground works. The scale of the management plan would generally be dependent on local conditions and the presence of sensitive receptors.<br>**Assumptions:**<br>• Stage 2 is estimated to generate approximately 14-36 vehicle movements a day over a 12-13 week period[23]<br>**Uncertainties:**<br>• The extent to which HGVs will meet euro IV standard, or are fitted with catalytic convertors and particulate traps;<br>The pollutant content from the gas mix from testing. |
| 3 | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring;<br>• Provision of pipeline connections; | **-/--** | **-/--** | **Assessment of Effects:**<br>Activities which give rise to adverse effects on air quality at this Stage would be similar to Stage 2. These include:<br>• Groundworks;<br>• Deliveries to the site to deliver equipment and plant;<br>• Drilling equipment powered by diesel or other forms of combustion engines;<br>• Deliveries of water (however it is assumed that 90% of wells will have access to water from the mains;<br>• Deliveries of materials used in the fracturing fluid (other than raw water);<br>• Fracturing fluid pumps; and<br>• Removal of cuttings and spent drilling muds. |

[23] For more information on the calculation of vehicle movements please refer to **Table 4.7** in main report.

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| Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • (Possibly) re-fracturing. | | | Methane can be emitted from unconventional gas extraction during the fracturing stage. As the fracturing fluid comes back to the surface, it also contains natural gas. Standard practice is normally to flare the natural gas and direct the sand, water and other liquids into tanks. However, where there is a grid connection, it may be possible to export this gas.<br>In assessing the likely effect these activities would have on air quality, it is assumed that each production pad will be 2-3ha in size and there would be an average of 6-12 wells per pad for the low activity scenario and 12-24 wells per pad for the high activity scenario. In addition, the well may be re-fractured again in the future.<br>Bringing multiple wells per pad into production would cause a medium term continuation of the activities outlined above. As these activities would result in emissions from several different sources, it is likely that there would be a strong and sustained negative effect on local communities and biodiversity resulting in a significant increase in air pollution and particulate deposition.<br>A mixed score of minor negative and significant negative has been given to this stage due to the uncertainty on the sitting of well pads and the potential for significant negative effects in areas when sites are located within or immediately adjacent to areas with existing air quality issues.<br>**Low and High Activity Scenarios:**<br>The high activity scenario assumes a total of 1,440-2,880 wells. It can reasonably be expected that these wells would not all be produced simultaneously. Also, given that well pad sites are assumed to be more than 5km apart it is assumed that the potential for cumulative negative impacts on local air quality as a result of construction activities.<br>However, given the high number of vehicle trips to and from sites (expected to be 16-51 vehicle movements a day) these effects may not be limited to the immediate site vicinity and there may be potential for negative impact from HGV movements depending on routes.<br>Notwithstanding, it can be anticipated that regulatory controls through the Town and Country planning system and subsequent environmental permitting will ensure that these effects are not unacceptable. In this respect, Public Health England has recently published a review of the available evidence on potential public health impacts[24]. While noting that caution is required in extrapolating evidence from overseas into the UK context, they consider that the potential risks to public health from emissions to air are low if the operations are properly run and regulated. |

[24] Public Health England (2013) *Review of the Potential Public Health Impacts of Exposures to Chemical and Radioactive Pollutants as a Result of Shale Gas Extraction: Draft for Comment*, available from http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317140158707 [Accessed November 2013]

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| **Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Mitigation:**<br>• Air Quality Monitoring should be carried out on a continuous basis during this stage. While this will not prevent air pollution, per se, it will allow for early identification of any potential significant effects;<br>• Air emission specifications should be considered during all equipment selection and procurement;<br>• Vehicles and machinery could shut down their engines when stationery or not in use to reduce emissions;<br>• A Dust Suppression Plan could reduce the levels of dust that are caused by ground works.<br>**Assumptions**<br>• It is assumed that all plant and equipment on site would be run from internal combustion engines. Should electricity be available for use on site, the likelihood of significant effects would decrease as exhaust emissions would be lower;<br>• It is estimated that stage 3 will generate 16-51 vehicle movements a day over a 32-145 week period[25].<br>**Uncertainties:**<br>• None. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | - | - | **Assessment of Effects:**<br>Once the wells are operational, there is a risk that there would be ongoing fugitive losses of methane and other trace hydrocarbons via leakages from values, flanges, compressors etc. It has been assumed that there would be 50,000m$^3$ of methane emissions per well. On pads with multiple wells, this figure could rise to 600,000 m$^3$ for the entire pad site. Methane is known to contribute to ozone pollution. Evidence from the US also suggests that gases such as methane could leak from the well during production due to loss of well integrity[26] However, there is insufficient evidence to conclude the likelihood or quantities of gases that may be released (although it is expected to be minor, if at all). Furthermore, it is assumed that regular well integrity testing will prevent or mitigate against any loss of well integrity.<br>As under Stage 3, methane can be emitted from unconventional gas extraction during the re-fracturing stage. As the fracturing fluid comes back to the surface, it also contains natural gas. Standard practice is normally to flare the natural gas and direct the sand, water and other liquids into tanks. However, where there is a grid connection, it may be possible to export this gas. |

[25] For more information on the calculation of vehicle movements refer to table 4.7 in the Main Report

[26] Ingraffea, A. (2012). Fluid Migration Mechanisms Due to Faulty Well Design and/or Construction: An overview and Recent Experiences in the Pennsylvania and Marcellus Play. *PSE.*

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|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Transportation of materials and equipment and wastes from the site during the production and maintenance phase is expected to be minimal in the most part. However, re-fracturing would result in the need for HGV movements to deliver water, chemicals to site. This increase in vehicle movement may generate emissions from vehicles alongside local transport networks within rural areas. However, given the short term nature of this work, this is not expected to be significant.<br>Although there would still be activities occurring on site which would have adverse effects on air quality, the scale of activities would be considerably lower at this stage. Minor negative effects would be expected as the low level emission of certain pollutants over a long period of time (up to 20 years) may cause depositions that impact on certain habitats or other vulnerable receptors.<br>**Low and High Activity Scenarios:**<br>Additional activities associated with the higher number of pad site and wells under the high activity scenario would not be of a scale to result in significant effects.<br>**Mitigation:**<br>• Regular testing of well integrity during the production lifecycle;<br>• Due to the uncertainty of emissions to air during production due to well leakage it is suggested that Air Quality Monitoring should be carried out on a continuous basis during this stage. While this will not prevent air pollution, per se, it will allow for early identification of leakages/loss of well integrity.<br>**Assumptions**<br>• It is assumed that gas will be transported off the site via a pipeline and truck transportation will not be required;<br>• It is assumed that well blowouts would not occur for the purposes of this assessment.<br>**Uncertainties:**<br>• None. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **-/0** | **-** | **Assessment of Effects:**<br>The decommissioning of an unconventional gas well would be generally similar to the process used for a conventional oil and gas.<br>Activities which may affect local air quality would be primarily associated with vehicle movements to and from the site to removal plant, equipment, wastes and other materials. The total number of movements is unknown, however, it is assumed likely to be of a smaller scale than that in stage 2 (given that there will be no drilling activities or associated vehicle movements).<br>The plugging of the well would require some construction related activities but these would be of a small scale and short term in duration. |

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| Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Evidence from the US suggests that gases such as methane could leak from the well during production due to loss of well integrity[27] However, there is insufficient evidence to conclude the likelihood or quantities of gases that may be released (although it is expected to be minor, if at all). Furthermore, it is assumed that regular well integrity testing will prevent or mitigate against any loss of well integrity.<br>**Low and High Activity Scenarios:**<br>Under the high activity scenario, there would be considerably more wells to decommission (1,440-2,880 wells as opposed to 180-360 wells under the low activity scenario). Although the scale of works required to complete this activity is minor and generally restricted to vehicle movements, the decommissioning of up to 24 wells on a single pad would be likely to result in minor negative effects on air quality.<br>**Mitigation:**<br>• Transport Plans should be drafted up to reduce the number of trips required to remove materials and plant from the site;<br>• Low Emission Vehicles should be used if possible;<br>• Due to the uncertainty of emissions to air after production due to well leakage it is suggested that Air Quality Monitoring should be carried out. While this will not prevent air pollution, per se, it will allow for early identification of leakages/loss of well integrity.<br>**Assumptions:**<br>• It is assumed that wells will be sealed to the correct specifications to prevent fugitive emissions.<br>**Uncertainties:**<br>• None. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>The restoration of the site would involve a similar level of activity required to prepare the pad site. Large plant and machinery would be expected to be on site for a period of 2-4 weeks and there would be movements of earth and soil. This may give rise to dust depending on ground conditions, soil types and recent rainfall patterns. This would have a negligible effect on the air quality objective.<br>**Low and High Activity Scenarios:**<br>Under the high activity scenario, there would be considerably more pads sites to restore. However as the scale of works - required to complete his activity is minor, any effects on air quality would be short term and unlikely to lead to a decreases in local air quality. |

[27] Ingraffea, A. (2012). Fluid Migration Mechanisms Due to Faulty Well Design and/or Construction: An overview and Recent Experiences in the Pennsylvania and Marcellus Play. *PSE.*

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| Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Mitigation:**<br>• Dust suppressions practices should be adopted where necessary.<br>**Assumptions:**<br>• None.<br>**Uncertainties:**<br>• None. |

***Summary***

Similar to the assessment of the conventional oil and gas production stages, no positive effects are expected on the air quality objective for unconventional oil and gas. Stages 1 and 6 are not expected to give rise to any discernable effects on local air quality. Exploration drilling under the low activity scenario is expected to result in minor negative effects on air quality, primarily associated with emissions from on site plant and equipment, in conjunction with vehicle trips to and from the site. Locally significant adverse effects may be expected at Stage 2 for the high activity scenario as there is an increased likelihood of cumulative effects occurring. During Stage 4, the effects on air quality would also be minor in scale.

Locally significant adverse effects could also occur during Stage 3 as the use of multiple wells per pad will result in more emissions than associated with conventional oil and gas production. In addition, there would be a far greater number of vehicle trips to and from the site to deliver and remove materials, wastes, water (only in some instances). Multiple wells per pads also raises the likelihood of the movement of plant and machinery within the site boundary.

**Mitigation Summary**

- Vehicles and machinery could shut down their engines when stationery or not in use to reduce emissions
- Transport Plans could reduce the amount of trips made or the mileage that vehicles need to complete
- Low Emissions Vehicles should be used where possible
- Where possible, low sulphur fuels should be used for the engines of drilling rigs and fracturing equipment.

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 6.9 Virgin Coalbed Methane

The effects of exploration and production activities associated with virgin coalbed methane (VCBM) are similar to those described in the assessment of effects of unconventional oil and gas (Stages 1-6) in **Table 6.5** above, although fracturing is not normally required. No attempt has been made to provide an indication of low and high levels of activity.

VCBM exploration drilling and production sites are usually smaller than conventional and unconventional oil and gas drilling sites whilst commercially viable VCBM containing formations tend to be shallower

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(200-1,500m depth) and drilling times may therefore be relatively shorter **Error! Bookmark not defined.**. In consequence, it can be reasonably assumed that emissions to air arising from construction activities and drilling (per well) would be less than those associated with conventional and unconventional oil land gas exploration and production. However, it is recognised that this is dependent on site specific characteristics which are currently uncertain.

## 6.10 Gas Storage

The development of gas storage capacity is likely to entail the following activities:

1. Construction and Installation of Pipelines and Storage Facilities;
2. Storage operations; and
3. Decommissioning.

The likely effects of these activities are appraised in **Table 6.6.**

**Table 6.6 Assessment of Effects: Gas Storage**

| **Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives** | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| 1 | **Construction and Installation of Pipelines and Storage Facilities** | - | **Assessment of Effects:**<br>Construction activities would generate emissions to air. Sources of emissions would include construction traffic, plant and generators. There would also be additional emissions associated with transportation and treatment of wastes arising from construction activities.<br>Works may give rise to dust, particularly during periods of low rainfall.<br>The extent of emissions to air related to construction would be dependent on the number of facilities, site specific characteristics such as requirements for infrastructure including roads and the distance to be travelled by vehicles during the transportation of materials and wastes which are currently uncertain. However, gas storage projects under consideration in this SEA involve the use of depleted reservoirs, implying that some existing infrastructure is in place. The magnitude of effects on this objective would also be dependent on existing air quality and the proximity of sensitive receptors to construction sites and along HGV routes.<br>Overall, Stage 1 of the gas storage lifecycle has been assessed as having a minor negative effect on air quality.<br>**Mitigation:**<br>• Air emission specifications should be considered during all equipment selection and procurement;<br>• Vehicles and machinery could shut down their engines when stationery or not in use to reduce emissions; |

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| Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| | | | • A Dust Suppression Plan could reduce the levels of dust that are caused by ground works. The scale of the management plan would generally be dependent on local conditions and the presence of sensitive receptors.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• The extent to which HGVs will meet euro IV standard, or are fitted with catalytic convertors and particulate traps is uncertain;<br>• The magnitude of emissions to air related to construction would be dependent on the number of facilities, site specific characteristics such as requirements for infrastructure such as roads and the distance to be travelled by vehicles during the transportation of materials and wastes which are currently uncertain. |
| 2 | **Storage Operations** | - | During storage operations there would be emissions to air associated with power generation and combustion plant. Additionally, there would be expected to be further emissions from vehicle movements related to the transportation of maintenance workers and wastes to/from sites. However, it is not expected that emissions from these sources would be significant.<br>Once storage facilities are operational, a further source of emissions is likely to be fugitive methane and other trace hydrocarbons via leakages from on-site equipment including valves, flanges and compressors as well as from flaring and venting. However, DECC requires that flaring or venting during operation be kept to the minimum that is technically and economically justified.<br>Overall, Stage 2 of the gas storage lifecycle has been assessed as having a minor negative effect on this objective, although it is recognised that uncertainties exist particularly with respect to the number of facilities that might be operational.<br>**Mitigation:**<br>• Air Quality Monitoring should be carried out on a continuous basis during this stage. While this will not prevent air pollution, per se, it will allow for early identification of any potential significant effects;<br>• Air emission specifications should be considered during all equipment selection and procurement.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• Emissions associated with gas storage would be dependent on the number of operational facilities which is currently uncertain. |

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## Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives

| *Stage* | *Description* | *Score* | *Commentary* |
|---|---|---|---|
| 3 | **Decommissioning** | - | **Assessment of Effects:**<br>During decommissioning there would be emissions to air from machinery and plant as well as from construction traffic. There would also be emissions associated with the treatment of any waste arisings. The magnitude of effects would be dependent on existing air quality and the proximity of sensitive receptors, although it is not anticipated that effects would be significant.<br>Overall, Stage 3 of the gas storage lifecycle has been assessed as having a minor negative effect on this objective, although it is recognised that uncertainties exist particularly with respect to the number of facilities that might require decommissioning.<br>**Mitigation:**<br>• Air emission specifications should be considered during all equipment selection and procurement;<br>• Vehicles and machinery could shut down their engines when stationery or not in use to reduce emissions<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• The extent to which HGVs will meet euro IV standard, or are fitted with catalytic convertors and particulate traps is uncertain. |

### *Summary*

The assessment has not identified any significant positive or significant negative effects on air quality. Construction activities during Stage 1 and also decommissioning (Stage 3) would generate emissions to air from sources including construction traffic, plant and generators. The exact magnitude of emissions related to construction would be dependent on the number of facilities, site specific characteristics such as requirements for infrastructure such as roads and the distance to be travelled by vehicles during the transportation of materials and wastes which are currently uncertain. However, gas storage projects under consideration in this SEA involve the use of depleted reservoirs, implying that some existing infrastructure is in place. The magnitude of effects would also be dependent on the existing air quality and the proximity of sensitive receptors.

Once storage facilities are operational, a further source of emissions to air is likely to be fugitive methane and other trace hydrocarbons via leakages from on-site equipment including valves, flanges and compressors as well as from flaring and venting. However, DECC requires that flaring or venting during operation be kept to the minimum that is technically and economically justified. In consequence, Stage 2 of the gas storage lifecycle has been assessed as having a minor negative effect on this objective, although it is recognised that uncertainties exist particularly with respect to the number of facilities that might be operational.

**Mitigation Summary:**

- Air emission specifications should be considered during all equipment selection and procurement.
- Vehicles and machinery could shut down their engines when stationery or not in use to reduce emissions
- A Dust Suppression Plan could reduce the levels of dust that are caused by ground works. The scale of the management plan would generally be dependent on local conditions and the presence of sensitive receptors.
- Air Quality Monitoring should be carried out on a continuous basis during this stage. While this will not prevent air pollution, per se, it will allow for early identification of any potential significant effects.

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could*

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| Objective 7: To minimise emissions of pollutant gases and particulates and enhance air quality, helping to achieve the objectives of the Air Quality, Ambient Air and Cleaner Air for Europe Directives | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| *be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.* | | | |
| *S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)* | | | |

## 6.11 SEA Areas

The following sections consider in-turn the potential effects of Licensing Plan activities on the air quality objective in the five SEA Areas. The assessment draws on the findings presented in **Table 6.4** and **Table 6.5** above and takes account of the environmental characteristics of the areas as detailed in **Section 6.4.**

### 6.11.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

#### Conventional Oil and Gas

Existing air quality issues in SEA Area 1 are primarily as a result of vehicle emissions in the urban conurbations, particularly Glasgow and Edinburgh and the road networks between urban areas. While it is unlikely that conventional oil and gas operations would be undertaken in densely populated urban areas, a review of exploratory wells in the region and significant oil and gas discoveries indicates that reserves in this region tend to be in close proximity to the Edinburgh, Glasgow and Grangemouth areas. Although no significant effects have been identified in the assessment, conventional oil and gas production in some areas of SEA Area 1 would contribute to additional air pollution in areas with high ambient levels.

#### Unconventional Oil and Gas

DECC's Shale Gas Basins Report indicates that the outcrop of formations with the best shale gas potential lie primarily over Glasgow, West Edinburgh and the southern Fife coast. These areas tend to have the highest levels of air pollution in Scotland. While there is an excellent road transport network in this region, on site activities, particularly during Stages 2 and 3 would result in significant adverse effects on air quality in a region with existing high levels of pollution. In addition, the region is highly populated. Cumulative effects would also be likely where sites are developed in close proximity during overlapping timeframes.

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### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 1 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

Gas Storage in this area is not likely in additional issues other than those identified in **Tables 6.4 and 6.5** with regards to the air quality objectives.

## 6.11.2 SEA Area 2: West Midlands, North West England and Southern Scotland

### Conventional Oil and Gas

Air Quality in SEA Area 2 varies. Rural regions in Scotland and the North West generally have good air quality while there are several areas with elevated $NO_2$ levels. Conventional oil and gas operations in the vicinity of Air Quality Management Areas, or in areas with elevated levels of key pollutants, will exacerbate efforts to reach air quality targets. Cumulative effects are generally not expected, given that the high activity scenario envisages only six pad sites nationally.

### Unconventional Oil and Gas

Cumulative effects are more likely to occur for unconventional oil and gas production, particularly in the West Lancashire Basin and the Cheshire Basin. Activities in areas with existing poor air quality would be more likely to result in significant effects.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 2 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

Gas Storage in this area is not likely in additional issues other than those identified in **Tables 6.4 and 6.5** with regards to the air quality objectives.

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## 6.11.3 SEA Area 3: East Midlands and Eastern England

### Conventional Oil and Gas

Conventional wells in SEA Area 3 have historically focused on an area between Sheffield, Lincoln and Nottingham and an area between Hull and Middlesbrough. The area between Hull and Middlesbrough is likely to have low air quality pollution levels and major emissions would tend to be associated with large energy or industrial facilities. The area in the East Midlands suffers from poor air quality due to vehicle emissions. The area is generally heavily populated and has strong transport links. In general, production in rural areas is unlikely to give rise to significant effects. However, production in areas with high ambient levels may result in a failure to reach short term air quality objective levels. Long term effects are unlikely, as most effects are expected for the exploratory drilling and production development stages.

### Unconventional Oil and Gas

Unconventional oil and gas activities have a higher potential to result in cumulative effects in this region. The production of multiple pad sites in close vicinity would be likely to have localised adverse effects. These effects may be significant in areas close to transport corridors, or urban areas. Production in rural areas would result in higher emissions overall but good ambient air quality levels can be reasonably expected in rural areas. Effects in more southern regions of SEA Area 3 may be amplified by high sunshine levels and low average wind speeds, which generally worsen air quality.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 3 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

Gas Storage in this area is not likely in additional issues other than those identified in **Tables 6.4 and 6.5** with regards to the air quality objectives.

## 6.11.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

### Conventional Oil and Gas

Air Quality in SEA Area 4 is generally poor as a result of high levels of emissions associated with vehicle emissions. Conventional oil and gas production would result in further emissions in this area. Whether these emissions are likely to result in significant effects would depend of the exact location of production pads.

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### Unconventional Oil and Gas

Unconventional oil and gas production in SEA Area 4 would result in high levels of emissions from multiple sources on pad sites in areas which generally suffer from the worst air quality in Wales. In addition to high ambient levels, the population density of SEA Area 4 is high and local communities would be expected to be affected. As with other SEA Areas, there is a risk that cumulative effects would occur in this area, particularly under the high activity scenario.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 4 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

Gas Storage in this area is not likely in additional issues other than those identified in **Tables 6.4 and 6.5** with regards to the air quality objectives.

## 6.11.5 SEA Area 5: Southern and South West England

### Conventional Oil and Gas

AQMAs in SEA Area 5 tend to be focused in principal urban areas or densely populated sections of the London Commuter Belt. Conventional oil and gas production outside of these areas is likely to take place is regions which meet short term and long term air quality objectives. Although SEA Area 5 is generally perceived as highly populated, there are regions with low population levels. Some of these sparsely populated areas are designated for landscape of biodiversity features (New Forest, North Wessex Downs, etc.).

### Unconventional Oil and Gas

Similar to conventional production, unconventional oil and gas production in SEA Area 5 is more likely to encounter high levels of existing air pollution in urban areas, major transport arteries or large energy/ infrastructure facilities (such as Gatwick Airport, Dover Docks, etc.). Cumulative effects in rural areas may result in short term to medium term adverse effects.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 5 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

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## Gas Storage

Gas Storage in this area is not likely in additional issues other than those identified in **Tables 6.4 and 6.5** with regards to the air quality objectives.

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# 7. Climate Change

## 7.1 Introduction

The overview of plans and programmes and baseline information contained in this section provides the context for the assessment of potential effects of the proposals on climate change. Information is presented for both national and regional levels.

Climate change within this context in concerned with increasing the likelihood of climate change effects through greenhouse gas emissions, and the ability to adapt to the effects of climate change such as the occurrence of more extreme weather events.

There are links between the climate change and other topics in the SEA, specifically biodiversity and nature conservation, water, human health and air.

## 7.2 Review of Plans and Programmes

### 7.2.1 International/European

The ***United Nations Framework Convention on Climate Change*** (UNFCCC) sets an overall framework for international action to tackle the challenges posed by climate change. The Convention sets an ultimate objective of stabilising greenhouse gas concentrations *"at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system."* The Convention requires the development and regular update of greenhouse gas emissions inventories from industrialised countries, with developing countries also being encouraged to carry out inventories. The countries who have ratified the Treaty, known as the Parties to the Convention, agree to take climate change into account in such matters as agriculture, industry, energy, natural resources and where activities involve coastal regions. The Parties also agree to develop national programmes to slow climate change.

The ***Kyoto Protocol***, adopted in 1997, is the key international mechanism agreed to reduce emissions of greenhouse gases. The Kyoto Protocol sets binding targets for 37 industrialised countries and the European Community for reducing greenhouse gas emissions. These targets equate to an average of 5% reductions relative to 1990 levels over the five-year period 2008-12. The key distinction between this and the UNFCCC is that the Convention encourages nations to stabilise greenhouse gases while the Kyoto Protocol commits them to doing so through greenhouse gas reductions. Countries must meet their targets primarily through national measures however, the Kyoto Protocol offers them an additional means of meeting their targets by way of three market-based mechanisms: emissions trading, the clean development mechanism (CDM) and Joint Implementation (JI).

The Protocol's first commitment period started in 2008 and ends in 2012. At the Durban conference in

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December 2011, governments decided that the Kyoto Protocol would move into a second commitment period in 2013, in a seamless transition from the end of the second commitment period in 2012. Governments of Parties to the Kyoto Protocol also made a few amendments to the Protocol, among others, the range of greenhouse gases covered. A major outcome of was the establishment of the Durban Platform for Enhanced Action, which spelt out a path to negotiate a new legal and universal emission reduction agreement by 2015, to be adopted by 2020.

In March 2007 the EU's leaders endorsed an integrated approach to climate and energy policy that aims to combat climate change and increase the EU's energy security while strengthening its competitiveness. They committed Europe to transforming itself into a highly energy-efficient, low carbon economy. It set a series of demanding climate and energy targets to be met by 2020, known as the "20-20-20" targets. These are:

- a reduction in EU greenhouse gas emissions of at least 20% below 1990 levels;
- 20% of EU energy consumption to come from renewable resources; and
- a 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency.

To secure a reduction in EU greenhouse gases, the ***EU Emissions Trading Scheme (EU ETS),*** a Europe wide scheme had been introduced in 2005. EU ETS puts a price on carbon that businesses use and creates a market for carbon. It allows countries that have emission units to spare (emissions permitted to them but not "used") to sell this excess capacity to countries which are likely to exceed their own targets. Since carbon dioxide ($CO_2$) is the principal greenhouse gas, this is often described as a carbon market or trading in carbon; the total amount of carbon emissions within the trading scheme being limited, and reduced over time. The ***Integrated Climate and Energy Package*** included a revision and strengthening of the Emissions Trading System (ETS). A single EU-wide cap on emission allowances will apply from 2013 and will be cut annually, reducing the number of allowances available to businesses to 21% below the 2005 level in 2020. The free allocation of allowances will be progressively replaced by auctioning, and the sectors and gases covered by the system will be somewhat expanded.

The ***EU Sixth Environmental Action Plan (EAP) (2002-2012)*** reviews the significant environmental challenges and provides a framework for European environmental policy up to 2012. The four priority areas are Climate Change; Nature and Biodiversity; Environment and Health; Natural Resources and Waste. The European Commission has recently consulted on the EU environment policy priorities for 2020: Towards a 7$^{th}$ EU Environment Action Programme. This looks to further integrating climate and environment into other policies and instruments.

**The Renewable Energy Directive (2009/28/EC)** mandates levels of renewable energy use within the European Union. The directive requires EU member states to produce a pre-agreed proportion of energy consumption from renewable sources such that the EU as a whole shall obtain at least 20% of total energy consumption from renewables by 2020. This is then apportioned across member states.

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The UK's target is for 15% of energy consumption in 2020 to be from renewable sources. Under Article 4 of the directive each Member State is also required to complete a National Renewable Energy Action Plan that will set out the trajectory and measures that will enable the target to be met.

### 7.2.2 UK

In the UK, the ***Climate Change Act (2008)*** introduces legislative targets for reducing the UK's impacts on climate change and the need to prepare for its now inevitable impacts. The Act sets binding targets for a reduction in $CO_2$ emissions of 80% by 2050, compared to a 1990 baseline. Interim targets and five-year carbon budget periods will be used to ensure progress towards the 2050 target. The Climate Change Act 2008 also requires the Government, on a regular basis, to assess the risks to the UK from the impact of climate change and report to Parliament. The first ***Climate Change Risk Assessment*** was published in 2012. Government will be required to publish and regularly update a programme setting out how the UK will address these likely impacts, based on the principles of sustainable development, thereby ensuring that environmental, economic and social issues are all fully considered. The Climate Change Act 2008 also introduced powers for Government to require public bodies and statutory undertakers (in this context these are utilities companies which provide a public service) to carry out their own risk assessments and make plans to address those risks.

The ***Carbon Plan: Delivering our low carbon future (2011)*** sets out how the UK will achieve decarbonisation within the framework of energy policy: to make the transition to a low carbon economy while maintaining energy security, and minimising costs to consumers, particularly those in poorer households. It includes proposals for energy efficiency, heating, transport and industry.

The ***Energy Act 2011*** provides for some of the key elements of the Government's energy programme and including a step change in the provision of energy efficiency measures to homes and businesses. It also makes improvements to the framework for enabling and securing low carbon energy supplies and fair competition in the energy markets.

Gas is expected to retain a key role in electricity generation, as well as remaining a dominant fuel for domestic heating and a major fuel source for industry. The UK Government published its ***Gas Generation Strategy*** in December 2012 setting out the important role gas has to play to maintain adequate capacity margins, meet demand and provide supply-side flexibility. The role of gas will be determined by the market, whilst keeping emissions within the limits set out in the Carbon Budgets. The Government expects a continued need for new investment in gas plant (up to 26GW could be required by 2030), and the objective of the Strategy is to reduce the uncertainty around gas generation for investors.

### 7.2.3 England & Wales

The **National Planning Policy Framework** (2012) (which does not apply in Wales) provides a set of core land-use planning principles that should underpin both plan-making and decision-taking. These

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include supporting "*the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change, and encourage the re-use of existing resources, including conversion of existing buildings, and encourage the use of renewable resources (for example, by the development of renewable energy)*". The Framework underlines that planning's role in tackling climate change is central to the economic, social and environmental dimensions of sustainable development. Local planning authorities are therefore expected to adopt proactive strategies to mitigate and adapt to climate change (in line with the objectives and provisions of the Climate Change Act 2008), taking full account of flood risk, coastal change and water supply and demand considerations.

To support the move to a low carbon future, local planning authorities are expected to plan for new development in locations and ways which reduce greenhouse gas emissions; actively support energy efficiency improvements to existing buildings and have a positive strategy to promote energy from renewable and low carbon sources. Local Plans are also expected to take account of climate change over the longer term, including factors such as flood risk, coastal change, water supply and changes to biodiversity and landscape. New development should be planned to avoid increased vulnerability to the range of impacts arising from climate change.

### 7.2.4 Scotland

#### Climate Change

The Climate Change (Scotland) Act 2009 sets an interim 42% reduction target for greenhouse gases by 2020, increasing to 80% by 2050 on 1990 levels. This covers the basket of six greenhouse gases recognised by the United Nations Framework Convention on Climate Change, and includes Scotland's share of emissions from international aviation and international shipping.

## 7.3 Overview of the Baseline

### 7.3.1 UK

The UK is presently influenced by predominantly westerly tracking storm systems throughout the year. Variations in temperature, precipitation and wind speeds may be partly accounted for by exposure, latitude and altitude. The surrounding seas also have a significant effect on the national and local weather conditions. The temperatures of air masses reaching the UK have been modified by the ocean such that the UK tends to experience lower summer temperatures than mainland Europe, but milder winters. In the recent past, the Central England temperature has risen ~1°C since 1970, and Scottish temperatures have risen 0.8°C since the 1980.

Future trajectories are uncertain, but UK specific scenarios based on current information are presented in the most recent (UKCP09) work by the UK Climate Impacts Programme (UKCIP). In 2011, UK emissions of the basket of six greenhouse gases covered by the Kyoto Protocol were estimated to be

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552.6 million tonnes carbon dioxide equivalent ($MtCO_2e$)[1]. This was 7.0% lower than the 2010 figure of 594.0 million tonnes. Between 2010 and 2011 the largest decreases were experienced in the residential sector, down 22.5% (20.2 $MtCO_2e$), and the energy supply sector, down by 6.5% (13.3$MtCO_2e$). Emissions from the business, transport, industrial process and public sectors were also down slightly on 2010, but all other sectors were relatively stable compared to 2010 levels.

All areas of the UK are getting warmer, and the warming is greater in summer than in winter[2]. There is little change in the amount of precipitation (rain, hail, snow, etc.) that falls annually, but more is falling in the winter, with drier summers, for much of the UK. Sea levels are rising, and are greater in the South of the UK than the North. Widespread flooding events cannot be directly attributed to climate change but it is expected to see more extreme rainfall events in the future, and hence more flooding as the climate changes.

The main source for determining how the climate of the UK may change is the UK Climate Impacts Programme scenarios, published in 2009 and known as UKCP09. The UKCP09 findings indicate that all areas of the UK are getting warmer, and the warming is greater in summer than in winter. There is little change in the amount of precipitation (rain, hail, snow, etc.) that falls annually, but more is falling in the winter, with drier summers, for much of the UK. Sea levels are rising, and are greater in the south of the UK than the north.

The UK is experiencing sea level rise of approximately 1mm per year. Global sea-level is rising at about 3mm per year[3]. Central England's temperature has risen by about 0.7ºC over the last century, with 2004 being the warmest on record[4]. Sea-surface temperatures around the UK coast have risen over the past three decades by about 0.7ºC. Global average temperatures are rising at about 0.2ºC per decade. Severe windstorms around the UK have become more frequent in the past few decades, though not above that seen in the 1920s. Annual mean precipitation over England and Wales has not changed significantly since records began; however seasonal rainfall appears to be decreasing in summer and increasing in winter.

### *Emissions by Sector[5]*

Carbon dioxide ($CO_2$) is the main greenhouse gas, accounting for about 83% of total UK greenhouse gas emissions in 2011, the latest year for which final results are available. In 2012, UK net emissions of carbon dioxide were provisionally estimated to be 479.1 million tonnes (Mt). This was 4.5% higher than the 2011 figure of 458.6 Mt.

[1]DECC Statistical Release February 2013
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/180823/ghg_national_statistics_release_2011_final_results.pdf

[3] Defra, Environment in your Pocket Statistics, 2009, http://www.defra.gov.uk/evidence/statistics/environment/eiyp/

[5] http://naei.defra.gov.uk/overview/ghg-overview

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Between 2011 and 2012, there were increases in $CO_2$ emissions from most of the main sectors. The provisional estimates show increases in emissions of 5.5% (9.9 Mt) from the energy supply sector, 11.8% (7.8 Mt) from the residential sector, and 4.8% (3.6 Mt) from the business sector. Emissions from the transport sector were down by 1.2% (1.4 Mt) from 2011. All these sectoral breakdowns are based on the source of the emissions, as opposed to where the end-user activity occurred. Emissions related to electricity generation are therefore attributed to power stations, the source of these emissions, rather than homes and businesses where electricity is used. The increase in $CO_2$ emissions between 2011 and 2012 resulted primarily from lower use of gas and greater use of coal for electricity generation at power stations, combined with an increase in residential gas use. The GHG inventory covers the six direct greenhouse gases under the Kyoto Protocol:

- Carbon dioxide ($CO_2$);
- Methane ($CH_4$);
- Nitrous oxide ($N_2O$);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and
- Sulphur hexafluoride ($SF_6$).

These gases contribute directly to climate change owing to their positive radiative forcing effect. HFCs, PFCs and $SF_6$ are collectively known as the 'F-gases'. In general terms, the largest contributor to global warming is carbon dioxide which makes it the focus of many climate change initiatives. Methane and nitrous oxide contribute to a smaller proportion, typically <10%, and the contribution of F-gases is even smaller (in spite of their high Global Warming Potentials) at <5% of the total.

The largest source is the combustion of fossil fuels in the energy sector, typically approximately 85% of total emissions. Emissions of $CO_2$, $CH_4$ and $N_2O$ arise from this sector. Energy sector emissions have declined since the base year of 1990, primarily due to fuel switching to less carbon-intensive energy sources (e.g. coal to gas in the power sector) and reduced energy intensity of the economy (e.g. declining iron and steel and metal production industries).

The second largest source of greenhouse gases in the UK is the agricultural sector at up to 10% of total emissions. Emissions from this sector arise for both $CH_4$ and $N_2O$. Since 1990, emissions from this sector have declined due to a reduction in livestock numbers, changes in the management of manure and restrictions in the use of synthetic fertiliser.

Industrial processes sector makes up the third largest source of greenhouse gases in the UK, contributing to up to 5% of the national total. Emissions of all six direct greenhouse gases occur from this sector. Emissions from this sector include non-energy related emissions from the production and use of cement and lime, chemical industry and metal production as well as F-gases from refrigeration, air

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conditioning and other industrial and product use. Since 1990, this category has seen a large decline in emissions, mostly due to a reduction in bulk chemical production and metal processing industries and due to changes in process.

The Land Use, Land Use Change and Forestry (LULUCF) sector contains absorbers (sinks) as well as sources of $CO_2$ emissions. LULUCF has been a net sink since 2001. Emissions from this source occur for $CO_2$, $N_2O$ and $CH_4$ from clearing of forests and vegetation, flooding of land and from application of fertilizers and lime.

Emissions from the waste sector contributed to <3% to greenhouse gas emissions, the majority from $CH_4$ from solid waste disposal on land. Overall emissions from the waste sector have decreased since 1990, mostly due to the implementation of methane recovery systems at UK landfill sites, and reductions in the amount of waste disposed of at landfill sites.

### 7.3.2 England and Wales

According to UKCIP[6], average UK temperature has risen since the mid 20th Century, as have average sea level and sea surface temperature around the UK coast. Over the same time period, trends in precipitation are harder to identify. However, the following observations can be made:

- Central England Temperature has risen by about a degree Celsius since the 1970s, with 2006 being the warmest on record. All regions of the UK have experienced an increase in average temperatures between 1961 and 2006 annually, and for all seasons. Increases in annual average temperature are typically between 1.0 and 1.7°C, tending to be largest in the south and east of England and smallest in Scotland;
- All regions of the UK have experienced an increase over the past 45 years in the contribution to winter rainfall from heavy precipitation events; in summer all regions except north east England and north Scotland show decreases;
- Severe windstorms around the UK have become more frequent in the past few decades, though not above that seen in the 1920s;
- There has been considerable variability in the North Atlantic Oscillation, but with no significant trend over the past few decades;
- Sea-surface temperatures around the UK coast have risen over the past three decades by about 0.7ºC;
- Sea level around the UK rose by about 1 mm/yr in the 20th Century, corrected for land movement. The rate for the 1990s and 2000s has been higher than this;

[6] http://www.ukcip.org.uk/essentials/climate-trends/

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- The annual number of days with air frost has reduced in all regions of the UK between 1961 and 2006. There are now typically between 20 and 30 fewer days of air frost per year, compared to the 1960s, with the largest reductions in northern England and Scotland;

- There has been a decrease in the average number of Heating Degree Days (HDD), and an increase in the average number of Cooling Degree Days (CDD) in all administrative regions of the UK as a whole, between 1961 and 2006;

- There has been a slight increase in average annual precipitation in all regions of the UK between 1961 and 2006, however this trend is only statistically significant above background natural variation in Scotland where an increase of around 20% has been observed. Likewise, for an increase in average winter is only statistically significant in northern England and Scotland where increases of 30-65% have been experienced; and

- Average annual and seasonal relative humidity has decreased in all regions of the UK, except Northern Ireland, between 1961 and 2006, by up to 5%.

### 7.3.3 Scotland

A report from the Scottish Government[7] sets out the following observations on the current state of greenhouse gas emissions in the country.

In 2010, Scottish emissions of the basket of six greenhouse gases are estimated to be 55.7 million tonnes carbon dioxide equivalent ($MtCO_2e$). This is 5.8% higher than the 2009 figure of 52.7 $MtCO_2e$, a 3.1 increase. Between 1990 and 2010, there was a 22.8% reduction in emissions.

When emissions are adjusted to take into account of trading in the EU Emissions Trading System (EU ETS), emissions increased by 1.9% between 2009 and 2010 (from 53.687 $MtCO_2e$ to 54.714 $MtCO_2e$). Compared with the 1990 base year, emissions in 2010 (after taking account of trading in the EU ETS) were 24.3% lower. The annual target for 2010, as published in the Climate Change (Annual Targets) (Scotland) Order 2010, is 53.652 $MtCO_2e$. The target is assessed using the adjusted emissions.

Between 2009 and 2010, there were large increases in greenhouse gas emissions in the energy supply and residential sectors, of 2.2 and 1.1 $MtCO_2e$ respectively (increases of 12 and 15%). This was primarily due to a rise in fossil fuel heating in the residential sector, combined with an increase in electricity generation from coal fired power stations. Emissions from the residential and public sectors are affected by changes in weather among other factors. 2010 was, on average, the tenth coldest in the period since 1910. In particular, the average temperature for the six months January-March and October-December was the coldest since 1919.

Net removals from the forestry sector reduced in size from 10.0 $MtCO_2e$ to 9.6 $MtCO_2e$ (a 4% reduction and 0.4 $MtCO_2e$ decrease) between 2009 and 2010. There were increases in emissions of 2% from the business and industrial process sector (0.1 $MtCO_2e$) while the public sector saw a 3% rise (0.03

[7] http://www.scotland.gov.uk/Publications/2012/07/9583

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$MtCO_2e$). International aviation and shipping showed the largest per cent reduction in emissions at 12% (down 0.3 $MtCO_2e$). Net emissions from agriculture and related land use and waste management both decreased by 3% (0.3 $MtCO_2e$ and 0.1 $MtCO_2e$ respectively), while transport (excluding international aviation and shipping) and development emissions both reduced by 1% (0.1 $MtCO_2e$ and 0.01 $MtCO_2e$ respectively).

Since 1990, emissions from transport (excluding international aviation and shipping) have increased by 0.2 $MtCO_2e$ (2%). Residential emissions also saw an increase of 0.2 $MtCO_2e$, a 3% increase since 1990. The largest absolute reduction was for the business and industrial process sector at 5.3 $MtCO_2e$, a 40% reduction. Other sectors with significant reductions are waste management down 4.4 $MtCO_2e$ (67% reduction), agriculture and related land use down 3.8 $MtCO_2e$ (27%), energy supply down 1.6 $MtCO_2e$ (7%) and public down 0.4 $MtCO_2e$ (29%). Development emissions decreased by 0.2 $MtCO_2e$ (9%) and emissions from international aviation and shipping decreased by 0.02 $MtCO_2e$ (1%). Net removals from forestry increased by 1.3 $MtCO_2e$; 15% more than removed in 1990.

Carbon dioxide is the main greenhouse gas, accounting for around 79% of Scottish greenhouse gas emissions in 2010 equating to 43.8 $MtCO_2$. This was 7.6% higher than the 2009 figure of 40.7 $MtCO_2$. Since 1990, emissions of carbon dioxide have fallen by 18% and emissions of the other greenhouse gases (methane, nitrous oxide and F-gases) have fallen by 37%.

## 7.4 Key Environmental Characteristics of those Areas most likely to be Significantly Affected

The UKCP09 findings indicate that all areas of the UK are getting warmer, and the warming is greater in summer than in winter. There is little change in the amount of precipitation (rain, hail, snow etc) that falls annually, but more is falling in the winter, with drier summers, for much of the UK. Sea levels are rising, and are greater in the south of the UK than the north[8]. However, some areas, such as the east coast and the Humber Estuary, are particularly vulnerable both to sea level rise and increased flood risk associated with climate change, as the floods of the Year 2000 across Yorkshire and the Humber illustrate.

The Climate Change Risk Assessment[9] (2012) outlines some of the most important risks and opportunities that climate change may present. It provides an indication of their potential magnitude, when they might become significant and the level of confidence in each finding. As well as the overall picture, specific findings are presented for five complementary themes: Agriculture & Forestry, Business, Health & Wellbeing, Buildings & Infrastructure and the Natural Environment. Key messages from the assessment include:

[8] DECC (2007) http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/loc_reg_dev/ni185_186/ni185_186.aspx
[9] Defra (2012) http://randd.defra.gov.uk/Document.aspx?Document=Summary_of_Key_Findings.pdf

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- Flood risk is projected to increase significantly across the UK. Increases in the frequency of flooding would affect people's homes and wellbeing, especially for vulnerable groups (e.g. those affected by poverty, older people, people in poor health and those with disabilities), and the operation of businesses and critical infrastructure systems. Annual damage to UK properties due to flooding from rivers and the sea currently totals around £1.3 billion. For England and Wales alone, the figure is projected to rise to between £2.1 billion and £12 billion by the 2080s, based on future population growth and if no adaptive action is taken;
- UK water resources are projected to come under increased pressure. This is a potential consequence of climate-driven changes in hydrological conditions, as well as population growth and the desire to improve the ecological status of rivers. By the 2050s, between 27 million and 59 million people in the UK may be living in areas affected by water supply-demand deficits (based on existing population levels). Adaptation action will be needed to increase water efficiency across all sectors and decrease levels of water abstraction in the summer months;
- Potentially, there are health benefits as well as threats related to climate change, affecting the most vulnerable groups in our society. These are likely to place different burdens on National Health Service (NHS), public health and social care services. For example, premature deaths due to cold winters are projected to decrease significantly (e.g. by between 3,900 and 24,000 by the 2050s) and premature deaths due to hotter summers are projected to increase (e.g. by between 580 and 5,900 by the 2050s). Other health risks that may increase include problems caused by ground-level ozone and by marine and freshwater pathogens;
- Sensitive ecosystems are likely to come under increasing pressure. Although some species could benefit, many more would be negatively impacted. These impacts would have knock-on effects on habitats and on the goods and services that ecosystems provide (e.g. regulating water flows, pollination services).

The UK is experiencing sea level rise of approximately 1mm per year. Global sea-level is rising at about 3mm per year[10]. Central England's temperature has risen by about 0.7ºC over the last century, with 2004 being the warmest on record[11]. Sea-surface temperatures around the UK coast have risen over the past three decades by about 0.7ºC. Global average temperatures are rising at about 0.2ºC per decade. Severe windstorms around the UK have become more frequent in the past few decades, though not above that seen in the 1920s. Annual mean precipitation over England and Wales has not changed significantly since records began; however seasonal rainfall appears to be decreasing in summer and increasing in winter [10].

Key climate change include that the UK climate is warming and becoming more seasonal; climate changes are more pronounced in south east of the UK compared to the north west; sea levels are rising, and UK greenhouse gas emissions are falling with a target of an 80% cut in emissions by 2050 (compared to 1990 levels).

[10] Defra, Environment in your Pocket Statistics, 2009, http://www.defra.gov.uk/evidence/statistics/environment/eiyp/

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### 7.4.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

On average eastern Scotland received 1,135mm of rainfall a year with rainfall recorded on 159 days (1971-2000). Western Scotland received 1,732mm of rainfall a year over 189 days (1971-2000). December and January were the wettest months with about 120 and 195mm of rainfall in the east and west respectively.

UKCP09 presents climate change predictions for two regions which encompass the Scottish Midlands SEA area, that for West and East Scotland. The key climate change figures for mean seasonal temperature and precipitation for the medium emissions scenario [12] are given below for the 2050s (2040-69).

**Table 7.1 Climate Change Predictions (SEA Area 1)**

| Change in Mean Seasonal Figure | Scotland West | Scotland East |
|---|---|---|
| summer mean temperature | +2.4°C (+1.1-3.8°C) | +2.3°C (+1.1-3.9°C) |
| winter mean temperature | +1.9°C (+1-3°C) | +1.7°C (+0.7-2.9°C) |
| summer mean precipitation | -12% (-26-1%) | -12% (-26-1%) |
| winter mean precipitation | +15% (+5-28%) | +10% (+2-20%) |

Note: figures are central estimates relative to a baseline of 1971-2000, with the 10th and 90th percentile probability estimates indicated in brackets. Source: Murphy et al. (2009)

### 7.4.2 SEA Area 2: West Midlands, North West England and Southern Scotland

On average the Midlands received 785mm of rainfall a year with rainfall recorded on 130 days (1971-2000 average) with the North West receiving 1,290mm a year over 163 days (1971-2000 average). December and January were the wettest months with about 82mm in the Midlands and 147mm in North West. The table below indicates the changes in temperature and precipitation projected in UKCP09 for UK areas which form parts of the West Midlands and North West England SEA area for the 2050s (2040-2069), for the medium emissions scenario.

**Table 7.2 Climate Change Predictions (SEA Area 2)**

| Change in Mean Seasonal Figure | North West England |
|---|---|
| summer mean temperature | +2.6°C (1.2-4.1°C) |
| winter mean temperature | +2°C (+1-3°C) |

[12] Emission scenarios based on projections developed by the IPCC Special Report on Emissions Scenarios (SRES)

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| Change in Mean Seasonal Figure | North West England |
|---|---|
| summer mean precipitation | -17% (-34-1%) |
| winter mean precipitation | +13% (+3-26%) |

Note: figures are central estimates relative to a baseline of 1971-2000, with the 10th and 90th percentile probability estimates indicated in brackets. Source: Murphy et al. (2009)

### 7.4.3 SEA Area 3: East Midlands and Eastern England

On average the eastern and North East region received 755mm of rainfall a year with rainfall recorded on 129 days (1971-2000 average). East Anglia was drier receiving 605mm a year over 112 days (1971-2000). November and December were the wettest months in eastern and north eastern parts (about 76mm) with October and December wettest in East Anglia (about 59mm).

The table below indicates the change in temperatures and precipitation projected in UKCP09 for UK areas which form parts of the East Midlands and Eastern England SEA area for the 2050s (2040-69) under the medium emissions scenario.

**Table 7.3 Climate Change Predictions (SEA Area 3)**

| Change in Mean Seasonal Figure | North East England | Yorkshire & Humberside | East Midlands | East of England |
|---|---|---|---|---|
| summer mean temperature | +2.5°C (1.2-4.1°C) | +2.3°C (+1.1-3.9°C) | +2.5°C (+1.2-4.2°C) | +2.5°C (+1.2-4.3°C) |
| winter mean temperature | +2°C (+1-3.1°C) | +2.1°C (+1.1-3.3°C) | +2.2°C (+1.1-3.4°C) | +2.2°C (+1.1-3.4°C) |
| summer mean precipitation | +14% (-29-1%) | -17% (-35-1%) | -15% (-35-6%) | -16% (-37-6%) |
| winter mean precipitation | +11% (+1-24%) | +11% (+2-24%) | +14% (+2-29%) | +14% (+3-31%) |

Note: figures are central estimates relative to a baseline of 1971-2000, with the 10th and 90th percentile probability estimates indicated in brackets. Source: Murphy et al. (2009)

### 7.4.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

Rainfall figures for North Wales were included in those for the North West region which were 1,290mm a year over 163 days (1971-2000). Similarly figures for South Wales were included in those for South West England (1,247mm a year over 154 days). December and January are the wettest months with between 147-151mm of rainfall.

The table below indicates the change in temperatures and precipitation projected in UKCP09 for UK areas which form parts of the North and South Wales SEA area for the 2050s (2040-69) under the medium emissions scenario.

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**Table 7.4 Climate Change Predictions (SEA Area 4)**

| Change in Mean Seasonal Figure | Wales |
|---|---|
| summer mean temperature | +2.5°C (+1.2-4.1°C) |
| winter mean temperature | +2°C (+1.1-3.1°C) |
| summer mean precipitation | -16% (-36-6%) |
| winter mean precipitation | +14% (+2-30%) |

Note: figures are central estimates relative to a baseline of 1971-2000, with the 10th and 90th percentile probability estimates indicated in brackets. Source: Murphy et al. (2009)

### 7.4.5 SEA Area 5: Southern and South West England

The South West received 1,247mm of rain a year over 154 days (1971-2000 average) with central and eastern parts of the region receiving 776mm a year over 120 days (1971-2000 average). December and January were the wettest months in the South West (about 151mm) with October and December in more central and eastern areas (about 86mm) (Met Office website).

The table below indicates the changes in temperature and precipitation projected in UKCP09 for UK areas which form parts of the Southern and South West England SEA area for the 2050s (2040-69) under the medium emissions scenario.

**Table 7.5 Climate Change Predictions (SEA Area 5)**

| Change in Mean Seasonal Figure | South East England | South West England |
|---|---|---|
| summer mean temperature | +2.7°C (+1.3-4.6°C) | +2.7°C (+1.3-4.6°C) |
| winter mean temperature | +2.2°C (+1.1-3.4°C) | +2.1°C (+1.1-3.2°C) |
| summer mean precipitation | -18% (-40-7%) | -19% (-41-7%) |
| winter mean precipitation | +16% (+2-36%) | +17% (+4-38%) |

Note: figures are central estimates relative to a baseline of 1971-2000, with the 10th and 90th percentile probability estimates indicated in brackets. Source: Murphy et al. (2009)

## 7.5 Summary of Existing Problems Relevant to Onshore Oil and Gas Licensing

The following existing problems for Climate Change have been identified:

- The input of greenhouse gasses (e.g. $CO_2$, $CH_4$, $N_2O$, $O_3$) resulting from fossil fuel usage, agriculture and other land use have been linked with atmospheric warming and undesirable climate change;

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- Fossil fuel dependency remains high and is likely to remain so for some time;
- Legally binding EU and government targets (see: the Climate Change Act 2008 and subsequent revisions: The Climate Change Act 2008 (2020 Target, Credit Limit and Definitions) Order 2009, The Carbon Budgets Order 2009) seek to reduce emissions (based on a carbon budget of $MtCO_2$ equivalent) by 80% on 1990 levels by 2050, with an interim target of 34% by 2020; and
- Changes in temperature and rainfall patterns, along with more and more frequent extreme weather events creates the situation where a greater degree of resilience will have be incorporated into plans and proposals.

## 7.6 Likely Evolution of the United Kingdom Baseline

UKCP09 provides the following prediction on changes to climate within the UK based on the medium emission scenario with 90% probability[13]:

- **2080 mean winter temperature**: the central estimates of change are projected to be generally between 2 and 3ºC across most of the country, with slightly larger changes in the south-east and slightly smaller in the north-west of Britain;
- **2080 mean summer temperature**: a more pronounced south to north gradient exists with changes in some parts of southern England being just over 4ºC and in parts of northern Scotland about 2.5ºC;
- **2080 mean summer daily maximum temperature**: central estimates show a gradient between parts of southern England, where they can be 5ºC or more, and northern Scotland, where they can be somewhat less than 3ºC;
- **2080 mean annual precipitation**: shows little change (few percent or zero);
- **2080 mean winter precipitation:** increases are in the range +10 to +30% over the majority of the country. Increases are smaller than this in some parts of the country, generally on higher ground;
- **2080 mean summer precipitation**: general south to north gradient, from decreases of almost 40% in SW England to almost no change in Shetland;
- The range of absolute sea level rise around the UK (before land movements are included) and across the three emissions scenarios is projected to be between 12 and 76cm for the period 1990-2095, which is a wider spread than that of the global average;

[13] http://ukclimateprojections.defra.gov.uk/21708#key

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- The projected long-term future trends in storm surge that we find in UKCP09 are physically small everywhere around the UK, and in many places can be accounted for by natural variability. The surge level we expect to be exceeded on average once in 2, 10, 20 or 50 yr is not projected to increase by more than 9cm by 2100 anywhere around the UK coast (not including the mean sea level change). The largest trends are found in the Bristol Channel and Severn Estuary;

- Seasonal mean and extreme waves are generally expected to increase to the South West of the UK, reduce to the north of the UK and experience a small change in the southern North Sea. Changes in the winter mean wave height are projected to be between –35 and +5cm. Changes in the annual maxima are projected to be between –1.5 and +1m.

The Climate Change Act 2008 was passed in November 2008 and creates a new approach to managing and responding to climate change in the UK. This includes putting in place legally binding targets with the aim of reducing emissions by at least 80% by 2050 (compared to 1990 levels) and a set of five-year carbon budgets (legally binding limits on the total quantity of greenhouse gas emissions that the country produces over a five year period) to 2022. Included within the Fourth Carbon Budget the Committee on Climate Change is the recommendation for an indicative 2030 target to reduce emissions by 60% relative to 1990 levels (46% relative to 2009 levels)[14].

The Carbon Plan 2011 explains that if the UK is to cut emissions by 80% by 2050, there will have to be major changes in how energy is generated and used. In particular:

- Energy efficiency will have to increase dramatically across all sectors;

- The oil and gas used to drive cars, heat buildings and power industry will, in large part, need to be replaced by electricity, sustainable bioenergy, or hydrogen;

- Electricity will need to be decarbonised through renewable and nuclear power, and the use of carbon capture and storage (CCS);

- The electricity grid will be larger and smarter at balancing demand and supply. In the next decade, the UK is expected to complete the installation of proven and cost effective technologies that are worth installing under all future scenarios;

- All cavity walls and lofts in homes, where practicable, are expected to be insulated by 2020;

- The fuel efficiency of internal combustion engine cars will improve dramatically, with $CO_2$ emissions from new cars set to fall by around a third;

- Many of our existing coal-fired power stations will close, replaced primarily by gas and renewable;

[14] Committee on Climate Change (2010) Fourth Carbon Budget, http://www.theccc.org.uk/reports/fourth-carbon-budget

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- More efficient buildings and cars will cut fuel costs; and
- More diverse sources of electricity will improve energy security and reduce exposure to fossil fuel imports and price spikes.

As part of this evolution, the UK is committed to delivering 15% of its energy from renewable sources by 2020.

**Figure 7.1**, **Figure 7.2** and **Table 7.6** present projections for summer and winter temperature and precipitation for the 2050s (2040-2069) by administrative region, as defined in Murphy *et al.* (2009). Though impractical to reproduce all the relevant figures here, please refer to the UKCP09 technical website[15] for more information.

[15] (http://ukclimateprojections.defra.gov.uk/)

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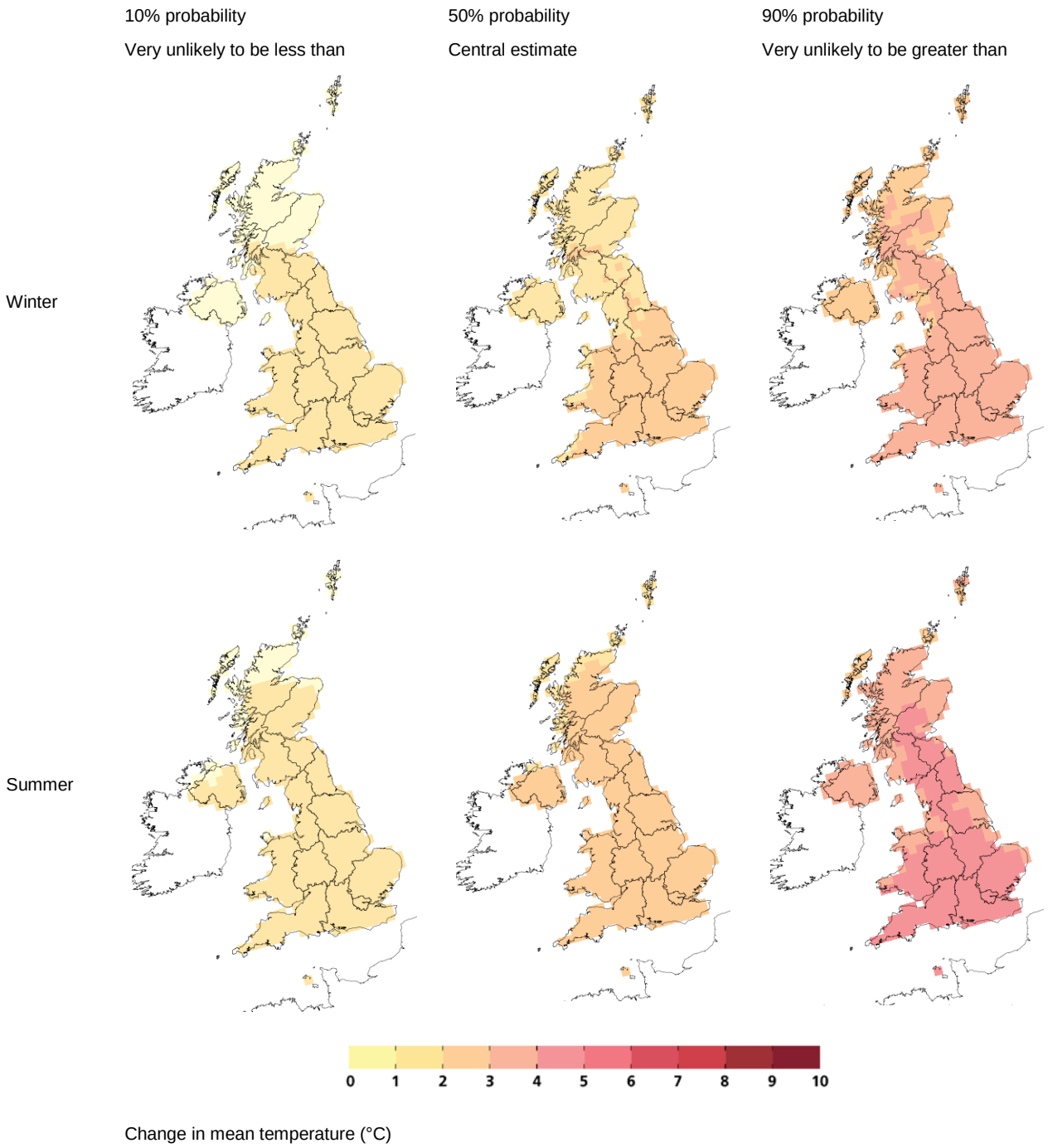
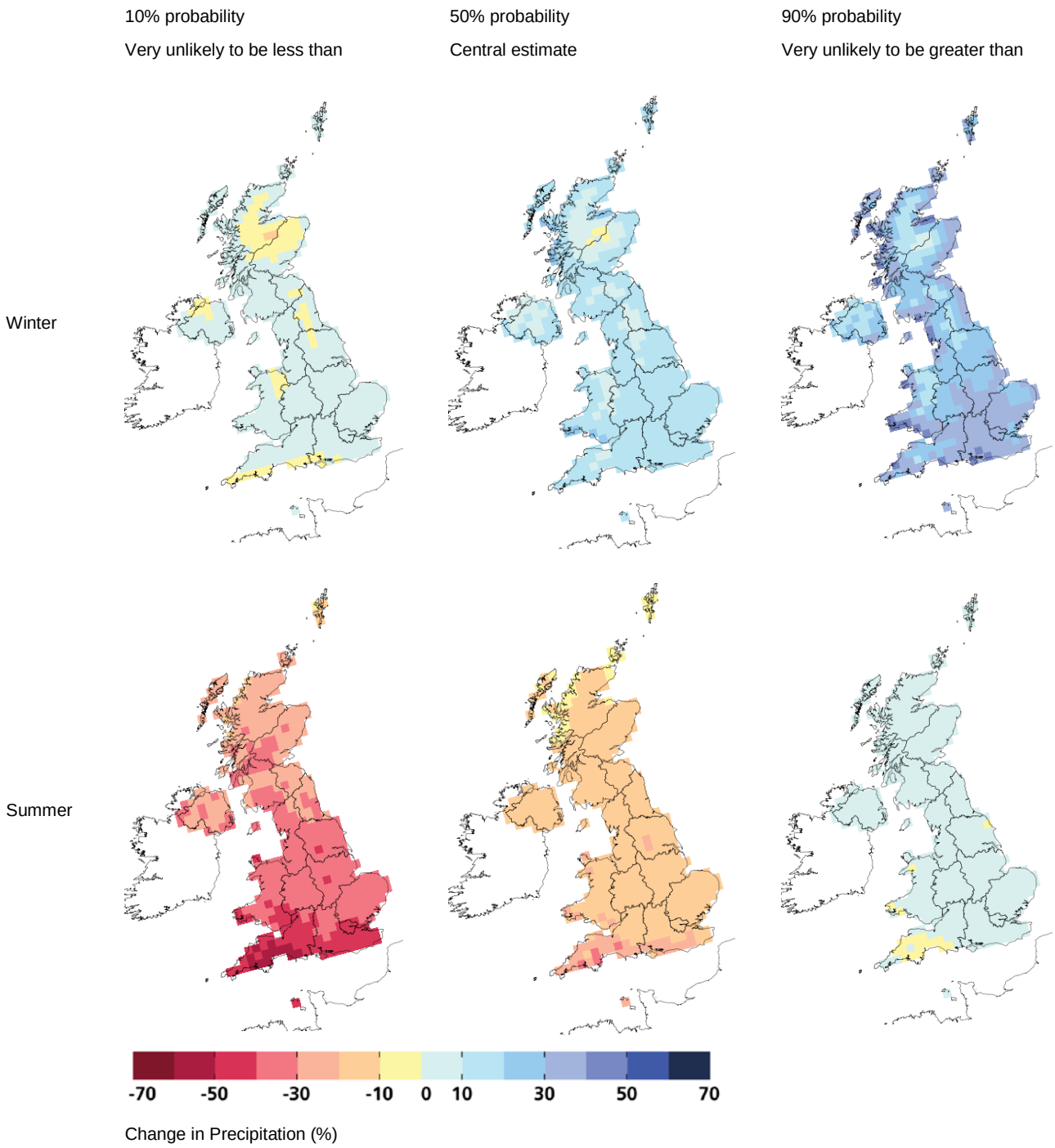
**Figure 7.1 Mean Seasonal Probabilistic Temperature Projections for the 2050s, based on the Medium Emissions Scenario**




*©Crown Copyright 2009*
*Source: UKCP user interface (http://ukclimateprojections-ui.defra.gov.uk/ui/)*
*Note: grid size 25x25km, figures are relative to the 1961-1990 baseline dataset*

**Figure 7.2 Mean Seasonal Probabilistic Precipitation Projections for the 2050s, based on the Medium Emissions Scenario**




*©Crown Copyright 2009*
*Source: UKCP user interface (http://ukclimateprojections-ui.defra.gov.uk/ui/)*
*Note: grid size 25x25km, figures are relative to the 1961-1990 baseline dataset*

**Table 7.6 Highest and Lowest Changes in Mean Summer and Winter Temperature (°C) and Precipitation (%) by the 2050s, Relative to 1961-1990 for the Medium Emissions Scenario**

| Variable | Mean Winter Temperature | | | Mean Summer Temperature | | | Mean Winter Precipitation | | | Mean Summer Precipitation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Probability level (%) | 10 | 50 | 90 | 10 | 50 | 90 | 10 | 50 | 90 | 10 | 50 | 90 |
| North Scotland | 0.6 | 1.7 | 2.8 | 0.9 | 2 | 3.4 | 3 | 13 | 24 | –23 | –10 | 2 |
| East Scotland | 0.7 | 1.7 | 2.9 | 1.1 | 2.3 | 3.9 | 2 | 10 | 20 | –26 | –12 | 1 |
| West Scotland | 1 | 1.9 | 3 | 1.1 | 2.4 | 3.8 | 5 | 15 | 28 | –26 | –12 | 1 |
| NE England | 1 | 2 | 3.1 | 1.2 | 2.5 | 4.1 | 1 | 11 | 24 | –29 | –14 | 1 |
| NW England | 1 | 2 | 3 | 1.2 | 2.6 | 4.1 | 3 | 13 | 26 | –34 | –17 | 1 |
| Yorkshire & Humber | 1.1 | 2.1 | 3.3 | 1.1 | 2.3 | 3.9 | 2 | 11 | 24 | –35 | –17 | 1 |
| East Midlands | 1.1 | 2.2 | 3.4 | 1.2 | 2.5 | 4.2 | 2 | 14 | 29 | –35 | –15 | 6 |
| West Midlands | 1.2 | 2.1 | 3.2 | 1.2 | 2.6 | 4.4 | 2 | 13 | 28 | –36 | –16 | 6 |
| Wales | 1.1 | 2 | 3.1 | 1.2 | 2.5 | 4.1 | 2 | 14 | 30 | –36 | –16 | 6 |
| East England | 1.1 | 2.2 | 3.4 | 1.2 | 2.5 | 4.3 | 3 | 14 | 31 | –37 | –16 | 6 |
| London | 1.2 | 2.2 | 3.5 | 1.3 | 2.7 | 4.6 | 2 | 15 | 33 | –39 | –18 | 7 |
| SE England | 1.1 | 2.2 | 3.4 | 1.3 | 2.7 | 4.6 | 2 | 16 | 36 | –40 | –18 | 7 |
| SW England | 1.1 | 2.1 | 3.2 | 1.3 | 2.7 | 4.6 | 4 | 17 | 38 | –41 | –19 | 7 |

Source: Murphy *et al.* (2009)

### 7.6.1 Greenhouse Gas Emissions

Since 1990, there has been a decrease in UK carbon dioxide emissions of around 19% (see **Figure 7.3**). This fall in emissions has been accompanied by a decrease in overall energy consumption over the period, of around 3%. If this figure is adjusted to allow for the effect of temperature, energy consumption has fallen by around 6% between 1990 and 2012. A number of factors explain this effect, such as changes in the efficiency in electricity generation and switching from coal to less carbon intensive fuels such as gas.

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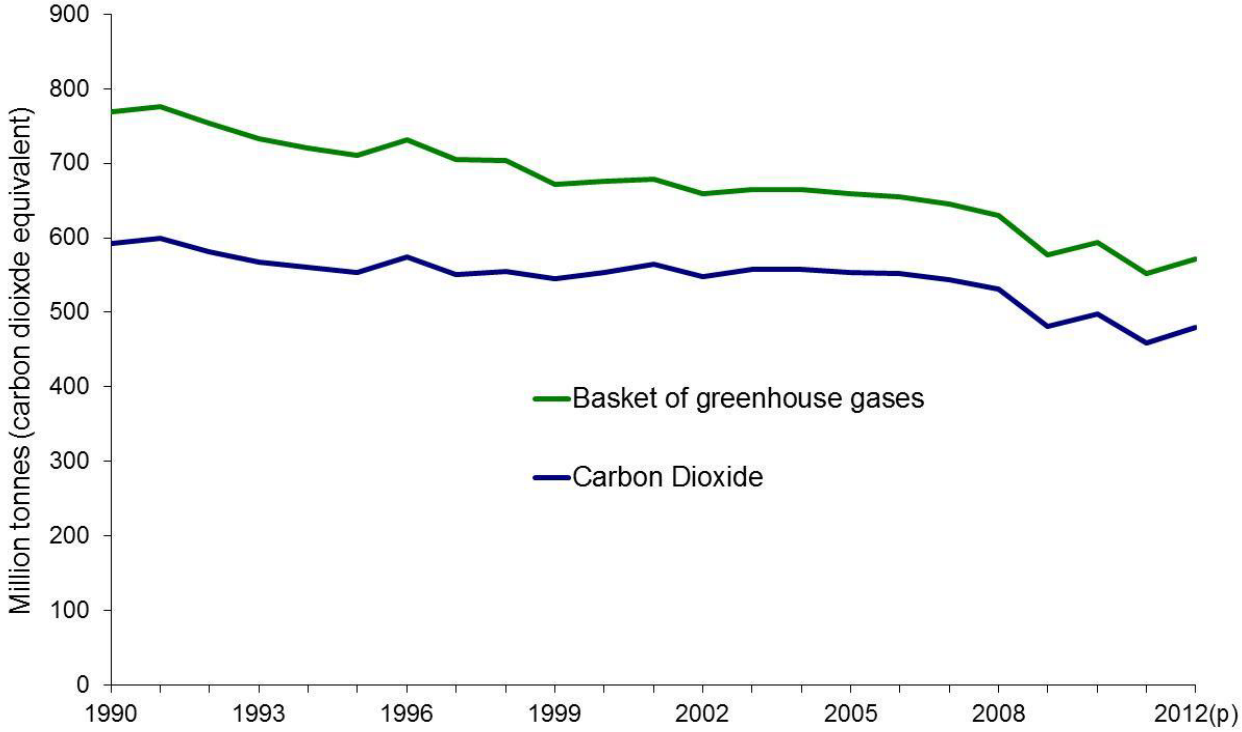
**Figure 7.3 Emissions of Greenhouse Gases, 1990-2012 (provisional)**




According to 2012 data[16] the UK's carbon dioxide footprint reached its peak in 2004 at 852 Mt $CO_2$ and since then has fallen 15% to 722 Mt $CO_2$, with a notably large dip occurring in 2009. The carbon footprint refers to emissions that are associated with the spending of UK residents on goods and services, wherever in the world these emissions arise along the supply chain, and those which are directly generated by UK households through private motoring, etc. These emissions are often referred to as 'consumption emissions' to distinguish them from estimates relating to the emissions 'produced' within a country's territory or economic sphere. The UK's carbon dioxide ($CO_2$) footprint can be separated into a number of components: those emissions relating to goods and services produced by UK business, those generated by UK households through heating and private motoring, and those emissions relating to imported goods and services, broken down into imports from China, imports from the EU and imports from the Rest of the World. These are often referred to as emissions that are 'embedded' in imports.

The pattern applies to a number of broad product groups, with emissions associated with electricity transmission and distribution (the largest contributor to consumption emissions) falling by over 20 Mt $CO_2$ between 2004 and 2010, a 25% drop. Emissions relating to agriculture products decreased by 61% over the same period whilst food services dropped by half and coke/refined petroleum emissions dropped by 37%. Relatively few key product groups showed any increase over the period: the largest

[16] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/85869/release-carbon-footprint-dec2012.pdf

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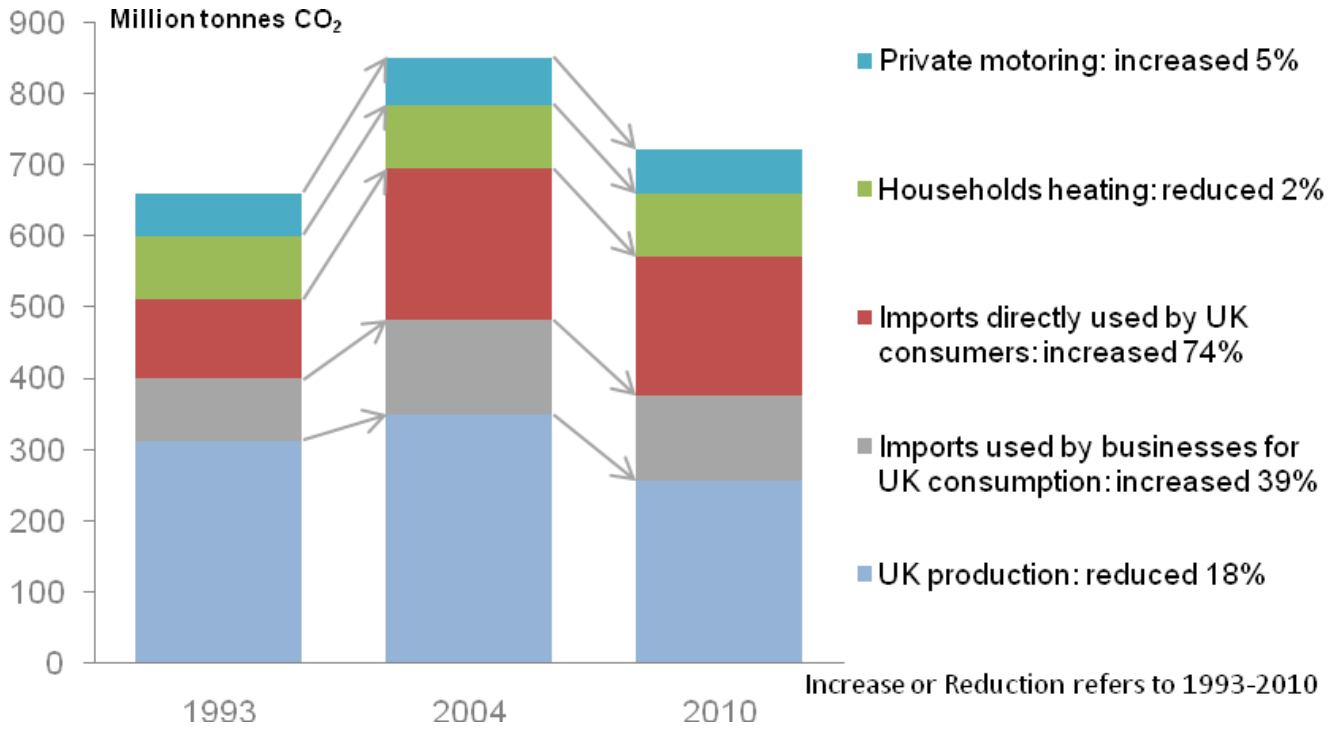
increases were from warehousing (50%), imputed rent services (34%), fabricated metal products (21%) and publishing services (21%). The increase in emissions embedded in goods and services between 1993 and 2010 is only weakly related to increased spending, as it is offset by improvements in the carbon efficiency of production and a switch to less carbon intensive products. Over the period, household final consumption expenditure (HHFCE)2, which measures total spending by households, when adjusted for the effects of price inflation, increased by 55% whereas the carbon footprint increased by 9%. Since a peak in 2008, HHFCE decreased by 2% to 2010, whilst the carbon dioxide footprint decreased by 11% (see **Figure 7.4**).

**Figure 7.4 Comparison of Consumption based $CO_2$ Emissions in 1993, 2004 and 2010**




## 7.6.2 Carbon Dioxide Emissions by Sector[17]

$CO_2$ accounted for about 83% of the UK's anthropogenic (man-made) greenhouse gas emissions in 2011. In 2012, an estimated 40% of carbon dioxide emissions were from the energy supply sector, 24% from transport, 17% from business and 15% from the residential sector. Between 2011 and 2012, provisional estimates indicate that $CO_2$ emissions increased by 5.5% (9.9 Mt) in the energy supply

17 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/193414/280313_ghg_national_statistics_release_2012_provisional.pdf

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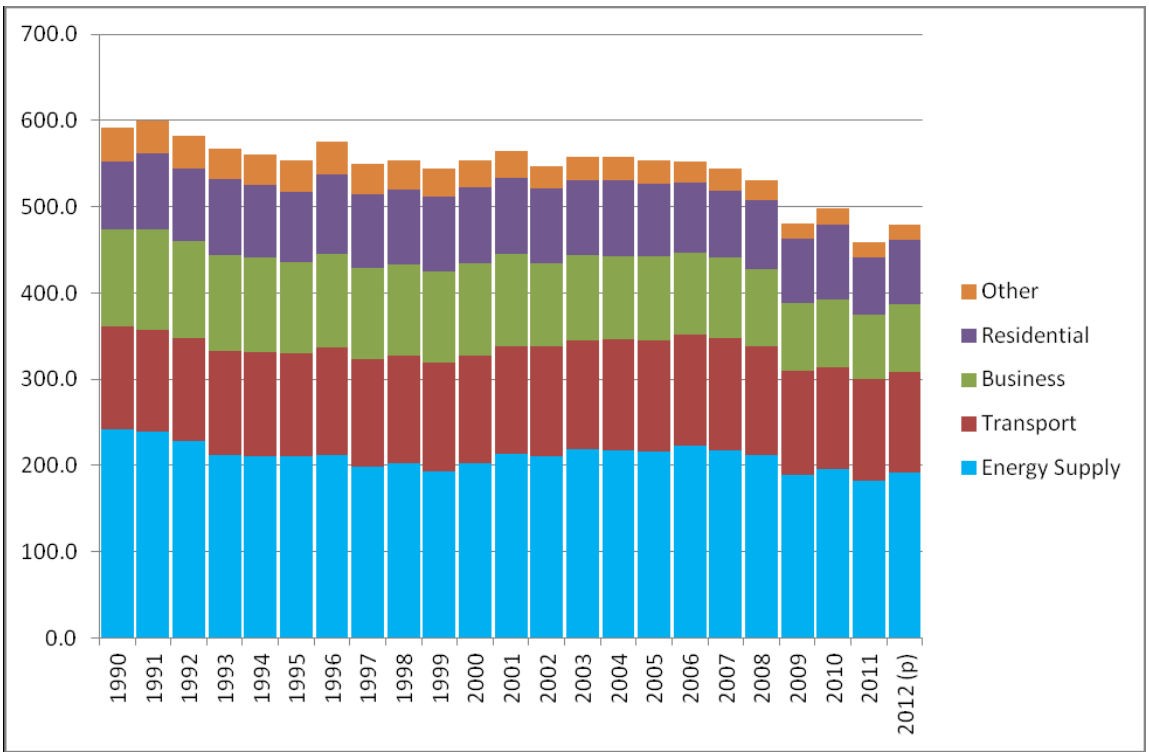
sector, 11.8% (7.8 Mt) in the residential sector and 4.8% (3.6 Mt) in the business sector. Emissions from the transport sector were down by 1.2% (1.4 Mt) from 2011. Since 1990, there has been a decrease in UK carbon dioxide emissions of around 19%. This fall in emissions has been accompanied by a decrease in overall energy consumption over the period, of around 3%. If this figure is adjusted to allow for the effect of temperature, energy consumption has fallen by around 6% between 1990 and 2012. A number of factors explain this effect, such as changes in the efficiency in electricity generation and switching from coal to less carbon intensive fuels such as gas (see **Figure 7.5**).

**Figure 7.5 Carbon Dioxide Emissions by Source, 1990-2012 (provisional) (Mt)**




## 7.6.3 Renewable Energy Generation Trends [18]

Since 2000, the main contributors to the growth in electricity generated from renewables have been wind (+29% a year on average), small scale hydro schemes (+11% a year), landfill gas (+8% a year), municipal solid waste (+7% a year), and sewage sludge digestion (+7% a year) (see **Figure 7.6**). Co-firing of biomass with fossil fuels was zero until 2002, but more than doubled each year between 2002 and 2005 before levelling off in 2006 and despite a decline until 2008, they co-firing exceeded the 2005 levels again in 2011. When combined, electricity generated from all forms of bioenergy increased by an average of 12% a year since 2000. Between 2000 and 2011 the rate of growth in electricity generated

[18] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/82879/5950-dukes-2012-internet.pdf

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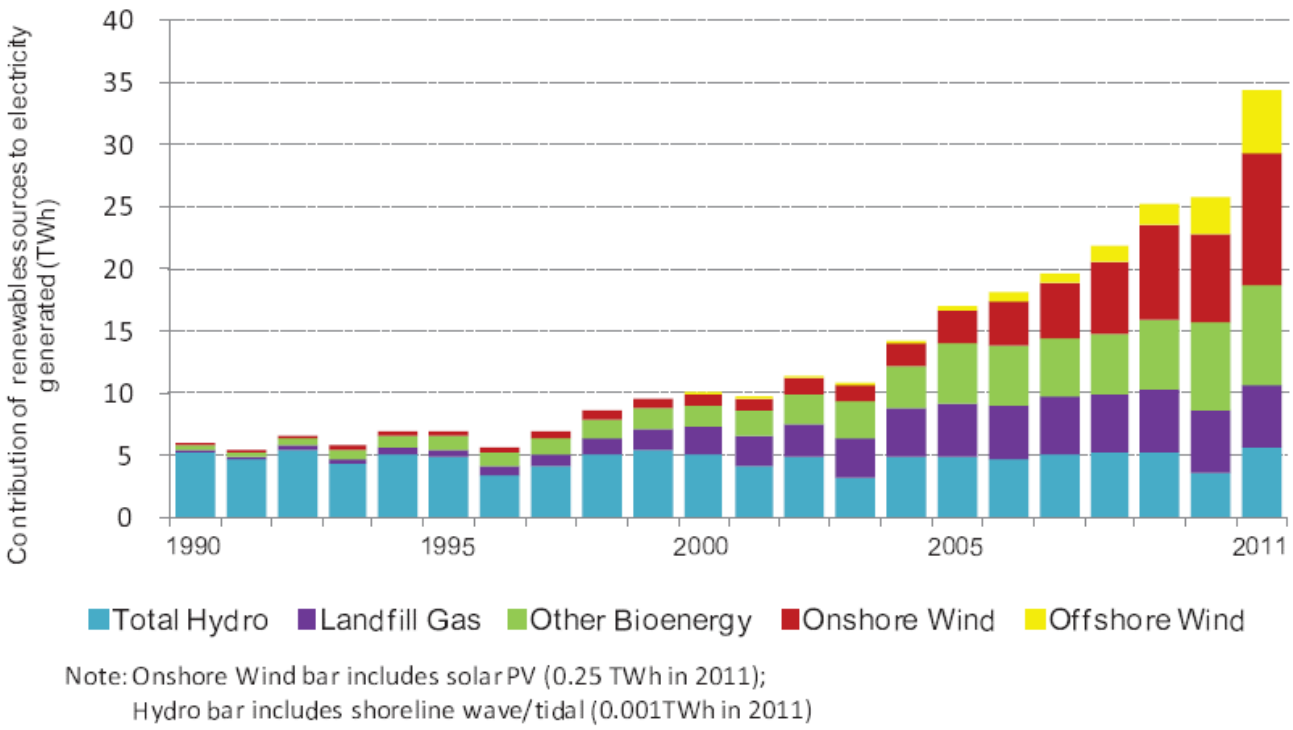
from all renewables averaged 12% a year, which incorporates a smaller (2%) rise between 2009 and 2010, reflecting lower rainfall and wind speeds, and a larger (33%) increase in the most recent year.

**Figure 7.6 Energy Generated from Renewable Sources 1990 - 2011**




The share of generation[19] from coal increased from 29.5% in 2011 to 39.3% in 2012, its highest share since 1996. Gas's share of generation decreased from 39.9% in 2011 to 27.5% in 2012, its lowest share since 1996. Nuclear's share of generation increased from 18.8% in 2011 to 19.4% in 2012. The share of renewables (hydro, wind and bioenergy) increased from 9.4% in 2011 to 11.3% in 2012. This was due to increased wind and bioenergy generation capacity. Low carbon electricity's share of generation increased from 28.1% in 2011 to 30.7% in 2012, the highest share in the last sixteen years, due to higher renewables and nuclear generation.

[19] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/170697/energy_trends_5_electricity.pdf

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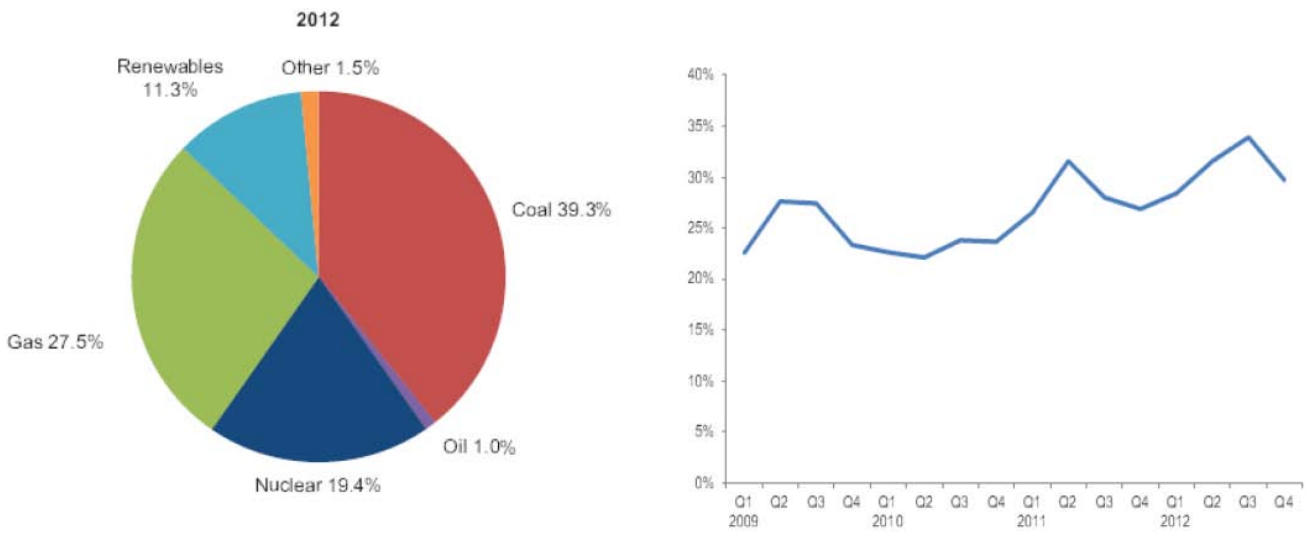
**Figure 7.7 Renewable Electricity Generated as a Percentage of Total Electricity, 2009 - 2012**




Source: DECC digest of UK Energy Statistics Webpages

(http://www.decc.gov.uk/en/content/cms/statistics/source/renewables/)

## 7.7 Assessing Significance

The objectives and guide questions related to climate change which have been identified for use in the appraisal of the effects of Licensing Plan proposals are set out in **Table 7.7**, together with reasons for their selection.

**Table 7.7 Approach to Assessing the Effects of the Licensing Plan on Climate Change**

| Objective/Guide Question | Reasoning |
|---|---|
| **Objective: To minimise greenhouse gas emissions as a contribution to climate change and ensure resilience to any consequences of climate change.** | The SEA Directive requires that the likely significant effects on the environment, which includes their integration in the interests of promoting sustainable development, should be taken into account in the Environmental Report. |
| Will the activities that follow the licensing round affect climate change? | Government legislation (Climate Change Act 2008) and strategies seek to address the causes and consequences of climate change, minimising harmful emissions and investing in infrastructure that will help limit the consequences of climate change on life, property and other environmental indicators considered as part of this assessment. |
| Will the activities that follow the licensing round be able to minimise the generation of greenhouse gases? | Government legislation (under international agreements) commits to the progressive reduction in $CO_2$ and other greenhouse gas emissions. |
| Will the activities that follow the licensing round be significantly affected by climate change (for example rising temperatures and more extreme weather events)? | UKCP09 scenarios show that increasing temperatures and changes to precipitation, increased storminess and extreme weather is expected, which has the potential to impact on the proposals. |

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**Table 7.8** sets out guidance that will be utilised during the assessment to help determine the relative significance of potential effects on the Climate Change objective. It should not be viewed as definitive or prescriptive; merely illustrative of the factors that may be considered as part of the assessment process.

**Table 7.8 Illustrative Guidance for the Assessment of Significance for Climate Change**

| Effect | Description | Illustrative Guidance |
|---|---|---|
| ++ | Significant Positive | • The option would help to significantly reduce carbon and other greenhouse gas emissions.<br>• The option will increase resilience/decrease vulnerability to climate change in the wider environment. |
| + | Minor Positive | • The option would help to reduce carbon and other greenhouse gas emissions<br>• The option may increase resilience/decrease vulnerability to climate change in the wider environment |
| 0 | Neutral | • The option would not lead to an overall change in carbon and other greenhouse gas emissions in a way that will not contribute to climate change or resilience to climate change within the wider environment. |
| - | Minor Negative | • The option would increase carbon and other greenhouse gas emissions from sources including:<br>o transportation of plant and equipment to the site;<br>o fugitive emissions of methane during drilling and production;<br>o emissions of carbon dioxide and methane arising from disturbance of the soil and land ; and<br>o the removal of carbon sinks.<br>• The option may decrease resilience/increase vulnerability to climate change in the wider environment. |
| -- | Significant Negative | • The option would significantly increase carbon and other greenhouse gas emissions from sources including:<br>o transportation of plant and equipment to the site;<br>o fugitive emissions of methane during drilling and production;<br>o emissions of carbon dioxide and methane arising from disturbance of the soil and land ; and<br>o the removal of carbon sinks.<br>• The option will decrease resilience/increase vulnerability to climate change in the wider environment. |
| ? | Uncertain | • From the level of information available the impact that the option would have on this objective is uncertain. |

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## 7.8 Assessment of Effects

This section comprises the assessment of the potential activities that could follow on from the licensing round on the climate change objective. There are a total of six main stages of oil and gas exploration and production (including gas storage) that are the subject of the assessment. These are highlighted in **Table 7.9** for both conventional and unconventional oil and gas together with an overview of the associated key activities at each stage. Please note that Stages 1, 2 and 4 do not necessarily apply to gas storage, depending on the history of the particular site.

**Table 7.9 Oil and Gas Exploration and Production Lifecycle and Key Activities**

| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| 1. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. |
| 2. | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring.* | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. |
| 3. | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring* | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. |
| 4. | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring.* | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. |
| 5. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. |

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| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| 6. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. |

Note: Exploration wells most usually move from Stage 2 to Stage 5, though some may be used for long-term production testing (which would require new consents including planning permission) and some may be retained and their sites redeveloped as a production project (this would also require new consents including planning permission). For the purposes of this assessment, the appraisal stage (a term commonly used in industry) spans Stages 2 and 3.

*Conventional oil and gas exploration and production activities (stages 2 to 4 above) can occasionally include hydraulic fracturing. However, the need to undertake hydraulic fracturing is relatively uncommon and has therefore not been considered in the assessment of conventional oil and gas activities as part of this SEA.

### 7.8.1 Conventional Oil and Gas

The assessment of the six main stages of conventional oil and gas production is contained in **Table 7.10**. The first two columns describe the exploration and production stage. The third and fourth columns summarise the expected effects on the climate change objective for both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report). The rationale for this relationship is explained in more detail in the final column and includes:

- the nature and scale of the potential effects on the climate change objective;
- when the effect could occur (timing) and its degree of permanence;
- what mitigation measures might be appropriate for potentially significant negative effects on the climate change objective;
- what options there are to enhance positive effects; and
- assumptions and uncertainties that underpin the assessment.

**Table 7.10 Assessment of Effects: Conventional Oil and Gas**

| **Objective 8: Climate Change** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys; | **0** | **0** | Stage 1 of the conventional oil and gas exploration and production lifecycle would comprise non-intrusive activities. Site identification, selection and characterisation and the securing of development and operation permits would be expected to be largely desk-based and in consequence, no substantial effects on climate change would be anticipated from these activities. |

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| Objective 8: Climate Change | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • Securing of necessary development and operation permits. | | | Vibroseis is the most common method of seismic survey and typically involves 3-5 large vibrator units which sub-sonically vibrate the ground while a number of support vehicles record the returning shock waves for analysis. Greenhouse gas (GHG) emissions will result from associated vehicle movements and the operation of machinery. However, it is anticipated that the intensity of activity would be low and number vehicle movements small such that any effects on climate change are unlikely to be significant in a local or national context.<br>There may be a requirement for the temporary construction of new roads to facilitate access to sites which could result in disturbance to soils and emissions of $CO_2$ and methane together with loss of soil carbon sequestration. However, it is assumed that landtake would be relatively small and that any soils displaced during construction would be returned following the completion of works.<br>Reflecting the scale and type of of activities, this stage has been assessed as having a neutral effect on climate change.<br>**Low and High Activity Scenarios:**<br>As noted above, this stage of the oil and gas exploration and production lifecycle would comprise limited, non-intrusive activities such that effects on climate change are likely to be limited.<br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed). In consequence, GHG emissions associated with vehicle movements and the operation of machinery would increase. Further, the volume of soil displaced to support the construction of vehicular access to sites and the potential for emissions of $CO_2$ and methane may also be increased. However, it is considered that total emissions would still be very low in the local/national context and as a result, effects on this objective would remain neutral.<br>**Mitigation:**<br>• DECC should consider the feasibility of measures to reduce GHG emissions through and related to the licensing process. These measures may include, for example:<br>o development of guidance suggesting measures to reduce GHG emissions during all stages of the conventional oil and gas exploration of production lifecycle with appropriate linkages to Environmental Impact Assessment;<br>o discussion with regulators on appropriate mandatory requirements to be applied at each stage to ensure that the best technology is implemented in all cases (MacKay and Stone, 2013);<br>o implementation of GHG emissions recording and monitoring protocols, reflecting recommendations contained in the AEA (2012) report[20] and of MacKay and Stone (2013); |

[20] AEA (2012) Climate impact of potential shale gas production in the EU: Report for the European Commission.

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| Objective 8: Climate Change | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | o the application of the emission limit values requirements under the Industrial Emissions Directive to methane emissions from exploration and production activities as per recommendations contained in the AEA (2012) review.<br>**Assumptions:**<br>• It is assumed that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible.<br>• It is assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>• It is assumed that any soils displaced during construction would be returned following the completion of works.<br>**Uncertainties:**<br>• None identified. |
| 2 | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring. | - | - | **Assessment of Effects:**<br>An important source of GHG emissions during Stage 2 would be those associated with pad preparation. Sources of emissions would include the direct or indirect combustion of fossil fuels from construction traffic, plant and generators and the embodied carbon within construction materials. Disturbance to soils and emissions of $CO_2$ and methane together with loss of soil carbon sequestration may also contribute to climate change, although it is anticipated that sites would be restored following either completion of exploration drilling or decommissioning of wells such that effects would be reduced in longer term (i.e. following exploratory drilling or beyond the site restoration stage, depending on whether a site is taken forward to the production stage). The magnitude of emissions would be dependent on site specific characteristics such as requirements for infrastructure such as roads, the distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain.<br>GHG emissions would be generated from the energy used in the drilling of boreholes. There would also be additional emissions associated with the transportation and treatment of wastes (e.g. mud and cuttings) arising from drilling activities and from the embodied carbon in materials associated with well construction. Whilst emissions would depend in particular upon the length of the well bore, taking into account the scale of activity envisaged during this stage, it is not expected that GHG emissions would be significant.<br>Wells that encounter commercial quantities of hydrocarbons may be subject to long-term production flow testing. In the case of gas, a relatively small amount may be vented or flared subject to planning conditions although effects on GHG emissions are not expected to be significant[21]. |

[21] DECC (2010) *Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds: Environmental Report*.

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| Objective 8: Climate Change | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Construction and exploration could be affected by climate change where sites are located, for example, in coastal areas that may be affected by coastal inundation or sea level rise or in areas of flood risk that could be susceptible to extreme weather conditions.<br>Current information indicates that the UK is experiencing a sea level rise of approximately 1mm per annum and a global sea level rise of approximately 3mm per annum. Climate change effects such as intensified weather events therefore have the potential to affect activities during Stage 2. However, in view of the nature of the development and associated activities together with the duration of the exploration stage (6 years), it is not expected that exploration would be substantially affected by the impacts of climate change. Further, it would be expected that development would be located away from areas at risk of climate change impacts (i.e. areas at risk of flooding), in accordance with national planning policy guidance.<br>Overall, Stage 2 of the conventional oil and gas exploration and production lifecycle has been assessed as having a minor negative effect on the climate change objective.<br>**Low and High Activity Scenarios:**<br>Emissions under the high activity scenario would be expected to be greater than those associated with the low activity scenario. This is commensurate with the total number of boreholes to be drilled and total area to be covered by exploration well pads under the high activity scenario (30 boreholes and 30ha of land compared to 5 boreholes and 5ha of land under the low activity scenario) and reflects the additional combustion of fossil fuels, increased vehicle movements and the potential for disturbance of soils. Notwithstanding, GHG emissions under the high activity scenario would not be expected to be significant.<br>As noted above, there is not considered to be a substantial risk of activities being adversely affected by climate change impacts. In consequence, effects in this regard are not expected to be significantly influenced by the quantum of activity.<br>**Mitigation:**<br>• During the site selection process, careful consideration should be given by the operator to the avoidance of carbon sinks (e.g. peats).<br>• Where possible, measures should be taken to offset (at least in part) GHG emissions arising from construction and operational activities. These measures may include, for example:<br>o the use of construction materials with low embodied carbon;<br>o measures to reduce private vehicle use for workers;<br>o provision for the transportation of materials and construction wastes by rail where practicable; |

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| Objective 8: Climate Change | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | o limiting the volume of construction waste on-site.<br>• Site selection should be informed by robust Flood Risk Assessment to ensure that risks associated with climate change impacts are identified and addressed (e.g. through the implementation of sustainable drainage systems).<br>• Reflecting the recommendations identified by MacKay and Stone (2013) (albeit identified in respect of shale gas, however which have wider applicability), operators should:<br>o in managing vented or flared methane throughout the exploration, pre-production and production of [shale] gas, adopt the principle of reducing emissions to as low a level as reasonably practicable (ALARP). In particular, "reduced emissions completions" (REC) or "green completions" should be adopted at all stages following exploration;<br>o monitor their sites to: (1) ensure early warning of unexpected leakages; and (2) obtain emissions estimates for regulators and government.<br>• DECC should consider the feasibility of measures, through and related to the licensing process, to reduce GHG emissions during Stage 2. These measures are detailed under the assessment of Stage 1.<br>**Assumptions:**<br>• It is assumed that GHG emissions would be greater under the high activity scenario compared to the low activity scenario, commensurate with the increased number of boreholes to be drilled and total site area.<br>**Uncertainties:**<br>• The exact magnitude of GHG emissions would be dependent on site specific characteristics such as requirements for infrastructure such as roads, distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain.<br>• The quantity of fuel consumed during the drilling of boreholes, and the associated emissions, will depend upon the length of the well bore which is currently uncertain.<br>• The potential for activities to be affected by climate change will be to some extent dependent on site location which is currently uncertain. |
| 3 | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring; | - | - | **Assessment of Effects:**<br>The range and type of effects associated with Stage 3 of the conventional oil and gas exploration and production lifecycle would be similar to those identified under Stage 2. This stage would require additional infrastructure including storage tanks, road connections and the installation of |

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| Objective 8: Climate Change | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring. | | | pipelines required to collect natural gas for transfer to the existing natural gas pipeline infrastructure.<br><br>This would generate further GHG emissions associated with construction traffic, plant and generators and the embodied carbon within construction materials. Disturbance to soils and emissions of $CO_2$ and methane together with loss of soil carbon sequestration may also contribute to climate change, although it is anticipated that sites would be restored following decommissioning such that effects would be reduced in longer term. Additionally, following the completion of Stage 3, some soils displaced during the development of well pads and associated infrastructure (e.g. pipelines) may be returned. As highlighted under Stage 2, the magnitude of emissions would be dependent on site specific characteristics such as requirements for infrastructure such as roads, the distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain.<br><br>GHG emissions would arise from the energy used in the drilling of wells. There would also be additional emissions associated with the transportation and treatment of wastes (e.g. mud and cuttings) arising from drilling activities and from the embodied carbon associated with well construction. Whilst the volume of emissions would depend in particular upon the length of the well bore, taking into account the scale of activity envisaged during this stage, it is considered that effects on GHG emissions would be minor.<br><br>As with Stage 2, construction could be affected by climate change where sites are located, for example, in coastal areas that may be affected by coastal inundation or sea level rise or in areas of flood risk that could be susceptible to extreme weather conditions. Current information indicates that the UK is experiencing a sea level rise of approximately 1mm per annum and a global sea level rise of approximately 3mm per annum. Climate change effects such as intensified weather events therefore have the potential to affect activities during Stage 3. However, in view of the nature of the development it is not expected that associated activities would be substantially affected by the impacts of climate change. Further, it would be expected that development would be located away from areas at risk of climate change impacts (i.e. areas at risk of flooding), in accordance with national planning policy guidance.<br><br>Overall, Stage 3 of the conventional oil and gas exploration and production lifecycle has been assessed as having a minor negative effect on the climate change objective.<br><br>**Low and High Activity Scenarios:**<br><br>Emissions under the high activity scenario would be expected to be greater than those associated with the low activity scenario. This is commensurate with the total number of wells and total area to be covered by well pads under the high activity scenario (12 wells and between 12-18ha of land compared to 6 wells and 6-9ha of land under the low activity scenario) and reflects the additional combustion of fossil fuels, increased vehicle movements and the potential for disturbance of soils. |

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| Objective 8: Climate Change | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Notwithstanding, emissions would not be expected to be significant.<br><br>As noted above, there is not considered to be a substantial risk of activities being adversely affected by climate change impacts. In consequence, effects in this regard are not expected to be significantly influenced by the quantum of activity.<br><br>**Mitigation:**<br><br>• During the site selection process, careful consideration should be given by the operator to the avoidance of carbon sinks (e.g. peats).<br><br>• Where possible, measures should be taken to offset (at least in part) GHG emissions arising from construction and operational activities. These measures may include, for example:<br>o the use of construction materials with low embodied carbon;<br>o measures to reduce private vehicle use for workers;<br>o provision for the transportation of materials and construction wastes by rail where practicable;<br>o limiting the volume of construction waste on-site.<br><br>• Site selection should be informed by robust Flood Risk Assessment to ensure that risks associated with climate change impacts are identified and addressed (e.g. through the implementation of sustainable drainage systems).<br><br>• Reflecting the recommendations identified by MacKay and Stone (2013) (albeit identified in respect of shale gas, however which have wider applicability), operators should:<br>o in managing vented or flared methane throughout the exploration, pre-production and production of [shale] gas, adopt the principle of reducing emissions to as low a level as reasonably practicable (ALARP). In particular, “reduced emissions completions” (REC) or “green completions” should be adopted at all stages following exploration;<br>o monitor their sites to: (1) ensure early warning of unexpected leakages; and (2) obtain emissions estimates for regulators and government.<br><br>• DECC should consider the feasibility of measures, through and related to the licensing process, to reduce GHG emissions during Stage 3. These measures are detailed under the assessment of Stage 1. |

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| Objective 8: Climate Change | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Assumptions:**<br>• It is assumed that emissions would be greater under the high activity scenario compared to the low activity scenario, commensurate with the increased number of wells to be drilled and total site area.<br>**Uncertainties:**<br>• The exact magnitude of GHG emissions would be dependent on site specific characteristics such as requirements for infrastructure such as roads, distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain.<br>• The quantity of fuel consumed during the drilling of wells, and the associated emissions, will depend upon the length of the well bore which is currently uncertain.<br>• The potential for activities to be affected by climate change will be to some extent dependent on site location which is currently uncertain. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | - | - | **Assessment of Effects:**<br>During the production stage there would be GHG emissions associated with power generation, the use of machinery and from vehicle movements (related to the transportation of maintenance workers and wastes to/from sites). A further source of GHG emissions is likely to be fugitive methane and other trace hydrocarbons via leakages from on-site equipment including valves, flanges and compressors as well as from flaring and venting. The Digest of UK Energy Statistics estimates emissions associated with production and processing of conventional gas to be 100 $tCO_2e$ per million $m^3$. Based on McKay and Stone's central estimate of well productivity[22] (an estimated total of 85 million $m^3$ over the 20 year lifetime of the wells), it is assumed that total GHG emissions per well would be 8,500 $tCO_2e$ (425 $tCO_2e$ per annum). However, taking into account the small number of wells (between 6 and 12), total GHG emissions would not be expected to be significant.<br>Indirectly, the combustion of extracted hydrocarbons would generate approximately 190 $gCO_2e/kWh$ (which represents combustion emissions for methane)[33]. As of 2011, natural gas consumption accounted for 28.9% of GHG emissions from all fuel types (164.6 million $tCO_2eq$).[23] The extent to which domestic production and consumption of gas would affect GHG emissions would vary subject to changes in prices affecting demand and supply relative to Liquefied Natural Gas (LNG) imports and relative to coal. In this context, a report by the Institute of Directors (IoD)[39] highlights that the use of domestic gas as opposed to imported gas should reduce GHG emissions in the UK. |

[22] As adopted in MacKay, D.J.C. and Stone, T.J. (2013) *Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use*. Report on behalf of DECC. London: DECC

[23] See https://www.gov.uk/government/publications/final-uk-emissions-estimates [Accessed September 2013]

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| Objective 8: Climate Change | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | A recent report by MacKay and Stone (2013) concerning potential GHG emissions associated with shale gas extraction and use[24] also demonstrates that the carbon footprint of conventional gas sources (199-207 g $CO_2$e per $kWh_{(th)}$) is lower than LNG (233 – 270 g $CO_2$e per $kWh_{(th)}$). Further, when gas is used for electricity generation, its carbon footprint is significantly lower than coal.<br><br>However, MacKay and Stone (2013) also highlight (in respect of shale gas) the need to consider the impact of gas production and consumption on global emissions and highlight that the switch from coal to gas in the US has increased exports of coal which has in-turn increased the carbon intensity of electricity production in other countries. It is also important to acknowledge that domestic gas production and consumption could displace lower carbon energy sources and in this respect the recommendations at paragraph 159 of the Energy and Climate Change Committee (2011) report on shale gas that "*in planning to decarbonise the energy sector DECC should generally be cautious in its approach to natural gas... Although gas emissions are less than coal they are higher than many lower carbon technologies*" are noted. Notwithstanding, it is assumed that consumption of domestic gas would substitute the combustion of other currently imported hydrocarbons and that there would be no net change to the energy mix within the UK, other than those already anticipated by DECC in the 2050 pathways report. According to DECC's central forecasts, overall natural gas demand (for heating and industry as well as electricity generation) is projected to remain approximately at today's level over the next two decades – falling from 3,055 billion cubic feet (bcf) in 2011 to 2,621 bcf in 2020, before rising to 3,049 bcf by 2030. These gas demand projections are consistent with DECC's central forecasts for GHG emissions, which project the net UK carbon account to fall, relative to 1990 levels, by 37% by 2020 and 45% by 2025.[25] In consequence, gas production and consumption would not be expected to displace energy generation from renewable sources nor disincentivise investment in renewable and low carbon technologies, particularly given UK Government commitments and targets for renewable energy generation contained in the Renewable Energy Roadmap (2011). Domestic gas production and consumption could, however, help to reduce net UK GHG emissions associated with reduced imports of LNG in particular. This would generate a positive effect on this objective although the scale of any benefits would be dependent on the balance between conventional, LNG and unconventional gas production and consumption which is currently uncertain. |

[24] MacKay, D.J.C. and Stone, T.J. (2013) *Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use*. Report on behalf of DECC. London: DECC

[25] Institute of Directors (2013) *Getting Shale Gas Working*. Available from www.iod.com/~/.../IoD_Getting_shale_gas_working_MAIN_REPORT.pdf [Accessed September 2013]

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Production could be affected by climate change where sites are located, for example, in coastal areas that may be affected by coastal inundation or sea level rise or in areas of flood risk that could be susceptible to extreme weather conditions. Current information indicates that the UK is experiencing a sea level rise of approximately 1mm per annum and a global sea level rise of approximately 3mm per annum. Climate change effects such as intensified weather events therefore have the potential to affect activities during Stage 4, particularly given the fact that production would take place over a relatively long time frame (20 years) during which time the impacts of climate change (e.g. sea level rise) could become more pronounced. Notwithstanding, it would be expected that development would be located away from areas at risk of climate change impacts, in accordance with national planning policy guidance.<br><br>Overall, Stage 4 of the conventional oil and gas exploration and production lifecycle has been assessed as having a minor negative effect on this objective. Notwithstanding, it is important to recognise that there is the potential for an overall net reduction in GHG emissions associated with a decrease in the importation of LNG which could have a positive effect on this objective, although this is currently uncertain.<br><br>**Low and High Activity Scenarios:**<br><br>GHG emissions directly associated with production under the high activity scenario would be expected to be greater than those related to the low activity scenario. This is commensurate with the total number of wells under the high activity scenario (12 wells) compared to the low activity scenario (6 wells). Based on total emissions associated with production (8,500 $tCO_2eq$ per well over the lifetime of the well), the high activity scenario would generate a total of 102,000 $tCO_2eq$ (compared to 51,000 $tCO_2eq$ under the low activity scenario), although this is not considered to be nationally significant. Further, an increase in production associated with the high activity scenario could reduce the importation of LNG which could in-turn generate GHG reductions above the lower activity scenario, although this is currently uncertain.<br><br>As noted above, there is not considered to be a substantial risk of activities being adversely affected by climate change impacts. In consequence, effects in this regard are not expected to be significantly influenced by the quantum of activity.<br><br>**Mitigation:**<br><br>• Reflecting the recommendations identified by MacKay and Stone (2013) (in respect of shale gas), operators should:<br>  o in managing vented or flared methane throughout the exploration, pre-production and production of shale gas, adopt the principle of reducing emissions to as low a level as reasonably practicable (ALARP). In particular, “reduced emissions completions” (REC) or “green completions” should be adopted at all stages following exploration; |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
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| | | | | o monitor their sites to: (1) ensure early warning of unexpected leakages; and (2) obtain emissions estimates for regulators and government.<br>• DECC should consider the feasibility of measures, through and related to the licensing process, to reduce GHG emissions during Stage 4. These measures are detailed under the assessment of Stage 1.<br>**Assumptions:**<br>• It is assumed that direct GHG emissions during production would be greater under the high activity scenario compared to the low activity scenario, commensurate with the increased number of wells.<br>• It is assumed that emissions from flaring or venting would be kept to the minimum that is technically and economically justified.<br>• It is assumed that the consumption of extracted hydrocarbons would substitute the combustion of other currently imported hydrocarbons and that there would be no net change to the energy mix within the UK, other than those already anticipated by DECC in the 2050 pathways report.<br>**Uncertainties:**<br>• The extent to which domestic gas production and consumption could help to reduce net GHG emissions is uncertain and would be dependent on the balance between conventional, LNG and unconventional gas production and consumption. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | - | - | **Assessment of Effects:**<br>During decommissioning there would be emissions of GHGs associated with the use of machinery and plant as well as from construction traffic. There would also be emissions related to the embodied carbon in concrete used to plug wells and, potentially, the treatment of any waste arisings.<br>Associated works may require the clearance of vegetation and loss of soil layers which could result in emissions of $CO_2$ and methane together with loss of soil carbon sequestration. However, it is not expected that the area of land required to undertake decommissioning activities (beyond existing well pads) would be significant. In this respect, the AEA (2012:69) report for the European Commission notes that there is generally little difference between conventional and unconventional wells in the post-abandonment phase and that the consequences for land take would be "*comparable with many other industrial and commercial land-uses, and are of no more than minor significance*".<br>The total magnitude of GHG emissions associated with this stage would be dependent on site specific characteristics such as requirements for infrastructure such as roads, the distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of any soils displaced which are currently uncertain. However, taking into account the relatively low number of wells (up to 12) and well pad sites (up to 6), it is not expected that emissions of GHGs would be significant. |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
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| | | | | Decommissioning could be affected by climate change where sites are located, for example, in coastal areas that may be affected by coastal inundation or sea level rise or in areas of flood risk that could be susceptible to extreme weather conditions. Current information indicates that the UK is experiencing a sea level rise of approximately 1mm per annum and a global sea level rise of approximately 3mm per annum. Climate change effects such as intensified weather events therefore have the potential to affect activities during Stage 5 particularly given the fact that decommissioning would take place in the longer term (i.e. beyond the lifetime of a well) during which time the impacts of climate change (e.g. sea level rise) could become more pronounced. Notwithstanding, it would be expected that development would be located away from areas at risk of climate change impacts, in accordance with national planning policy guidance.<br>**Low and High Activity Scenarios:**<br>Emissions under the high activity scenario would be expected to be greater than those associated with the low activity scenario. This is commensurate with the total number wells/well pad sites to be decommissioned under the high activity scenario (6 well pad sites and 12 wells compared to 3 well pad sites and 6 wells under the low activity scenario) and reflects the additional combustion of fossil fuels, increased vehicle movements and the potential for disturbance of soils. Notwithstanding, emissions would not be expected to be significant.<br>As noted above, there is not considered to be a substantial risk of activities being adversely affected by climate change impacts. In consequence, effects in this regard are not expected to be significantly influenced by the quantum of activity.<br>**Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• It is assumed that wells would be appropriately sealed to prevent fugitive emissions.<br>**Uncertainties:**<br>• The exact magnitude of GHG emissions associated with this stage would be dependent on site specific characteristics such as requirements for infrastructure such as roads, the distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **+/-** | **+/-** | **Assessment of Effects:**<br>For the purposes of this assessment it is assumed that all associated infrastructure and hardstanding would be removed during the site restoration and relinquishment stage. Due to the need for invasive demolition techniques and land excavation there would be GHG emissions associated with the use of plant and from construction traffic. There may also be additional GHG emissions related to the treatment of wastes. |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | However, taking into account the number of well pad sites (up to a maximum of 6), wells (up to 12) and total area covered by well pads (12-18ha), it is not expected that emissions of GHGs would be significant.<br><br>Following completion of site restoration activities, there would be no further GHG emissions or energy use, reducing effects on climate change in the longer term. Depending on the end use of well pad sites (which would be determined on a site-by-site basis following discussions between the operator and the minerals planning authority), there may be opportunities to enhance carbon sequestration through rehabilitation and re-vegetation. In this respect, paragraph 143 of the National Planning Policy Framework (DCLG 2012) promotes high quality restoration and aftercare "*including for agriculture (safeguarding the long term potential of best and most versatile agricultural land and conserving soil resources), geodiversity, biodiversity, native woodland, the historic environment and recreation*". However, it should be noted that the AEA (2012) report highlights that it may not be possible to return entire sites to beneficial use due to, for example, concerns regarding public safety. The report states(at page 69) that over a wider area "*this could result in a significant loss of land, and/or fragmentation of land area such as an amenity or recreational facility, valuable farmland, or valuable natural habitat*".<br><br>Site restoration works could be affected by climate change where sites are located, for example, in coastal areas that may be affected by coastal inundation or sea level rise or in areas of flood risk that could be susceptible to extreme weather conditions. Current information indicates that the UK is experiencing a sea level rise of approximately 1mm per annum and a global sea level rise of approximately 3mm per annum. Climate change effects such as intensified weather events therefore have the potential to affect activities during Stage 6 particularly given the fact that site restoration would take place in the longer term during which time the impacts of climate change (e.g. sea level rise) could become more pronounced. Notwithstanding, it would be expected that development would be located away from areas at risk of climate change impacts, in accordance with national planning policy guidance.<br><br>Site restoration may provide an opportunity to enhance climate change resilience through measures such as green infrastructure provision that reduces surface water run-off or flood attenuation schemes. However, the extent to which such measures could be implemented would be dependent on a site's location, characteristics and end use which are currently uncertain.<br><br>Reflecting energy use and GHG emissions associated with site restoration but the reduction in emissions following the cessation of production, decommissioning and site restoration, this stage has been assessed as having a mixed positive and negative effect on this objective.<br><br>**Low and High Activity Scenarios:**<br><br>Emissions under the high activity scenario would be expected to be greater than those associated with the low activity scenario. This is commensurate with the area of |

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| *Stage* | *Description* | *Score* | | *Commentary* |
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| | | *Low Activity Scenario* | *High Activity Scenario* | |
| | | | | land to be restored, relative to the low activity scenario. Notwithstanding, emissions would not be expected to be significant.<br><br>As noted above, there is not considered to be a substantial risk of activities being adversely affected by climate change impacts. In consequence, effects in this regard are not expected to be significantly influenced by the quantum of activity.<br><br>**Mitigation:**<br>• Where appropriate, consideration should be given to the implementation of soil sequestration projects as part the restoration process.<br>• Where appropriate, consideration should be given to how sites can be used to enhance climate change resilience during restoration (e.g. through flood attenuation schemes).<br><br>**Assumptions:**<br>• It is assumed that wells would be appropriately sealed to prevent fugitive emissions.<br>• It is assumed that all associated infrastructure and hardstanding would be removed during this stage.<br><br>**Uncertainties:**<br>• The exact magnitude of GHG emissions associated with this stage would be dependent on site specific characteristics which are currently uncertain.<br>• The extent to which climate change adaptation measures could be implemented would be dependent on a site's location, characteristics and end use which are currently uncertain. |

### *Summary*

The assessment has not identified any significant positive or significant negative effects on climate change associated with all six stages of the conventional oil and gas exploration and production lifecycle. Pad preparation during Stage 2 and Stage 3 and also decommissioning (Stage 5) and site restoration (Stage 6) would generate GHG emissions from sources including the direct or indirect combustion of fossil fuels from construction traffic, plant and generators and the embodied carbon within construction materials. Disturbance to soils and emissions of $CO_2$ and methane together with loss of soil carbon sequestration may also contribute to climate change. GHG emissions would be generated from the energy used in the drilling of boreholes/wells. There would also be additional emissions associated with the transportation and treatment of wastes (e.g. mud and cuttings) arising from drilling activities and from the embodied carbon in materials associated with well construction. However, taking into account the number of wells/well pad sites, these stages have been assessed as having a minor negative effect on this objective.

During production (Stage 4) there would be GHG emissions associated with power generation, machinery and from vehicle movements. A further source of GHG emissions is likely to be fugitive methane and other trace hydrocarbons via leakages from on-site equipment including valves, flanges and compressors as well as from flaring and venting. The Digest of UK Energy Statistics estimates emissions associated with production and processing of conventional gas to be 100 tCO2e per million m3. Based on MacKay and Stone's (2013) central estimate of well productivity (85 million m3), it is assumed that GHG emissions per well would be 8,500 $tCO_2e$. Taking into account the number of wells under both the low and high activity scenarios, it is not considered that these emissions would be significant.

Indirectly, the combustion of extracted hydrocarbons would generate further GHG emissions, although these emissions would be lower than from other hydrocarbon sources including coal. It should also be noted that consumption of extracted hydrocarbons would substitute the combustion of other currently imported hydrocarbons and there would be no net change to the energy mix within the UK, other than those already anticipated by DECC in the 2050 pathways report. In consequence, the Licensing Plan would not disincentivise investment in renewable and low carbon technologies and, further, the use of domestic gas as opposed to imported LNG could serve to reduce overall GHG emissions which could generate a positive effect on this objective, although this is would be dependent on the balance between conventional, LNG and unconventional gas production and consumption which is currently uncertain.

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| *Stage* | *Description* | *Score* | | *Commentary* |
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| | | *Low Activity Scenario* | *High Activity Scenario* | |

No significant positive effects have been identified during the assessment. Stage 6 of the conventional oil and gas exploration and production lifecycle (site restoration and relinquishment) has been assessed as having a mixed positive and negative effect on climate change. As noted above, there would be GHG emissions associated with, for example, the use of plant. However, following site restoration there would be no further GHG emissions or energy use, reducing effects on climate change in the longer term. Depending on the end use of well pad sites (which would be determined on a site-by-site basis following discussions between the operator and the minerals planning authority), there may also be opportunities to enhance carbon sequestration through rehabilitation and re-vegetation.

**Mitigation Summary:**

- During the site selection process, careful consideration should be given by the operator to the avoidance of carbon sinks (e.g. peats).
- Where possible, measures should be taken to offset (at least in part) GHG emissions arising from construction and operational activities. These measures may include, for example:
    - the use of construction materials with low embodied carbon;
    - measures to reduce private vehicle use for workers;
    - provision for the transportation of materials and construction wastes by rail where practicable;
    - limiting the volume of construction waste on-site.
- Site selection should be informed by robust Flood Risk Assessment to ensure that risks associated with climate change impacts are identified and addressed (e.g. through the implementation of sustainable drainage systems).
- Reflecting the recommendations identified by MacKay and Stone (2013) (albeit in respect of shale gas but with wider applications to conventional oil and gas), operators should:
    - in managing vented or flared methane throughout the exploration, pre-production and production of shale gas, adopt the principle of reducing emissions to as low a level as reasonably practicable (ALARP). In particular, “reduced emissions completions” (REC) or “green completions” should be adopted at all stages following exploration;
    - monitor their sites to: (1) ensure early warning of unexpected leakages; and (2) obtain emissions estimates for regulators and government.
- DECC should consider the feasibility of measures to reduce GHG emissions through and related to the licensing process. These measures may include, for example:
    - development of guidance suggesting measures to reduce GHG emissions during all stages of the conventional oil and gas exploration of production lifecycle with appropriate linkages to Environmental Impact Assessment;
    - discussion with regulators on appropriate mandatory requirements to be applied at each stage to ensure that the best technology is implemented in all cases (MacKay and Stone, 2013);
    - implementation of GHG emissions recording and monitoring protocols, reflecting recommendations contained in the AEA (2012) report[26] and of MacKay and Stone (2013);
    - the application of the emission limit values requirements under the Industrial Emissions Directive to methane emissions from exploration and production activities as per recommendations contained in the AEA (2012) review.
- Where appropriate, consideration should be given to the implementation of soil sequestration projects as part the restoration process.
- Where appropriate, consideration should be given to how sites can be used to enhance climate change resilience during restoration (e.g. through flood attenuation schemes).

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could*

[26] AEA (2012) Climate impact of potential shale gas production in the EU: Report for the European Commission.

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| *be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.* | | | | |
| *S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)* | | | | |

## 7.8.2 Unconventional Oil and Gas

The assessment of the six main stages of unconventional oil and gas production is contained in **Table 7.11** under both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report).

**Table 7.11 Assessment of Effects: Unconventional Oil and Gas**

| Objective 8: Climate Change | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | The type, scale and magnitude of effects associated with Stage 1 of the unconventional oil and gas exploration and production lifecycle are likely to be similar to those identified in respect of conventional oil and gas (see **Table 7.10**) and would comprise non-intrusive activities.<br>Site identification, selection and characterisation and the securing of development and operation permits would be expected to be largely desk-based and in consequence, no substantial effects on climate change would be anticipated from these activities.<br>Vibroseis is the most common method of seismic survey and typically involves 3-5 large vibrator units which sub-sonically vibrate the ground while a number of support vehicles record the returning shock waves for analysis. Greenhouse gas (GHG) emissions will result from associated vehicle movements and the operation of machinery. However, it is anticipated that the intensity of activity would be low and number vehicle movements small such that any effects on climate change are unlikely to be significant in a strategic context.<br>There may be a requirement for the temporary construction of new roads to facilitate access to sites which could result in disturbance to soils and emissions of $CO_2$ and methane together with loss of soil carbon sequestration. However, it is assumed that landtake would be relatively small and that any soils displaced during construction would be returned following the completion of works. |

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| Objective 8: Climate Change | | | | |
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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Reflecting the scale and type of activities, this stage has been assessed as having a neutral effect on climate change.<br>**Low and High Activity Scenarios:**<br>As noted above, this stage of the unconventional oil and gas exploration and production lifecycle would comprise limited, non-intrusive activities such that effects on climate change are also likely to be limited.<br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed). In consequence, GHG emissions associated with vehicle movements and the operation of machinery would increase. Further, the volume of soil displaced to support the construction of vehicular access to sites and the potential for emissions of $CO_2$ and methane may also be increased. However, it is considered that total emissions would still be low in the strategic context and as a result, effects on this objective would remain neutral.<br>**Mitigation:**<br>• DECC should consider the feasibility of measures to reduce GHG emissions through and related to the licensing process. These measures may include, for example:<br>o development of guidance suggesting measures to reduce GHG emissions during all stages of the unconventional oil and gas exploration of production lifecycle with appropriate linkages to Environmental Impact Assessment;<br>o discussion with regulators on appropriate mandatory requirements to be applied at each stage to ensure that the best technology is implemented in all cases (MacKay and Stone, 2013);<br>o implementation of GHG emissions recording and monitoring protocols, reflecting recommendations contained in the AEA (2012) report concerning the climate impact of potential shale gas production in the EU[27] and of MacKay and Stone (2013);<br>o the application of the emission limit values requirements under the Industrial Emissions Directive to methane emissions from exploration and production activities as per recommendations contained in the AEA (2012) review.<br>**Assumptions:**<br>• It is assumed that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible.<br>• It is assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed). |

[27] AEA (2012) Climate impact of potential shale gas production in the EU: Report for the European Commission.

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • It is assumed that any soils displaced during construction would be returned following completion of works.<br>**Uncertainties:**<br>• None identified. |
| 2 | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. | - | -- | **Assessment of Effects:**<br>Pad preparation and associated construction activities would generate GHG emissions. Sources of emissions would include the direct or indirect combustion of fossil fuels from construction traffic, plant and generators and the embodied carbon within construction materials. Disturbance to soils and emissions of $CO_2$ and methane together with loss of soil carbon sequestration may also contribute to climate change, although it is anticipated that sites would be restored following either completion of exploration drilling or decommissioning of wells such that effects would be reduced in longer term (i.e. following exploratory drilling or beyond the site restoration stage, depending on whether a site is taken forward to the production stage). The exact magnitude of emissions related to pad preparation would be dependent on site specific characteristics such as requirements for infrastructure such as roads, the distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain. However, a recent report by MacKay and Stone (2013) concerning potential greenhouse gas emissions associated with shale gas extraction and use[28]estimates (based on median values of GHG emissions taken from a range of source data) that site preparation would generate 229 $tCO_2eq$ per well (taking into account GHG emissions during Stage 2 and Stage 3 of the unconventional oil and gas exploration and production lifecycle).<br>GHG emissions would also be generated from the energy used in the drilling of boreholes. There would also be additional emissions associated with transportation and treatment of wastes (e.g. mud and cuttings) arising from drilling activities and from the embodied carbon associated with well construction. Energy use and associated emissions would be greater than those related to conventional oil and gas exploration during this stage. This principally reflects the requirement for hydraulic fracturing to establish if hydrocarbons are present and to determine whether production would be commercially viable. Hydraulic fracturing is used to stimulate the production of gas by increasing the number of fractures in a rock formation, and therefore its permeability, through the injection of water under high pressure accompanied by (typically) sand which prevents the fractures closing[29]. The fracturing process is |

[28] MacKay, D.J.C. and Stone, T.J. (2013) *Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use*. Report on behalf of DECC. London: DECC

[29] AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: Report for the European Commission*.

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| Objective 8: Climate Change | | | | |
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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | typically powered by large, diesel-fired internal combustion engines and requires more energy to fracture the formation than required to drill the wellbore. Further, additional emissions are generated by the hydraulic fracturing process due to the requirement for the transportation and treatment of large volumes of water, sand and chemicals for the proppant fluids, as well as from the embodied carbon in the chemicals themselves and other additional construction materials (e.g. well casing). The exact volume of GHG emissions associated with these activities would depend on a number of factors including the length of the well bore, quantities of water and other chemicals required for hydraulic fracturing and transportation requirements.<br>MacKay and Stone (2013) estimate that drilling and hydraulic fracturing operations during the pre-production phase (i.e. stages 2 and 3 of the unconventional oil and gas exploration and production lifecycle) would generate 711 $tCO_2eq$ per well (based on median values of GHG emissions taken from a range of data sources). Indirect emissions associated with the transportation of water (including wastewater transport and treatment) are estimated to be 21 $tCO_2eq$ per well and the embodied carbon in chemicals 300 $tCO_2eq$ per well (note that estimates cover activities under both stages 2 and 3).<br>Following the completion of hydraulic fracturing, a combination of fracturing fluid and water is returned to the surface (flowback) which includes methane (known as well completion). As highlighted in reports by the AEA (2012) and MacKay and Stone (2013), well completion is likely to be the main source of GHG emissions during the pre-production phase (stages 2 and 3 of the unconventional oil and gas exploration and production lifecycle for the purposes of this assessment). GHG emissions associated with well completion are estimated to be 1,394 $tCO_2eq$ per well. This estimate is based on the median values of GHG emissions from a range of source data, as reported in MacKay and Stone (2013) and assumes that 90% of methane emissions released during flowback are captured and flared.<br>The work of Jackson *et al* (2013), amongst others, highlights that a potential source of GHG emissions associated with unconventional oil and gas exploration and production could be from gas that has escaped into aquifers, principally as a result of poor well construction during drilling, production or after abandonment[30]. In the US, for example, Vidic *et al* (2013) derived a figure of 3.4% well leakage based on data from the Department of Environmental Protection[31].<br>However, MacKay and Stone (2013) consider there to be sufficient regulations in place in the UK that leakage of gas into aquifers is unlikely to occur. In this respect, they highlight that UKOOG guidelines clearly set out good practice in well design. Future advances in self-healing cement are likely to mitigate this risk further. |

[30] Jackson *et al* (2013) *Increased stray gas abundance in a subset of drinking water wells near Marcellus shale gas extraction*, PNAS, 110 (28), 11250-11255. http://www.pnas.org/content/110/28/11250.short.

[31] Vidic *et al*. (2013) Impact of shale gas development on regional water quality. Science 17 May 2013: Vol. 340 no. 6134 1235009

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|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Construction and exploration could be affected by climate change where sites are located, for example, in coastal areas that may be affected by coastal inundation or sea level rise or in areas of flood risk that could be susceptible to extreme weather conditions. Current information indicates that the UK is experiencing a sea level rise of approximately 1mm per annum and a global sea level rise of approximately 3mm per annum. Climate change effects such as intensified weather events therefore have the potential to affect activities during Stage 2. However, in view of the nature of the development and associated activities together with the duration of the exploration stage (6 years), it is not expected that associated activities would be substantially affected by the impacts of climate change. Further, it would be expected that development would be located away from areas at risk of climate change impacts (i.e. areas at risk of flooding), in accordance with national planning policy guidance.<br><br>Given the requirement for hydraulic fracturing during this stage and associated water consumption (10,000m$^3$ – 25,000m$^3$ per well), there is the potential for activities to be both affected by climate change impacts on water resource availability and/or to affect future water resource availability, although this is dependent on existing and future local water resource availability. Effects in respect of water resources are considered further in **Chapter 5** of this appendix.<br><br>Overall, Stage 2 of the unconventional oil and gas exploration and production lifecycle has been assessed as having a negative effect on the climate change objective.<br><br>**Low and High Activity Scenarios:**<br><br>GHG emissions under the high activity scenario would be expected to be substantially greater than those associated with the low activity scenario. This is commensurate with the total number of boreholes to be drilled and total area to be covered by exploration well pads under the high activity scenario (240 boreholes and 240ha of land compared to 20 boreholes and 20ha of land under the low activity scenario) and reflects the additional combustion of fossil fuels, increased vehicle movements and waste treatment requirements, higher embodied carbon, and the potential for disturbance of soils. There would also be far higher GHG emissions associated with well completion under the high activity scenario.<br><br>For the pre-production phase as a whole (taking into account activities during stages 2 and 3 of the unconventional oil and gas exploration and production lifecycle), it is estimated that total GHG emissions under the high activity scenario would be between 3.8Mt$CO_2$eq and 7.6Mt$CO_2$eq (based on emissions of 2,655 t$CO_2$eq per well and assuming between 1,440 and 2,880 wells). This compares with emissions of between 0.48Mt$CO_2$eq and 0.96Mt$CO_2$eq under the low activity scenario (assuming between 180 and 360 wells).<br><br>At peak (assuming up to a maximum of 360 wells per annum), GHG emissions would be 0.96Mt$CO_2$eq per annum under the high activity scenario. This equates to 10.3% of all |

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| | | | | GHG emissions from exploration, production and transport of oil and gas in the UK in 2011, according to DECC statistics[32]. Under the low activity scenario, meanwhile, GHG emissions at peak (assuming a maximum of 60 wells per annum) would be 0.16Mt$CO_2$eq per annum. In consequence, the high activity scenario has been assessed as having a significant negative effect on this objective at a sector level whilst negative effects associated with the low activity scenario have been assessed as minor.<br>As noted above, there is not considered to be a substantial risk of activities being adversely affected by climate change impacts. However, additional water use associated with hydraulic fracturing under the high activity scenario in particular could affect, or be affected by future water resource availability.<br>**Mitigation:**<br>• During the site selection process, careful consideration should be given by the operator to the avoidance of carbon sinks (e.g. peats).<br>• Where possible, measures should be taken to offset (at least in part) GHG emissions arising from construction and operational activities. These measures may include, for example:<br>o the use of construction materials with low embodied carbon;<br>o measures to reduce private vehicle use for workers;<br>o provision for the transportation of materials and construction wastes by rail where practicable;<br>o limiting the volume of construction waste on-site.<br>• Reflecting the recommendations identified by MacKay and Stone (2013), operators should:<br>o in managing vented or flared methane throughout the exploration, pre-production and production of shale gas, adopt the principle of reducing emissions to as low a level as reasonably practicable (ALARP).<br>o monitor their sites to: (1) ensure early warning of unexpected leakages; and (2) obtain emissions estimates for regulators and government.<br>• Site selection should be informed by robust Flood Risk Assessment to ensure that risks associated with climate change impacts are identified and addressed (e.g. through the implementation of sustainable drainage systems).<br>• DECC should consider the feasibility of measures, through and related to the licensing process, to reduce GHG emissions during Stage 2. These measures are detailed under the assessment of Stage 1. |

[32] See https://www.gov.uk/government/publications/final-uk-emissions-estimates [Accessed September 2013]

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| | | | | • As per the recommendations of MacKay and Stone (2013), the Government and industry should undertake research into shale gas production in the UK with a view to developing more effective extraction techniques, such as improved REC and self-healing cements, reduced water consumption and vehicle demand which minimise wider environmental impacts including whole-life-cycle GHG emissions.<br>**Assumptions:**<br>• It is assumed that GHG emissions would be greater under the high activity scenario compared to the low activity scenario, commensurate with the increased number of boreholes to be drilled and total site area.<br>• It is assumed that 90% of methane emissions released during flowback are captured and flared.<br>• Under the low activity scenario it is assumed that all wells will be operational by the end of year 9. It is assumed that a maximum of 5 well pad sites would be constructed within one year, resulting in completion of 30-60 wells.<br>• Under the high activity scenario it is assumed that all wells would be operational by the end of year 12. It is assumed that a maximum of 15 well pad sites would be constructed within one year, resulting in completion of 180-360 wells.<br>**Uncertainties:**<br>• The exact magnitude of GHG emissions associated with site preparation would be dependent on site specific characteristics such as requirements for infrastructure such as roads, the distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain.<br>• The exact volume of GHG emissions associated with exploration activities would depend on a number of factors including the length of the well bore, quantities of water and other chemicals required for hydraulic fracturing and transportation requirements which are currently uncertain.<br>• The potential for activities to be affected by climate change will be to some extent dependent on site location which is currently uncertain. |
| 3 | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing; | - | -- | **Assessment of Effects:**<br>The range and type of effects associated with Stage 3 of the unconventional oil and gas exploration and production lifecycle would be similar to those identified under Stage 2. This stage would require additional infrastructure including storage tanks, road connections and the installation of pipelines required to collect natural gas for transfer to the existing natural gas pipeline infrastructure. This would generate further GHG emissions associated with construction traffic, plant and generators and the embodied carbon within construction materials. Disturbance to soils and emissions of $CO_2$ and methane together with loss of soil carbon sequestration may also contribute to climate change, |

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| | • Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. | | | although it is anticipated that sites would be restored following decommissioning such that effects would be reduced in longer term. Additionally, following the completion of Stage 3, some soils displaced during the development of well pads and associated infrastructure (e.g. pipelines) may be returned.<br>As highlighted under Stage 2, the exact magnitude of GHG emissions related to pad preparation would be dependent on site specific characteristics such as requirements for infrastructure such as roads, the distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain. However, a recent report by MacKay and Stone (2013) concerning potential greenhouse gas emissions associated with shale gas extraction and use[33] estimates (based on median values of GHG emissions taken from a range of source data) that site preparation would generate 229 $tCO_2eq$ per well (taking into account GHG emissions during Stage 2 and Stage 3 of the unconventional oil and gas exploration and production lifecycle).<br>GHG emissions would also be generated from the energy used in the drilling of wells. There would also be additional emissions associated with transportation and treatment of wastes (e.g. mud and cuttings) arising from drilling activities and from the embodied carbon associated with well construction. During Stage 3 there would be a need for further hydraulic fracturing to stimulate the production of gas. As highlighted under the assessment of Stage 2, MacKay and Stone (2013) estimate that drilling and hydraulic fracturing operations during the pre-production phase (i.e. stages 2 and 3 of the unconventional oil and gas exploration and production lifecycle) would generate 711 $tCO_2eq$ (based on median values of GHG emissions taken from a range of data sources). Indirect emissions associated with the transportation of water (including wastewater transport and treatment) are estimated to be 21 $tCO_2eq$ per well and the embodied carbon in chemicals 300 $tCO_2eq$ per well (note that estimates cover activities under both stages 2 and 3).<br>Following the completion of hydraulic fracturing, a combination of fracturing fluid and water is returned to the surface (flowback) which includes methane (known as well completion). As highlighted in reports by the AEA (2012) and MacKay and Stone (2013), well completion is likely to be the main source of GHG emissions during the pre-production phase (Stages 2 and 3 of the unconventional oil and gas exploration and production lifecycle for the purposes of this assessment). GHG emissions associated with well completion are estimated to be 1,394 $tCO_2eq$ per well. This estimate is based on the median values of GHG emissions from a range of source data, as reported in MacKay and Stone (2013) and assumes that 90% of methane emissions released during flowback are captured and flared. However, it should be noted that estimates of the volume of gas released during well completion vary significantly and would |

[33] MacKay, D.J.C. and Stone, T.J. (2013) *Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use*. Report on behalf of DECC. London: DECC

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| | | | | depend on, for example, geology, well productivity and the well completion method. For example, if 100% of methane released during flowback was captured and injected into the grid (if grid connection was available at this stage) there would be no emissions associated with well completion (MacKay and Stone, 2013).<br>In this respect, a recent study by Allen *et al* (2013) concerning methane emissions at natural gas production sites in the United States[34] concludes that the application of current good practice (in separation and capture of methane from the flowback fluid, so that it can be flared, utilised or sold) is more successful in reducing well completion emissions than previously estimated (the assumptions made in this Report are, however, consistent with the previous, more conservative estimates).<br>The work of Jackson *et al* (2013), amongst others, highlights that a potential source of GHG emissions associated with unconventional oil and gas exploration and production could be from gas that has escaped into aquifers, principally as a result of poor well construction during drilling, production or after abandonment[35]. In the US, for example, Vidic *et al* (2013) derived a figure of 3.4% well leakage based on data from the Department of Environmental Protection[36].<br>However, MacKay and Stone (2013) consider there to be sufficient regulations in place in the UK that leakage of gas into aquifers is unlikely to occur. In this respect, they highlight that UKOOG guidelines clearly set out good practice in well design. Future advances in self-healing cement are likely to mitigate this risk further.<br>As with Stage 2, construction could be affected by climate change where sites are located, for example, in coastal areas that may be affected by coastal inundation or sea level rise or in areas of flood risk that could be susceptible to extreme weather conditions. Current information indicates that the UK is experiencing a sea level rise of approximately 1mm per annum and a global sea level rise of approximately 3mm per annum. Climate change effects such as intensified weather events therefore have the potential to affect activities during Stage 3. However, in view of the nature of the development and associated activities, it is not expected that associated activities would be substantially affected by the impacts of climate change. Further, it would be expected that development would be located away from areas at risk of climate change impacts (i.e. areas at risk of flooding), in accordance with national planning policy guidance. |

[34] Allen, D.T., Torres, V.M., Thomas, J., Sullivan, D.W., Harrison, M. Hendler, A., Herndon, S.C., Kolb, C.E., Fraser, M.P., Hill, D. Lamb, B.K. Miskimins, J., Sawyer, R.F. and Seinfeld, J.H. (2013) Measurements of methane emissions at natural gas production sites in the United State. PNAS (2013) published ahead of print September 16, 2013, doi:10.1073/pnas.1304880110.

[35] Jackson *et al* (2013) *Increased stray gas abundance in a subset of drinking water wells near Marcellus shale gas extraction*, PNAS, 110 (28), 11250-11255. http://www.pnas.org/content/110/28/11250.short.

[36] Vidic *et al*. (2013) Impact of shale gas development on regional water quality. Science 17 May 2013: Vol. 340 no. 6134 1235009

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| | | | | Given the requirement for hydraulic fracturing during this stage and associated water consumption (10,000m$^3$ – 25,000m$^3$ per well), there is the potential for activities to be both affected by climate change impacts on water resource availability and/or to affect future water resource availability, although this is dependent on existing and future local water resource availability. Effects in respect of water resources are considered further in **Chapter 5** of this appendix.<br>Overall, Stage 3 of the unconventional oil and gas exploration and production lifecycle has been assessed as having a negative effect on the climate change objective.<br>**Low and High Activity Scenarios:**<br>GHG emissions under the high activity scenario would be expected to be substantially greater than those associated with the low activity scenario. This is commensurate with the total number of wells and total area to be covered by well pads under the high activity scenario (1,440- 2,880 wells and 240-360ha of land compared to 180-360 wells and 60-90ha of land under the low activity scenario) and reflects the additional combustion of fossil fuels, increased vehicle movements and waste treatment requirements, higher embodied carbon, and the potential for disturbance of soils. There would also be far higher GHG emissions associated with well completion under the high activity scenario.<br>At peak (assuming up to a maximum of 360 wells per annum), GHG emissions would be 0.96M t$CO_2$eq per annum under the high activity scenario. This equates to10.3% of the 9.3 M t$CO_2$eq from the exploration, production and transport of oil and gas in the UK in 2011 (the most recent year for which final data is available)[37]. Under the low activity scenario, meanwhile, GHG emissions at peak (assuming a maximum of 60 wells per annum) would be 0.16Mt$CO_2$eq per annum. In consequence, the high activity scenario has been assessed as having a significant negative effect on this objective at the sector level whilst negative effects associated with the low activity scenario have been assessed as minor. Notwithstanding, it should be noted that if 100% of methane released during well completion was captured and injected into the grid, the volume of GHG emissions would be substantially reduced (approximately 0.45Mt$CO_2$eq during peak under the high activity scenario).<br>As noted above, there is not considered to be a substantial risk of activities being adversely affected by climate change impacts. However, additional water use associated with hydraulic fracturing under the high activity scenario in particular could affect, or be affected by future water resource availability.<br>**Mitigation:**<br>• During the site selection process, careful consideration should be given by the operator to the avoidance of carbon sinks (e.g. peats); |

[37] See https://www.gov.uk/government/publications/final-uk-emissions-estimates [Accessed September 2013]

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| | | | | • Where possible, measures should be taken to offset (at least in part) GHG emissions arising from construction and operational activities. These measures may include, for example:<br>o the use of construction materials with low embodied carbon;<br>o measures to reduce private vehicle use for workers;<br>o provision for the transportation of materials and construction wastes by rail where practicable;<br>o limiting the volume of construction waste on-site.<br>• Reflecting the recommendations identified by MacKay and Stone (2013), operators should:<br>o in managing vented or flared methane throughout the exploration, pre-production and production of shale gas, adopt the principle of reducing emissions to as low a level as reasonably practicable (ALARP). In particular, "reduced emissions completions" (REC) or "green completions" should be adopted at all stages following exploration;<br>o monitor their sites to: (1) ensure early warning of unexpected leakages; and (2) obtain emissions estimates for regulators and government.<br>• Site selection should be informed by robust Flood Risk Assessment to ensure that risks associated with climate change impacts are identified and addressed (e.g. through the implementation of sustainable drainage systems).<br>• DECC should consider the feasibility of measures, through and related to the licensing process, to reduce GHG emissions during Stage 3. These measures are detailed under the assessment of Stage 1.<br>• As per the recommendations of MacKay and Stone (2013), the Government and industry should undertake research into shale gas production in the UK with a view to developing more effective extraction techniques, such as improved REC and self-healing cements, reduced water consumption and vehicle demand which minimise wider environmental impacts including whole-life-cycle GHG emissions.<br>**Assumptions:**<br>• It is assumed that emissions would be greater under the high activity scenario compared to the low activity scenario, commensurate with the increased number of wells and total site area.<br>• It is assumed that 90% of methane emissions released during flowback are captured and flared.<br>• Under the low activity scenario it is assumed that all wells would be operational by the end of year 9. It is assumed that a maximum of 5 well pad sites would be constructed within one year, resulting in completion of 30-60 wells. |

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| | | | | • Under the high activity scenario it is assumed that all wells would be operational by the end of year 12. It is assumed that a maximum of 15 well pad sites would be constructed within one year, resulting in completion of 180-360 wells.<br>**Uncertainties:**<br>• The exact magnitude of GHG emissions would be dependent on site specific characteristics such as requirements for infrastructure such as roads, the distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain.<br>• The quantity of fuel consumed during the drilling of wells, and the associated emissions, will depend upon the length of the well bore which is currently uncertain.<br>• The potential for activities to be affected by climate change will be to some extent dependent on site location which is currently uncertain. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | - | -- | **Assessment of Effects:**<br>The AEA (2012) report concerning the climate impact of potential shale gas production in the EU states (at page 28) that "*Since most of the emissions in this stage arise from equipment which would be used for conventional gas production, while there are significant emissions during the production stage, they are not significantly different from conventional gas production*". In consequence, the range and type of effects arising from Stage 4 are expected to be similar to those identified in respect of conventional oil and gas exploration and production (see **Table 7.10**).<br>During the production stage there would be GHG emissions associated with power generation and combustion plant and from vehicle movements related to the transportation of maintenance workers and wastes to/from sites. A further source of GHG emissions is likely to be fugitive methane and other trace hydrocarbons via leakages from on-site equipment including valves, flanges and compressors as well as from flaring and venting. MacKay and Stone's (2013) report concerning potential greenhouse gas emissions associated with shale gas extraction and use assumes that GHG emissions from these sources would be similar to those associated with conventional gas production. The Digest of UK Energy Statistics estimates emissions associated with production and processing of conventional gas to be 100 $tCO_2e$ per million $m^3$. Based on MacKay and Stone's central estimate of well productivity (estimated total of 85 million $m^3$ over the 20 year lifetime of the wells), it is assumed that total GHG emissions per well would be 8,500 $tCO_2e$ during production.<br>The AEA (2012) review states that an operator may choose to re-fracture a well during this stage in order to increase the rate of gas production, if this is considered worthwhile from a commercial perspective. Wells are likely to be re-fractured infrequently (either once every five to 10 years or not at all, based on US experience) and reflecting the findings of the AEA (2012) review and MacKay and Stone (2013), it has been assumed that each well would be re-fractured once during its operational lifetime with associated emissions |

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| | | | | likely to be similar to well completion during Stages 2 and 3 (1,394 $tCO_2eq$ per well). However, if 100% of methane released during flowback was captured and injected into the grid there would be no emissions associated with well completion (MacKay and Stone, 2013).<br><br>Indirectly, the combustion of extracted hydrocarbons would generate approximately 190 $gCO_2e/kWh$ (which represents combustion emissions for methane)[33]. As of 2011, natural gas consumption accounted for 28.9% of GHG emissions from all fuel types (164.6 million $tCO_2eq$)[38] . The extent to which domestic production and consumption of shale gas would affect GHG emissions would vary subject to changes in prices affecting demand and supply relative to Liquefied Natural Gas (LNG) imports and relative to coal. In this context, a report by the Institute of Directors (IoD)[39] highlights that the use of domestic gas as opposed to imported gas should reduce GHG emissions According to the AEA (2012) review, emissions from electricity generated from shale gas are 2-10% lower than electricity generated from conventional pipeline gas located outside of Europe (in Russia and Algeria), and 7-10% lower than electricity generated from LNG imported into Europe. MacKay and Stone (2013), meanwhile, state that lifecycle emissions associated with shale gas (between 200 and 253 g $CO_2e$ per $kWh_{(th)}$) are comparable to gas extracted from conventional sources (199-207 g $CO_2e$ per $kWh_{(th)}$) and lower than LNG (233 – 270 g $CO_2e$ per $kWh_{(th)}$). When shale gas is used for electricity generation, MacKay and Stone (2013) highlight that its carbon footprint is significantly lower than coal and point to US experience where a switch from coal to gas in electricity production has "*significantly reduced the USA's emissions rate*".<br><br>However, MacKay and Stone (2013) also highlight the need to consider the impact of shale gas production and consumption on global emissions and point to the fact that the switch to shale gas in the US has increased exports of coal, increasing the carbon intensity of energy production in other countries. Further, it is also important to acknowledge that shale gas production and consumption could displace lower carbon energy sources and in this respect the recommendations at paragraph 159 of the Energy and Climate Change Committee (2011) report on shale gas that "*in planning to decarbonise the energy sector DECC should generally be cautious in its approach to natural gas... Although gas emissions are less than coal they are higher than many lower carbon technologies*" are noted. However, it is assumed that consumption of shale gas would substitute the combustion of other currently imported hydrocarbons and that there would be no net change to the energy mix within the UK, other than those already anticipated by DECC in the 2050 pathways report. According to DECC's central forecasts, overall natural gas demand (for heating and industry as well as electricity generation) is projected to remain approximately at today's level over the next two decades – falling from 3,055 billion cubic feet (bcf) in 2011 to 2,621 bcf in 2020, before rising to 3,049 bcf by 2030. These |

[38] See https://www.gov.uk/government/publications/final-uk-emissions-estimates [Accessed September 2013]

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| | | | | gas demand projections are consistent with DECC's central forecasts for GHG emissions, which project the net UK carbon account to fall, relative to 1990 levels, by 37% by 2020 and 45% by 2025.[39] In consequence, shale gas production and consumption would not be expected to displace energy generation from renewable and low carbon sources nor disincentivise investment in renewable and low carbon technologies, particularly given UK Government commitments and targets for renewable energy generation contained in the Renewable Energy Roadmap (2011). Domestic shale gas production and consumption could, however, help to reduce net GHG emissions associated with reduced imports of LNG in particular. This would generate a positive effect on this objective although the scale of any benefits would be dependent on the balance between conventional, LNG and unconventional gas production and consumption which is currently uncertain.<br>Production could be affected by climate change where sites are located, for example, in coastal areas that may be affected by coastal inundation or sea level rise or in areas of flood risk that could be susceptible to extreme weather conditions. Current information indicates that the UK is experiencing a sea level rise of approximately 1mm per annum and a global sea level rise of approximately 3mm per annum. Climate change effects such as intensified weather events therefore have the potential to affect activities during Stage 4 particularly given the fact that production would take place over a relatively long time frame (20 years) during which time the impacts of climate change (e.g. sea level rise) could become more pronounced. Notwithstanding, it would be expected that development would be located away from areas at risk of climate change impacts, in accordance with national planning policy guidance.<br>Given the potential requirement for re- fracturing during this stage and associated water consumption, there is the potential for activities to be both affected by climate change impacts on water resource availability and/or to affect future water resource availability, although this is dependent on existing and future local water resource availability. Effects in respect of water resources are considered further in **Chapter 5** of this appendix.<br>Overall, Stage 4 of the unconventional oil and gas exploration and production lifecycle has been assessed as having a potentially significant negative effect on this objective at a sector level.<br>**Low and High Activity Scenarios:**<br>GHG emissions directly associated with production under the high activity scenario would be expected to be substantially greater than those related to the low activity scenario. This is commensurate with the total number of wells under the high activity scenario (between 1440 and 2880 wells). Based on total emissions associated with production including re-fracturing (9,894 $tCO_2eq$), emissions per annum under the high activity scenario would be |

[39] Institute of Directors (2013) *Getting Shale Gas Working*. Available from www.iod.com/~/.../IoD_Getting_shale_gas_working_MAIN_REPORT.pdf [Accessed September 2013]

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| | | | | between 0.7M and 1.4M $tCO_2eq$ for the peak period when all wells are productive. This is equivalent to between 7.6% and 15.3% of the 9.3M tCO2eq of sectoral emissions from the exploration, production and transport of oil and gas in the UK in 2011 (the most recent year for which final data is available). However, this equates to around 0.75% of all GHG emissions from the energy supply sector in 2011,[40] or less than 0.3% of the current total of the UK inventory of GHG emissions. In total, GHG emissions from Stage 4 for the high activity scenario have been estimated to be between 14.25M and 28.49M tCO2eq.<br>Whilst under the low activity scenario the number of wells would be much lower (between 180 and 360 wells), GHG emissions would be up to 0.18M tCO2eq per annum. This is equivalent to up to 2% of the 9.3 M tCO2eq from the exploration, production and transport of oil and gas in the UK in 2011 or 0.04% of UK GHG inventory. In total, GHG emissions from stage 4 for the low activity scenario have been estimated to be between 1.78M and 3.56M tCO2eq.<br>Overall, the volume of GHG emissions associated with both high activity scenarios have been assessed as having a significant negative effect on this objective at a sector level. Notwithstanding, it should be noted that, reflecting the potential that the production of gas domestically could reduce net GHG emissions relative to the importation of gas, an increase in production associated with the high activity scenario could generate GHG reductions above the lower activity scenario, although this is currently uncertain.<br>As noted above, there is not considered to be a substantial risk of activities being adversely affected by climate change impacts. However, additional water use associated with hydraulic fracturing under the high activity scenario in particular could affect, or be affected by future water resource availability.<br>**Mitigation:**<br>• Where possible, measures should be taken to offset (at least in part) GHG emissions arising from production activities. These measures may include, for example:<br>o measures to reduce private vehicle use for workers;<br>o provision for the transportation of wastes by rail where practicable.<br>• Reflecting the recommendations identified by MacKay and Stone (2013), operators should:<br>o in managing vented or flared methane throughout the exploration, pre-production and production of shale gas, adopt the principle of reducing emissions to as low a level as reasonably practicable (ALARP).<br>In particular, "reduced emissions completions" (REC) or "green completions" should be adopted at all stages following exploration; |

[40] See https://www.gov.uk/government/publications/final-uk-emissions-estimates [Accessed September 2013]

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | o monitor their sites to: (1) ensure early warning of unexpected leakages; and (2) obtain emissions estimates for regulators and government.<br>• DECC should consider the feasibility of measures, through and related to the licensing process, to reduce GHG emissions during Stage 4. These measures are detailed under the assessment of Stage 1.<br>**Assumptions:**<br>• It is assumed that GHG emissions associated with shale gas production would be similar to those associated with conventional gas.<br>• It is assumed that wells would be re-fractrured once during their operational lifetime with associated emissions likely to be similar to well completion during Stages 2 and 3.<br>• It is assumed that direct GHG emissions during production would be greater under the high activity scenario compared to the low activity scenario, commensurate with the increased number of wells.<br>• It is assumed that emissions from flaring or venting would be kept to the minimum that is technically and economically justified.<br>• It is assumed that the consumption of extracted hydrocarbons would substitute the combustion of other currently imported hydrocarbons and that there would be no net change to the energy mix within the UK, other than those already anticipated by DECC in the 2050 pathways report.<br>• It is assumed that 90% of methane emissions released during flowback are captured and flared.<br>**Uncertainties:**<br>• The extent to which domestic shale gas production and consumption could help to reduce net UK GHG emissions is uncertain and would be dependent on the balance between conventional, LNG and unconventional gas production and consumption which is currently uncertain. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | - | - | **Assessment of Effects:**<br>During decommissioning there would be emissions of GHGs associated with the use of machinery and plant as well as from construction traffic. There would also be emissions associated with the embodied carbon in concrete used plug wells and, potentially, the treatment of any waste arisings.<br>Associated works may require the clearance of vegetation and loss of soil layers which could result in emissions of $CO_2$ and methane together with loss of soil carbon sequestration. However, it is not expected that the area of land required to undertake decommissioning activities (beyond existing well pads) would be significant.<br>In this respect, the AEA (2012:69) report for the European Commission notes that there is generally little difference between conventional and unconventional wells in the post-abandonment phase and that the consequences for land |

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| Objective 8: Climate Change | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | take would be "*comparable with many other industrial and commercial land-uses, and are of no more than minor significance*".<br>The total magnitude of GHG emissions associated with this stage would be dependent on site specific characteristics such as requirements for infrastructure such as roads, the distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of any soils displaced which are currently uncertain. However, it is not expected that emissions would be of a magnitude considered to be nationally significant.<br>Decommissioning could be affected by climate change where sites are located, for example, in coastal areas that may be affected by coastal inundation or sea level rise or in areas of flood risk that could be susceptible to extreme weather conditions. Current information indicates that the UK is experiencing a sea level rise of approximately 1mm per annum and a global sea level rise of approximately 3mm per annum. Climate change effects such as intensified weather events therefore have the potential to affect activities during Stage 5 particularly given the fact that decommissioning would take place in the longer term (i.e. beyond the lifetime of a well) during which time the impacts of climate change (e.g. sea level rise) could become more pronounced. Notwithstanding, it would be expected that development would be located away from areas at risk of climate change impacts, in accordance with national planning policy guidance.<br>**Low and High Activity Scenarios:**<br>GHG emissions under the high activity scenario would be expected to be greater than those associated with the low activity scenario. This is commensurate with the total number wells to be decommissioned under the high activity scenario (up to 2,880 wells compared to up to 360 wells under the low activity scenario) and reflects the additional combustion of fossil fuels, increased vehicle movements and the potential for disturbance of soils. Notwithstanding, emissions would not be expected to be significant.<br>As noted above, there is not considered to be a substantial risk of activities being adversely affected by climate change impacts. In consequence, effects in this regard are not expected to be significantly influenced by the quantum of activity.<br>**Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• It is assumed that wells would be appropriately sealed to prevent fugitive emissions.<br>**Uncertainties:**<br>• The exact magnitude of GHG emissions associated with this stage would be dependent on site specific characteristics such as requirements for infrastructure such as roads, distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain. |

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| Objective 8: Climate Change | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **+/-** | **+/-** | **Assessment of Effects:**<br>For the purposes of this assessment it is assumed that all associated infrastructure and hardstanding would be removed during the site restoration and relinquishment stage. Due to the need for invasive demolition techniques and land excavation there would be GHG emissions associated with the use of plant and from construction traffic. There may also be additional GHG emissions related to the treatment of wastes.<br>Following completion of site restoration activities, there would be no further GHG emissions or energy use, reducing effects on climate change in the longer term. Depending on the end use of well pad sites (which would be determined on a site-by-site basis following discussions between the operator and the minerals planning authority), there may be opportunities to enhance carbon sequestration through rehabilitation and re-vegetation. In this respect, paragraph 143 of the National Planning Policy Framework (DCLG 2012) promotes high quality restoration and aftercare "*including for agriculture (safeguarding the long term potential of best and most versatile agricultural land and conserving soil resources), geodiversity, biodiversity, native woodland, the historic environment and recreation*". However, it should be noted that the AEA (2012) report highlights that it may not be possible to return entire sites to beneficial use due to, for example, concerns regarding public safety. The report states (at page 69) that over a wider area "*this could result in a significant loss of land, and/or fragmentation of land area such as an amenity or recreational facility, valuable farmland, or valuable natural habitat*".<br>Site restoration works could be affected by climate change where sites are located, for example, in coastal areas that may be affected by coastal inundation or sea level rise or in areas of flood risk that could be susceptible to extreme weather conditions. Current information indicates that the UK is experiencing a sea level rise of approximately 1mm per annum and a global sea level rise of approximately 3mm per annum. Climate change effects such as intensified weather events therefore have the potential to affect activities during Stage 6 particularly given the fact that site restoration would take place in the longer term during which time the impacts of climate change (e.g. sea level rise) could become more pronounced. Notwithstanding, it would be expected that development would be located away from areas at risk of climate change impacts, in accordance with national planning policy guidance.<br>Site restoration may provide an opportunity to enhance climate change resilience through measures such as green infrastructure provision that reduces surface water run-off or flood attenuation schemes. However, the extent to which such measures could be implemented would be dependent on a site's location, characteristics and end use which are currently uncertain.<br>Reflecting energy use and GHG emissions associated with site restoration but the reduction in emissions following the cessation of production, decommissioning and site restoration, this stage has been assessed as having a mixed positive and negative effect on this objective. |

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## Objective 8: Climate Change

| *Stage* | *Description* | *Score* | | *Commentary* |
|---|---|---|---|---|
| | | *Low Activity Scenario* | *High Activity Scenario* | |
| | | | | **Low and High Activity Scenarios:**<br>GHG emissions under the high activity scenario would be expected to be greater than those associated with the low activity scenario. This is commensurate with the area of land to be restored, relative to the low activity scenario. Notwithstanding, emissions would not be expected to be significant.<br>As noted above, there is not considered to be a substantial risk of activities being adversely affected by climate change impacts. In consequence, effects in this regard are not expected to be significantly influenced by the quantum of activity.<br>**Mitigation:**<br>• Where appropriate, consideration should be given to the implementation of soil sequestration projects as part the restoration process.<br>• Where appropriate, consideration should be given to how sites can be used to enhance climate change resilience during restoration (e.g. through flood attenuation schemes).<br>**Assumptions:**<br>• It is assumed that wells would be appropriately sealed to prevent fugitive emissions.<br>• It is assumed that all associated infrastructure and hardstanding would be removed during this stage.<br>**Uncertainties:**<br>• The exact magnitude of GHG emissions associated with this stage would be dependent on site specific characteristics which are currently uncertain.<br>• The extent to which climate change adaptation measures could be implemented would be dependent on a site's location, characteristics and end use which are currently uncertain. |

### *Summary*

Stage 2 (exploration drilling with coring and hydraulic fracturing) and Stage 3 (production development) of the unconventional oil and gas exploration and production lifecycle have been assessed as having a significant negative effect on climate change under the high activity scenario at a sector level. This reflects the volume of GHG emissions arising from hydraulic fracturing and well completion which could be up to 0.96 $MtCO_2eq$ per annum (assuming up to a maximum of 360 wells per annum). Notwithstanding, it should be noted that if 100% of methane released during well completion was captured and injected into the grid (assuming grid connection is available during Stage 3), the volume of GHG emissions would be substantially reduced (approximately 0.45 $MtCO_2eq$ during peak under the high activity scenario). Under the low activity scenario, Stages 2 and 3 were assessed as having a minor negative effect on this objective, commensurate with the lower number of wells.

Stage 4 (production/operation/maintenance) has been assessed as having a significant negative effect on this objective under both the low and high activity scenarios, when compared to the effects from the existing oil and gas sector. This reflects the scale of potential GHG emissions associated with gas production and arising from power generation, the use of machinery, transportation and fugitive methane and other trace hydrocarbons via leakages from on-site equipment including valves, flanges and compressors as well as from flaring and venting. Based on total emissions associated with production including re-fracturing (9,894 $tCO_2eq$ per well), emissions per annum under the high activity scenario would be between 0.71 and 1.4 $MtCO_2eq$ for the peak period when all wells are productive (a total of between 14.3 and 28.5 $MtCO_2eq$ ). This is equivalent to up to 15.3% of the 9.3 M tCO2eq of sectoral emissions from the exploration, production and transport of oil and gas in the UK in 2011 (the most recent year for which final data is available) and equates to up to 0.75% of all GHG emissions from the energy supply sector in 2011. Whilst under the low activity scenario the number of wells would be much lower (between 180 and 360 wells), GHG emissions would be up to 0.18 $MtCO_2eq$ per annum for the peak period when all wells are productive (a total of 3.6 $MtCO_2eq$ over a 20 year period).

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## Objective 8: Climate Change

| *Stage* | *Description* | *Score* | | *Commentary* |
|---|---|---|---|---|
| | | *Low Activity Scenario* | *High Activity Scenario* | |

Indirectly, the combustion of extracted hydrocarbons would generate further GHG emissions, although these emissions would be lower than from other hydrocarbon sources including coal. It should also be noted that consumption of extracted hydrocarbons would substitute the combustion of other currently imported hydrocarbons and there would be no net change to the energy mix within the UK, other than those already anticipated by DECC in the 2050 pathways report. In consequence, the Licensing Plan would not disincentivise investment in renewable and low carbon technologies and, further, the use of domestic gas as opposed to imported LNG could serve to reduce overall GHG emissions which could generate a positive effect on this objective, although this is would be dependent on the balance between conventional, LNG and unconventional gas production and consumption which is currently uncertain.

No further significant negative effects were identified during the assessment. Minor negative effects were identified in respect of Stage 5 (decommissioning of wells), reflecting GHG emissions associated with the use of plant and

No significant positive effects have been identified during the assessment. Stage 6 of the unconventional oil and gas exploration and production lifecycle (site restoration and relinquishment) has been assessed as having a mixed positive and negative effect on climate change. Whilst there would be GHG emissions associated with, for example, the use of plant, following site restoration there would be no further GHG emissions or energy use, reducing effects on climate change in the longer term. Depending on the end use of well pad sites (which would be determined on a site-by-site basis following discussions between the operator and the minerals planning authority), there may also be opportunities to enhance carbon sequestration through rehabilitation and re-vegetation.

**Mitigation Summary:**

- During the site selection process, careful consideration should be given by the operator to the avoidance of carbon sinks (e.g. peats).
- Where possible, measures should be taken to offset (at least in part) GHG emissions arising from construction and operational activities. These measures may include, for example:
    - the use of construction materials with low embodied carbon;
    - measures to reduce private vehicle use for workers;
    - provision for the transportation of materials and construction wastes by rail where practicable;
    - limiting the volume of construction waste on-site.
- Reflecting the recommendations identified by MacKay and Stone (2013), operators should:
    - in managing fugitive, vented or flared methane throughout the exploration, pre-production and production of shale gas, adopt the principle of reducing emissions to as low a level as reasonably practicable (ALARP). In particular, “reduced emissions completions” (REC) or “green completions” should be adopted at all stages following exploration;
    - monitor their sites to: (1) ensure early warning of unexpected leakages; and (2) obtain emissions estimates for regulators and government.
- Site selection should be informed by robust Flood Risk Assessment to ensure that risks associated with climate change impacts are identified and addressed (e.g. through the implementation of sustainable drainage systems).
- DECC should consider the feasibility of measures to reduce GHG emissions through and related to the licensing process. These measures may include, for example:
    - development of guidance suggesting measures to reduce GHG emissions during all stages of the unconventional oil and gas exploration of production lifecycle with appropriate linkages to Environmental Impact Assessment;
    - discussion with regulators on appropriate mandatory requirements to be applied at each stage to ensure that the best technology is implemented in all cases (MacKay and Stone, 2013);
    - implementation of GHG emissions recording and monitoring protocols, reflecting recommendations contained in the AEA (2012) report concerning the climate impact of potential shale gas production in the EU[41] and of MacKay and Stone (2013);
    - the application of the emission limit values requirements under the Industrial Emissions Directive to methane emissions from exploration and production activities as per recommendations contained in the AEA (2012) review.
- As per the recommendations of MacKay and Stone (2013), the Government and industry should undertake research into shale gas production in the UK with a view to developing more effective extraction techniques, such as improved REC and self-healing cements, reduced water consumption and vehicle demand which minimise wider environmental impacts including whole-life-cycle GHG emissions.

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|

[41] AEA (2012) Climate impact of potential shale gas production in the EU: Report for the European Commission.

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| Objective 8: Climate Change | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| *NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.* | | | | |
| *S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)* | | | | |

## 7.9 Virgin Coalbed Methane

The effects of exploration and production activities associated with virgin coalbed methane (VCBM) are similar to those described in the assessment of effects of unconventional oil and gas (Stages 1-6) in **Table 7.11** above although fracturing is not normally required. No attempt has been made to provide an indication of low and high levels of activity.

VCBM exploration drilling and production sites are usually smaller than conventional and unconventional oil and gas drilling sites whilst commercially viable VCBM containing formations tend to be shallower (200-1,500m depth) and drilling times may therefore be relatively shorter [21]. In consequence, it can be reasonably assumed that GHG emissions arising from construction activities and drilling (per well) would be less than those associated with conventional and unconventional oil land gas exploration and production. However, it is recognised that this is dependent on site specific characteristics which are currently uncertain.

## 7.10 Gas Storage

The development of gas storage capacity is likely to entail the following activities:

1. Construction and Installation of Pipelines and Storage Facilities;
2. Storage operations; and
3. Decommissioning.

The likely effects of these activities are appraised in **Table 7.12**.

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**Table 7.12 Assessment of Effects: Gas Storage**

| Objective 8: Climate Change | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| 1 | **Construction and Installation of Pipelines and Storage Facilities** | - | **Assessment of Effects:**<br>Construction activities would generate GHG emissions. Sources of emissions would include the direct or indirect combustion of fossil fuels from construction traffic, plant and generators and the embodied carbon within construction materials including pipelines. Disturbance to soils and emissions of $CO_2$ and methane together with loss of soil carbon sequestration may also contribute to climate change. GHG emissions would also be generated from the energy used in any drilling required during this stage. There would also be additional emissions associated with transportation and treatment of wastes (e.g. mud and cuttings) arising from drilling activities and from the embodied carbon associated with well construction.<br>The exact magnitude of GHG emissions related to construction would be dependent on the number of facilities, site specific characteristics such as requirements for infrastructure such as roads, the distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain. However, gas storage projects under consideration in this SEA involve the use of depleted reservoirs, implying that some existing infrastructure is in place. Given the potential to utilise existing infrastructure it is therefore expected that the volume of GHG emissions would be minor.<br>Construction could be affected by climate change where sites are located, for example, in coastal areas that may be affected by coastal inundation or sea level rise or in areas of flood risk that could be susceptible to extreme weather conditions. Current information indicates that the UK is experiencing a sea level rise of approximately 1mm per annum and a global sea level rise of approximately 3mm per annum. Climate change effects such as intensified weather events therefore have the potential to affect activities during Stage 1. However, it would be expected that development would be located away from areas at risk of climate change impacts (i.e. areas at risk of flooding), in accordance with national planning policy guidance.<br>Overall, Stage 1 of the gas storage lifecycle has been assessed as having a minor negative effect on the climate change objective.<br>**Mitigation:**<br>• Where possible, existing infrastructure should be utilised.<br>• During the site selection process, careful consideration should be given by the operator to the avoidance of carbon sinks (e.g. peats).<br>• Where possible, measures should be taken to offset (at least in part) GHG emissions arising from construction and operational activities. These measures may include, for example:<br>o the incorporation of renewables on site to meet energy demands;<br>o the use of construction materials with low embodied carbon; |

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| Objective 8: Climate Change | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| | | | o measures to reduce private vehicle use for workers;<br>o provision for the transportation of materials and construction wastes by rail where practicable;<br>o limiting the volume of construction waste on-site.<br>• Site selection should be informed by robust Flood Risk Assessment to ensure that risks associated with climate change impacts are identified and addressed (e.g. through the implementation of sustainable drainage systems).<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• The exact magnitude of GHG emissions related to construction would be dependent on the number of facilities, site specific characteristics such as requirements for infrastructure such as roads, the distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain. |
| 2 | **Storage Operations** | ***-/?*** | During storage operations there would be GHG emissions associated with power generation and combustion plant. Additionally, there would be expected to be further emissions from vehicle movements related to the transportation of maintenance workers and wastes to/from sites. However, it is not expected that GHG emissions from these sources would be significant.<br>Once storage facilities are operational, a further source of GHG emissions is likely to be fugitive methane and other trace hydrocarbons via leakages from on-site equipment including valves, flanges and compressors as well as from flaring and venting. Although no estimates of emissions from these sources are currently available, it is noted that DECC requires that flaring or venting during operation be kept to the minimum that is technically and economically justified. Gas emissions are controlled by requiring Licensees to apply for consent to flare or vent gas emitted by their oil or gas fields. The main purpose of this requirement is to ensure that gas is conserved by avoiding unnecessary wastage[21].<br>Storage operations could be affected by climate change where sites are located, for example, in coastal areas that may be affected by coastal inundation or sea level rise or in areas of flood risk that could be susceptible to extreme weather conditions. Current information indicates that the UK is experiencing a sea level rise of approximately 1mm per annum and a global sea level rise of approximately 3mm per annum. Climate change effects such as intensified weather events therefore have the potential to affect activities during Stage 2 particularly given the fact that activities would be over a long period during which time the impacts of climate change (e.g. sea level rise) could become more pronounced.<br>Notwithstanding, it would be expected that development would be located away from areas at risk of climate change impacts, in accordance with national planning policy guidance. |

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| Objective 8: Climate Change | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| | | | Overall, Stage 2 of the gas storage lifecycle has been assessed as having a minor negative effect on this objective, although it is recognised that uncertainties exist particularly with respect to the number of facilities that might be operational. .<br>**Mitigation:**<br>• Where possible, measures should be taken to offset (at least in part) GHG emissions arising from production activities. These measures may include, for example:<br>o the incorporation of renewables on site to meet energy demands;<br>o measures to reduce private vehicle use for workers;<br>o provision for the transportation of wastes by rail where practicable.<br>• Reflecting the recommendations identified by MacKay and Stone (2013), operators should:<br>o in managing fugitive, vented or flared methane throughout the exploration, pre-production and production of shale gas, adopt the principle of reducing emissions to as low a level as reasonably practicable (ALARP). In particular, "reduced emissions completions" (REC) or "green completions" should be adopted at all stages following exploration;<br>o monitor their sites to: (1) ensure early warning of unexpected leakages; and (2) obtain emissions estimates for regulators and government.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• Total GHG emissions associated with gas storage would be dependent on the number of operational facilities which is currently uncertain. |
| 3 | **Decommissioning** | - | **Assessment of Effects:**<br>During decommissioning there would be emissions of GHGs associated with the use of machinery and plant as well as from construction traffic. There would also be emissions associated with the embodied carbon in concrete used plug wells and, potentially, the treatment of any waste arisings.<br>Associated works may require the clearance of vegetation and loss of soil layers which could result in emissions of $CO_2$ and methane together with loss of soil carbon sequestration. However, it is not expected that the area of land required to undertake decommissioning activities (beyond existing well pads) would be significant.<br>The total magnitude of GHG emissions associated with this stage would be dependent on site specific characteristics such as requirements for infrastructure such as roads, the distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of any soils displaced which are currently uncertain. However, it is not expected that emissions would be of a magnitude considered to be nationally significant. |

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## Objective 8: Climate Change

| *Stage* | *Description* | *Score* | *Commentary* |
|---|---|---|---|
| | | | Decommissioning could be affected by climate change where sites are located, for example, in coastal areas that may be affected by coastal inundation or sea level rise or in areas of flood risk that could be susceptible to extreme weather conditions. Current information indicates that the UK is experiencing a sea level rise of approximately 1mm per annum and a global sea level rise of approximately 3mm per annum. Climate change effects such as intensified weather events therefore have the potential to affect activities during Stage 3 particularly given the fact that decommissioning would take place in the longer term during which time the impacts of climate change (e.g. sea level rise) could become more pronounced. Notwithstanding, it would be expected that development would be located away from areas at risk of climate change impacts, in accordance with national planning policy guidance.<br>**Mitigation:**<br>• Non identified.<br>**Assumptions:**<br>• The exact magnitude of GHG emissions associated with this stage would be dependent on site specific characteristics such as requirements for infrastructure such as roads, distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain.<br>**Uncertainties:**<br>• It is assumed that wells would be appropriately sealed to prevent fugitive emissions. |

### *Summary*

The assessment has not identified any significant positive or significant negative effects on climate change associated with all six stages of the gas storage lifecycle. Construction activities during Stage 1 and also decommissioning (Stage 3) would generate GHG emissions from sources including the direct or indirect combustion of fossil fuels from construction traffic, plant and generators and the embodied carbon within construction materials. Disturbance to soils and emissions of $CO_2$ and methane together with loss of soil carbon sequestration may also contribute to climate change. GHG emissions would be generated from the energy used in any drilling required during Stage 1. The exact magnitude of GHG emissions related to construction would be dependent on the number of facilities, site specific characteristics such as requirements for infrastructure such as roads, the distance to be travelled by vehicles during the transportation of materials and wastes and the carbon content of soils which are currently uncertain. However, gas storage projects under consideration in this SEA involve the use of depleted reservoirs, implying that some existing infrastructure is in place. Given the potential to utilise existing infrastructure it is therefore expected that the volume of GHG emissions would be minor.

Once storage facilities are operational, a further source of GHG emissions is likely to be fugitive methane and other trace hydrocarbons via leakages from on-site equipment including valves, flanges and compressors as well as from flaring and venting. Although no estimates of emissions from these sources are currently available, it is noted that DECC requires that flaring or venting during operation be kept to the minimum that is technically and economically justified. Gas emissions are controlled by requiring Licensees to apply for consent to flare or vent gas emitted by their oil or gas fields. The main purpose of this requirement is to ensure that gas is conserved by avoiding unnecessary wastage. In consequence, Stage 2 of the gas storage lifecycle has been assessed as having a minor negative effect on this objective, although it is recognised that uncertainties exist particularly with respect to the number of facilities that might be operational.

No significant or minor positive effects were identified during the assessment.

**Mitigation Summary:**

- Where possible, existing infrastructure should be utilised.
- During the site selection process, careful consideration should be given by the operator to the avoidance of carbon sinks (e.g. peats).
- Where possible, measures should be taken to offset (at least in part) GHG emissions arising from construction and operational activities. These measures may include, for example:
    - the incorporation of renewables on site to meet energy demands;
    - the use of construction materials with low embodied carbon;

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| Objective 8: Climate Change | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |

- measures to reduce private vehicle use for workers;
- provision for the transportation of materials and construction wastes by rail where practicable;
- limiting the volume of construction waste on-site.

- Site selection should be informed by robust Flood Risk Assessment to ensure that risks associated with climate change impacts are identified and addressed (e.g. through the implementation of sustainable drainage systems).
- Reflecting the recommendations identified by MacKay and Stone (2013), operators should:
  - in managing fugitive, vented or flared methane throughout the exploration, pre-production and production of shale gas, adopt the principle of reducing emissions to as low a level as reasonably practicable (ALARP). In particular, "reduced emissions completions" (REC) or "green completions" should be adopted at all stages following exploration;
  - monitor their sites to: (1) ensure early warning of unexpected leakages; and (2) obtain emissions estimates for regulators and government.
- Site selection should be informed by robust Flood Risk Assessment to ensure that risks associated with climate change impacts are identified and addressed (e.g. through the implementation of sustainable drainage systems).
- DECC should consider the feasibility of measures to reduce GHG emissions through and related to the licensing process. These measures may include, for example:
  - Development of guidance suggesting measures to reduce GHG emissions during;
  - Discussion with regulators on appropriate mandatory requirements to be applied at each stage to ensure that the best technology is implemented in all cases (MacKay and Stone, 2013).
  - Implementation of GHG emissions recording and monitoring protocols, reflecting recommendations contained in the AEA (2012) report concerning the climate impact of potential shale gas production in the EU[42] and of MacKay and Stone (2013).
  - The application of the emission limit values requirements under the Industrial Emissions Directive to methane emissions from exploration and production activities as per recommendations contained in the AEA (2012) review.

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 7.11 SEA Areas

As climate change mitigation is a national/global issue, it has not been possible to differentiate the potential effects of Licensing Plan activities on this objective in the five SEA Areas. The impacts of climate change, meanwhile, may vary across the SEA Areas which could in-turn affect the resilience of Licensing Plan activities. However, it is considered that climate change impacts can only be considered once the exact location of sites has been identified as the type, scale and magnitude of effects will be dependent on localised characteristics including, for example, flood and coastal erosion risk.

[42] AEA (2012) Climate impact of potential shale gas production in the EU: Report for the European Commission.

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Notwithstanding, the potential effects of Licensing Plan activities on future water resource availability (which takes into account the effects of climate change) across the five SEA Areas is considered in **Appendix B5.**

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# 8. Waste and Resource Use

## 8.1 Introduction

The overview of plans and programmes and baseline information contained in this section provides the context for the assessment of potential effects of Licensing Plan proposals on waste and resource use. Information is presented for both national and regional levels.

Waste management in this context is defined as the processing, recycling or disposal of a range of waste types including municipal, commercial and industrial, construction, excavation and demolition and hazardous wastes. However, it is important to note that consideration of the management of waste links to a number of other SEA topics, the most relevant being climate change given the potential for waste to be recovered for energy use.

## 8.2 Review of Plans and Programmes

### 8.2.1 International/European

The ***Waste Framework Directive*** 75/442/EEC as amended by 91/156/EEC, 91/92/EEC and 2008/98/EC provides the overarching framework for waste management at the EU level. It relates to waste disposal and the protection of the environment from harmful effects caused by the collection, transport, treatment, storage and tipping of waste. In particular, it aims to encourage the recovery and use of waste in order to conserve natural resources. The key principles of the Directive include the 'Waste Management Hierarchy' which stipulates waste management options based on their desirability. In order, these are: prevention; preparing for re-use; recycling; other recovery, e.g. energy recovery; and disposal. Key objectives are to reduce the adverse impacts of the generation of waste and the overall impacts of resource use. This should be done through a variety of mechanisms, including:

- by 2020, requiring member states to recycle 50% of their household waste and 70% of their non-hazardous construction and demolition waste;
- applying the waste hierarchy - promoting waste minimisation followed by reuse and recycling, other recovery (such as energy recovery) and disposal - as a priority order in waste prevention and management legislation and policy;
- ensuring that four specified materials (paper, metal, plastics and glass) are collected separately by 2015;
- taking measures as appropriate to promote the re-use of products and preparing for re-use activities; and
- extending the self-sufficiency and proximity principles to apply to installations for recovery of mixed municipal waste from households.

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The Directive was transposed into English legislation through the Waste (England and Wales) Regulations 2011 (SI2011 No.988).

A compromise agreement was reached between the Council of Environment Ministers and the European Parliament in June 2008 on revisions to the Waste Framework Directive. The main changes include EU-wide targets for reuse and recycling 50% of household waste by 2020, and for reuse, recycling and recovery of 70% of construction and demolition waste by 2020. In this context, the ***Landfill Directive*** (European Commission, 1999) focuses on waste minimisation and increasing levels of recycling and recovery. The overall aim of the Directive is to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air and on the global environment, including the greenhouse effect as well as any resulting risk to human health from the landfilling of waste, during the whole lifecycle of the landfill. The Directive sets the target of reducing biodegradable municipal waste landfilled to 35% of that produced in 1995 by 2020.

There are a number of **Producer Responsibility Directives** relating specifically to consumer products. Their purpose is to require businesses to reuse, recover and recycle waste which comes from products they produce, and each Directive sets national targets for recovery and recycling of these wastes.

The ***EU Thematic Strategy on the Prevention and Recycling of Waste (2002-2012)*** is a long-term strategy aims to help Europe become a recycling society that seeks to avoid waste and uses waste as a resource.

The ***Mineral Waste Directive*** 2006/21/EC aims to prevent or reduce as far as possible the adverse effects on the environment and any resultant risks to human health from the management of waste from the extractive industries. The Directive sets out how to achieve this aim by providing for measures, procedures and guidance on how extractive industries should be managed.

The ***Basel Convention*** came into force in 1992 and is a global agreement, ratified by several member countries and the European Union, for addressing the problems and challenges posed by hazardous waste. The key objectives of the Basel Convention are:

- to minimise the generation of hazardous wastes in terms of quantity and hazardousness;
- to dispose of them as close to the source of generation as possible; and
- to reduce the movement of hazardous wastes.

The ***World Summit on Sustainable Development (2002)*** in Johannesburg proposed broad-scale principles which should underlie sustainable development and growth including an objective on greater resource efficiency.

The ***European Sustainable Development Strategy (2006)*** includes sustainable consumption & production and conservation & management of natural resources as key challenge areas.

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### 8.2.2 UK

UK Government's ***Sustainable Development Strategy: Securing the Future (2005)*** and the UK's ***Shared Framework for Sustainable Development, One Future - Different Paths (2005)*** includes sustainable Consumption and Production as one of four priorities and considers the five guiding principles:

- living within Environmental Limits;
- ensuring a Strong, Healthy and Just Society;
- achieving a Sustainable Economy;
- using Sound Science Responsibly; and
- promoting Good Governance.

In February 2011, the Coalition Government published its vision for sustainable development and a package of measures to deliver it through the Green Economy, action to tackle climate change, protecting and enhancing the natural environment, fairness and wellbeing and building a Big Society. ***Mainstreaming Sustainable Development (2011)*** is a refreshed vision and builds on commitments and principles that underpinned the UK's 2005 Sustainable Development strategy by recognising the needs of the economy, society and the natural environment, alongside the use of good governance and sound science.

### 8.2.3 England

The **Waste Strategy (2007)** translates the principles of the previous EU Waste Framework Directive into UK policy. Its key objectives include:

- decoupling waste growth (in all sectors) from economic growth and put more emphasis on waste prevention and re-use;
- meeting and exceeding the Landfill Directive diversion targets for biodegradable municipal waste in 2010, 2013 and 2020;
- increase diversion from landfill of non-municipal waste and secure better integration of treatment for municipal and non-municipal waste;
- secure the investment in infrastructure needed to divert waste from landfill and for the management of hazardous waste; and
- get the most environmental benefit from that investment, through increased recycling of resources and recovery of energy from residual waste using a mix of technologies.

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The Strategy sets national targets for:

- reducing the amount of household waste that is not either re-used, recycled or composted;
- recycling and composting of household waste - at least 40% by 2010, 45% by 2015 and 50% by 2020; and
- recovery of municipal waste - 53% by 2010, 67% by 2015 and 75% by 2020.

The Coalition Government carried out a ***National Review of Waste Policy in England (2011)***, looking at the most effective ways of reducing waste, maximising the money to be made from waste and recycling and considering how waste policies affect local communities and individual households. The report set out a number of 'Principal Commitments' which aims to achieve a more sustainable approach to the use of materials, deliver environmental benefits and support economic growth. These include:

- promoting resource efficient product design and manufacture and target those waste streams with high carbon impacts, both in terms of embedded carbon (food, metals, plastics, textiles) and direct emissions from landfill (food, paper and card, textiles, wood);
- promoting the use of life cycle thinking in all waste policy and waste management decisions and the reporting of waste management in carbon terms, as an alternative to weight-based measures;
- developing a comprehensive Waste Prevention Programme and in the meantime will work with businesses and other organisations across supply chains on a range of measures designed to drive waste reduction and re-use as part of a broader resource efficiency programme; and
- continue to help local communities develop fit for purpose local solutions for collecting and dealing with household waste and work with councils to meet households' reasonable expectations for weekly collections, particularly of smelly waste.

***PPS10: Planning for Sustainable Waste Management (2005)*** sets out the national planning framework in relation to waste. It states that planning has a key role in delivering sustainable waste management through both the development of appropriate strategies for growth, regeneration and the prudent use of resources and by providing sufficient opportunities for the development of new waste management facilities. PPS10 states that:

- Waste planning authorities should identify in their plans (development plan documents) sites and areas suitable for new or enhanced waste management facilities for the waste management needs of their area. Development plans form the framework within which decisions on proposals for development are taken;
- The regional planning body should convene a broadly-based 'Regional Technical Advisory Board' (RTAB) to provide advice on the preparation of the strategy for waste management in the Regional Spatial Strategy and its implementation. PPS10 sets out the role and composition of a RTAB - it should be broadly based drawing from those with a direct interest in and knowledge of sustainable waste management; and

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- In deciding which sites and areas to identify for such facilities, waste planning authorities should assess their suitability against criteria set out in PPS10. This includes the physical and environmental constraints on development and the cumulative effect of previous waste disposal facilities on the well-being of the local community.

With the exception of PPS10 which will remain in place until the National Waste Management Plan is published, the ***National Planning Policy Framework (2012)*** has replaced Planning Policy Statements, Planning Policy Guidance notes, Minerals Planning Statements, Minerals Planning Guidance and some Circulars. It sets out the Government's planning policies for England and how these are expected to be applied including in plan making and decision-taking on planning applications.

The Framework expects local planning authorities to set out the strategic priorities for the area in the local plan and include strategic policies to deliver the provision of infrastructure for waste management and the provision of minerals. In doing so, they should work with other relevant organisations and providers to assess the quality and capacity of infrastructure for waste and its ability to meet forecast demands. Specifically, minerals planning authorities are expected to develop and maintain an understanding of the mineral resource (of both local and national importance) in their areas and assess the projected demand for their use, taking full account of opportunities to use materials from secondary and other sources which could provide suitable alternatives to primary materials.

The framework defines 'minerals of local and national importance' as mineral which are necessary to meet society's needs, including aggregates, brickclay, silica sand, cement raw materials, gypsum, salt, fluorspar, coal, oil and gas (including hydrocarbons) tungsten, kaolin, ball clay, potash and local minerals of importance to heritage assets and local distinctiveness.

In order to facilitate the sustainable use of minerals, the Framework sets out a number of expectations relating to specific minerals for local authority plan-making and decisions on planning applications. In doing so the Framework includes safeguards so as to ensure permitted operations do not have unacceptable adverse impacts on the natural and historic environment or human health.

The ***Natural Environment White Paper (The Natural Choice-securing the value of nature) (2011)*** sets out the ambition that the use of peat will be reduced to zero in England by 2030. This will contribute to the protection of important lowland peat habitats (both here and overseas) and significant carbon stores, and will promote a shift towards the greater use of waste-derived and by-product materials. It also sets ambitious targets for reducing use within individual sectors, to drive action and provide clarity about the long-term direction of policy.

The ***Resource Security Action Plan (2012)*** provides a framework for business action to address risks about the availability of some non-renewable raw materials (including minerals), and sets out high level actions to build on the developing partnership between Government and businesses to address resource concerns. This Action Plan emphasises the need to make best use of resources currently in use, reducing as far as practicable the quantity of material used and waste generated, and using as much recycled and secondary material as possible, before securing the remainder of material needed through new primary extraction.

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Defra's ***Strategy for Hazardous Waste Management in England (2010)*** sets out the following principles for hazardous waste management:

- waste hierarchy;
- infrastructure provision;
- reduce our reliance on landfill;
- no mixing or dilution;
- treatment of hazardous organic wastes; and
- end reliance on the use of Landfill Directive waste acceptance criteria derogations.

### 8.2.4 Scotland

***The Town and Country Planning (Scotland) Act 1997*** governs the use and development of land within Scotland. This primary legislation covers topics such as development plans, development control, compensation and enforcement.

***Choosing our Future: Scotland's Sustainable Development Strategy*** reflects the five principles found within the UK Sustainable Development Strategy and includes objectives on protecting Scotland's natural heritage and resources. In 2011, the Scottish Government published the ***Government Economic Strategy*** which reaffirmed its commitment to delivering increased sustainable economic growth.

The ***National Planning Framework*** sets out the spatial strategy for Scotland to 2030. This strategy is underpinned by the following aims:

- to contribute to a wealthier and fairer Scotland by supporting sustainable economic growth and improved competitiveness and connectivity;
- to promote a greener Scotland by contributing to the achievement of climate change targets and protecting and enhancing the quality of the natural and built environments;
- to help build safer, stronger and healthier communities, by promoting improved opportunities and a better quality of life; and
- to contribute to a smarter Scotland by supporting the development of the knowledge economy.

***Scotland Rural Development Programme 2007-2013 - The Strategic Plan*** recognises that rural Scotland should be integral to Scotland's success. The following cross-cutting principles are to guide the approach to the strategy and the Programme itself:

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- an integrated approach to policy delivery that combines economic, social and environmental actions;
- flexibility to meet diversity and local distinctiveness across rural Scotland; and
- promotion of sustainability, resilience and vigour in the rural economy, communities and natural heritage.

Scotland's ***Zero Waste Plan (2010)*** sets out the Scottish Government's vision for a zero waste society. To achieve this vision the Plan sets out new measures including:

- development of a Waste Prevention Programme for all wastes, ensuring the prevention and reuse of waste is central to all our actions and policies;
- landfill bans for specific waste types therefore reducing our greenhouse gas emissions and capturing the value from these resources;
- separate collections of specific waste types, including food, to avoid contaminating other materials, increasing reuse and recycling opportunities and contributing to our renewable energy targets;
- two new targets that will apply to all waste: 70% target recycled, and maximum 5% sent to landfill, both by 2025;
- restrictions on the input to all energy from waste facilities, in the past only applicable to municipal waste, therefore encouraging greater waste prevention, reuse and recycling;
- encouraging local authorities and the resource management sector to establish good practice commitments and work together to create consistent waste management services, benefitting businesses and the public;
- improved information on different waste sources, types and management highlighting further economic and environmental opportunities; and
- measure the carbon impacts of waste to prioritise the recycling of resources which offer the greatest environmental and climate change outcomes.

**Scottish Planning Policy (2010)** sets out policies for all minerals. It explains that:

- sufficient supplies of minerals should be provided to meet the needs of Society;
- the planning system should be used to steer development to sites where impacts on communities and the environment are acceptable;
- mineral resources should be safeguarded as far as possible; and
- mineral consents are reviewed every 15 years to ensure that extraction is subjected to modern working standards.

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***Scottish Planning Policy (2010)*** contains separate policies that apply to on shore oil and gas extraction. It states that Planning authorities and licensed operators should work together to ensure that operational requirements and likely environmental impacts of development associated with extraction are understood. Relevant factors may include disturbance and disruption from noise, potential pollution of land, air and water, impact on communities and the economy, cumulative impact, impact on the natural heritage and historic environment, landscape and visual impact and transport impacts.

The ***draft Scottish Planning Policy (2013)*** follows the general theme of the extant SPP with regard to the extraction of resources. It notes that the planning system should:

- recognise the continuing role of indigenous coal, oil and gas in maintaining a diverse energy mix and improving energy security;
- safeguard workable resources and ensure that an adequate and steady supply is available to meet the needs of the construction, energy and other sectors;
- minimise the impacts of extraction on local communities, built and natural heritage, and the water environment; and
- secure the sustainable restoration of mineral sites to a relevant use after working has ceased.

With regard to the extraction of unconventional onshore oil and gas reserves, the ***Draft National Planning Framework 3 (2013)*** notes that there are emerging opportunities to utilise reserves in ways which are compatible with the protection of the environment.

### 8.2.5 Wales

The ***One Wales: One Planet, A New Sustainable Development Scheme for Wales Sustainable Development Scheme (2009)*** sets out the Welsh Government's vision of a sustainable Wales and describes specific outcomes that WG will seek to achieve through its main policies and programmes and processes that it will put in place to ensure its work coherently reflects the goals of sustainable development.

The ***Wales Spatial Plan (2006)*** was further updated to be in keeping with the One Wales, One Planet principles in 2008 and provides the context and direction of travel for local development plans and the work of local service boards. The key themes of the update are:

- building sustainable communities;
- promoting a sustainable economy;
- valuing our environment;
- achieving sustainable accessibility; and
- respecting distinctiveness.

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***Technical Advice Note 12 (TAN12) (2009)*** sets out the Welsh Government's land use planning policy in respect of promoting sustainability through good design. It contains the following objectives for good design:

- movement - promoting sustainable means of travel;
- access- ensuring access for all;
- character - sustaining or enhancing local character, promoting legible development, promoting a successful relationship between public and private space, promoting quality, choice and variety, promoting innovative design;
- community safety - ensuring attractive, safe public spaces and security through natural surveillance;
- environmental sustainability - achieving efficient use and protection of natural resources, enhancing biodiversity and designing for change.

***Minerals Planning Policy Wales (2001)*** sets out planning policy guidance in relation to minerals extraction and related development in Wales, which includes all minerals and substances in, on or under land extracted either by underground or surface mining. The overriding objective is to provide a sustainable pattern of minerals extraction including by providing mineral resources to meet society's needs and to safeguard resources from sterilisation. ***Minerals Technical Advice Note 1: Aggregates (MTS1)*** main objective is to provide aggregate resources in a sustainable way to meet society's needs for construction materials.

## 8.3 Overview of the Baseline

### 8.3.1 UK

Some 203 million tonnes of minerals were extracted from the UK landmass for sale in 2010 (see **Figure 8.1**). These can be broken down into the following main categories with percentages of total production in brackets:

- 160.5 million tonnes (79%) of construction minerals;
- 23.1 million tonnes (11%) of industrial minerals;
- 18.4 million tonnes (9%) of coal; and
- 1 million tonnes (1%) of oil and gas (oil equivalent).

A further 128.7 million tonnes, consisting mainly of oil and gas (oil equivalent), but also marine–dredged sand and gravel, were extracted from the UK Continental Shelf.

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**Figure 8.1 Minerals Produced in the UK in 2010**

**MINERALS PRODUCED IN THE UNITED KINGDOM IN 2010**

| | Thousand tonnes |
|---|---|
| **ENERGY MINERALS** | |
| Coal: Deep-mined | 7 390 |
| Coal: Opencast | 10 426 |
| Coal: Other (a) | 600 |
| Oil: Onshore | 941 |
| Oil: Offshore | 57 106 |
| Gas: Onshore (oil equivalent) | 88 |
| Gas: Offshore (oil equivalent) | 57 036 |
| | |
| **CONSTRUCTION MINERALS** | |
| Aggregates | 155 903 |
| of which: Land-won sand & gravel | 47 167 |
| of which: Marine-dredged sand & gravel | 14 533 |
| of which: Crushed rock | 94 203 |
| Clay & shale for construction | 769 |
| Cement raw materials (limestone & chalk, clay & shale) (GB) | 10 056 |
| Clay & shale and Fireclay (for bricks) (GB) | 3 788 |
| Gypsum, natural (b) | 1 700 |
| Slate | 695 |
| Building (dimension) stone (GB) | 2 100 |
| | |
| **INDUSTRIAL, AGRICULTURAL AND HORTICULTURAL MINERALS** | |
| Limestone / dolomite / chalk (Industrial use) (GB) | 6 764 |
| Limestone / dolomite / chalk (Agricultural use) (GB) | 1 795 |
| Brine / Rock salt | 6 666 |
| Potash (refined potassium chloride) | 700 |
| Silica (Industrial) sands | 4 070 |
| Kaolin (china clay) (b) | 1 000 |
| Ball clay (b) | 1 000 |
| Fluorspar | 26 |
| Barytes | 34 |
| Peat (thousand $m^3$) | 1 004 |
| Other minerals (c) | 4 |
| | |
| **UK Landmass** | **202 986** |
| **UK Continental Shelf** | **128 675** |
| **TOTAL** | **331 661** |

(a) Slurry etc. recovered from dumps, ponds, rivers etc.
(b) BGS estimate.
(c) Other minerals: calcspar, lead ore, iron ore, china stone, talc, and chert and flint.
GB: Figures for Great Britain only.
*Sources: UK Minerals Yearbook, British Geological Survey; Office for National Statistics; Department for Business Innovation and Skills*

The total value of this production was £34, 373 million with 72% of this value attributable to oil and a further 22% to gas.

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## 8.3.2 England

### Waste

In 2004, total non-radioactive waste arisings in England were around 272,000,000 tonnes. Of this, 32% was construction and demolition waste; 30% was mining and quarrying waste; 13% was industrial waste; 11% was commercial waste; 9% was household waste; 5% was dredged material; and agricultural and sewage wastes made up for less than 1% each[1].

In 2010-11, household waste generation was 22.9 million tonnes, continuing the year on year fall seen since 2007-08. This amounts to 431kg of waste per person. 43% of household waste was recycled. Although this is the highest recycling rate recorded for England, the rate of increase has been levelling off, with 2011-12 being the lowest year on year increase for ten years[2]

Waste to landfill has decreased minimally between 2009 and 2010. It fell by less than 2% between 2009 and 2010 and has fallen by around 46% since 2000. One of the principal reasons is the implementation of the Landfill Directive. Many older landfill sites that did not meet the stringent requirements of the Directive had to close by July 2009 at the latest and diversion targets for biodegradable municipal waste to landfill increase year on year. Also, the slow down in economic growth in 2010 is associated with the minimal decrease in waste generated[3].

A total of 47.9 million tonnes of commercial and industrial (C&I) waste were generated in England in 2010, a decrease from 67.9 million tonnes in 2002-03. C&I waste was roughly evenly split between the commercial and industrial sectors.

During 2011 in England and Wales over 4.3 million tonnes of hazardous waste were managed, generated from nearly 160,000 businesses and industry, with:

- 21% landfilled;
- 22% transferred, before final disposal or recovery;
- 27% treated;
- 30% recycled, recovered or re-used; and
- 7% incinerated.

This total amount of hazardous waste managed in 2011 was almost 15% less than in 2000[4].

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[1] Waste Strategy for England 2007, Defra, http://www.defra.gov.uk/environment/waste/strategy/strategy07/documents/waste07-strategy.pdf

[2] Defra (2012) Local Authority Collected Waste Management Statistics for England- Final Annual Results 2011/12, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/85918/mwb201112_statsrelease.pdf

[3] http://www.environment-agency.gov.uk/research/library/data/132641.aspx

[4] Environment Agency (2011) Waste Management Key Facts, http://www.environment-

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## Minerals

Over 34 different minerals were extracted in England in 2010. The main minerals are outlined in **Table 8.1**.

**Table 8.1 Minerals with Highest Production Tonnage in England in 2010**

| Mineral | Thousand Tonnes |
|---|---|
| *Coal* | |
| Deep-mined | 7,344 |
| Opencast | 2,689 |
| Clay and Shale | 5,424 |
| Limestone | 47,569 |
| *Sand and Gravel (Land)* | 36,723 |
| Salt | 6,333 |
| Marine | 732 |
| Sandstone | 2,807 |

Source: British Geological Survey (2012) United Kingdom Minerals Yearbook 2011

### 8.3.3 Scotland

## Waste

In 2010, the total amount of controlled waste generated in Scotland was 16.86 million tonnes - the lowest amount during the period 2006 and 2010. This was composed of approximately 44% construction and demolition waste, 28% commercial waste, 16% household waste and 11% other industrial waste[5].

In 2010, approximately 423,000 tonnes of hazardous waste was consigned (sent) to waste management facilities in Scotland. This was about 2.5% of the total controlled waste generated in Scotland in this year. The majority of the special waste managed in Scotland was produced in Scotland (363,000 tonnes; 86%). An additional 117,000 tonnes of waste were produced in Scotland, but managed in England and Wales.

agency.gov.uk/research/library/data/142511.aspx

[5] SEPA (2012) Waste Data Digest 12: Key Facts and Trends, http://www.sepa.org.uk/waste/waste_data/waste_data_digest.aspx

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Scotland recycled and composted 38.2% of its local authority collected municipal waste in 2010-11. Of the local authorities in Scotland:

- 17 recycled or composted more than 40% of their waste;
- 11 recycled or composted more than 30%;
- 2 recycled or more than 20%; and
- 2 recycled less than 20%.

In 2010-11, Scotland's local authorities operated 176 recycling centres and 4,263 recycling points. Paper and card made up 37% of all recycled material.

### Minerals

Mineral production in Scotland for 2010 is outlined in **Table 8.2**.

**Table 8.2 Minerals Production in Scotland 2010**

| Mineral | Thousand Tonnes |
|---|---|
| *Coal* | |
| Opencast | 6,036 |
| Igneous Rock | 19,684 |
| Limestone | 1,072 |
| *Sand and Gravel* (Land) | 7,365 |
| Sandstone | 1,806 |
| Barytes | 31 |
| Fireclay | 3 |
| Peat (000m$^3$) | 548 |
| Talc | 3 |

Source: British Geological Survey (2012) United Kingdom Minerals Yearbook 2011

## 8.3.4 Wales

### Waste

Total municipal waste produced in Wales in 2011-12 was 1,567, 161 tonnes. 86% of all municipal waste produced was household waste.

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The amount of waste disposed of in landfill continued to fall with 0.7 million tonnes sent to landfill in 2011-12, accounting for 46% of all waste. For the first time the amount sent to landfill is now less than the amount of waste sent for reuse, recycling or composting (0.8 million tonnes)[6].

The percentage of local authority municipal waste (excluding abandoned vehicles) that was reused, recycled or composted in Wales has seen a continued increase since 2000-01 to reach 50% in 2011-12.

The most recent figures for Industrial and Commercial Waste in Wales date back to 2007. Key results from this survey include:

- Welsh industrial and commercial sectors generated an estimated 3.6 million tonnes of waste, with 53% from industrial companies and 47% from commercial companies; and
- In addition, 1.8 million tonnes of 'non-wastes' were produced, specifically blast furnace slag and virgin timber[7].

## Minerals

Mineral production in Wales for 2010 is outlined in **Table 8.3**.

**Table 8.3 Mineral Production in Wales 2010**

| Mineral | Thousand Tonnes |
|---|---|
| *Coal* | |
| Deep-mined | 47 |
| Opencast | 1,699 |
| Igneous Rock | 2,294 |
| Limestone | 7,878 |
| *Sand and Gravel* | |
| Land | 901 |
| Marine | 732 |
| Sandstone | 2,807 |

Source: British Geological Survey (2012) United Kingdom Minerals Yearbook 2011

[6] Welsh Government (2012) Local Authority Municipal Waste Management Report 2011-12

[7] Environment Agency (2007) Survey of Industrial and Commercial Waste Arisings in Wales

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## 8.4 Environmental Characteristics of those Areas most likely to be Significantly Affected

### 8.4.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

#### Waste

**Table 8.4** lists the local authority collected municipal waste recycling and composting rates by local authority for Scotland in 2010-11. Recycling rates tend to be lower in the urban areas of this SEA Area. For instance, Dundee, Edinburgh and Glasgow recycle between 13%-20% of waste collected.

**Table 8.4 Local Authority Collected Municipal Waste Recycling and Composting Rates (SEA Area 1)**

| Local authority | Total arisings (tonnes) | Waste recycled | Waste composted | Waste composted or recycled |
|---|---|---|---|---|
| Aberdeenshire* | 154,164 | 26.3 | 6.1 | 32.4 |
| Angus | 72,965 | 21.5 | 15.3 | 36.7 |
| Clackmannanshire | 31,367 | 36.8 | 13.0 | 49.8 |
| Dumfries and Galloway* | 94,864 | 12.9 | 26.5 | 39.4 |
| Dundee | 94,944 | 19.9 | 14.6 | 34.6 |
| East Dunbartonshire | 66,003 | 22.5 | 18.0 | 40.4 |
| East Lothian | 61,986 | 28.1 | 15.3 | 43.4 |
| East Renfrewshire | 47,002 | 22.7 | 22.6 | 45.4 |
| Edinburgh | 221,865 | 20.6 | 11.0 | 31.5 |
| Falkirk | 90,122 | 34.2 | 15.1 | 49.3 |
| Fife | 253,991 | 33.4 | 14.8 | 48.1 |
| Glasgow | 334,906 | 13.1 | 10.9 | 24.0 |
| Inverclyde | 46,422 | 23.5 | 7.9 | 31.5 |
| Midlothian | 46,621 | 26.0 | 18.1 | 44.1 |
| North Lanarkshire | 207,166 | 28.4 | 14.9 | 43.2 |
| Perth and Kinross* | 92,808 | 25.8 | 20.8 | 46.7 |
| Renfrewshire | 92,123 | 30.1 | 12.7 | 42.8 |
| Scottish Borders* | 67,749 | 26.9 | 12.9 | 39.9 |
| South Lanarkshire | 177,021 | 25.8 | 12.4 | 38.2 |
| Stirling* | 52,051 | 28.0 | 19.5 | 47.5 |
| West Dunbartonshire | 47,927 | 27.1 | 11.2 | 38.3 |
| West Lothian | 109,783 | 26.9 | 16.3 | 43.3 |

Note: *only part of this administrative area resides within the SEA area

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### Minerals

The Midland Valley of Scotland is prospective for oil and gas with Silesian (Carboniferous) sandstone reservoir and mudstone and coal source rocks. Examples of fields include Dalkeith (oil) and Cousland (gas). Areas currently licensed for oil and gas occur in parts of Fife, Clackmannanshire, Falkirk, the Lothians and Lanarkshire.

Coal is present at the surface and down to 1,200m in a band across the Midland Valley. All of the coal produced in Scotland in 2012 came from SEA Area 1 with over half coming from East Ayrshire alone[8].

Fertile soils ensure that the Midland Valley contains much of Scotland's prime agricultural land (Agricultural capability classes 1 and 2), including the Valley of Strathmore, the Mearns, East Lothian, the Forth and Clyde Valleys and Ayrshire.

## 8.4.2 SEA Area 2: West Midlands, North West England and Southern Scotland

### Waste

The Environment Agency notes that in 2008 [9] there were 1,269 permitted waste management facilities in the West Midlands with a total permitted capacity to handle over 155 million tonnes of waste per annum. Of these, 532 sites were active (handling waste) during 2008. Each active Waste Facility is required to submit returns to us reporting the amount of waste handled by the facility for the calendar year. Amongst the active permitted Waste Facilities in the West Midlands in 2008 there were:

- 36 landfill sites;
- 73 waste treatment facilities, with waste inputs of nearly 1.6 million tonnes;
- 380 waste transfer stations;
- 13 waste incinerators, with an annual capacity to handle 1.4 million tonnes of waste; and
- 80% of region's incineration capacity is designated for municipal energy from waste incinerator facilities.

The total amount of waste produced in the North West in 2009 was 12.7 million tonnes. Over 90% of non-hazardous waste in the North West was managed in the region and almost three-quarters in the same sub-region. This is in line with policy objectives in the region towards achieving self-sufficiency.

Amongst the active permitted Waste Facilities in the North West in 2009 there were:

[8] The Coal Authority, Production and Manpower Returns for 12 month period January 2012-December 2012.

[9] Environment Agency (2010) State of the Environment Report: West Midlands

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- 49 landfill sites;
- 207 waste treatment facilities;
- 539 waste transfer stations;
- 10 waste incinerators; and
- 361 metal recycling sites.

In the national context the recycling rate for the North West region as a whole at 36.6% remains marginally below the average for England of 37.6% (2008/09). Only the North East region at 730kg per household produces more residual waste than the North West (701kg per household) with the average for England being 669kg per household. As with overall household waste arisings, there is a considerable variation in performance between the sub-regions. Given that four authorities are now achieving over 40% recycling and composting, the 2015 regional target of 45% would appear to be in reach. However, the 55% regional target at 2020 may prove more stretching for even the best performing authorities.

The North West region produced 477,000 tonnes of hazardous waste in 2009. Around 57% of this waste was treated in the region, with the majority of the remainder going to the Midlands region[10].

## Minerals

Coal is present over much of the region with deep coal resources extending offshore into the eastern Irish Sea. Large areas of coal bed methane potential exist around the Mersey Estuary and north along the Cumbria coastline, with coal gasification potential around the northern rim of the Cheshire basin and in Staffordshire[11]. Relevant deep mining output figures for year ending December 2012 were 1,405kt for Warwickshire with opencast figures of 399kt for Telford & Wreckin.

The North West has a well-established minerals industry concentrated on sand and gravel, sandstone and limestone/dolomite (see **Figure 8.2**). This forms an important part of the North West's Non-agricultural land use. The North West is a major producer of sand and gravel (mainly silica sand) for non-aggregate (industrial) uses. Silica sand has widespread use in general construction, glass, and foundry casting industries and industrial applications[12].

[10] North West Regional Technical Advisory Body, 6th Waste Management Monitoring Report

[11] Department of Communities and Local Government (2006) Mineral Planning Factsheet: Coal and Coalbed Methane

[12] See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/36925/SEA_North_West.pdf [Accessed September 2013]

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**Figure 8.2 North West Aggregate Sites 2009**

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## 8.4.3 SEA Area 3: East Midlands and Eastern England

### Waste

Amongst the active permitted waste facilities in the East Midlands in 2008 there were:

- 55 landfill sites;
- 84 waste treatment facilities, with waste inputs of over two million tonnes; and
- 231 waste transfer stations.

According to the Environment Agency State of the Environment Report[13], the East Midlands produced over 2.4 million tonnes of municipal waste in 2008, including 2.1 million tonnes of household waste. The latest commercial and industrial waste data showed the East Midlands produced 6.2 million tonnes of this waste type. In 2008, 5.5 million tonnes of waste was disposed of in landfill sites, with five million tonnes of waste going to waste transfer and treatment facilities. A further one million tonnes was sent to metal recycling sites. Waste going for treatment has increased by 135% to over 2.0 million tonnes. At the end of 2008 the East Midlands had landfill capacity of over 69 million cubic metres. At current rates of disposal, this is only enough for another seven years. Nearly 0.4 million tonnes of waste was incinerated at permitted facilities in the East Midlands in 2008, 42% of which was municipal waste. In 2008, 43% of municipal waste was recycled and/or composted.

Yorkshire and Humber produces around 16 million tonnes of waste a year. This is made up of 2.5 million tonnes of household waste, 13 million tons of industrial/commercial and construction/demolition waste and 0.5 million tonnes of hazardous waste.

Landfill inputs in the region are provided below in **Table 8.5.**

[13] http://www.environment-agency.gov.uk/static/documents/Research/MIDS_SOE_East_WARM.pdf

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**Table 8.5 Landfill Inputs Yorkshire and the Humber**

| Landfill Type | Sub-Region | | | | YORKSHIRE & THE HUMBER |
|---|---|---|---|---|---|
| | Former Humberside | North Yorkshire | South Yorkshire | West Yorkshire | |
| Hazardous Merchant | 46 | - | - | - | **46** |
| Hazardous Restricted | - | - | - | 9 | **9** |
| Non Hazardous with SNRHW cell | 98 | 57 | - | 493 | **648** |
| Non Hazardous | 700 | 609 | 692 | 714 | **2,716** |
| Non Hazardous Restricted | 118 | 713 | 23 | - | **853** |
| Inert | 230 | 149 | 205 | 406 | **990** |
| **Total** | **1,191** | **1,527** | **920** | **1,623** | **5,262** |

Note: all figures are provided in 000s tonnes

Great strides have been made in Yorkshire and the Humber in the recycling and recovery of household waste. The amount landfilled has reduced and the amount recycled and recovered has increased from 7.3% in 2000-01 to 33.8% in 2008/09. In 2009-10, this figure improved again, with local authorities in the region recycling 37% of household waste during that period. However, this is lower than the English average of 40%[14].

## Minerals

Gas in the Yorkshire/NE England Province comes from a Permian limestone reservoir and Carboniferous Coal Measures source rocks (e.g. Malton, Marishes, Lockton, Eskdale). The East Midlands province covering Lincolnshire, Nottinghamshire and northern Leicestershire has been one of the most prospective areas for onshore oil and gas. The province comprises a series of major rift basins containing important source and reservoir rocks deposited during the late Carboniferous. Examples include Eakring, Welton, Rempstone, Scampton, Gainsborough (oil), Hatfield Moors and Hatfield West, Trumfleet, Saltfleetby (gas). Licensed areas are restricted largely to North Yorkshire, Lincolnshire, Nottinghamshire and parts of Norfolk.

Coal is present at surface and down to 1,200m (the normal limit of conventional mining) in parts of the North East (e.g. Northumberland, Tyne and Weir and Durham), Lincolnshire and Nottinghamshire. Very large resources of Carboniferous coal remain at depths below 1,200m particularly in the eastward extension of the East Pennine Coalfield, both within the UK land area and below the North Sea. There also exist further large resources of coal in Mesozoic and Palaeogene strata although much is lignite rather than bituminous coal. Deep-mining production figures for year ending December 2012 were Doncaster (612kt), Rotherham (801kt), Nottinghamshire (1,161kt), and North Yorkshire (2,000kt).

[14] Office for National Statistics (2011) Regional Profile Summaries Yorkshire and the Humber.

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Opencast production was smaller with Northumberland (1,627kt) and Derbyshire (176kt) the main producers.

Sales of primary aggregates from North East England in 2011 were 4.8 million tonnes[15]. Sales included 3.4 million tonnes of crushed rock, 509,000 tonnes of land-won sand and gravel and 678,000 tonnes of marine-dredged sand and gravel. Sales of primary aggregates from North East England in 2010 have decreased by 40% when compared with sales 2005. This includes a 40% decrease in sales of crushed rock, a 44% decrease in sales of land-won sand and gravel and a 35% decrease in sales of marine-dredged sand and gravel. This decrease is considered to be mainly as a result of the economic downturn and the resulting reduction in demand for primary aggregates. It does, however, appear that the level of sales have stabilised somewhat following significant declines from 2007 to 2009.

### 8.4.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

#### Waste

The Environment Agency has published regional waste data in 2010. This information is presented in **Figure 8.3** below.

[15] North East Aggregate Working Party, Annual Aggregates Report 2011.

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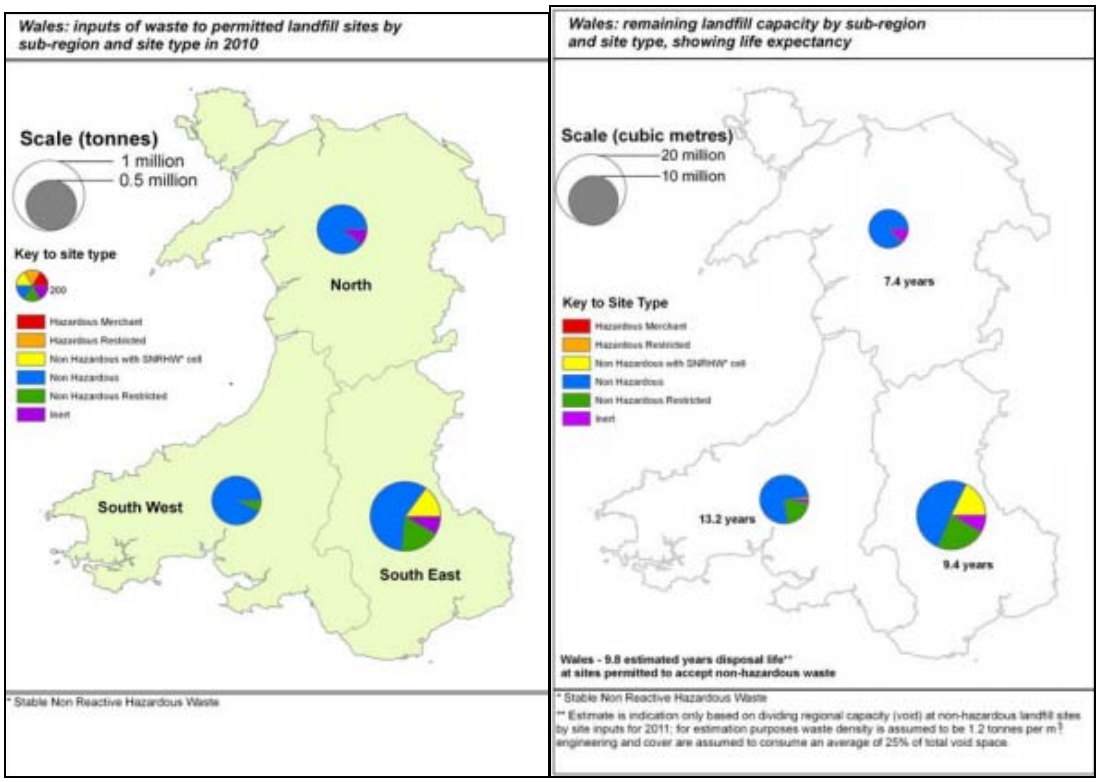
**Figure 8.3 Wales Regional Waste Data**




There was a large increase in physical treatment activity in South East Wales, resulting in an increase of nearly 184,000 tonnes compared to 2009. North Wales saw a slight increase, but a decrease was noticed in South West Wales.

## Minerals

The Cheshire Basin is not a proven petroleum province but possesses similarities to both the productive offshore East Irish Sea Basin and the East Midlands hydrocarbon province. Carboniferous source rocks include Holywell Shales which crop out in Clwyd adjacent to its coalfield. In the Flint district, curly cannel coal yields reasonable amounts of oil.

Carboniferous rocks in all the coalfields surrounding the Cheshire Basin have fair to good shows of hydrocarbons. Many of the coal seams are gassy, attracting drilling on three UK coalbed methane exploration licences. Licensed areas are restricted to localised areas of Flintshire and Wrexham in the north but are more extensive in the south particularly to the west over Swansea, Neath, Port Talbot and Brigend.

Coal at the surface and down to 1,200m underlies the South Wales valleys area as well as parts of North Wales. In the South Wales coal field coal rank increases from the east to the North West, where

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anthracite occurs, the only source in Britain. There are a number of opencast coal mines in North and South Wales with outputs for the year ending December 2012 of 870kt (Neath Port Talbot) and 369kt (Powys). Deep coal mining is restricted to the South with outputs to the year end (December 2012) of 139kt (Neath Port Talbot) and 65kt (Torfaen).

## 8.4.5 SEA Area 5: Southern and South West England

### Waste

In 2008, the South East region landfilled 11.6 million tonnes[16]:

- 45% (5.3 million tonnes) of the waste that went to landfill in 2008 was construction, demolition and excavation waste;
- 37% (4.3 million tonnes) was commercial and industrial;
- 16% (2 million tonnes) municipal; and
- Less than 1% (65,000 tonnes) of waste going to landfill in the South East was classified as hazardous.

The South East sends more waste to landfill than any other region in the UK with having to take waste from London Authorities, therefore creating significant pressure on the region's landfill sites. Kent as a sub-region deposited the most waste to landfill in 2010 at 2.26 million tonnes. Landfill capacity in total across the region has increased from 96,000,000 cubic metre tonnes in 2006 to 102,043,000 illustrating the increasing land take required for landfill despite measures to reduce the amount of waste going to landfill.

For the period 2010-11, total municipal waste produced in the South West was 2,709,000 tonnes. **Figure 8.4** shows how waste in the South West has been treated since 2000[17].

[16] CLG, Current State of the Environment- South East (Draft) (17/05/2012)

[17] Defra (2012) Local Authority collected waste statistics

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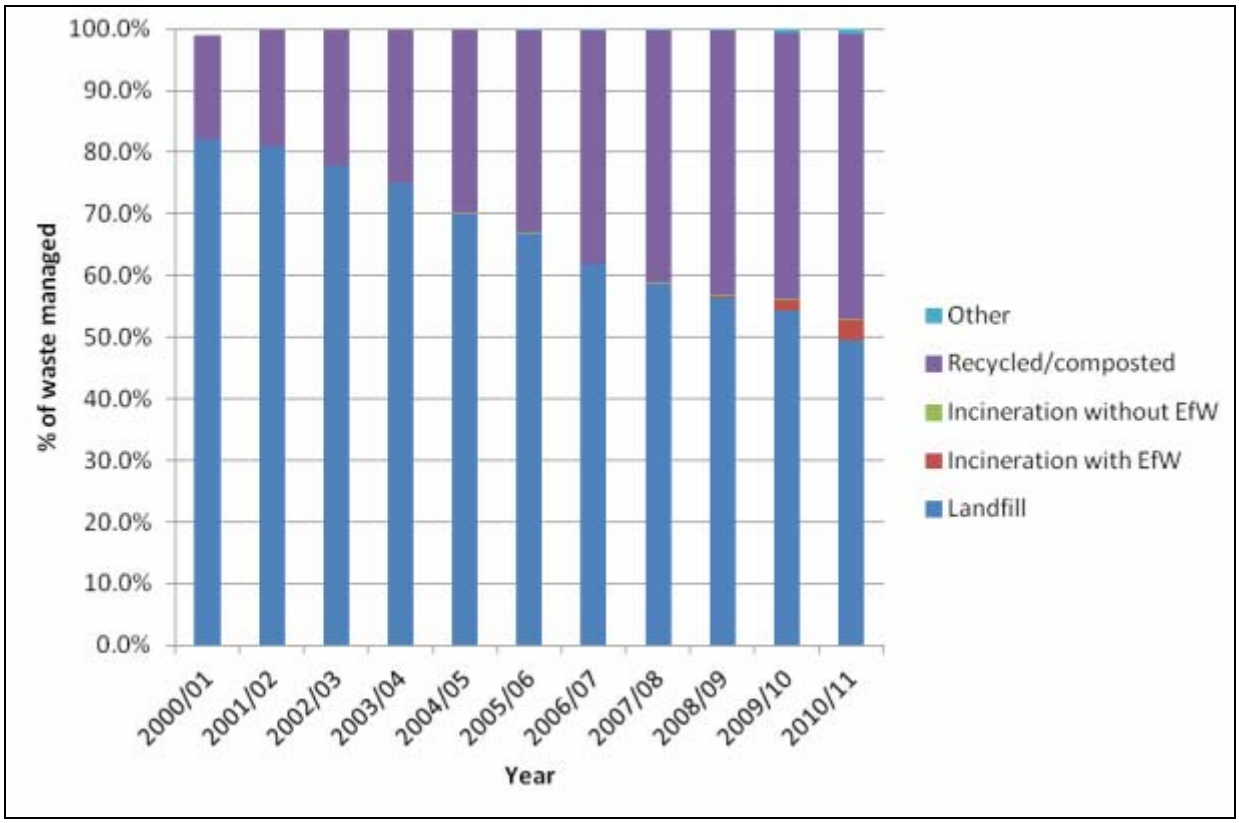
**Figure 8.4 Treatment of Waste in the South West over the Period 2000/01 to 2010/11**




These figures highlight that the region has reduced the proportion of waste sent to landfill since 2000-01, from 82.0% to 49.6% in 2010-11 (a reduction of 858,000 tonnes). Conversely, the proportion of waste that has had some value recovered has increased with recycling/composting rates growing by 29.1% over the same period and the volume of waste sent to incineration with EfW increasing to 89,000 tonnes (3.3% of all local authority waste collected).

The proportion of waste sent to landfill is greater in the South West than any other English region with the exception of the North West although the proportion recycled/composted is the second highest (behind the East of England). In terms of incineration with EfW, management rates vary considerably across the regions with the proportion of waste managed by this method in the South West significantly lower than London, West Midlands, North East and Yorkshire and Humber.

## Minerals

The South East has a variety of mineral assets. Some key statistics for minerals supply and use within the South East are provided below:

- Sand and gravel sales have fallen for the tenth year running to 6.0 million tonnes (Mt), some 1.3Mt less than in 2008. Nonetheless, they continue to supply nearly 50% of the primary aggregate supply from the region;

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- Sales of crushed rock were some 1.3Mt in 2009, 100,000 tonnes less than in 2008; and
- In 2009, some 800,000 tonnes of aggregate was sold from quarries in or partly within a National Park or AONB, over 2Mt from quarries in or partly within SSSIs/SPA/SAC sites, and 2Mt from quarries in the Green Belt[18].

Similarly, a range of minerals are exploited in the South West, including aggregates such as crushed rock, land and marine won sand and gravel, china and ball clays, and natural building stones. Other minerals found in the region include peat and brick clay. Their exploitation is recognised as generating locally significant employment, and about 0.5% of Gross Value Added (GVA) in the South West.

Production (sales) of crushed rock aggregates (limestone, igneous rock and sandstone) was 17.29Mt in 2010, a very slight increase on 2009 (17.21Mt); production in 2009 had been 15.3% down on 2008. Somerset continues to be the main production area with about 56% of sales. Production (sales) of land won sand and gravel was only 3.33Mt in 2010 but this represented a 6% increase on 2009 production. Approximately 43% of the South West's reserves were held at sites in Dorset which had a landbank of about 10.7 years. Marine dredged landings in the region, mainly sand dredged from licensed areas in the Bristol Channel, amounted to only 0.467m but this was almost the same as the 2009 landings; virtually all of this amount was sourced from the Bristol Channel[19].

Oil and gas in the Wessex-Channel (including the Weald) Basin arises from the presence of both Triassic and Jurassic source and reservoir rocks. Production from the large Wytch Farm oilfield discovered in Dorset in the early 1970s has dominated onshore oil output. Ten other oil and gasfields have been subsequently discovered in the Wessex-Channel Basin, some of which (e.g. Humbly Grove, now a 10 billion cubic feet storage facility operated by Star Energy) are now depleting and being considered for underground gas storage purposes.

Oil and gas licensed areas are restricted largely to the south east and central parts of southern England with a couple of blocks adjacent to the Severn Estuary.

Coal is absent over much the region with small coal deposits at surface to 1,200m in the East Kent and Gloucestershire areas. Coal was mined in East Kent until the 1980s and was deep-mined on a small scale in the Forest of Dean in Gloucestershire. The latest figures from the Coal Authority report than 150 tonnes were produced in Gloucestershire in 2012.

## 8.5 Summary of Existing Problems Relevant to Onshore Oil and Gas Licensing

The following existing problems for waste and resource use have been identified:

[18] South East Aggregates Monitoring Report 2009, published Feb 2011

[19] South West Aggregates Working Party: Annual Report 2010

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- The total amount of waste produced each year is likely to grown in coming years; and
- The consumption of non-renewable sources will deplete overall stocks and result in a scarcity of resources for future generations.

## 8.6 Likely Evolution of the Baseline

### 8.6.1 UK

Non-radioactive waste management in the UK is moving towards greater reuse and recycling and less landfill. Between 2002 and 2007 in the UK, there was 19.5% decrease in waste disposed of in landfill sites. This includes waste produced by households, commerce and industry and construction and demolition[20].

Hazardous waste production in England and Wales has decreased since 2004 by 17%. The majority of the decrease is due to the reduction in liquid inputs to one treatment facility on Teesside in 2009[21].

### 8.6.2 England

In England, the total amount of non-radioactive waste sent to landfill has decreased from 80,000,000 tonnes annually in 2000-01 to 72,500,000 tonnes in 2004-05 at licenced landfill sites: with falls from 50% to 44% for industrial and commercial waste between 1998-99 and 2002-03. Between 1998-99 and 2002-03 there was a 1% reduction in the total amount (in tonnes) of commercial and industrial waste produced in England. Within this total, industrial waste had reduced to 38,000,000 tonnes in 2002-03 while the amount of commercial waste had grown to 30,000,000 tonnes. During this period, the tonnage of commercial and industrial waste sent to landfill has decreased, with more waste handled by transfer stations and treatment facilities.192 In 2002-03 for the first time, recycling and reuse had overtaken landfill as the most common method of waste management. Overall, 44% was sent to landfill and 45% recycled.

Defra has established targets for England which includes a greater focus on waste prevention seeking to achieve a fall of 50% per person of household waste arising. Recycling and composting of household waste targets have been established - at least 40% by 2010, 45% by 2015 and 50% by 2020; and recovery of municipal waste - 53% by 2010, 67% by 2015 and 75% by 2020.

On the basis of the policies set out in Waste Strategy for England 2007, levels of commercial and industrial waste landfilled are expected to fall by 20% by 2010 compared to 2004.

[20] Waste Strategy for England 2007, Defra

[21] http://www.environment-agency.gov.uk/research/library/data/123472.aspx

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### 8.6.3 Scotland

In Scotland, total non-radioactive waste arisings increased by 1,483,444 tonnes between 2004 and 2008. During the same period, however, commercial and industrial waste arisings decreased. The total amount of Scottish Waste sent to landfill decreased from 7,814,879 tonnes to 6,112,198 tonnes over the same five year period[22].

The quantity of hazardous waste in Scotland reduced from 109,995 tonnes in 2006 to 104,001 tonnes in 2009, a decrease of 5.4%[23].

Under the 'Zero Waste Plan', the Scottish Government has set a long term target of 70% recycling/ composting and preparing for reuse of all waste arising in Scotland by 2025, regardless of its source. The Scottish Government has also set a target of no more than 5% of all waste produced to go to landfill by 2025 [24].

### 8.6.4 Wales

In Wales, the landfilling of all wastes has decreased by 1,409,000 tonnes between 1998-99 (4,377,000 tonnes) and 2007 (2,968,000 tonnes)[25]. Commercial and industrial waste arisings rose slightly in 2007 when compared to the previous year, which reflects the increase in commercial waste production between 2002-03 and 2007 (and may also in part due to inaccuracies in monitoring. However, commercial and industrial arisings have decreased by 13% overall since 1998-99. The amount of commercial and industrial waste disposed of to landfill also continues to reduce; the amount of waste landfilled in 2007 was 57% of the 1998-99 figure.

Industrial waste arisings during the period 2010-11 to 2013-14 are predicted to remain relatively static in Wales, due to likely future decoupling between economic growth and waste growth because of regulatory and economic measures and cultural factors, and the decline, and likely further decline, in the industrial/manufacturing sector in Wales. During the same period, although there is expected to be continued growth in the commercial sector, commercial waste arisings are expected to remain static as further waste reduction/prevention measures are implemented.

Towards Zero Waste' the Waste Strategy for Wales, sets the following targets for commercial and industrial waste:

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[22] Scotland's Zero Waste Plan Data, Scottish Environment Protection Agency, June 2010, http://www.sepa.org.uk/waste/waste_data/zero_waste_plan_data.aspx

[23] Environment Agency Waste Trends, http://www.environment-agency.gov.uk/research/library/data/123472.aspx

[24] Scotland's Zero Waste Plan Data, Scottish Environment Protection Agency, June 2010, http://www.sepa.org.uk/waste/waste_data/zero_waste_plan_data.aspx

[25] Towards Zero Waste: and Waste Strategy Progress Report 2002- 2008, Welsh Government, June 2010, http://wales.gov.uk/docs/desh/publications/100730wasteprogressen.pdf

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- to achieve a reduction in commercial and industrial waste produced equivalent to at least 77% of 2006 levels by 2020;
- to reduce the amount of commercial and industrial waste sent to landfill to less than 75% of the 2007 baseline; and
- to recycle 70% of all commercial and industrial waste by 2025[26].

## 8.6.5 SEA Areas

### SEA Area 1: Scottish Midlands (including the Inner Forth)

**Table 8.6** displays the total amount of waste produced and the total amount of waste that was either composted or recycled for the local authorities in SEA Area 1 for the period 2000-01 and 2010-11. The data clearly highlights that there has been a significant trend in the increase of recycling and composting rates in all local authorities from an average of 9% in 2000 to 41% in 2011. It is likely that this trend will continue to rise in the coming years in line with the Scottish Government's target of 70% recycling. It is likely that the total amount of waste produced will be marginally reduced, although this may be difficult to achieve in the context of population growth.

[26] Towards Zero Waste: and Waste Strategy Progress Report 2002-2008, Welsh Government, June 2010, http://wales.gov.uk/docs/desh/publications/100730wasteprogressen.pdf

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**Table 8.6 Comparison of Waste Arising and Recycling/Composting Rates for Selected Local Authorities in Scotland: 2000 and 2011**

| Local authority | Total arisings (tonnes) 2000 | Waste composted or recycled 2000 (%) | Total arisings (tonnes) 2011 | Waste composted or recycled 2011 (%) |
|---|---|---|---|---|
| Aberdeenshire | 149,626 | 9 | 154,164 | 32 |
| Angus | 73,650 | 18 | 72,965 | 37 |
| Clackmannanshire | 34,423 | 7 | 31,367 | 50 |
| Dumfries and Galloway | 85,653 | 4 | 94,864 | 39 |
| Dundee | 102,291 | 22 | 94,944 | 35 |
| East Ayrshire | 81,804 | 4 | 69,069 | 44 |
| East Dunbartonshire | 68,302 | 10 | 66,003 | 40 |
| East Lothian | 60,517 | 12 | 61,986 | 43 |
| East Renfrewshire | 57,889 | 13 | 47,002 | 45 |
| Edinburgh | 257,796 | 7 | 221,865 | 32 |
| Falkirk | 122,537 | 6 | 90,122 | 49 |
| Fife | 260,837 | 5 | 253,991 | 48 |
| Glasgow | 360,576 | 5 | 334,906 | 24 |
| Inverclyde | 49,231 | 4 | 46,422 | 31 |
| Midlothian | 55,650 | 4 | 46,621 | 44 |
| North Ayrshire | 82,171 | 12 | 84,483 | 44 |
| North Lanarkshire | 208,706 | 7 | 207,166 | 43 |
| Perth and Kinross | 98,172 | 18 | 92,808 | 47 |
| Renfrewshire | 106,956 | 8 | 92,123 | 43 |
| Scottish Borders | 69,919 | 9 | 67,749 | 40 |
| South Ayrshire | 77,100 | 5 | 77,501 | 43 |
| South Lanarkshire | 172,512 | 5 | 177,021 | 38 |
| Stirling | 83,959 | 7 | 52,051 | 48 |
| West Dunbartonshire | 58,375 | 7 | 47,927 | 38 |
| West Lothian | 99,696 | 7 | 109,783 | 43 |

National data from 2004 to 2010 suggests that some mineral production in falling in Scotland (open-cast mining, igneous rock, limestone and fireclay) but some is increasing (clay and shale, sandstone and peat)[27]. It is likely that these trends will also be experienced in SEA Area 1 also.

## SEA Area 2: West Midlands, North West England and Southern Scotland

Urban areas of SEA Area 2 are likely to utilise waste for district heating or combined heat and power facilities. This should help result in higher incineration and treatment rates in the region. Recycling rates

[27] British Geological Survey (2012) United Kingdom Minerals Yearbook 2011.

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are expected to grow, in line with national objectives. Housing projections for the region are likely to result in the production of construction and demolition waste, particularly where brownfield sites are being utilised.

Although the West Midlands area is well endowed with mineral resources, the West Midlands Regional Aggregates Working Party (WMRAWP) believe that the principal burden will fall on Shropshire for both sand & gravel and crushed rock, with attendant potential consequences for a range of environmental criteria

## SEA Area 3: East Midlands and Eastern England

The national trend in waste being disposed of to landfill has been reflected in the East of England, Yorkshire & Humber and the North East, with quantities decreasing by 40-42% between 2001 and 2009.

Waste Authorities include figures for waste arisings in their waste and mineral plans, allowing for population increases over the period for waste reduction in their waste and mineral plans. For example, in Cambridgeshire and Peterborough Minerals and Waste Core Strategy (adopted July 2011) the overall amounts of waste are expected to increase as follows:

- 5.1 million tonnes in 2011;
- 5.3 million tonnes in 2016;
- 5.6 million tonnes in 2021; and
- 6.0 million tonnes in 2026.

Plans also include recycling and recovery targets for the different waste streams. For example in Cambridgeshire and Peterborough as follows:

- Municipal Solid Waste: aiming to recycle/compost 67% of waste arisings by 2026;
- Commercial and Industrial aiming to recycle/compost 88% of waste arising by 2026; and
- Construction and demolition aiming to recycle/recover 70% of waste arising by 2026.

Despite Government objectives to reduce the amount of waste produced, it is likely that overall waste levels will continue to rise in the coming years, primarily due to population growth. However, the trend towards increased recycling and recovery will continue and the proportion of waste sent to landfill in SEA Area 3 will continue to decline.

## SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

Recycling rates for local authorities in SEA Area 4 have risen in recent years (see **Table 8.7**) and are expected to continue to increase in line with Welsh Government objectives.

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**Table 8.7 Comparison of Waste Arising and Recycling/Composting Rates for Selected Local Authorities in Wales: 2007 and 2012**

| Local authority | Waste composted or recycled 2007 (%) | Waste composted or recycled 2012 (%) |
|---|---|---|
| Flintshire | 40.4 | 47.1 |
| Denbighshire | 28.3 | 57.3 |
| Wrexham | 35.9 | 47.5 |
| Swansea | 34.4 | 46.3 |
| Neath Port Talbot | 35.6 | 40.2 |
| Bridgend | 38.6 | 50.7 |
| Vale of Glamorgan | 38.1 | 51.8 |
| Cardiff | 26.5 | 52.6 |
| Rhondda Cynon Taf | 33.1 | 43.8 |
| Merthyr Tydfil | 28.5 | 46.3 |
| Caerphilly | 37.2 | 56 |
| Blaenau Gwent | 21.5 | 45.7 |
| Torfaen | 39.5 | 43.8 |
| Monmouthshire | 36.6 | 52.3 |
| Newport | 38.2 | 49.1 |

Source: Stat Wales, available at: https://statswales.wales.gov.uk/Catalogue/Environment-and-Countryside/Waste-Management/Local-Authority-Municipal-Waste/Quarterly/MunicipalWasteRecyclingCompostingRates-by-LocalAuthority-Quarter (accessed on: 03/06/2013)

Total municipal waste per person per annum in Wales has fallen from 655 tonnes in 2004 to 540 tonnes in 2011. Total household waste rose throughout the early 2000's before peaking in 2006 at 1,572,420. The decline since then may be attributable to the current economic slowdown. It is therefore likely that with population growth expected in South Wales, waste arising in SEA Area 4 will increase again.

The total amount of deep mined coal in Wales has fallen from 461 thousand tonnes in 2004 to just 47 thousand tonnes in 2010. However, levels of opencast coal produced in Wales has remained constant from 2004 to 2010. It is likely that opencast coal production values will remain constant in the short term future.

## SEA Area 5: Southern and South West England

The South East is forecast to direct 86% of waste from landfill by 2025 in line with landfill directive targets and national waste strategy. Most waste authorities in the South East are expected to continue to accept waste from London, but in declining volumes.

The national trend in waste being disposed of to landfill has been reflected in the South West region which has reduced the proportion of waste sent to landfill since 2000/01, from 82.0% to 49.6% in 2010-11 (a reduction of 858,000 tonnes). The South West's landfill capacity has reduced by 29.5% since 2000-01 (when capacity was 55.3 million cubic meters in 2000-01) and the amount of waste sent to landfill by 39.7%.

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## 8.7 Assessing Significance

The objectives and guide questions related to waste and resource use which have been identified for use in the appraisal of the effects of Licensing Plan proposals are set out in **Table 8.8**, together with reasons for their selection.

**Table 8.8 Approach to Assessing the Effects of the Licensing Plan on Waste and Resource Use**

| Objective/guide question | Reasoning |
|---|---|
| **Objective: to minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities** | The Waste Framework Directive promotes a hierarchical approach to waste management which is reflected in national strategy, such as the Waste Strategy for England. The Licensing Plan proposals should seek to accord with these principles and, consequently, the effects on waste management should be taken into account in the Environmental Report |
| Will the activities that follow the licensing round affect the amount of hazardous and non-hazardous wastes produced? | The Waste Framework Directive promotes a hierarchical approach to waste management with waste prevention at the top of the hierarchy. This is supported through national strategies such as Waste Strategy for England, Scotland's Zero Waste Plan and Towards Zero Waste, One Wales: One Planet. In addition, the Basel Convention promotes minimisation of generation of quantities of hazardous waste in order to prevent against problems and challenges posed by hazardous waste. |
| Will the activities that follow the licensing round affect the capacity of existing waste management systems, both nationally and locally? | The capacity of landfill sites is diminishing and European legislation, in particular the Landfill Directive, means that other options need to be considered to manage the volume of waste we generate, such as recycling. |
| Will the activities that follow the licensing round maximise re-use and recycling of recovered components and materials? | Recovering and recycling waste will assist in decreasing the amount of waste to landfill. The Landfill Directive aims to reduce amount of biodegradable waste going to landfill to 35% of the 1995 figures by 2020.<br>National strategies such as Waste Strategy for England, Scotland's Zero Waste Plan and Towards Zero Waste, One Wales: One Planet also include targets for recycling rates. |
| Will the activities that follow the licensing round help achieve government and national targets for minimising, recovering and recycling waste? | Minimising, recovering and recycling waste will assist in decreasing the amount of waste to landfill. The Landfill Directive aims to reduce amount of biodegradable waste going to landfill to 35% of the 1995 figures by 2020.<br>This is supported through national strategies such as Waste Strategy for England, Scotland's Zero Waste Plan and Towards Zero Waste, One Wales: One Planet. |
| **Objective: Contribute to the sustainable use of natural and material assets.** | The SEA Directive requires likely effects on resources be taken into effect in the Environmental Report.<br>The Resource Security Action Plan (2012) emphasises the need to make best use of resources currently in use, reducing as far as practicable the quantity of material used and waste generated, and using as much recycled and secondary material as possible, before securing the remainder of material needed through new primary extraction. |

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| Objective/guide question | Reasoning |
|---|---|
| Will the activities that follow the licensing round minimise the demand for mineral resources and unsustainable construction materials? | Conservation of resources and living within environmental limits are underlying objectives of several the international policies such as European Spatial Development Perspective, and national policy, such as Framework for Sustainable Development.<br>The National Planning Policy Framework, Scottish Planning Policy and Minerals Planning Policy Wales seek to facilitate the sustainable use of minerals. |
| Will the activities that follow the licensing round make best use of existing infrastructure and resources? | Use of existing infrastructure and resources will decrease the total resources required and will increase efficiency. |

**Table 8.9** sets out guidance that will be utilised during the assessment to help determine the relative significance of potential effects on the resource use and waste objectives. It should not be viewed as definitive or prescriptive; merely illustrative of the factors that may be considered as part of the assessment process.

**Table 8.9 Illustrative Guidance for the Assessment of Significance for Waste and Resource Use**

| Effect | Description | Illustrative Guidance |
|---|---|---|
| ++ | Significant Positive | • Proposal would increase capacity of waste management infrastructure;<br>• Proposal will create no additional hazardous or non-recyclable waste, whilst maximising the proportion of materials that are re-useable or recyclable;<br>• Proposal will ensure the safe handling of hazardous wastes;<br>• Proposal makes best use of existing infrastructure and resources (e.g. buildings and other facilities on site) and helps conserve natural resources. |
| + | Minor Positive | • Proposal would not create an increase in the volume of hazardous and non-recyclable wastes that require disposal;<br>• Proposal would increase the volume of materials reused and recycled;<br>• Proposal will ensure the safe handling of hazardous wastes;<br>• Proposal makes best use of existing infrastructure and resources (e.g. buildings and other facilities on site). |
| 0 | Neutral | • Proposal would not create an increase in the volume of hazardous and non-recyclable wastes that require disposal;<br>• Proposal will have no effect on the capacity of waste management infrastructure;<br>• Proposal would not have any impact on existing natural resources. |
| - | Minor Negative | • Proposal will increase volumes of hazardous and non-recyclable waste that would require disposal;<br>• Proposal may have a limited adverse impact on the capacity of existing waste management systems;<br>• Proposal will require the limited use of natural resources during construction and operational stages. |
| | Significant Negative | • Proposal will generate a high volume of hazardous and non-recyclable waste that would require disposal; |

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| Effect | Description | Illustrative Guidance |
|---|---|---|
| -- | | • Proposal will impede the achievement of government and national targets for minimising, recovering and recycling waste;<br>• Proposal will have a significant adverse impact on the capacity of existing waste management systems (e.g. leading to the permitting of additional landfill capacity to accommodate waste);<br>• Proposal may increase risks associated with the handling of hazardous wastes;<br>• Option is likely to require a significant volume of natural resources and result in the direct loss of resources |
| ? | Uncertain | • From the level of information available the effects the impact that the option would have on this objective is uncertain. |

## 8.8 Assessment of Effects

This section comprises the assessment of the potential activities that could follow on from the licensing round on the resource use and waste objectives. There are a total of six main stages of oil and gas exploration and production (including gas storage) that are the subject of the assessment. These are highlighted in **Table 8.10** for both conventional and unconventional oil and gas together with an overview of the associated key activities at each stage. Please note that Stages 1, 2 and 4 do not necessarily apply to gas storage, depending on the development history of the particular site.

**Table 8.10 Oil and Gas Exploration and Production Lifecycle and Key Activities**

| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| 1. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. |
| 2. | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring.* | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. |

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| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| 3. | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring* | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. |
| 4. | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring.* | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. |
| 5. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. |
| 6. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. |

Note: Exploration wells most usually move from Stage 2 to Stage 5, though some may be used for long-term production testing (which would require new consents including planning permission) and some may be retained and their sites redeveloped as a production project (this would also require new consents including planning permission). For the purposes of this assessment, the appraisal stage (a term commonly used in industry) spans Stages 2 and 3.

*Conventional oil and gas exploration and production activities (stages 2 to 4 above) can occasionally include hydraulic fracturing. However, the need to undertake hydraulic fracturing is relatively uncommon and has therefore not been considered in the assessment of conventional oil and gas activities as part of this SEA.

### 8.8.1 Conventional Oil and Gas

The assessment of the six main stages of conventional oil and gas production is contained in **Table 8.11**. The first two columns describe the exploration and production stage. The third and fourth columns summarise the expected effects on the waste and resource use objectives for both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report). The rationale for this relationship is explained in more detail in the final column and includes:

- the nature and scale of the potential effects on the waste and natural resources objectives;
- when the effect could occur (timing) and its degree of permanence;
- what mitigation measures might be appropriate for potentially significant negative effects on the waste and use of resources objectives;

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- what options there are to enhance positive effects; and
- assumptions and uncertainties that underpin the assessment.

**Table 8.11 Assessment of Effects: Conventional Oil and Gas**

| **Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>The majority of activities in this Stage are desk-based such as site identification and securing permits. As a result, it is not expected that waste would be generated.<br>Certain seismic survey techniques, such as vibroseis, require roads or hard surfaces for use. In the majority of cases, it is assumed that a site can be accessed by existing roads, however, if an area is not accessible by existing road it may require the construction of temporary access routes. Given the temporary nature of the road it will be expected to consist of a layer of crushed stone/gravel/cobbles. Although these access roads may be used again should the site be used for production, the removal of the road would not be expected to result in a waste stream as the materials could be recycled.<br>In general, a neutral effect is expected at this stage as it would not create an increase in the volume of non-recyclable wastes that require disposal.<br>**Low and High Activity Scenarios:**<br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed). As the only materials used at this stage could be recycled, it is expected that the type and magnitude of effects under the high and low scenario would not differ substantially.<br>**Mitigation:**<br>• Materials used for the construction of access roads should be chosen dependant on their ability to be recycled into a product for which there is a viable market.<br>**Assumptions:**<br>• It is assumed that any top soil removed to facilitate the construction of temporary access routes would not enter a waste stream and would be relaid once the access route is no longer in use.<br>**Uncertainties:**<br>• None. |
| 2 | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion; | **-** | **-** | **Assessment of Effects:**<br>The preparation of the pad would require the clearance of vegetation, the stripping of topsoils and the levelling of the site in order to lay a solid foundation. This is not expected to result in producing waste as the soil would be stored around the perimeter of the site, creating screening bunds to be accessed following site decommissioning for the restoration of the site. |

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| Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • Well testing including flaring. | | | Initial test boreholes would be drilled, with some being developed into full wells. The process of drilling creates waste in the form of drill cuttings, spent drill muds and excess cement which is returned to the surface. Drilling wastes are covered under section 1, 'wastes resulting from exploration, mining, quarrying, and physical and chemical treatment of minerals' in schedule 1 of the List of Wastes (England) Regulations 2005, implemented following the adoption of the Waste Directive (67/548/EEC) and after the List of Wastes Decision (2000/532/EC). Those wastes in the list relevant to drill cuttings and which are considered hazardous include:<br>• oil-containing drilling muds and wastes (waste: 01 05 05)<br>• drilling muds and other drilling wastes containing dangerous substances (waste: 01 05 06)<br>Drill cuttings are rock fragments created from the drill process, flushed to the surface by the drill mud. The average volume of drill cuttings per well (of a total length of 2,100m) is assumed to be 117m$^3$. Cuttings may be moved offsite and disposed of at a licensed landfill site, disposed of onsite if appropriate, or reinjected into a geological formation. The Environmental Protection (Duty of Care) Regulations requires operators to take suitable steps to manage such waste and provide appropriate information to any third party operator who may transport and/or dispose of the material elsewhere. The requirements of the Landfill Regulations 2002 (and subsequent amendments) will need to be met, including the waste acceptance criteria, and under the Water Framework Directive it would also need to be demonstrated that water resources could not be contaminated by disposal of mud and cuttings. Regulatory controls under existing legislation will therefore effectively minimise and mitigate potential effects. Reinjection is usually the preferred option (BAT) under PPC and is now a proven technology and geological risks (i.e. loss of containment in receiving formation) are low.<br>Drilling muds may be oil or water-based. Drilling muds are re-circulated, however spent muds are a waste. They typically contain a mix of the geological formations encountered (drill cuttings), liquid (water or oil), clay (bentonite) plus any additives used. In general, their physical and chemical composition will vary according to each project drilling design and underlying geology.<br>Water based drilling muds will contain rock fragments from the drill cuttings which after appropriate treatment, may be suitable for use in recovery operations. Oil based muds are more likely to be classified as a hazardous waste.<br>In order to ensure the integrity of the well and protect groundwater, steel casing is cemented into the wellbore in stages by pumping cement slurry between the wall of the well and the steel casing. As a result of this process, a proportion of the cement will return to the surface and will require on site storage before being taken offsite for treatment/disposal at a suitable site.<br>Other waste that is likely to be generated on site includes: waste oils; paraffins; waxes; oil contaminated rags; used |

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| Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | batteries; waste chemicals, scrap metals and used containers.<br>The process of well testing which extracts trapped hydrocarbons will generate extractive waste which has the potential to contain Naturally Occurring Radioactive Material (NORM). This waste usually takes the form of formation water which is naturally occurring in the geological formation and could be released during the well testing. This liquid is usually routed through a separator at surface to separate it from hydrocarbons. For conventional wells, it is usually stored on site in bunded large steel containers before being either re-injected back into the formation reservoir or removed for off-site disposal at a permitted waste treatment/disposal facility.<br>Any natural gas that may arise from drilling will be disposed of by flaring.<br>In general, exploratory drilling would produce waste streams, including some hazardous waste. However given the volumes of waste likely to be produced, and the opportunities available to recycle some materials, the effect on the waste objective would be minor negative.<br>**Low and High Activity Scenarios:**<br>The high activity scenario would involve considerably more boreholes to be drilled than under the low activity scenario (30 boreholes compared to 5 boreholes) and will generate waste cuttings, which (along with the wells) for the high activity scenario will be in excess of 700m$^3$, dependent on the depth and diameter of boreholes drilled. As this volume of waste could be generated across the entire SEA Areas, the amount of waste generated in each area is like to be lower and not of a scale to result in significant effects on current waste management facilities.<br>**Mitigation:**<br>• Site Waste Management Plans should be put into place to ensure that all wastes produced during construction and pad preparation are handled according to regulatory requirements and best practice. Waste management planning should establish a clear strategy for wastes that will be generated including options for waste elimination, reduction, recycling, treatment and disposal.<br>• All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible.<br>• Minimising the volumes of drilling fluids and cuttings produced by using coiled tubing drilling techniques.<br>• Consider options to treat spent fluids in order to recycle them back to vendors.<br>• Use BAT in selected methods to transport and treat produced water generated during this stage. |

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| Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Explore opportunities to recycle treated drill cuttings through reinjection or use as a construction aggregate.<br>**Assumptions:**<br>• It is assumed that some hazardous wastes would be produced on exploratory drilling sites.<br>• It is assumed that the majority of drill cuttings would be treated so that they are not classified as a hazardous waste.<br>• It is assumed that cuttings would not be permanently buried on site but either disposed of at a licensed landfill or reinjected, upon decommissioning of the well.<br>• It is assumed that produced water would be re-injected into the formation reservoir.<br>**Uncertainties:**<br>• The exact composition of chemicals to be used in the drilling mud is unknown.<br>• The precise forms of treatment and disposal of drilling fluids and dried cuttings is known. |
| 3 | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring. | - | - | **Assessment of Effects:**<br>The range and type of effects associated with Stage 3 of the oil and gas exploration and production lifecycle would be similar to those identified under Stage 2. However, the area of land take required per well pad would be greater than that associated with the exploratory drilling stage (in the region of 2-3ha) reflecting the need for additional infrastructure such as storage tanks and on-site pipelines. Additional wells would be drilled. Additional activities could also include the completion of road connections and the installation of pipelines required to collect natural gas for transfer to the existing natural gas pipeline infrastructure.<br>The extension of the pad is not expected to result in additional waste as the soil would be collected and stored in banks around the site perimeter. Once the well is decommissioned, the soil would be used to restore the site.<br>Drilling operations at this stage would generate similar waste streams to those expected at Stage 2. It is assumed that there would be a maximum of 2 wells per pad. This would result in additional volumes of waste than expected under Stage 2.<br>The reuse of exploratory wells for production would result in less drill waste being generated (then requiring all new wells to be completed), as it would not be necessary to drill the well from the surface again.<br>**Low and High Activity Scenarios:**<br>A total of 12 wells are assumed to be completed under the high activity scenario. However, half of these will be drilled as exploratory wells during stage 2. This is estimated to produce approximately 700m$^3$. In total the level of waste this stage is likely to produce, including hazardous waste is not likely to be considered significant in the content of existing waste arisings in the UK. |

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| Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | As a result, minor negative effects have been expected under the low activity and high activity scenario.<br>**Mitigation:**<br>• Site Waste Management Plans should be extended to cover the management of waste during stage 3 operations. Waste management planning should establish a clear strategy for wastes that will be generated including options for waste elimination, reduction, recycling, treatment and disposal.<br>• All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible.<br>• Good practice guidance in the protection of soil materials should be followed.<br>• Minimising the volumes of drilling fluids and cuttings produced by using coiled tubing drilling techniques.<br>• Consider options to treat spent fluids in order to recycle them back to vendors.<br>• Use BAT in selected methods to transport and treat produced water generated during this stage.<br>• Explore opportunities to recycle treated drill cuttings through reinjection or reuse as a construction aggregate.<br>**Assumptions:**<br>• It is assumed that some hazardous wastes would be produced on exploratory drilling sites.<br>• It is assumed that the majority of drill cuttings would be treated so that they are not classified as a hazardous waste.<br>• It is assumed that cuttings would not be permanently buried on site.<br>• It is assumed that produced water would be re-injected into the formation reservoir.<br>**Uncertainties:**<br>• The exact composition of chemicals to be used in the drilling mud is unknown.<br>• The precise forms of treatment and disposal of drilling fluids and dried cuttings is known. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, | - | - | **Assessment of Effects:**<br>Once the well is in production, the volume of waste generated would be expected to decline significantly from Stages 2 and 3.<br>Produced water is likely to be re-injected back into the formation reservoirs in most instances, thereby removing the need to treat and/or dispose of it. |

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| Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | | | Once in production, the well may be stimulated for the purposes of restoring, prolonging or enhancing the production of hydrocarbons. This is known as 'work-over' and it is usually achieved by cleaning the borehole with work-over fluids. These fluids typically include brines, acids, methanol and other chemical systems. Once used they may contain oil, solid material and other chemical additives. The treatment/disposal of these fluids may include: collection in a closed system in order to send back to vendor for recycling; off site biological or chemical treatment at an approved facility; or disposal.<br>**Low and High Activity Scenarios:**<br>There would generally be minor levels of waste produced during this stage. Assuming that produced water is re-injected, there would be no high volumes of waste produced during this stage of works. Accordingly, a minor negative effect is expected under the low and high activity scenarios.<br>**Mitigation:**<br>• Waste Management Plans should be put into place to ensure that all wastes produced over the lifetime of the well are handled according to best practice. Waste management planning should establish a clear strategy for wastes that will be generated including options for waste elimination, reduction, recycling, treatment and disposal.<br>**Assumptions:**<br>• It is assumed that produced water will be re-injected and therefore will not need to be treated as a waste.<br>• It is assumed that under normal production, there would be no blowouts and the spillage of oils or other contaminants on site would be kept to a minimum in line with best practice.<br>**Uncertainties:**<br>• None. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>During decommissioning, there is a general requirement on operators to remove as much equipment and structures from the pad site as possible, with the exception of infrastructure required to ensure the well is safely plugged.<br>It is expected that a proportion of the well infrastructure could be re-used at other locations, or recycled (although to some extent that will depend on the viability of future onshore operations in the UK as well as functioning, efficiency and operational safety of the well infrastructure to be reused). Large waste streams are not expected therefore at this stage; however, may still be more substantial than that outlined.<br>Although some waste will be generated, and will need to be managed, these are expected to be negligible in scale and therefore a neutral effect is expected on the objective.<br>**Low and High Activity Scenarios:**<br>Although more waste is likely to be generated under the high activity scenario, it can be reasonably assumed that this would still be of a negligible scale. |

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| **Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Mitigation:**<br>• A Waste Management Plan should be adopted prior to decommissioning to ensure that all plant and infrastructure that is required to be decommissioned is re-used or recycled.<br>**Assumptions:**<br>• It is assumed that the majority plant and equipment will be re-used or recycled and not disposed of<br>**Uncertainties:**<br>• None. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>Site restoration will involve the removal of all remaining surface structures and the excavation and transport of the concrete and hard core pad based used for the pad site, or other materials which were laid or used to prepare the pad site. It is assumed that these materials, once broken up and graded could be reused as construction aggregate.<br>Soil that has been stored on site will be reused to restore the site to the previous land use (or to support the land use determined by the local planning authority). It is assumed that the soil will be free of any contamination that may have occurred during the exploration and/or production phase.<br>It is assumed that the site will be reseeded with an appropriate mix, compatible with existing land use (whether amenity greenspace, grazing or arable land).<br>As appropriate landscaping will also take place.<br>**Low and High Activity Scenarios:**<br>Although more waste is likely to be generated under the high activity scenario, it can be reasonably assumed that this would still be of a negligible scale in line with extant local waste arisings.<br>**Mitigation:**<br>• The decommissioning Waste Management Plan should be extended and adopted prior to site restoration to ensure that all plant and infrastructure that is required to be decommissioned is re-used or recycled.<br>**Assumptions:**<br>• It is assumed that some access roads will remain in place.<br>• It is assumed that concrete removed from the site would be recycled.<br>• It is assumed that soil used to create bunding will be re-used to restore the site. It is also presumed that this soil has not been polluted as a result of accidental spills or blowouts<br>**Uncertainties:**<br>• None. |

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| Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| ***Summary*** | | | | |
| No positive effects are expected on the waste objective during any of the Stages of conventional oil and gas exploration. Neutral effects are expected at several of the stages, under both the low and high activity scenarios. These stages include Stage 1 (Non-intrusive exploration), Stage 5 (Decommissioning) and Stage 6 (Site Restoration). Waste volumes on conventional oil and gas production sites typically peak during drilling operations. Good waste management planning and technology options to treat waste that is produced should result in low levels of waste (hazardous and non-hazardous) that need to be disposed of. In addition, it is unlikely that the volumes of waste that are expected to be generated would result in significant adverse effects on existing waste management systems. Minor negative effects are therefore expected on the waste objective during Stage 2 (Exploration drilling), Stage 3 (Production Development) and Stage 4(Production/operation/maintenance).<br>**Mitigation Summary:**<br>• Materials used for the construction of access roads which are expected to be short term or temporary should be chosen dependant on their ability to be recycled into a product for which there is a viable market.<br>• The volumes of drilling fluids and cuttings produced should be minimised by using coiled tubing drilling techniques.<br>• Options to treat spent fluids in order to recycle them back to vendors should be considered.<br>• Option to recycled drilling cuttings should be considered.<br>• Waste Management Plans should be put into place to ensure that all wastes produced over the lifetime of the well are handled according to best practice. Waste management planning should establish a clear strategy for wastes that will be generated including options for waste elimination, reduction, recycling, treatment and disposal. | | | | |

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

**Table 8.12 Assessment of Effects: Conventional Oil and Gas**

| Objective 10: To contribute to the sustainable use of natural and material assets. | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>This majority of activities in this Stage are desk-based such as site identification and securing permits.<br>Certain seismic survey techniques, such as vibroseis, require roads or hard surfaces for use. In the majority of cases, it is assumed that a site can be accessed by existing roads, however, if an area is not accessible by existing road it may require the construction of temporary access routes. Given the temporary nature of the road and the minimal traffic expected it is assumed these access routes will consist of a layer of crushed stone/gravel/cobbles Although these access roads may be used again should the site be |

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| Objective 10: To contribute to the sustainable use of natural and material assets. | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | used for production, the removal of the road would not be expected to result in a waste stream as the materials could be recycled.<br>**Low and High Activity Scenarios:**<br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed). However there is negligible resource use associated with both the low and high level activity scenario.<br>**Mitigation:**<br>• If temporary access roads are required, options to construct them using recycled materials should be considered;<br>• Options to consider using vehicles powered by alternative fuels should be explored.<br>**Assumptions:**<br>• None.<br>**Uncertainties:**<br>• None. |
| 2 | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring. | **-/+** | **-/+** | **Assessment of Effects:**<br>The preparation of the pad would require the clearance of vegetation, the stripping of topsoils and the levelling of the site in order to lay a solid foundation. This foundation is likely to require construction aggregate. The soil would be stored around the perimeter of the site, creating screening bunds to be accessed following site decommissioning for the restoration of the site.<br>Drilling operations will require the installation of well casings to seal the well from surrounding formations and stabilise the completed well. Casing is typically steel pipe lining the inside of the drilled hole and cemented in place. Drilling operations would also involve the recycling of drilling muds through a closed-loop system. The energy required to carry out drilling operations would also involve the use materials that are derived from fossil fuels.<br>Flaring, in almost all instances, would be considered to lead to the depletion of non-renewable natural resources (natural gas), as it could be recovered for use.<br>Exploratory drilling is generally undertaken to estimate the amount of oil of gas that can be technically and economically produced from a geological formation. This oil and gas is known as 'reserves'. Estimates of reserves would be expected to develop and improve in line with increased exploratory drilling. This would lead to an increase in hydrocarbon resource within the UK. The scale of exploratory drilling under conventional oil and gas is expected to discover a minor increase, resulting in a minor positive effect on this objective.<br>The energy required to carry out the majority of activities at this stage would also involve the use materials that are derived from fossil fuels<br>Overall, this stage is expected to have a mixed minor negative and minor positive effect on this objective due to the limited use of natural resources and the discovery of minor resources of hydrocarbons through exploratory drilling. as a result. |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Low and High Activity Scenarios:**<br>The high activity scenario would involve considerably more boreholes to be drilled than under the low activity scenario. However, the volume of resources required to meet the high level scenario would still be limited and minor negative effects are also expected<br>**Mitigation:**<br>• If possible, materials used should be from recycled sources<br>• Flaring should be kept to an absolute minimum.<br>**Assumptions:**<br>• It is assumed that steel used to construct well casings would be partially sourced from recycled steel.<br>• It is assumed that diesel generators would power the majority of plant and equipment on the site.<br>**Uncertainties:**<br>• None. |
| 3 | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring. | - | - | **Assessment of Effects:**<br>Activities at this stage would be similar to those at Stage 2 in terms of resource consumption. The main material required would be steel and cement. Additional resources would also be required to complete pipeline connections and other ancillary parts of infrastructure. These resources would typically come from virgin materials.<br>The energy required to carry out the majority of activities at this Stage would also involve the use materials that are derived from fossil fuels.<br>**Low and High Activity Scenarios:**<br>Under the high activity scenario, additional resources would be consumed to facilitate additional drilling and other ancillary works. These are not expected to give rise to significant effects.<br>**Mitigation:**<br>• Opportunities should be explored to consider energy sources to power on site activities that demonstrate good resource efficiency.<br>• Options to consider using vehicles powered by alternative fuels should be explored.<br>**Assumptions:**<br>• It is assumed that steel used to construct well casings would be partially sourced from recycled steel.<br>**Uncertainties:**<br>• It is not known how operations on site will be powered. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring; | - | - | **Assessment of Effects:**<br>Once in production, the well may be stimulated for the purposes of restoring, prolonging or enhancing the production of hydrocarbons. This is known as 'work-over' and it is usually achieved by cleaning the borehole with work-over fluids. These fluids typically include brines, acids, methanol and other chemical systems.<br>The extraction of hydrocarbon reserves would result in the recovery but then direct loss of a primary natural resource that is non-renewable. |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • Environmental monitoring and well integrity monitoring. | | | According to figures from DECC, cumulative oil production to the end of 2012 stood at 3,542 million tonnes. Maximum oil reserves (proven, probable and possible reserved) as of 2012 stood at 1,064 million tonnes.<br>The exact production values for the oil and gas production that will be licensed under the plan are difficult to ascertain and will depend on a number of factors. In general, it can be reasonably assumed that production would involve the depletion of oil and gas resources and therefore negative effects would be expected (the corollary of Stage 2, when discover was recognised as a positive effect).<br>**Low and High Activity Scenarios:**<br>As a result of the uncertainties outlined above, it is not possible to predict whether the scale of extraction under the low and high activity scenarios, however, the number of wells involved ranging from 6 to 12 are unlikely to means resources would ever be considered significant and their extraction ever considered a significant depletion of total resources.<br>**Mitigation:**<br>• Waste Management Plans should be put into place to ensure that all wastes produced over the lifetime of the well are handled according to best practice. Waste management planning should establish a clear strategy for wastes that will be generated including options for waste elimination, reduction, recycling, treatment and disposal.<br>**Assumptions:**<br>• None.<br>**Uncertainties:**<br>• See comments above regarding the inherent uncertainties in this assessment of the activities in this stage. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>During decommissioning, there is a general requirement on operators to remove as much equipment and structures from the pad site as possible, with the exception of infrastructure required to ensure the well is safely plugged. This would require cement and could also include the reinjection of drill cuttings, which had been stored on site for this purpose. The scale of resources needed is likely to be of a minor scale.<br>It is expected that a proportion of the well infrastructure could be re-used at other locations, or recycled (although to some extent that will depend on the viability of future onshore operations in the UK as well as functioning, efficiency and operational safety of the well infrastructure to be reused). Large waste streams are not expected therefore at this stage; however, may still be more substantial than that outlined.<br>**Low and High Activity Scenarios:**<br>More resources would be needed to decommission the additional number of wells under the high level scenario. However the effect this would have on the resource is in minor in scale as would any positive effects from the reuse of infrastructure. |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
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| | | | | **Mitigation:**<br>• Materials that include recycled components should be used where possible.<br>**Assumptions:**<br>• None.<br>**Uncertainties:**<br>• None. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>Site restoration will involve the removal of all remaining surface structures and the excavation and transport of the concrete and hard core pad based used for the pad site, or other materials which were laid or used to prepare the pad site. It is assumed that these materials, once broken up and graded could be reused as construction aggregate. This would reduce the demand for primary aggregates. Overall, a neutral effect is therefore expected.<br>**Low and High Activity Scenarios:**<br>No difference is expected between the effects under the low and high activity scenarios.<br>**Mitigation:**<br>• Options to consider using vehicles powered by alternative fuels should be explored.<br>**Assumptions:**<br>• It is assumed that some access roads will remain in place.<br>• It is assumed that soil used to create bunding will be re-used to restore the site. It is also presumed that this soil has not been polluted as a result of accidental spills or blowouts<br>**Uncertainties:**<br>• None. |

***Summary***

Neutral effects are expected during Stage 1, 5 and Stage 6 as there would be a negligible use of resources during these stages with some potential for reuse of materials (either directly on site as pad of decommissioning and restoration or indirectly through the reuse of materials as construction aggregate off site). Stage 2 is expected to result in a minor positive. This reflects the additional hydrocarbon reserves identified. Stage 3 is expected to result in minor negative effects. This is due to the resources that will be required in order to complete activities during these stages. These resources however would not be of a scale to result in a significant effects occurring. During Stage 4, the extraction of hydrocarbons would cause a depletion of UK resources of oil and gas. This would result in an adverse effect although due to the scale of activity involved it is not assumed to be significant.

**Mitigation Summary:**

- Access roads should be constructed from recycled aggregate sources to reduce the need to use primary aggregates.
- Option to use vehicles run on alternative fuels such as biodiesels, bioalcohols and vegetable oils and should be considered.
- Flaring should be kept to an absolute minimum.
- Opportunities should be explored to consider energy sources to power on site activities that demonstrate good resource efficiency.

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| *NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.* | | | | |
| *S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)* | | | | |

## 8.8.2 Unconventional Oil and Gas

The assessment of the six main stages of unconventional oil and gas production is contained in **Table 8.13** under both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report).

**Table 8.13 Assessment of Effects: Unconventional Oil and Gas**

| Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities | | | | |
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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>This majority of activities in this Stage are desk-based such as site identification and securing permits. As a result, it is not expected that waste would be generated.<br>Certain seismic survey techniques, such as vibroseis, require roads or hard surfaces for use. In the majority of cases, it is assumed that a site can be accessed by existing roads, however, if an area is not accessible by existing road it may require the construction of temporary access routes. Given the temporary nature of the road and the minimal traffic expected it is assumed these access routes will consist of a layer of crushed stone/gravel/cobbles. Although these access roads may be used again should the site be used for production, the removal of the road would not be expected to result in a waste stream as the materials could be recycled.<br>In general, a neutral effect is expected at this stage as it would not create an increase in the volume of non-recyclable wastes that require disposal.<br>**Low and High Activity Scenarios:**<br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed). As the only materials used at this stage could be recycled, it is expected that the |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | type and magnitude of effects under the high and low scenario would not differ substantially.<br>**Mitigation:**<br>• Materials used for the construction of access roads should be chosen dependant on their ability to be recycled into a product for which there is a viable market.<br>**Assumptions:**<br>• It is assumed that any top soil removed to facilitate the construction of temporary access routes would not enter a waste stream and would be re-laid once the access route is no longer in use.<br>**Uncertainties:**<br>• None. |
| 2 | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. | - | -- | **Assessment of Effects:**<br>The preparation of the pad would require the clearance of vegetation, the stripping of topsoils and the levelling of the site in order to lay a solid foundation. This is not expected to result in producing waste as the soil would be stored around the perimeter of the site, creating screening bunds to be accessed following site decommissioning for the restoration of the site.<br>Initial test boreholes would be drilled, with some being developed into full wells. The process of drilling creates waste in the form of drill cuttings, spent drill muds and excess cement which is returned to the surface. Drilling wastes are covered under section 1, 'wastes resulting from exploration, mining, quarrying, and physical and chemical treatment of minerals' in schedule 1 of the List of Wastes (England) Regulations 2005, implemented following the adoption of the Waste Directive (67/548/EEC) and after the List of Wastes Decision (2000/532/EC). Those wastes in the list relevant to drill cuttings and which are considered hazardous include:<br>• oil-containing drilling muds and wastes (waste: 01 05 05)<br>• drilling muds and other drilling wastes containing dangerous substances (waste: 01 05 06)<br>Drill cuttings are rock fragments created from the drill process, flushed to the surface by the drill mud. The average volume of drill cuttings per well for unconventional oil and gas is typically higher than for conventional operations as the length of wells is considerable longer (assumed average of 5,500m against 2000m). The average quantity of drill cuttings per well would therefore increase, estimated at 270m$^3$ as opposed to 117m$^3$ per conventional well.<br>Cuttings may be moved offsite and disposed of at a licensed landfill site, disposed of onsite if appropriate, or reinjected into a geological formation. The Environmental Protection (Duty of Care) Regulations requires operators to take suitable steps to manage such waste and provide appropriate information to any third party operator who may |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | transport and/or dispose of the material elsewhere. The requirements of the Landfill Regulations 2002 (and subsequent amendments) will need to be met, including the waste acceptance criteria, and under the Water Framework Directive it would also need to be demonstrated that water resources could not be contaminated by disposal of mud and cuttings. Regulatory controls under existing legislation will therefore effectively minimise and mitigate potential effects. Reinjection is usually the preferred option (BAT) under PPC and is now a proven technology and geological risks (i.e. loss of containment in receiving formation) are low.<br>Drilling muds may be oil or water-based. Drilling muds are re-circulated, however spent muds are a waste. They typically contain a mix of the geological formations encountered (drill cuttings), liquid (water or oil), clay (bentonite) plus any additives used. In general, their physical and chemical composition will vary according to each project drilling design and underlying geology.<br>Water based drilling muds will contain rock fragments from the drill cuttings which after appropriate treatment, may be suitable for use in recovery operations. Oil based muds are more likely to be classified as a hazardous waste.<br>In order to ensure the integrity of the well and protect groundwater, steel casing is cemented into the wellbore in stages by pumping cement slurry between the wall of the well and the steel casing. As a result of this process, a proportion of the cement will return to the surface and will require on site storage before being taken offsite for treatment/disposal at a suitable site.<br>Other waste that is likely to be generated on site includes: waste oils; paraffins; waxes; oil contaminated rags; used batteries; waste chemicals, scrap metals and used containers.<br>Some of the water (it is assumed between 30 and 75%) that is injected into the shale rock during hydraulic fracturing returns to the surface through the drilled well. This fluid is known as 'flowback water' and typically is very saline and contains minerals dissolved from the rocks.<br>Some of the water that flows to the surface also includes produced water. After the initial recovery of the hydraulic flowback fluid (in the flowback water), produced water will continue in many cases to come to the surface with decreasing quantities of hydraulic fracturing fluid. Although due to the low permeability of shale, it contains a very low water content and does not permit any flow and so produced water is not anticipated to arise from unconventional wells in the UK.<br>The disposal of flowback water simply be re-injecting it into the shale strata is not permissible under current groundwater protection legislation.<br>Flowback water analysed by the Environment Agency from the Preese Hall exploratory well in Lancashire contained |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | high levels of sodium, chloride, bromide, iron, lead, magnesium, zinc and low levels of NORMs. [28]<br>According to the EA, flowback water at Preese Hall was stored on site in double skinned tanks. It was then transported to the Davyhulme wastewater treatment work (WwTW). This WwTW treats other industrial effluents from the Manchester area and was considered by the Agency as capable of dealing with the levels of minerals contained in the flowback water from the Preese Hall site.<br>The EA also deem that although flowback fluid is a waste when it returns to the surface, if it can be treated to the point where it performs the same function as fresh injection fluid, it will no longer be a waste and could be used in well stimulation. Therefore the Agency considers the reuse of flowback fluid following treatment and blending with fresh water to be the preferred and sustainable option for its management.[29] The re-use of flowback water is however less likely during exploratory drilling and therefore it is assumed that it will require treatment and disposal.<br>The treatment of flowback water in WwTWs may also result in sludge becoming contaminated with hazardous wastes. In addition, it is likely that the salinity of the flowback water would cause damage to some elements of the WwTW. Some levels of pre-treatment may be necessary before the waste enters the WwTWs are a result.<br>Any natural gas that may arise from drilling will be disposed of by flaring. Although this is an extractive waste, it is not considered to be a hazardous waste and would be likely to be considered a gaseous effluent.<br>Overall, activities during this stage are expected to generate volumes of waste, primarily from drill cuttings, spent drilling mud and flowback water.<br>Any natural gas that may arise from drilling will be disposed of by flaring.<br>In general, exploratory drilling would produce waste streams, including some hazardous waste. However given the volumes of waste likely to be produced, and the opportunities available to recycle some materials, the effect on the waste objective would be minor negative.<br>**Low and High Activity Scenarios:**<br>Under the low activity scenario, 20 boreholes would be drilled, some of which are then assumed to lead onto exploration wells. Assuming each well produces 270m$^3$ of cuttings, 20 wells would produce 5,400m$^3$ of drill cuttings. The addition of 5,400m$^3$ into the waste management system would not result in significant effects.<br>With regards to flowback water, assuming that each well will require 10,000m$^3$ to 25,000m$^3$, and flowback rates are assumed to be 30-75%, the volume of flowback water can be assumed to range between 3,000m$^3$ to 18,750m$^3$ per well. |

[28] Environment Agency (2011) Shale Gas North West- Monitoring of Flowback Water

[29] Environment Agency (2013) Onshore oil and gas exploratory operations: technical guidance, Consultation Draft

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Under the high activity scenario, 240 boreholes could be drilled. Assuming that these all lead onto wells, they would therefore produce up to 4,500,000m$^3$ of wastewater which would require treatment. Depending on where this requires treatment, this volume of wastewater could place a substantial burden on existing wastewater treatment infrastructure capacity. In consequence, the high activity scenario has been assessed as having a significant negative effect on this objective. However, scrutiny through the environmental permitting system can be assumed to ensure that these effects would not be unacceptable in a local context. Water UK, which represents the water industry, and UKOOG have also signed a Memorandum of Understanding (MoU) which ensures their respective members will cooperate throughout the shale gas exploration and extraction process in order minimise adverse effects on water resources and the environment. Under the MoU, members of UKOOG and Water UK will undertake timely consultation that will include discussions on the expected volumes and chemical and biological composition of wastewater as well as preferred disposal routes. It is also noteworthy that the industry is not expected to be at substantial scale before the 2020s. This will allow time for any necessary new investment in infrastructure such as waste water treatment capacity. Further, if on-site treatment and recycling could occur, wastewater volumes could be reduced.<br><br>Under the low activity scenario, there would be up to 375,000m$^3$ of water that would require treatment. Although this is less than under the high activity scenario, it would nonetheless place a burden on existing WwTWs and minor negative effects would therefore be expected.<br><br>**Mitigation:**<br>• Site Waste Management Plans should be put into place to ensure that all wastes produced during construction and pad preparation are handled according to regulatory requirements and best practice. Waste management planning should establish a clear strategy for wastes that will be generated including options for waste elimination, reduction, recycling, treatment and disposal.<br>• All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible.<br>• Minimising the volumes of drilling fluids and cuttings produced by using coiled tubing drilling techniques.<br>• Consider options to treat spent fluids in order to recycle them back to vendors.<br>• Use BAT in selected methods to transport and treat produced water generated during this stage.<br>• Explore opportunities to recycle treated drill cuttings through reinjection or use as a construction aggregate. |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Assumptions:**<br>• It is assumed that cuttings will not be classified as hazardous material.<br>• It is assumed that 30-75% of injected water will return as 'flowback water'.<br>• It is assumed that any produced water that comes to the surface would contain fracturing fluid and therefore would be classified as flowback water.<br>• It is assumed that cuttings would not be permanently buried on site but either disposed of at a licensed landfill or reinjected, upon decommissioning of the well.<br>**Uncertainties:**<br>• The exact composition of chemicals to be used in the drilling mud is unknown. |
| 3 | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. | -- | -- | **Assessment of Effects:**<br>The range and type of effects associated with Stage 3 of the unconventional oil and gas exploration and production lifecycle would be similar to those identified under Stage 2. However, the area of land take required per well pad would be greater than that associated with the exploratory drilling stage (in the region of 2-3ha compared to 1ha) reflecting the need for additional infrastructure such as storage tanks and on-site pipelines. Additional wells would be drilled. Additional activities could also include the completion of road connections and the installation of pipelines required to collect natural gas for transfer to the existing natural gas pipeline infrastructure.<br>The extension of the pad is not expected to result in additional waste as the soil would be collected and stored in banks around the site perimeter. Once the well is decommissioned, the soil would be used to restore the site.<br>Drilling operations at this stage would generate similar waste streams to those expected at Stage 2 but the scale of activity would increase substantially (see scenarios below) through the use of multiple well pads. This would result in additional volumes of waste than expected under Stage 2.<br>The reuse of exploratory wells for production would result in less drill waste being generated (then requiring all new wells to be completed), as it would not be necessary to drill the well from the surface again.<br>**Low and High Activity Scenarios:**<br>The two largest waste streams are likely to be drilling cuttings and flowback water. Under the low activity scenario, depending on the average number of wells drilled between 48,600m$^3$ to 97,200m$^3$ of drilling cuttings would be generated. Under the high activity scenario, 324,000m$^3$ to 712,800m$^3$ of drilling cuttings would be generated. This is unlikely to result in significant burdens on waste management facilities however cumulative effects in areas with limited capacity may occur.<br>With regards to flowback water, assuming that each well will generate between 10,000m$^3$ to 25,000m$^3$, and flowback rates are assumed to be 30-75%, the volume of flowback |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | water can be assumed to range between 3,000m$^3$ to 18,750m$^3$ per well. Assuming flowback water per well would be between 3,000m$^3$ to 18,750m$^3$, under the high activity scenario (up to 2640 wells) up to 49,500,000m$^3$ of wastewater would require treatment. Under the low activity scenario (340 wells) meanwhile, up to 6,375,000m$^3$ of wastewater would need to be treated. Depending on where this requires treatment, this volume of wastewater could place a substantial burden on existing wastewater treatment infrastructure capacity. In consequence, this stage (for both low and high activity scenarios) has been assessed as having a significant negative effect on this objective. However, scrutiny through the environmental permitting system can be assumed to ensure that these effects would not be unacceptable in a local context. The Water UK and UKOOG MoU will also ensure that their respective members will cooperate throughout the shale gas exploration and extraction process in order minimise adverse effects on water resources and the environment. Under the MoU, members of UKOOG and Water UK will undertake timely consultation that will include discussions on the expected volumes and chemical and biological composition of wastewater as well as preferred disposal routes. It is also noteworthy that the industry is not expected to be at substantial scale before the 2020s. This will allow time for any necessary new investment in infrastructure such as waste water treatment capacity. Further, wastewater could be substantially reduced if flowback water was recycled and reused.<br>**Mitigation:**<br>• Site Waste Management Plans should be extended to cover the management of waste during stage 3 operations. Waste management planning should establish a clear strategy for wastes that will be generated including options for waste elimination, reduction, recycling, treatment and disposal.<br>• All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible.<br>• Good practice guidance in the protection of soil materials should be followed.<br>• Minimising the volumes of drilling fluids and cuttings produced by using coiled tubing drilling techniques.<br>• Explore opportunities to recycle treated drill cuttings through reinjection or use as a construction aggregate.<br>• Consider options to treat spent fluids in order to recycle them back to vendors.<br>• Use BAT in selected methods to transport and treat wastewater generated during this stage. |

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| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Assumptions:**<br>• It is assumed that cuttings will not be classified as hazardous material.<br>• It is assumed that cuttings would not be permanently buried on site but either disposed of at a licensed landfill or reinjected, upon decommissioning of the well.<br>• It is assumed that 30-75% of injected water will return as 'flowback water'.<br>• It is assumed that some produced water that comes to the surface would contain fracturing fluid and therefore would be classified as flowback water and not produced water.<br>• It is assumed that only large WwTWs would be capable of treating flowback water.<br>• It is assumed there would be no change to extant regulation which prohibits the injection of flowback water into formations.<br>**Uncertainties:**<br>• The exact composition of chemicals to be used in the drilling mud is unknown. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | -- | -- | **Assessment of Effects:**<br>Once in production, the volumes of waste being generated typically are lower for conventional wells. With regard to unconventional wells, there is a strong likelihood they will be refractured again to stimulate the flow of shale gas again.<br>It is assumed that each well would be refractured once. This would result in similar levels of flowback water being generated as estimated in Stage 3 (approximately 3,000m$^3$-18,750m$^3$ per well).<br>**Low and High Activity Scenarios:**<br>As it is assumed wells would be re-fractured, and similar levels of wastewater would be expected to be generated as in the activity scenarios discussed in the Stage 3 assessment. As a result, significant negative effects would be expected.<br>**Mitigation:**<br>• Use BAT in selected methods to transport and treat wastewater generated during this stage.<br>**Assumptions**<br>• It is assumed that only large WwTWs would be capable of treating flowback water.<br>• It is assumed that some produced water that comes to the surface would contain fracturing fluid and therefore would be classified as flowback water and not produced water.<br>• It is assumed there would be no change to extant regulation which prohibits the injection of flowback water into formations. |

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| **Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Uncertainties:**<br>• The substances that will be found in the flowback water cannot be precisely ascertained at this Stage. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>There is a general requirement on operators to remove as much equipment and structures from the pad site as possible, with the exception of infrastructure required to ensure the well is safely plugged.<br>It is expected that a proportion of the well infrastructure could be re-used at other locations, or recycled (although to some extent that will depend on the viability of future onshore operations in the UK as well as functioning, efficiency and operational safety of the well infrastructure to be reused. Large waste streams are not expected therefore at this stage; however, may still be more substantial than that outlined.<br>Although some waste will be generated, and will need to be managed, these are expected to be negligible in scale and therefore a neutral effect is expected on the objective.<br>**Low and High Activity Scenarios:**<br>Although more waste is likely to be generated under the high activity scenario, it can be reasonably assumed that this would still be of a negligible scale in line with extant local waste arisings.<br>**Mitigation:**<br>• A Waste Management Plan should be adopted prior to decommissioning to ensure that all plant and infrastructure that is required to be decommissioned is re-used or recycled.<br>**Assumptions:**<br>• It is assumed that the majority plant and equipment will be re-used or recycled and not disposed of<br>**Uncertainties:**<br>• None. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>Site restoration will involve the removal of all remaining surface structures and the excavation and transport of the concrete and hard core pad based used for the pad site, or other materials which were laid or used to prepare the pad site. It is assumed that these materials, once broken up and graded could be reused as construction aggregate.<br>Soil that has been stored on site will be reused to restore the site to the previous land use (or to support the land use determined by the local planning authority). It is assumed that the soil will be free of any contamination that may have occurred during the exploration and/or production phase.<br>It is assumed that the site will be reseeded with an appropriate mix, compatible with existing land use (whether amenity greenspace, grazing or arable land).<br>As appropriate landscaping will also take place. |

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| Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Low and High Activity Scenarios:**<br>Although more waste is likely to be generated under the high activity scenario, it can be reasonably assumed that this would still be of a negligible scale in line with extant local waste arisings.<br>**Mitigation:**<br>• The decommissioning Waste Management Plan should be extended and adopted prior to site restoration to ensure that all plant and infrastructure that is required to be decommissioned is re-used or recycled.<br>**Assumptions:**<br>• It is assumed that some access roads will remain in place.<br>• It is assumed that soil used to create bunding will be re-used to restore the site. It is also presumed that this soil has not been polluted as a result of accidental spills or blowouts.<br>**Uncertainties:**<br>• None |

***Summary***

No positive effects are expected on the waste objectives for any of the unconventional oil and gas stages. Neutral effects have been identified for Stage 1 (Non-intrusive exploration), Stage 5 (Decommissioning) and Stage 6 (Site restoration) as negligible volumes of waste are expected to be produced. Unconventional oil and gas activities are likely to generate significant quantities of wastewater as a result of flowback which requires treatment which due to the technological challenges involved in treating this waste to appropriate standards. Depending on where this requires treatment, this volume of wastewater could place a substantial burden on existing wastewater treatment infrastructure capacity. However, scrutiny through the environmental permitting system can be assumed to ensure that these effects would not be unacceptable in a local context. Water UK, which represents the water industry, and UKOOG have also signed a Memorandum of Understanding (MoU) which ensures their respective members will cooperate throughout the shale gas exploration and extraction process in order minimise adverse effects on water resources and the environment. Under the MoU, members of UKOOG and Water UK will undertake timely consultation that will include discussions on the expected volumes and chemical and biological composition of wastewater as well as preferred disposal routes. It is also noteworthy that the industry is not expected to be at substantial scale before the 2020s. This will allow time for any necessary new investment in infrastructure such as waste water treatment capacity. Further, wastewater could also be substantially reduced if flowback water was recycled and reused. For example, reported recycling rates in the US vary between 10% and 77%.

**Mitigation Summary:**

- A Site Waste Management Plan should be adopted prior to the exploration stage and revised and implements across all subsequent stages. Waste management planning should establish a clear strategy for wastes that will be generated including options for waste elimination, reduction, recycling, treatment and disposal. It should ensure compliance with all regulatory compliance.
- Materials used for the construction of access roads should be chosen dependant on their ability to be recycled into a product for which there is a viable market.
- All soils should be handled in suitable conditions (e.g. dry weather) and the most appropriate method of soil handling should be used. Soils should be stored in allocated heaps and protected from erosion, contamination or degradation. Different soil types should be stored separately and the length of time soils are stored should be minimised where possible.
- Minimising the volumes of drilling fluids and cuttings produced by using coiled tubing drilling techniques. Opportunities to recycle treated drill cuttings through reinjection or use as a construction aggregate should be explored.
- Consider options to treat spent fluids in order to recycle them back to vendors.
- Use BAT in selected methods to transport and treat produced water generated during this stage.
- Minimising the volumes of drilling fluids and cuttings produced by using coiled tubing drilling techniques.

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| **Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Stage*** | ***Description*** | | | | ***Score*** | | | | ***Commentary*** | | | |
| | | | | | ***Low Activity Scenario*** | | ***High Activity Scenario*** | | | | | |
| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | | **?** **Score uncertain** | |
| *NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.* | | | | | | | | | | | | |
| *S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)* | | | | | | | | | | | | |

**Table 8.14 Assessment of Effects: Unconventional Oil and Gas**

| **Objective 10: To contribute to the sustainable use of natural and material assets.** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>This majority of activities in this Stage are desk-based such as site identification and securing permits.<br>More intrusive activities such as seismic surveys (vibroseis and shot hole techniques) may require the construction of temporary access roads. These roads could be constructed using recycled aggregate and thereby remove the need to use raw materials.<br>In general, a neutral effect is expected at this stage as there is a negligible demand on existing resources.<br>**Low and High Activity Scenarios:**<br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed). However under the high activity scenario, a neutral effect is still expected at this stage.<br>**Mitigation:**<br>• Recycled materials should be chosen should access roads be required.<br>**Assumptions:**<br>• None.<br>**Uncertainties:**<br>• None. |

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| Objective 10: To contribute to the sustainable use of natural and material assets. | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 2 | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. | -/++ | -/++ | **Assessment of Effects:**<br>The preparation of the pad would require the clearance of vegetation, the stripping of topsoils and the levelling of the site in order to lay a solid foundation. This foundation is likely to require construction aggregate. The soil would be stored around the perimeter of the site, creating screening bunds to be accessed following site decommissioning for the restoration of the site.<br>The main material required at this stage would be steel and cement. Additional resources would also be required to complete pipeline connections and other ancillary parts of infrastructure. These resources would typically come from virgin materials.<br>Hydraulic fracturing would require water, sand and chemicals. Data from Cuadrilla's disclosure of compositions used to fracture one well at Preese Hall[30] indicates that 6 fracturing episodes would require 462 metric tons of Congleton and Chelford Sand.<br>The use of water resources is considered in chapter 5 of this Appendix.<br>Drill cuttings may be moved offsite and disposed of at a licensed landfill site, disposed of onsite if appropriate, or reinjected into a geological formation. The Environmental Protection (Duty of Care) Regulations will require operators to take suitable steps to manage such waste and provide appropriate information to any third party operator who may transport and/or dispose of the material elsewhere. The requirements of the Landfill Regulations 2002 (and subsequent amendments) will need to be met, including the waste acceptance criteria, and under the Water Framework Directive it would also need to be demonstrated that water resources could not be contaminated by disposal of mud and cuttings. Regulatory controls under existing legislation will therefore effectively minimise and mitigate potential effects. Reinjection is usually the preferred option (BAT) under PPC and is now a proven technology and geological risks (i.e. loss of containment in receiving formation) are low.<br>Flaring, in almost all instances, would be considered as resulting in the depletion of non-renewable natural resources (natural gas).<br>The energy required to carry out the majority of activities at this Stage would also involve the use materials that are derived from fossil fuels.<br>Exploratory drilling is generally undertaken to estimate the amount of oil of gas that can be technically and economically produced from a geological formation. This oil and gas is known as 'reserves'. Estimates of reserves would be expected to develop and improve in line with increased exploratory drilling. |

[30] Cuadrilla Resources, Composition of Components in Bowland Shale Hydraulic Fracturing Fluid for Preese Hall Well , available from http://www.cuadrillaresources.com/wp-content/uploads/2012/02/Chemical-Disclosure-PH-1.jpg (accessed on 04/09/2013)

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| Objective 10: To contribute to the sustainable use of natural and material assets. | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | A recent report by the BGS[31] noted that the assessment of shale gas resources in the UK is in its infancy. DECC have noted[32] that studies carried out by the BGS show that while shale gas clearly has potential in the UK, little drilling or testing has taken place and therefore it is not possible to make meaningful estimates of how much shale gas may be practically and commercially recoverable.<br>In addition to uncertainty regarding UK resources, it is difficult to predict the known reserves due to the infancy of the industry in the UK. However, given the likely scale of activity anticipated in the scenarios, both would be based on substantial (and potentially very substantial) quantities of gas being recovered. Therefore this expected to have a significantly positive effect on this objective.<br>The energy required to carry out the majority of activities at this Stage would also involve the use materials that are derived from fossil fuels<br>**Low and High Activity Scenarios:**<br>Under the high activity scenario, additional resources would be consumed to facilitate additional drilling and other ancillary works. These are not expected to give rise to significant effects. A minor negative effect has been identified under both the low and high activity scenarios as a result.<br>**Mitigation:**<br>• Opportunities should be explored to consider energy sources to power on site activities that demonstrate good resource efficiency.<br>• Options to consider using vehicles powered by alternative fuels should be explored.<br>**Assumptions:**<br>• It is assumed that steel used to construct well casings would be partially sourced from recycled steel.<br>**Uncertainties:**<br>• It is not known how operations on site will be powered. |
| 3 | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion; | - | - | **Assessment of Effects:**<br>Activities at this stage would be similar to those at Stage 2 in terms of resource consumption. The main material required would be steel and cement. Additional resources would also be required to complete pipeline connections and other ancillary parts of infrastructure. These resources would typically come from virgin materials.<br>The energy required to carry out the majority of activities at this Stage would also involve the use materials that are derived from fossil fuels. |

[31] DECC (2013) The Carboniferous Bowland Shale gas study: geology and resource estimation

[32] DECC (2013) About shale gas and hydraulic fracturing (fracking) Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/226040/About_Shale_gas_and_hydraulic_fracking.pdf. Accessed on 04/09/2013

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| Objective 10: To contribute to the sustainable use of natural and material assets. | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | • Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. | | | **Low and High Activity Scenarios:**<br>Under the high activity scenario, additional resources would be consumed to facilitate additional drilling and other ancillary works. These are not expected to give rise to significant effects.<br>**Mitigation:**<br>• Opportunities should be explored to consider energy sources to power on site activities that demonstrate good resource efficiency.<br>• Options to consider using vehicles powered by alternative fuels should be explored.<br>**Assumptions:**<br>• It is assumed that steel used to construct well casings would be partially sourced from recycled steel.<br>**Uncertainties:**<br>• It is not known how operations on site will be powered. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | **-/--** | **-/--** | **Assessment of Effects:**<br>Once in production, the volumes of waste being generated typically are lower for conventional wells. With regard to unconventional wells, there is a strong likelihood they will be refractured again to stimulate the flow of shale gas again.<br>It is assumed that each well would be refractured once. This would result in similar levels of flowback water (detailed earlier in the assessment).<br>The extraction of hydrocarbon reserves would result in the direct loss of a primary natural resource that is non-renewable. However a determination as whether the extraction would give rise to significant effects cannot be made as:<br>(i) The determination of total UK resources is still at early stages<br>(ii) The estimation of what likely reserves are in also currently unknown<br>(iii) The likely yield per well is not possible to ascertain currently.<br>**Low and High Activity Scenarios:**<br>As a result of the uncertainties outlined above, it is not possible to predict whether the scale of extraction under the low and high activity scenarios would result in a significant depletion of total resources.<br>As a result, a mixed score of minor/significantly negative has been expected under the low activity and high activity scenario. In general however, significant effects would be more likely under the high activity scenario as it could be reasonable assumed that more reserves would be extracted.<br>**Mitigation:**<br>• Waste Management Plans should be put into place to ensure that all wastes produced over the lifetime of the well are handled according to best practice. Waste management planning should establish a clear strategy for wastes that will be generated including options for waste elimination, reduction, recycling, treatment and disposal. |

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| Objective 10: To contribute to the sustainable use of natural and material assets. | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Assumptions:**<br>• None.<br>**Uncertainties:**<br>• See comments above regarding the inherent uncertainties in this assessment of the activities in this stage |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>During decommissioning, there is a general requirement on operators to remove as much equipment and structures from the pad site as possible, with the exception of infrastructure required to ensure the well is safely plugged. This would require cement and could also include the reinjection of drill cuttings, which had been stored on site for this purpose. The scale of resources needed is likely to be of a minor scale.<br>It is expected that a proportion of the well infrastructure could be re-used at other locations, or recycled (although to some extent that will depend on the viability of future onshore operations in the UK as well as functioning, efficiency and operational safety of the well infrastructure to be reused. Large waste streams are not expected therefore at this stage; however, may still be more substantial than that outlined.<br>**Low and High Activity Scenarios:**<br>Although more waste is likely to be generated under the high activity scenario, it can be reasonably assumed that this would still be of a negligible scale in line with extant local waste arisings.<br>**Mitigation:**<br>• A Waste Management Plan should be adopted prior to decommissioning to ensure that all plant and infrastructure that is required to be decommissioned is re-used or recycled.<br>**Assumptions:**<br>• It is assumed that the majority plant and equipment will be re-used or recycled and not disposed of<br>**Uncertainties:**<br>• None. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>Site restoration will involve the removal of all remaining surface structures and the excavation and transport of the concrete and hard core pad based used for the pad site, or other materials which were laid or used to prepare the pad site. It is assumed that these materials, once broken up and graded could be reused as construction aggregate. This would reduce the demand for primary aggregates. Overall, a neutral effect is therefore expected.<br>**Low and High Activity Scenarios:**<br>No difference is expected between the effects under the low and high activity scenarios.<br>**Mitigation:**<br>• A Waste Management Plan should be adopted prior to site restoration to ensure that all plant and infrastructure that is required to be decommissioned is re-used or recycled. |

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| Objective 10: To contribute to the sustainable use of natural and material assets. | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Assumptions:**<br>• It is assumed that some access roads will remain in place.<br>• It is assumed that soil used to create bunding will be re-used to restore the site. It is also presumed that this soil has not been polluted as a result of accidental spills or blowouts.<br>**Uncertainties:**<br>• None. |

***Summary***

Neutral effects are identified during Stages 1, 5 and Stage 6 as there would be a negligible use of resources during these stages. Stages 2, 3 and 5 are expected to result in minor negative effects. This is due to the resources that will be required in order to complete activities during these stages. These resources however would not be of a scale to result in a significant effects occurring. Stage 2 is also expected to result in a significant positive effect. This reflects the additional hydrocarbon reserves identified. However, during Stage 4, the extraction of hydrocarbons would cause a depletion of UK resources of oil and gas. This would result in an adverse effect although it is not ascertainable whether this effect would be significant. A mixed score of minor/significant negative is therefore expected.

**Mitigation Summary:**

- Access roads should be constructed from recycled aggregate sources to reduce the need to use primary aggregates.
- Option to use vehicles run on alternative fuels such as biodiesels, bioalcohols and vegetable oils and should be considered.
- Flaring should be kept to an absolute minimum.
- Opportunities should be explored to consider energy sources to power on site activities that demonstrate good resource efficiency.

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 8.9 Virgin Coal Bed Methane

The effects of exploration and production activities associated with VCBM are similar to those described in the assessment of effects of unconventional oil and gas (Stages 1-6) although hydraulic fracturing is not normally required. No attempt has been made to provide an indication of low and high levels of activity. Commercially viable VCBM containing formations tend to be shallower (200-1,500m depth) than traditional oil and gas targets and therefore less drilling would be required. This would result in the production of fewer cuttings and other drilling related wastes.

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## 8.10 Gas Storage

The development of gas storage capacity is likely to entail the following activities:

1. Construction and Installation of Pipelines and Storage Facilities;
2. Storage operations; and
3. Decommissioning.

The likely effects of these activities are appraised in **Table 8.15**.

**Table 8.15 Assessment of Effects: Gas Storage**

| **Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities**<br>**Objective 10: To contribute to the sustainable use of natural and material assets.** | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| 1 | **Construction and Installation of Pipelines and Storage Facilities** | **+** | **Assessment of Effects:**<br>As gas storage projects under consideration here involve the (re)use of depleted reservoirs for storage. This involves the re-use of underground structure and surface infrastructure and therefore minimises the need for further natural resources to be used. Therefore it is expected that this stage would have a positive effect on this objective.<br>**Mitigation:**<br>• Materials that need to be removed from the existing facility should be recycled where possible<br>**Assumptions:**<br>• None.<br>**Uncertainties:**<br>• As outlined above, it is uncertain whether the re-development of the site would generate waste |
| 2 | **Storage Operations** | **0** | **Assessment of Effects:**<br>During storage operations, venting or flaring may occur. In addition, fugitive emissions are likely although are expected to be negligible. These are not considered to place burdens on existing waste management faculties and a neutral effect is therefore expected.<br>**Mitigation:**<br>• None.<br>**Assumptions:**<br>• It is assumed that waste generated over the lifetime of the storage operation would be restricted to small scale items.<br>**Uncertainties:**<br>• None. |

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| **Objective 9: To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities**<br>**Objective 10: To contribute to the sustainable use of natural and material assets.** | | | |
|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | ***Commentary*** |
| 3 | **Decommissioning** | **0** | **Assessment of Effects:**<br>The decommissioning of the facility would be likely to generate waste streams. It is expected that a large majority of the waste (metals, etc) could be recycled. However even if materials could not be recycled, it is likely that the waste generated would be negligible in scale and therefore a neutral effect is expected.<br>**Mitigation:**<br>• Materials should be recycled where possible.<br>**Assumptions:**<br>• None.<br>**Uncertainties:**<br>• None. |
| ***Summary*** | | | |
| The implementation of Gas Storage would not be expected to have positive effects on the waste objective. No discernible waste generation activities have been identified at Stage 2 or 3 and therefore a neutral effect is expected. As it is not certain whether the construction stage would result in waste being generated, an uncertain effect is expected.<br>**Mitigation Summary:**<br>• Materials should be recycled where possible. | | | |

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 8.11 SEA Areas

The following sections consider in-turn the potential effects of Licensing Plan activities on the waste and use of resources objectives in the five SEA Areas. The assessment draws on the findings presented in **Table 8.11** to **Table 8.15** above and takes account of the environmental characteristics of the areas as detailed in **Section 8.4**.

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## 8.11.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

### Conventional Oil and Gas

SEA Area 1 is currently where all onshore conventional oil and gas activities are undertaken in Scotland. It is therefore likely that existing waste management practices would be adopted for production to be licensed under this plan. As SEA Area 1 serves a large population, is it likely that waste management facilities in the vicinity of production sites would be utilised. There is over 66 million tonnes of landfill capacity in Scotland. Most local authorities in SEA Area 1 (with the exception of Clackmannanshire, East Dunbartonshire, East Renfrewshire, Inverclyde and Stirling) have landfill capacity [33]. There is only one hazardous landfill in Scotland (Falkirk). This facility has capacity of circa 342,970 tonnes but almost 45,000 tonnes was landfilled at the site in 2011 alone. However, it is expected that generation of hazardous waste will not be significant and therefore it is not expected to be within the capacity of the landfill.

### Unconventional Oil and Gas

Unconventional Oil and Gas activities would generate more volumes of waste than for conventional activities. Higher levels of waste will place an additional burden on existing waste management facilities. Non hazardous waste is likely to be accommodated without placing a significant burden on current facilities. As outlined above, hazardous waste landfill capacity is limited, and significant effects may occur in the medium to long term, particularly given the potential scale of activity anticipated by the scenarios. As there are several industrial and nuclear wastewater generating facilities in SEA Area 1, it is possible that there will be facilities with capability to treat flowback water. However, the volume of wastewater that is expected to be generated requires facilities of considerable capacity and is likely to result in cumulative effects and place significant burden on existing facilities.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 1 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required. Commercially viable VCBM containing formations tend to be shallower (200-1,500m depth) than traditional oil and gas targets and therefore less drilling would be required. This would result in the production of fewer cuttings and other drilling related wastes.

### Gas Storage

Gas Storage in this area is not likely in additional issues other than those identified in Table 8.13 with regards to the waste and use of resources objectives.

[33] SEPA (2012) Landfill sites and Capacity Report for Scotland 2011

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## 8.11.2 SEA Area 2: West Midlands, North West England and Southern Scotland

### Conventional Oil and Gas

Waste Management Facilities in the West Midland alone have the capacity to handle over 155 million tonnes of waste per annum across 1,269 permitted sites. The volumes of waste expected to be generated under the low and high activity scenarios are unlikely to place any discernible pressure of facilities as a result. Only half of the hazardous waste generated in the North West region is treated in the region and therefore it is reasonable to assume that additional hazardous waste arisings in the North West may not be treated in the region.

Waste Management facilities in Southern Scotland are likely to be limited, especially for hazardous waste and it is therefore plausible that hazardous waste will have to be disposed in other parts of England, or in SEA Area 1.

Resources should as steel, cement and aggregates would be expected to be available in SEA Area 2. As in the case of other areas, production would result in the direct loss of hydrocarbon resources.

### Unconventional Oil and Gas

SEA Area 2 has large treatment facilities which may have the capacity to accept wastewater from unconventional operations, although this is uncertain. However, the volume of wastewater that would require treatment may place significant burden on treatment works and increase the volume of hazardous waste by-products.

The use of natural resources is not likely to give rise to significant issues which are particularly relevant to SEA Area 2.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 2 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required. Commercially viable VCBM containing formations tend to be shallower (200-1,500m depth) than traditional oil and gas targets and therefore less drilling would be required. This would result in the production of fewer cuttings and other drilling related wastes.

### Gas Storage

Gas Storage in this area is not likely in additional issues other than those identified in table 8.13 with regards to the waste and use of resources objectives.

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## 8.11.3 SEA Area 3: East Midlands and Eastern England

### Conventional Oil and Gas

Hazardous waste capacity in Yorkshire and Humber alone is 46,000 tonnes while non-hazardous waste capacity is 2,716,000 tonnes. It is therefore likely that while non-hazardous waste generated by conventional production would be met by existing facilities and capacity, the long term generation of hazardous waste may place burdens on existing landfill facilities.

### Unconventional Oil and Gas

Unconventional production would result in additional waste streams and volumes than would normally be expected from conventional production. In addition, unconventional oil and gas production would generate high volumes of wastewater than would require treatment. Only treatment facilities in high population areas would be suitable to process this wastewater, due to the additional volumes required for blending and therefore cumulative effects would be likely to place significant demands on treatment facilities.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 3 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required. Commercially viable VCBM containing formations tend to be shallower (200-1,500m depth) than traditional oil and gas targets and therefore less drilling would be required. This would result in the production of fewer cuttings and other drilling related wastes.

### Gas Storage

Gas Storage in this area is not likely in additional issues other than those identified in tables 8.13 with regards to the waste and use of resources objectives.

## 8.11.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

### Conventional Oil and Gas

Recycling rates have risen in recent years in SEA Area 4 and municipal waste generated per person has been dropping since 2007. However, this area of Wales is expected to see the largest growth in population numbers. Landfill capacity as of 2010 in South West Wales stood at circa 20 million cubic meters, or around 9.4 years. There is capacity for non-hazardous stable non reactive hazardous waste in the South West, but not in western or northern Wales. Therefore it can be assumed that although landfill capacity for non hazardous waste to be disposed of in landfill would be met in the short to medium term future, secure long term landfill disposal may depend on additional capacity coming on-

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stream. As in the case for most other SEA regions, hazardous waste may also present issues for existing waste management facilities and significant effects may occur.

Historical resource depletion in this area tends to be associated with opencast coal mining. This has left a legacy on several environmental aspects, including waste and use of resources. The extraction of oil and gas would lead to a continuation of the depletion of a non-renewable natural resource.

### Unconventional Oil and Gas

SEA Area 4 is likely to have large treatment facilities which have the capacity to accept wastewater from unconventional operations. However, the volume of wastewater that would require treatment may place significant burden on treatment works and increase the volume of hazardous waste by-products.

The use of natural resources is not likely to give rise to significant issues which are particularly relevant to SEA Area 4.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 4 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required. Commercially viable VCBM containing formations tend to be shallower (200-1,500m depth) than traditional oil and gas targets and therefore less drilling would be required. This would result in the production of fewer cuttings and other drilling related wastes.

### Gas Storage

Gas Storage in this area is not likely in additional issues other than those identified in table 8.13 with regards to the waste and use of resources objectives.

## 8.11.5 SEA Area 5: Southern and South West England

### Conventional Oil and Gas

The South East Region sends more waste to landfill than any other region of the UK. However, landfill capacity has increased slightly in recent years and as of 2012 was 102,043,000 cubic metre tonnes. In the South West, the proportion of waste sent to landfill over the 10 year period 2000 to 2010 decreased from 82% to 49%. The drop of waste being sent directly to landfill, coupled with measures to improve self-sufficiency in London should erode pressures on landfill capacity in SEA Area 5.

Southern England has the UK's largest onshore oilfield (Wytch Farm). Conventional operations in this area would therefore result in the continuation of the depletion of hydrocarbon resources.

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## Unconventional Oil and Gas

SEA Area 5 includes some of the most densely populated parts of Europe and features large population centres. There are considerable pressures on public infrastructure, including wastewater treatment works. As wastewater from unconventional oil and gas operations will likely require treatment at large facilities, there is a risk that significant burdens would be places on these facilities.

## Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 5 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required. Commercially viable VCBM containing formations tend to be shallower (200-1,500m depth) than traditional oil and gas targets and therefore less drilling would be required. This would result in the production of fewer cuttings and other drilling related wastes.

## Gas Storage

Gas Storage in this area is not likely in additional issues other than those identified in table 8.13 with regards to the waste and use of resources objectives.

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# 9. Cultural Heritage

## 9.1 Introduction

Cultural heritage, including architectural and archaeological heritage, within this context is defined as below-ground and upstanding evidence of past human activity and encompasses artefacts, buried and underwater archaeological sites, earthworks, buildings, battlefields, historic gardens, historic landscapes, wrecks, hedgerows and ancient woodland.

There are links between the cultural heritage topic and other topics in the SEA, specifically landscape and land use (as part of soils and geology).

## 9.2 Review of Plans and Programmes

### 9.2.1 International/European

The ***World Heritage Convention*** aims to promote co-operation amongst nations to protect heritage that is of such outstanding value that its conservation is important for current and future generations; and established a register of World Heritage Sites. It is intended that properties on the World Heritage List will be conserved for all time. Member states commit themselves to ensure the identification, protection, conservation, and presentation of World Heritage properties.

The World Heritage Committee's ***Operational Guidelines for the Implementation of the World Heritage Convention (2008)*** set out: the procedure from the inscription of properties on the World Heritage List and the List of World Heritage in Danger; the protection and conservation of World Heritage properties; the granting of International Assistance under the World Heritage Fund; and the mobilisation of national and international support in favour of the Convention.

The ***UNESCO Convention for the Protection of the Archaeological Heritage of Europe (revised)*** is a Europe-wide international treaty which establishes the basic common principles to be applied in national archaeological heritage policies. It supplements the general provisions of the ***UNESCO World Heritage Convention (1972)*** and aims to protect archaeological heritage as a source of the European collective memory and as an instrument for historical and scientific study. It sets out a framework which requires the member states to:

- maintain an inventory of archaeological heritage and designated protected monuments and areas;
- create archaeological reserves; and
- for finders of any element of archaeological heritage to report and make it available to the competent authority.

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The ***European Convention on the Protection of the Archaeological Heritage (1992)*** made a number of important agreements including setting the definition of archaeological heritage as: "*all remains and objects and any other traces of mankind from past epochs….shall include structures, constructions, groups of buildings, developed sites, moveable objects, monuments of other kinds as well as their context, whether situated on land or under water'"*.

### 9.2.2 UK

The Department for Culture, Media and Sport White Paper ***Heritage Protection for the 21st Century (2007)*** sets out a strategy for protecting the historic environment, based on three core principles: developing a unified approach to the historic environment; maximising opportunities for inclusion and involvement; and supporting sustainable communities by putting the historic environment at the heart of an effective planning system.

At a national level, the draft ***Heritage Protection Bill*** contains provisions to unify the designation and consent regimes for terrestrial heritage assets, and transfer responsibility for designation of these assets. It also contains provisions to reform the marine heritage protection regime in England and Wales by broadening the range of marine historic assets that can be protected. The draft Bill is based on the proposals set out in the White Paper, Heritage Protection for the 21st Century (2007), and is one element of a wider programme of on-going heritage protection reforms. There are however, no current plans to enact the Bill and it is not known whether its provisions will become statute.

The ***Ancient Monuments and Archaeological Areas Act (1979)*** provides for the scheduling of ancient monuments and offers the only legal protection specifically for archaeological sites. The ***Planning (Listed Buildings and Conservation Areas) Act (1990)*** outlines the level of protection received by listed buildings, scheduled monuments and buildings within Conservation Areas.

There are a number of other Acts which afford protection to cultural and historical assets, including the ***Protection of Wrecks Act (1973)***, which provides protection for shipwrecks of historical, archaeological or artistic value; the ***Protection of Military Remains Act (1986)***, which provides protection for the wreckage of military aircraft and designated military vessels, and the ***Treasure Act (1996)***, which sets out procedures for dealing with finds of treasure, its ownership and rewards, in England, Wales and Northern Ireland.

### 9.2.3 England

***The National Planning Policy Statement (NPPF)*** sets out the core land use planning principles that should underpin both plan-making and decision-taking and in doing so expects planning to "*conserve heritage assets in a manner appropriate to their significance, so that they can be enjoyed for their contribution to the quality of life of this and future generations*".

The Framework stipulates (paragraph 126) that Local planning authorities should set out in their Local Plan a positive strategy for the conservation and enjoyment of the historic environment. In addition, it

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provides (paragraph 131) that in determining planning applications, local planning authorities should take account of: the desirability of sustaining and enhancing the significance of heritage assets and putting them to viable uses consistent with their conservation; the positive contribution that conservation of heritage assets can make to sustainable communities and their economic vitality; and the desirability of new development making a positive contribution to local character and distinctiveness.

As heritage assets are irreplaceable, the Framework expects any harm or loss to require clear and convincing justification. Where a proposed development will lead to substantial harm to or total loss of significance of a designated heritage asset, "*local planning authorities should refuse consent, unless it can be demonstrated that the substantial harm or loss is necessary to achieve substantial public benefits that outweigh that harm or loss*", or all of the criteria set out in paragraph 133 (mostly relating to the lack of a viable use) apply.

***Planning Practice Guidance for Onshore Oil and Gas (2013)*** provides advice on the planning issues associated with the extraction of hydrocarbons. It will be kept under review and should be read alongside other planning guidance and the NPPF. The guidance identifies a range of issues that mineral planning authorities may need to address. Those particularly relevant to cultural heritage include archaeological and heritage features.

**English Heritage**, the Government's statutory adviser on the historic environment in England, has published a number of guidance documents for the protection of the historic environment, including ***Climate Change and the Historic Environment (2005)*** and ***Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment (2008)***.

### 9.2.4 Scotland

The ***Natural Heritage (Scotland) Act 1991*** established a body to be known as **Scottish Natural Heritage (SNH)** whose general aims and purposes were to secure the conservation and enhancement of the natural heritage of Scotland and to foster understanding and enjoyment of this heritage.

The ***Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997*** outlines the level of protection received by listed buildings, scheduled monument and buildings within conservation areas in Scotland.

***Scottish Historic Environment Policy (2009)*** sets out Scottish Ministers' policies for the historic environment, including the following key outcomes:

- that the historic environment is cared for, protected and enhanced for the benefit of our own and future generations;
- to secure greater economic benefits from the historic environment; and
- the people of Scotland and visitors to our country value, understand and enjoy the historic environment.

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Following the merger of Historic Scotland and the Royal Commission on the Ancient and Historic Monuments of Scotland, the first-ever overarching strategy for Scotland's historic environment was published for consultation in May 2013[1]. The strategy contains a number of key aims including:

- to ensure that the cultural, social, environmental and economic value of heritage continues to make a major contribution to the nation's wellbeing;
- to investigate and record the historic environment to continually develop knowledge, understanding and interpretation of the past and how best to conserve, sustain and present it;
- to care for and protect the historic environment in order to both enjoy and benefit from it and conserve and enhance it for future benefit of future generations; and
- sharing and celebrating the richness and significance of the historic environment, enabling us to enjoy the fascinating and inspirational diversity of the heritage.

***Scotland's Culture (2006)*** sets out the Scottish Minister's vision for the strategic direction of future cultural policy and identifies key initiatives, legislation, investment and infrastructure changes needed to implement those decisions. The policy aims to provide support nationally for talent and excellence in culture and enable more people to enjoy culture; and to encourage more people to enjoy cultural activities locally by asking local authorities to develop cultural 'entitlements' for their area, to undertake cultural planning.

Policies in ***Scottish Planning Policy (SPP)*** reflect the importance of the historic environment, as a key part of Scotland's cultural heritage, to the Scottish Government's central purpose. With the careful application of policy and sensitive decision making, the historic environment can often be adapted to accommodate new uses, offering opportunities for new and creative design, whilst retaining its special character. In principle, therefore, the aim should be to identify the best viable use that is compatible with the fabric, setting and character of the historic environment.

***Planning Advice Note 42 (PAN42)*** provides advice on the handling of archaeological matters within the planning process and on the separate controls over scheduled monuments under the Ancient Monuments and Archaeological Areas Act 1979. ***Planning Advice Note 71 (PAN71)*** identifies good practice for managing change, sets out a checklist for appraising conservation areas and provides advice on funding and implementation.

### 9.2.5 Wales

***Planning Policy Wales* (2012)** has the following objectives regarding the historic environment:

[1] Scottish Government (2013) The Historic Environment Strategy for Scotland, http://www.scotland.gov.uk/Resource/0042/00421650.pdf

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- to preserve or enhance the historic environment, recognising its contribution to economic vitality and culture, civic pride and the quality of life, and its importance as a resource for future generations; and specifically to;
- to protect archaeological remains, which are a finite and non-renewable resource, part of the historical and cultural identity of Wales, and valuable both for their own sake and for their role in education, leisure and the economy, particularly tourism;
- to ensure that the character of historic buildings is safeguarded from alterations, extensions or demolition that would compromise a building's special architectural and historic interest; and
- to ensure that conservation areas are protected or enhanced, while at the same time remaining alive and prosperous, avoiding unnecessarily detailed controls over businesses.

***Technical Advice Note 12: Design (TAN 12)*** sets out the Assembly Government's policies and objectives in respect of the design of new development, including sustaining or enhancing local character.

## 9.3 Overview of the Baseline

### 9.3.1 UK

The UK has over 459,000 listed buildings, approximately 33,720 scheduled monuments, 2,416 historic parks and gardens, in excess of 10,259 conservation areas and 28 World Heritage Sites.

### 9.3.2 National

#### England

In England there are approximately 374,081 listed building entries, 19,717 scheduled monuments, 1,601 registered historic parks and gardens, 9,080 conservation areas, 43 registered historic battlefields, 46 designated wrecks and 17 World Heritage Sites. Nearly 19,446 sites in England are 'at risk'.

The density of shipwreck remains in the English territorial sea is amongst the highest in the world due to the combined effects of historically high volumes of shipping traffic, a long history of seafaring and an often hazardous coastline [2].

English Heritage has identified the following proportions of heritage sites as at risk within England:

- 3.1% of grade I and II listed buildings;
- 7.4% of conservation areas (from those that were included within the report);

[2] English Heritage, http://www.english-heritage.org.uk/caring/listing/what-can-we-protect/listed-buildings/

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- 17.2% of scheduled monuments;
- 6.1% of registered parks and gardens;
- 14% of registered battlefields; and
- 17% of protected wreck sites[3].

A nationwide survey of conservation areas, conducted by English Heritage and the 75% of England's local planning authorities who responded, indicates that approximately 1 in 7 is at risk from neglect, decay or unsympathetic change[4]. The main threats identified were:

- unsympathetic replacement doors and windows (83% of conservation areas);
- poorly maintained roads and pavements (60%);
- the amount of street clutter (45%);
- loss of boundary walls, fences or hedges (43%);
- unsightly satellite dishes (38%);
- the effects of traffic calming or traffic management (36%);
- alterations to front elevations, roofs and chimneys (34%);
- unsympathetic new extensions (31%);
- the impact of advertisements (23%); and
- neglected green spaces (18%).

## Scotland

In Scotland there are approximately 8,089 scheduled monuments[5], in excess of 47,000 listed buildings[6], in excess of 600 conservation areas, five World Heritage Sites, and more than 275 sites listed in the

[3] English Heritage, 2010, Heritage at Risk Summary, http://www.english-heritage.org.uk/publications/har-2010-summary/
[4] http://www.english-heritage.org.uk/content/publications/publicationsNew/heritage-at-risk/Conservation_Areas_at_Risk/caar-booklet-acc.pdf
[5] Historic Scotland, http://www.historic-scotland.gov.uk/index/ancientmonuments/searchmonuments.htm
[6] Scottish Government, 2010, Land Use Strategy, Strategic Environmental Assessment Screening and Scoping Report, http://www.scotland.gov.uk/Resource/Doc/1051/0095735.pdf

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Inventory of Historic Parks, Gardens and Designed Landscapes. In England, 2,360 sites are currently 'at risk'[7].

### Wales

In Wales there are approximately 4,111 Scheduled Monuments[8], 29,889 listed buildings, 519 conservation areas, three World Heritage Sites, 386 registered parks and gardens, and six designated historic wrecks. There are currently 127 monuments in state care in Wales.

The Historic Landscape Characterisation of Wales has identified 58 areas which are regarded as representing the best examples of the variety of historic landscapes in Wales.

## 9.4 Key Environmental Characteristics of those Areas most likely to be Significantly Affected

### 9.4.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

There are three World Heritage Sites in SEA Area 1 which are designated due to their historic cultural attributes. The Antonine Wall was the most northerly frontier of the Roman army in the years following AD140. The wall was built for 60km, running from Bo'ness to Old Kilpatrick. Forts and fortlets were built along its length to provide accommodation and crossing points.

The Edinburgh New and Old Towns have been designated as they fulfil criteria c (ii) [to exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design] and c (iv) [to be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history]

New Lanark comprises of a small 18th century village where the philanthropist and Utopian idealist Robert Owen moulded a model industrial community in the early 19th Century. It was designated as a WHS in 2001.

**Table 9.1** below records the number of Listed Buildings, Scheduled Monuments and Battlefields in the local authorities which fall within the boundary of SEA Area 1.

[7] The Scottish Civic Trust, 2010, Buildings at Risk: Register for Scotland, http://www.buildingsatrisk.org.uk/BAR/
[8] StatsWales, 2008, State of the Environment Indicator 26 http://www.statswales.wales.gov.uk/TableViewer/document.aspx?ReportId=6001

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**Table 9.1 Cultural Heritage Assets (SEA Area 1)**

| Area | Listed Buildings | Scheduled Monuments | Battlefields |
|---|---|---|---|
| Aberdeenshire* | 3,789 | 553 | 4 |
| Angus | 2,142 | 392 | - |
| Clackmannanshire | 306 | 17 | - |
| Dumfries & Galloway* | 3,409 | 1,019 | - |
| Dundee City | 893 | 14 | - |
| East Dunbartonshire | 181 | 41 | - |
| East Lothian | 1,814 | 290 | 4 |
| East Renfrewshire | 136 | 4 | - |
| Edinburgh | 4,846 | 76 | |
| Falkirk | 353 | 82 | 2 |
| Fife | 4,963 | 257 | 1 |
| Glasgow | 1,847 | 16 | 1 |
| Inverclyde | 246 | 13 | - |
| Midlothian | 714 | 79 | 2 |
| North Lanarkshire | 305 | 28 | 1 |
| Perth & Kinross* | 3,134 | 660 | 4 |
| Renfrewshire | 563 | 18 | - |
| Scottish Borders* | 3,022 | 744 | 2 |
| West Dunbartonshire | 182 | 30 | - |
| West Lothian | 450 | 50 | 1 |
| Stirling* | 1,474 | 192 | 4 |

Note: *only part of this administrative area resides within the SEA area

### 9.4.2 SEA Area 2: West Midlands, North West England and Southern Scotland

There are two World Heritage Sites in SEA Area 2 which are designated due to their historic cultural attributes. Ironbridge Gorge WHS is known throughout the world as the symbol of the Industrial Revolution. The bridge at Ironbridge, the world's first bridge constructed of iron, had a considerable influence on developments in the fields of technology and architecture.

The Liverpool Maritime Mercantile City WHS consists of six areas of the historic centre and docklands of Liverpool that was a pioneer in the development of modern dock technology, transport systems and port management.

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The density and distribution of listed buildings in the West Midlands and the North West of England is illustrated in **Figure 9.1** and **Figure 9.2**.

**Figure 9.1 Density and Distribution of Listed Buildings in the West Midlands**

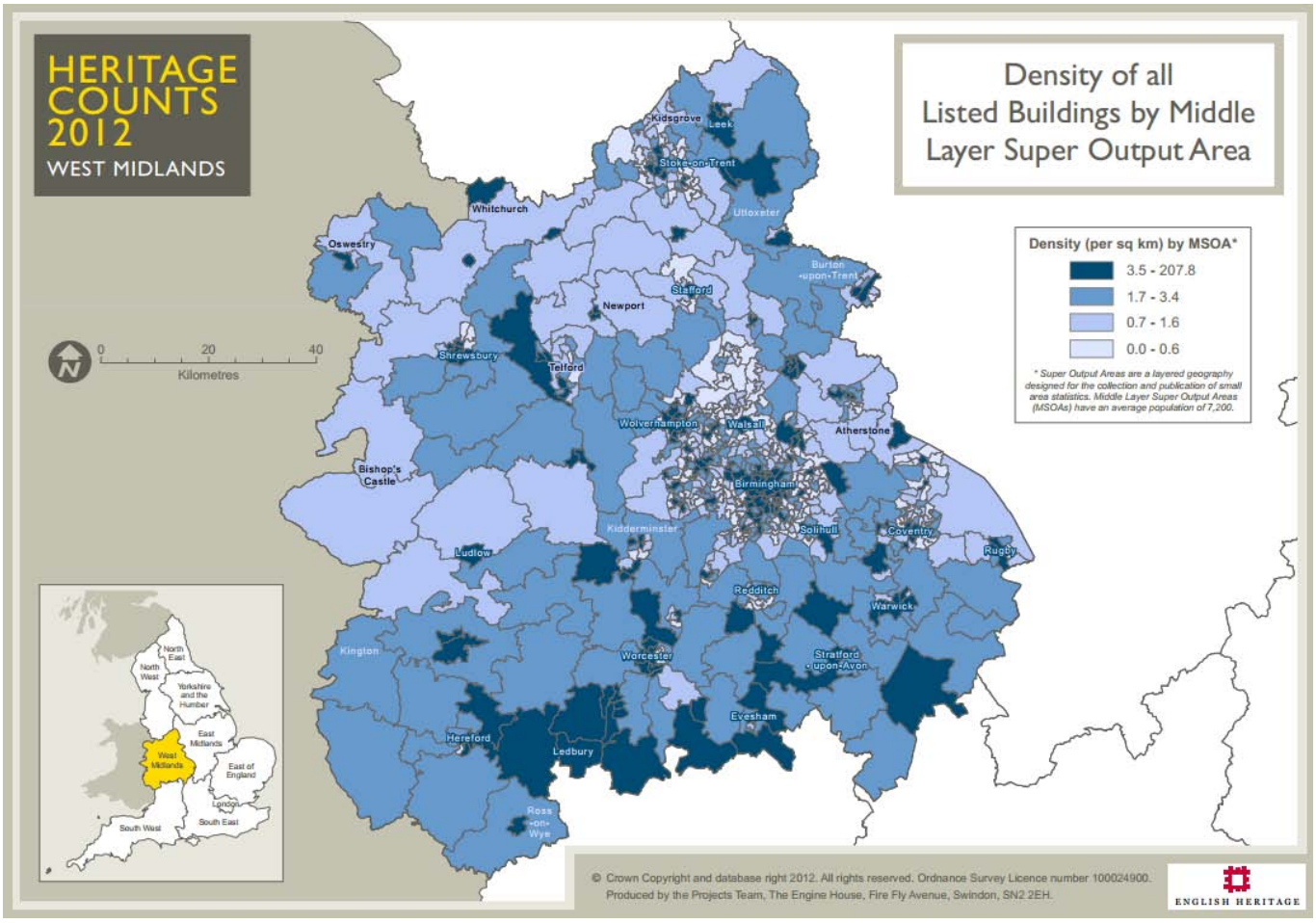
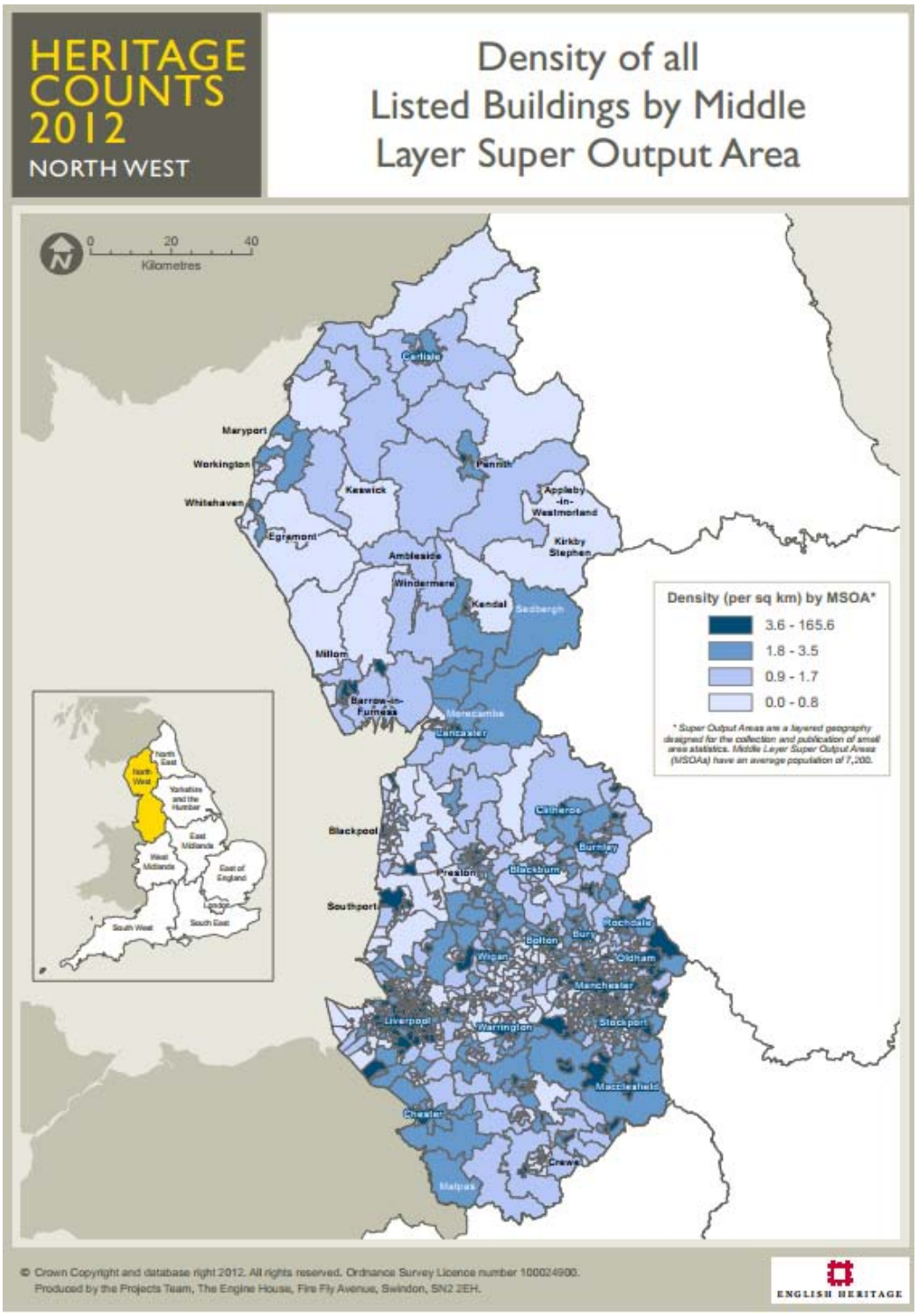


**Figure 9.2 Density and Distribution of Listed Buildings in the North West of England**[9]




[9] Note: *only part of this administrative area resides within the SEA area*

The density and distribution of scheduled monuments in the West Midlands and the North West of England is illustrated in **Figure 9.3** and **Figure 9.4**.

**Figure 9.3 Density and Distribution of Scheduled Monuments in the West Midlands**

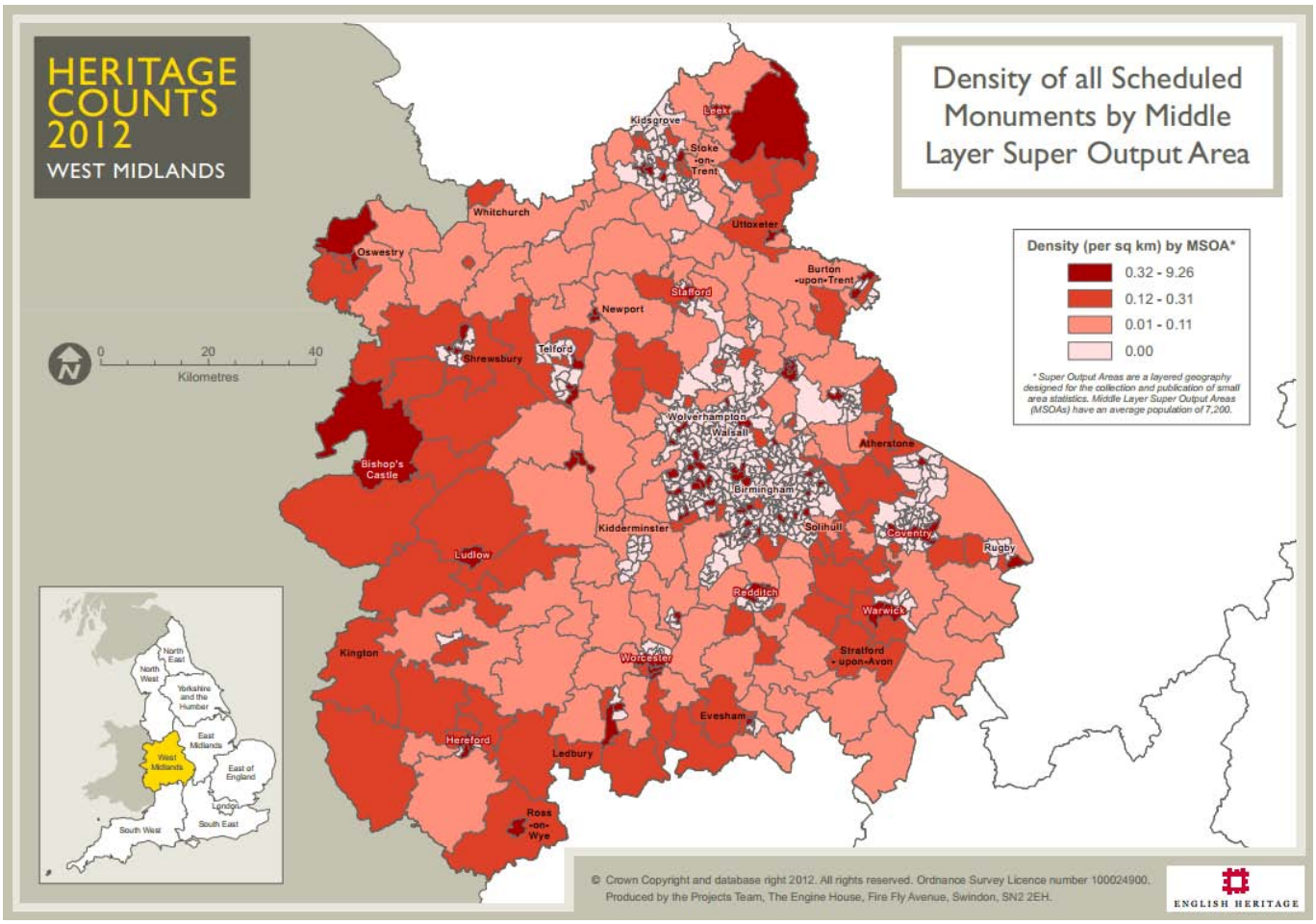
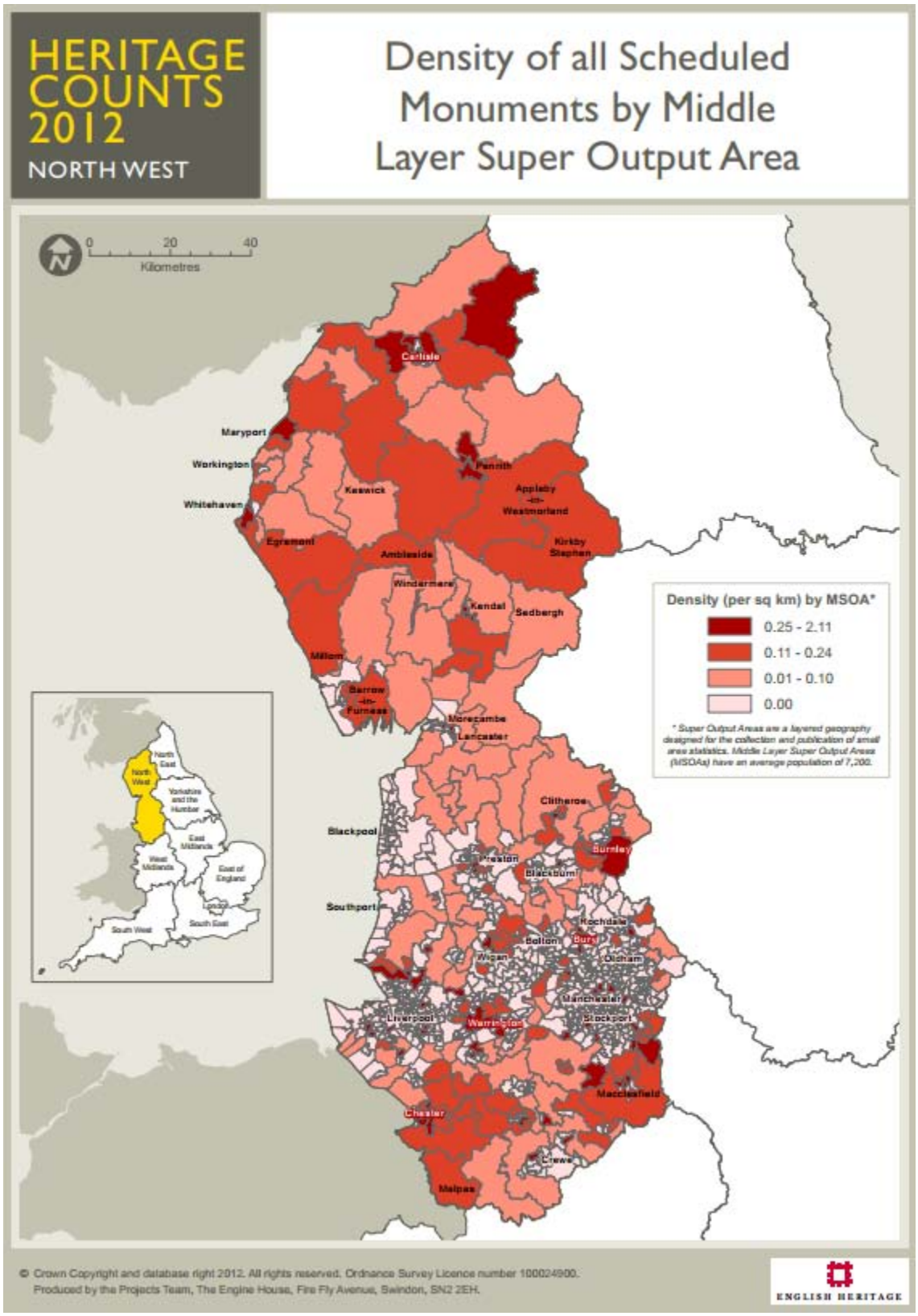


**Figure 9.4 Density and Distribution of Scheduled Monuments in the North West of England**



### 9.4.3 SEA Area 3: East Midlands and Eastern England

There are five World Heritage Sites in SEA Area 3 which are designated due to their historic cultural attributes. Three of these (Hadrian's Wall, Saltaire and Derwent Valley Mills) have been discussed in the landscape baseline for SEA Area 3.

The two remaining are Durham Castle and Cathedral and Studley Royal Park. The latter is a striking landscape that was created around the ruins of the Cistercian Fountains Abbey and Fountains Hall Castle, in Yorkshire. The former was built in the late 11$^{th}$ and early 12$^{th}$ Centuries to house the relics of St Cuthbert (evangelizer of Northumbria) and the Venerable Bede. It is the largest and finest example of Norman architecture in England.

The density and distribution of listed buildings in the East Midlands, the East of England and the North East of England (including Yorkshire and Humber) are illustrated in **Figure 9.5 to 9.8**.

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**Figure 9.5 Density and Distribution of Listed Buildings in the East Midlands**

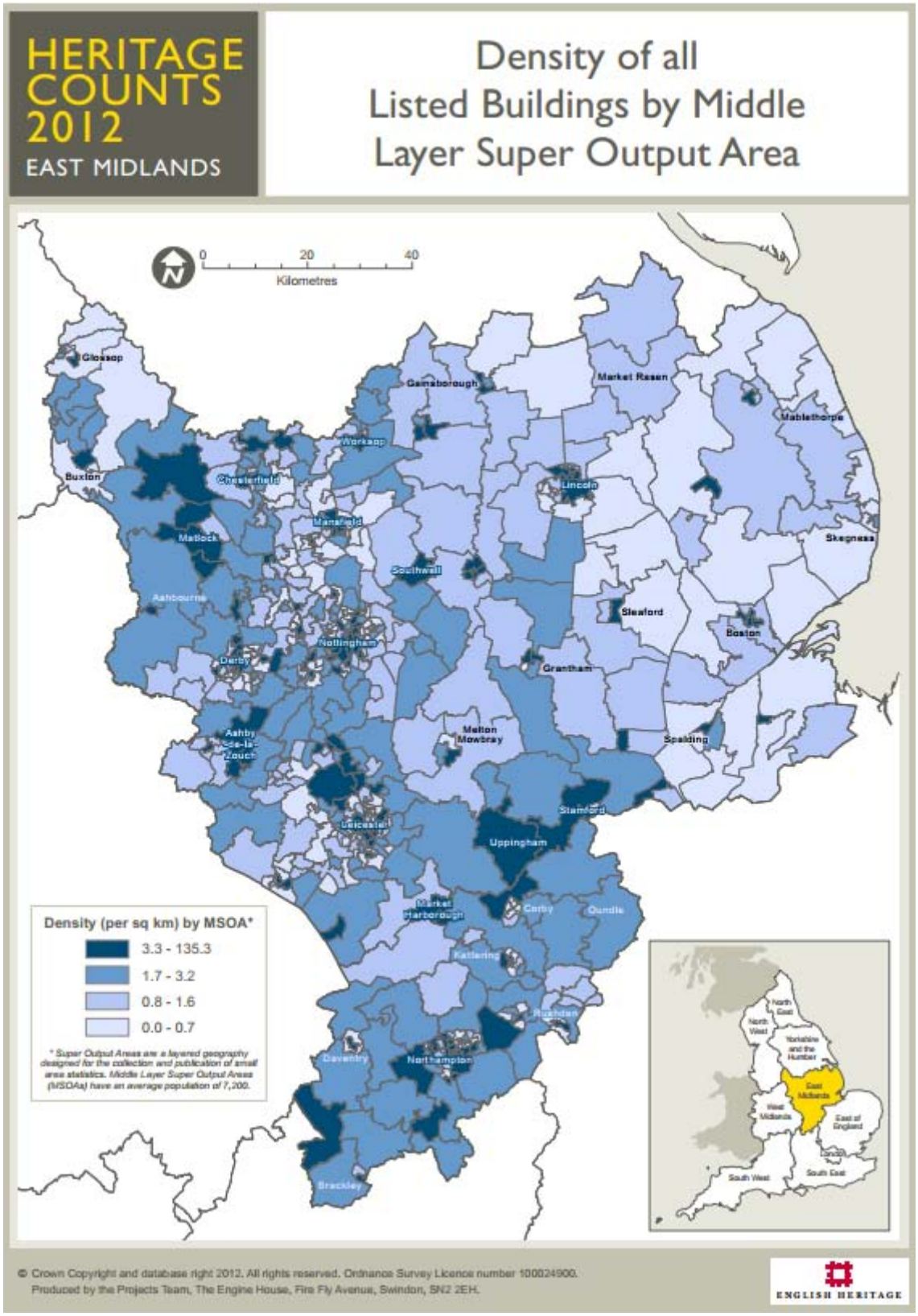
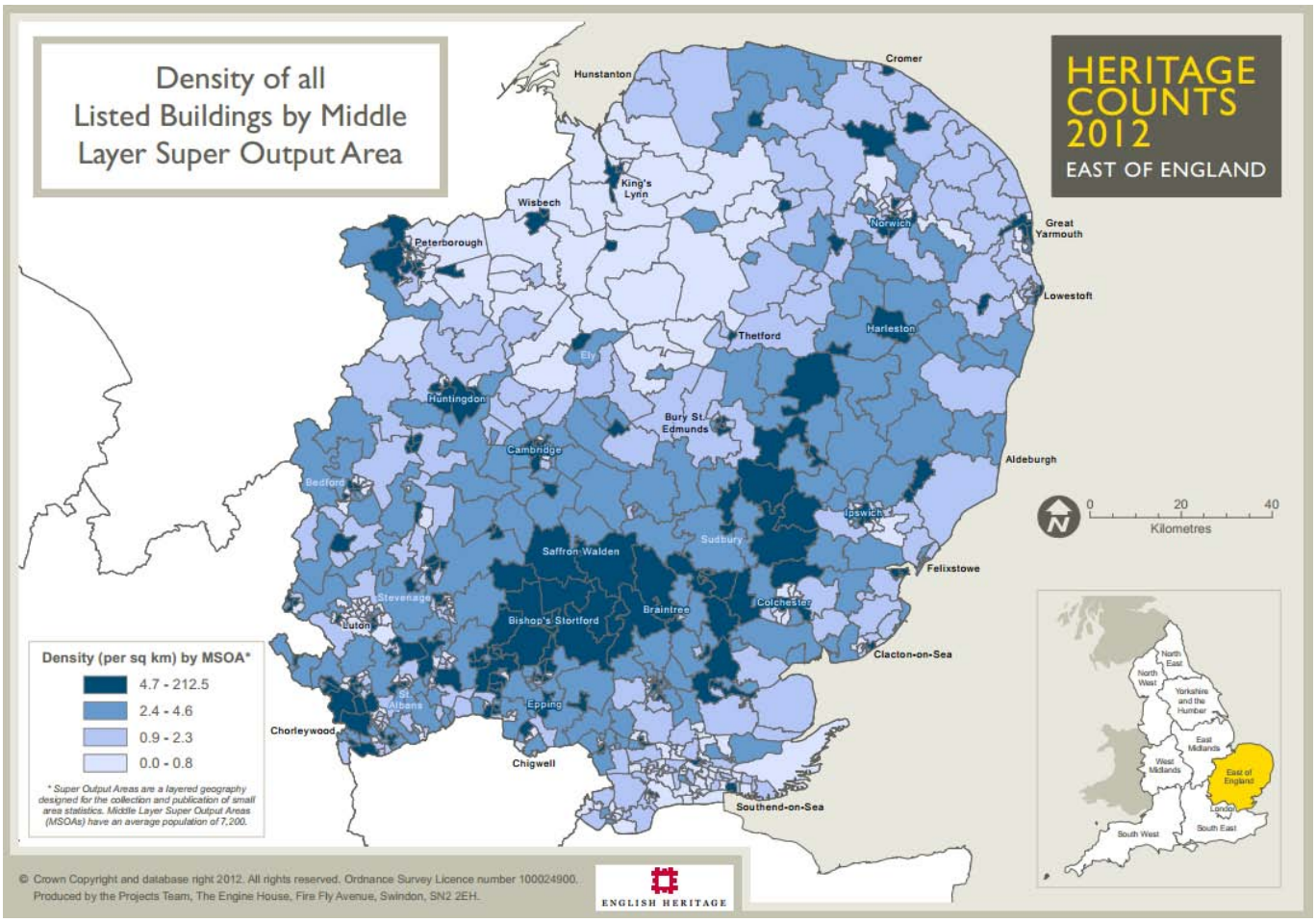


**Figure 9.6 Density and Distribution of Listed Buildings in the East of England**[10]




[10] Note: only part of this administrative area resides within the SEA area

**Figure 9.7 Density and Distribution of Listed Buildings in Yorkshire and the Humber**

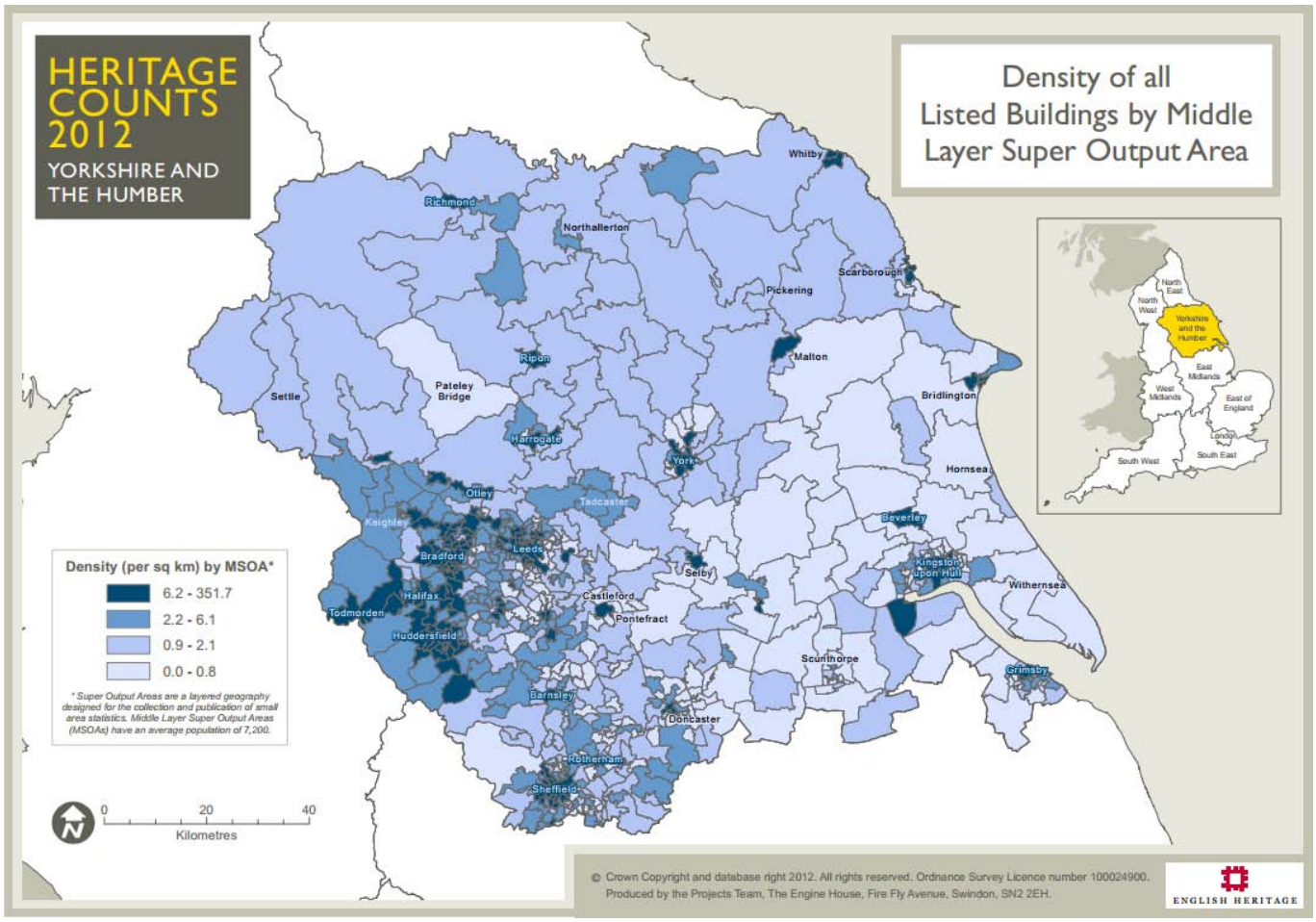
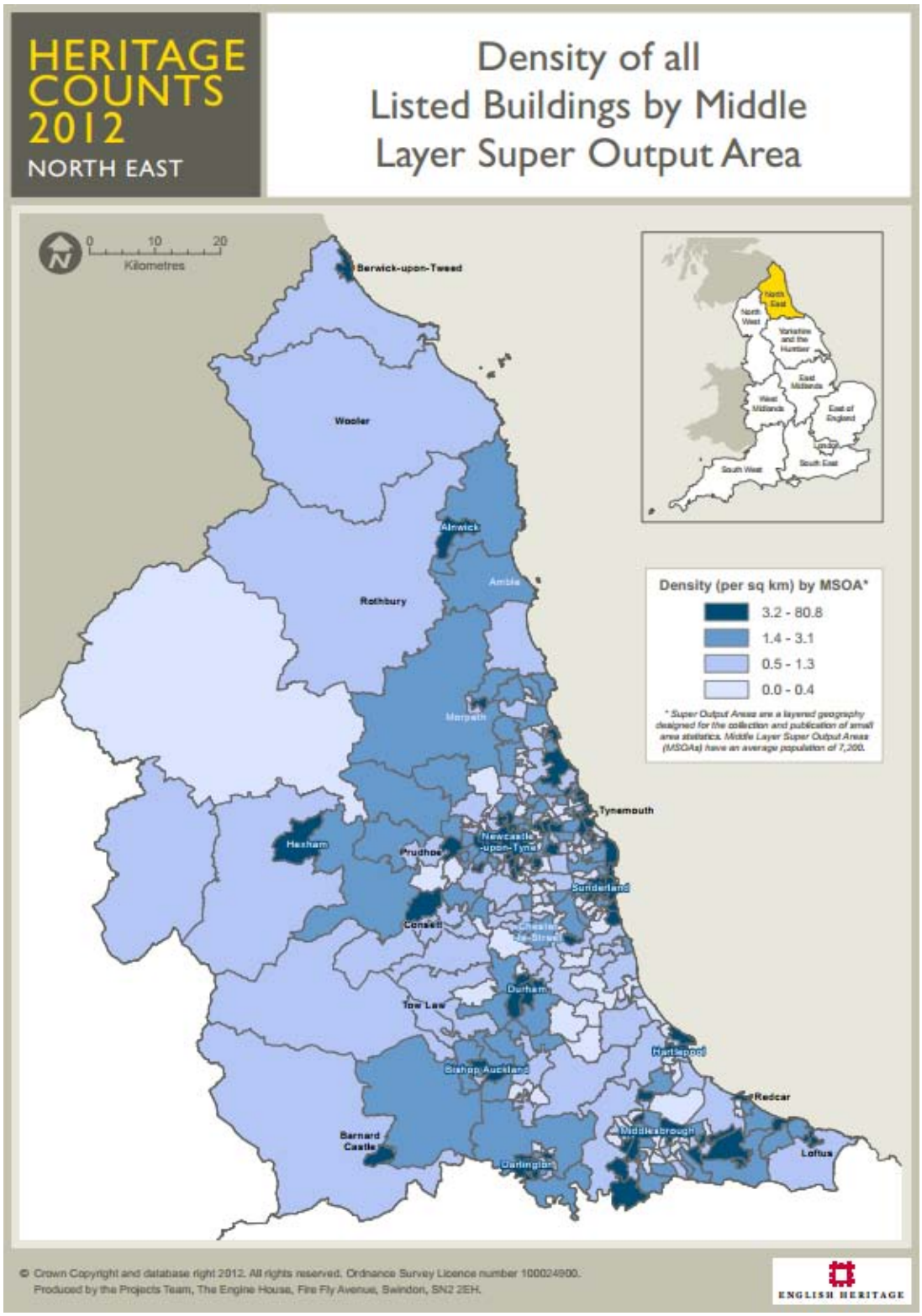


**Figure 9.8 Density and Distribution of Listed Buildings in the North East of England**[11]




[11] Note: only part of this administrative area resides within the SEA area

The density and distribution of scheduled monuments in the East Midlands, the East of England and the North East (including Yorkshire and Humber) are illustrated in **Figures 9.9 to 9.12**.

**Figure 9.9 Density and Distribution of Scheduled Monuments in the East Midlands**

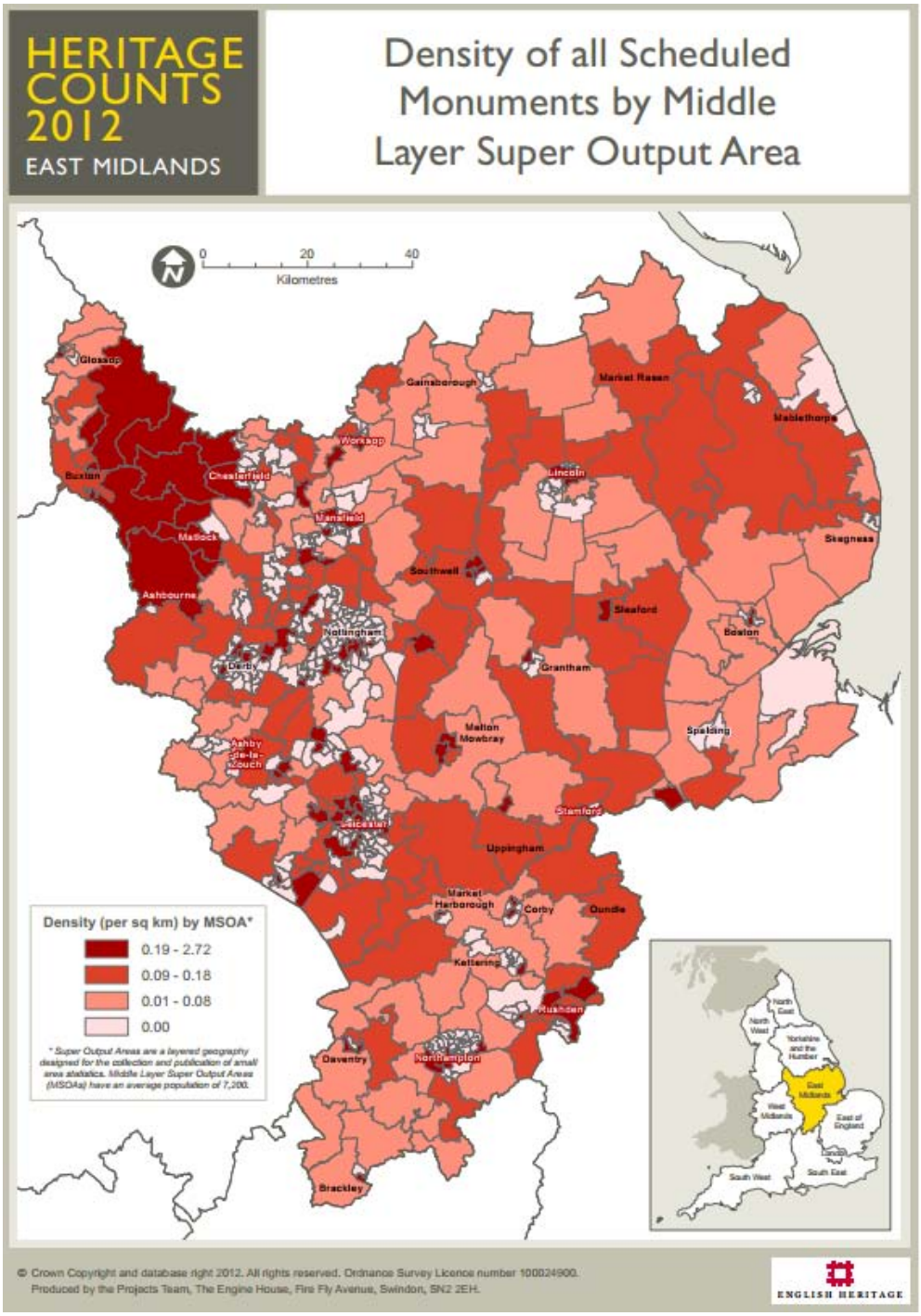


**Figure 9.10 Density and Distribution of Scheduled Monuments in the East of England**

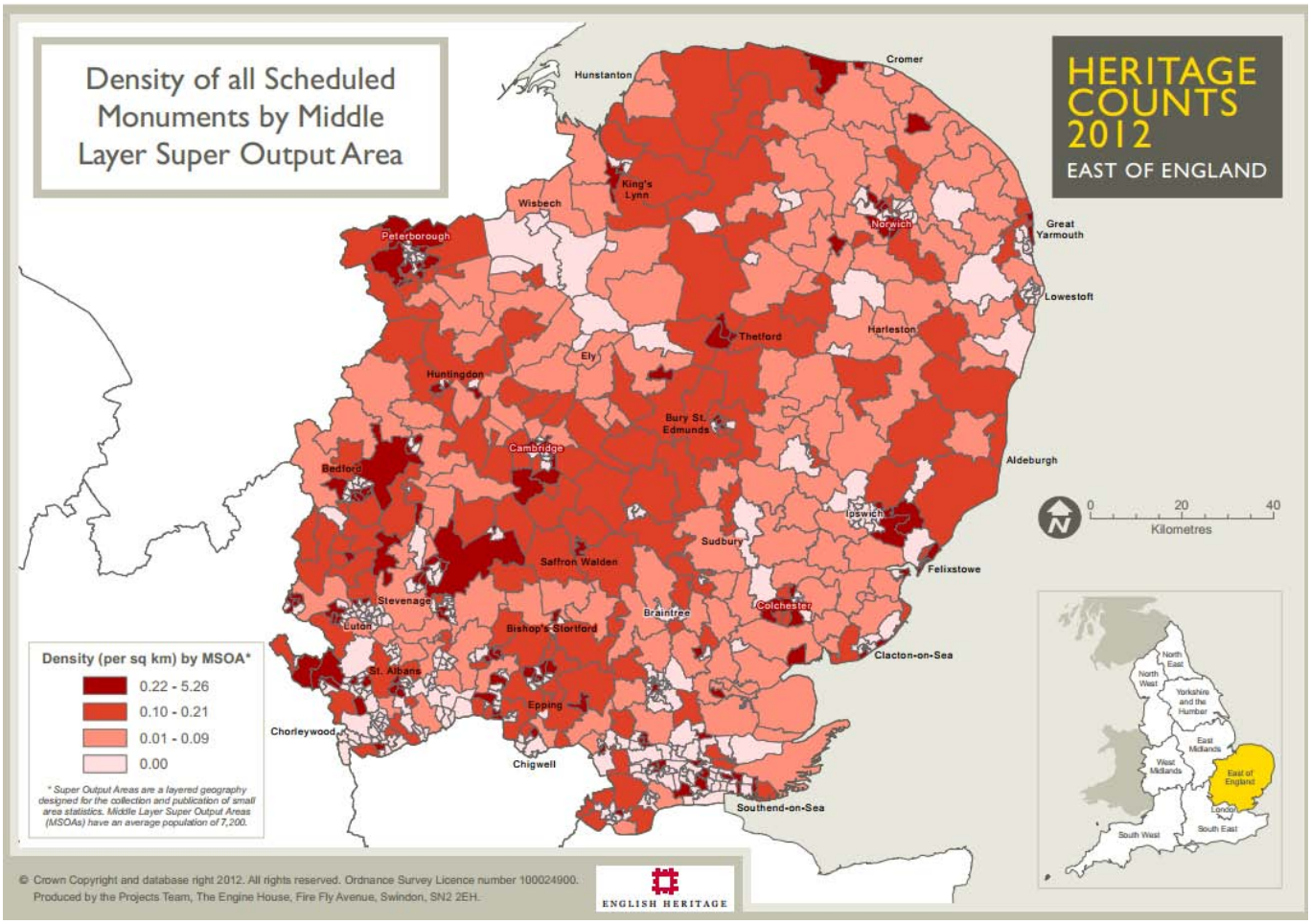


**Figure 9.11 Density and Distribution of Scheduled Monuments in Yorkshire and the Humber**

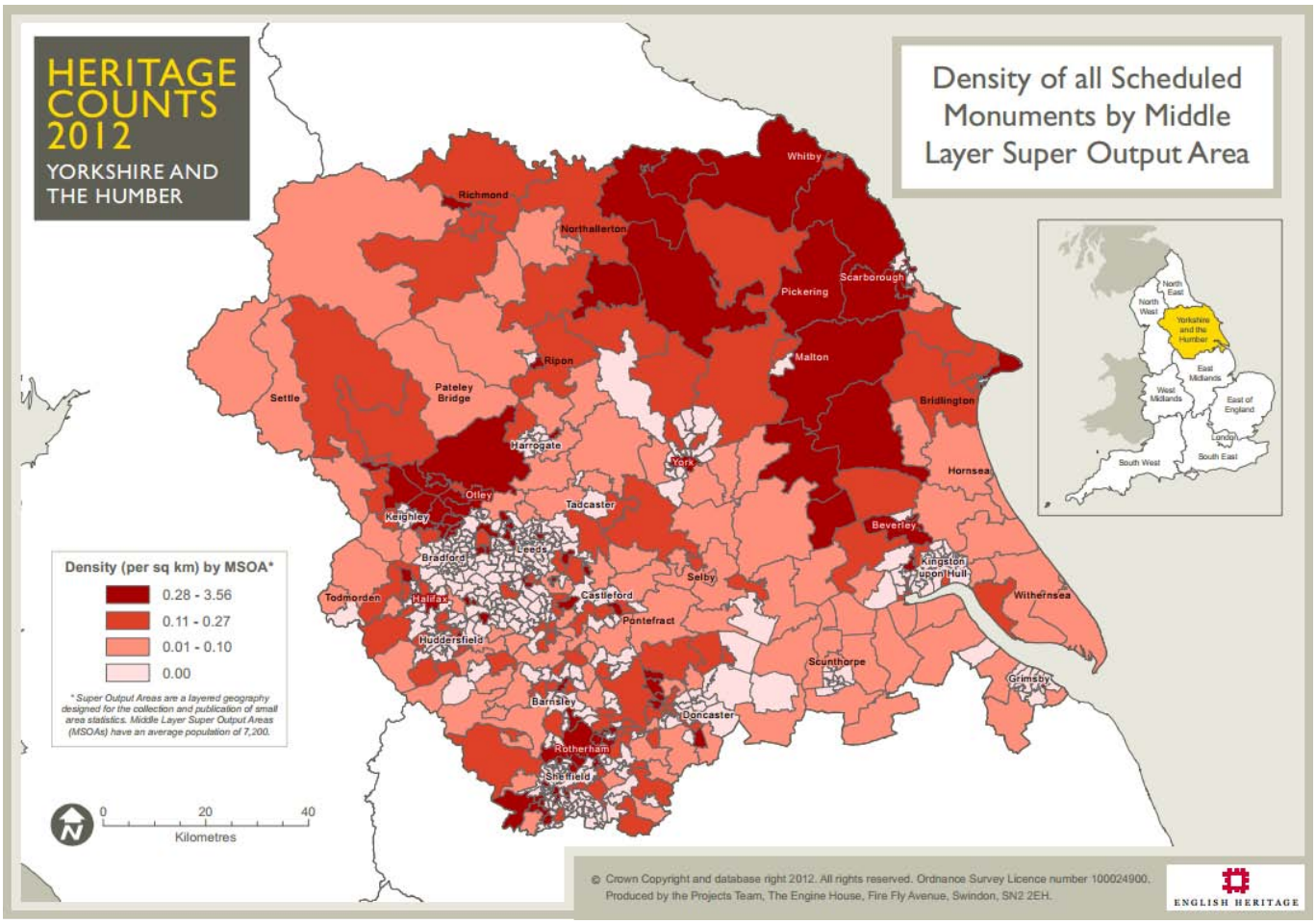
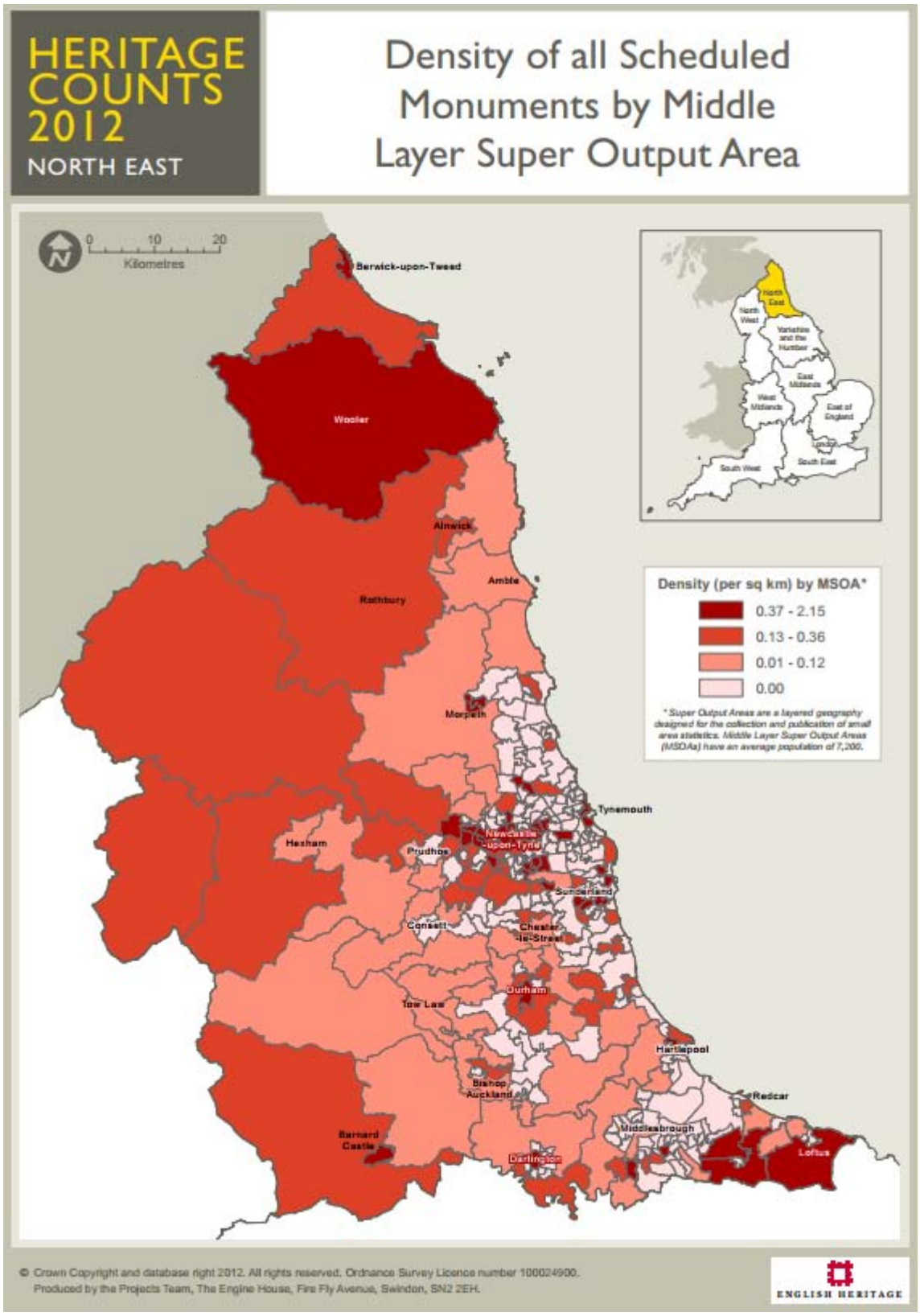


**Figure 9.12 Density and Distribution of Scheduled Monuments in the North East of England**



## 9.4.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

There are two World Heritage Sites in SEA Area 4 which are designated due to their historic cultural attributes. These are the Blaenavon Industrial Landscape in South Wales and the Pontcysyllte Aqueduct and Canal in the north east of Wales.

There are approximately 1,500 Scheduled Monuments and 184 Parks and Gardens of Special Historic Interest in SEA Area 4.

**Figure 9.13** outlines the spatial distribution of scheduled monuments in Wales.

**Figure 9.13 Distribution of Scheduled Monuments in the Wales**

Of the 58 landscapes identified in the Historic Landscape Characterisation of Wales, 13 are located within SEA Area 4 (see **Figure 9.14** below).

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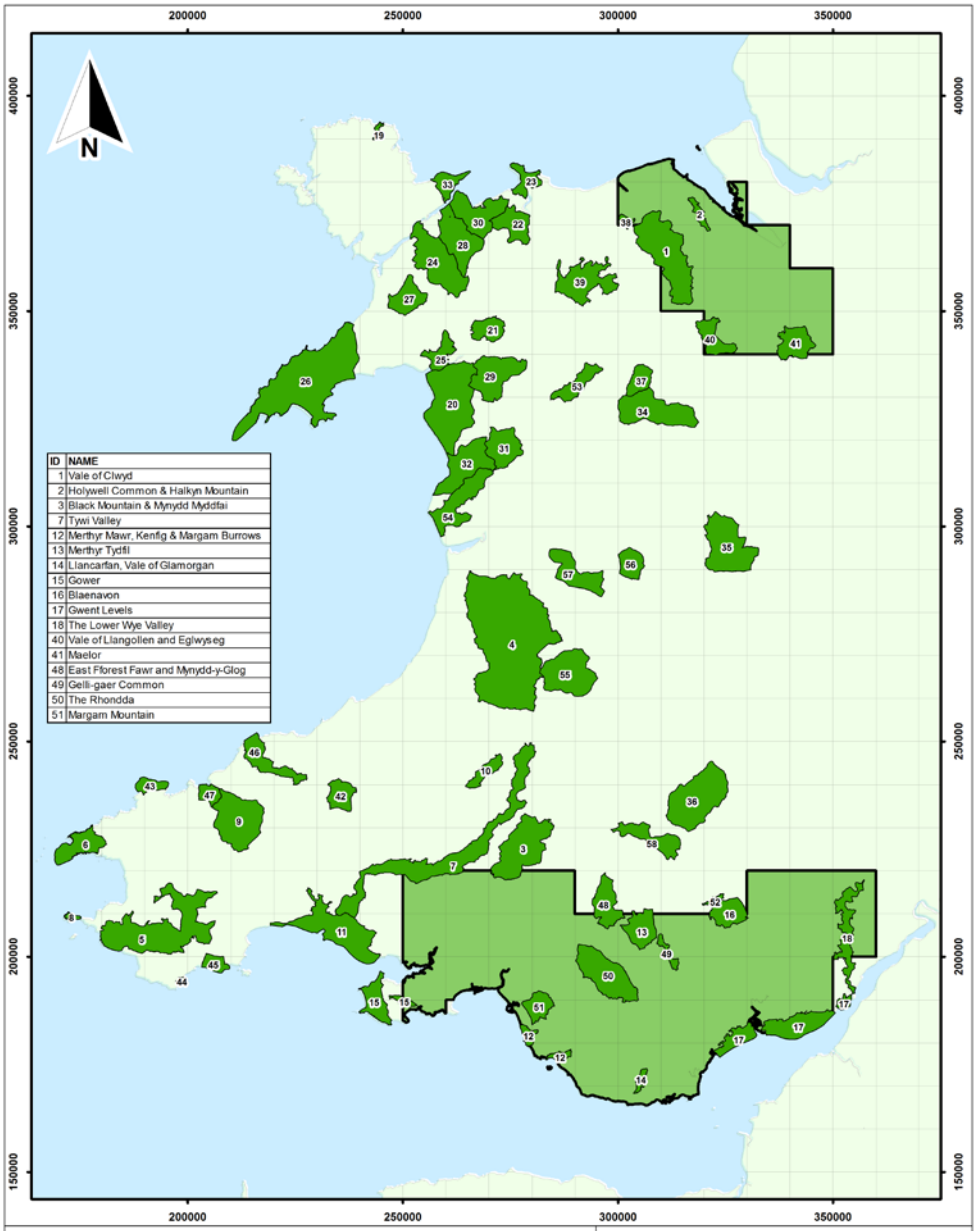
**Figure 9.14 Landscapes on the Register of Landscapes of Outstanding Historic Interest, or Special Historic Interest in Wales**




**Key**

**SEA Areas**

North and South Wales (SEA Area 4)

Historic Landscape Areas

0 10 20 30 km

Scale: 1:1,250,000 @ A4

\Projects\33917 SEA of Onshore Licensing\5 Design\Drawings\GIS\33917-Lea17.mxd

SEA of Onshore Licensing Plan

**Figure 9.14**
**Landscapes on the Register of Landscapes of Outstanding Historic Interest, or Special Historic Interest in Wales**

June 2013
33917-Lea17 browj

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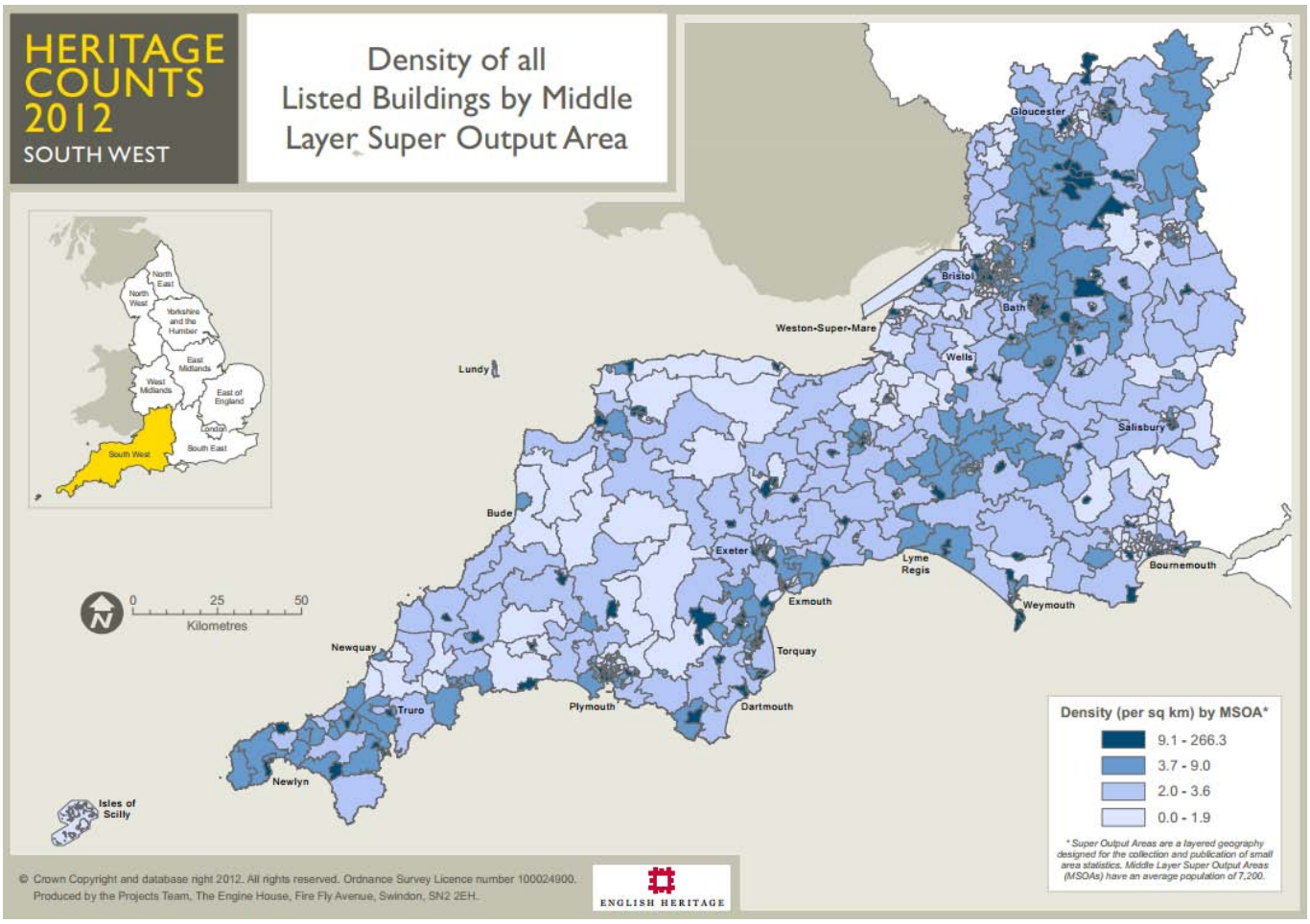
## 9.4.5 SEA Area 5: Southern and South West England

There are seven World Heritage Sites in SEA Area 5 which are designated due to their historic cultural attributes. These have been discussed in more detail in the landscape baseline section.

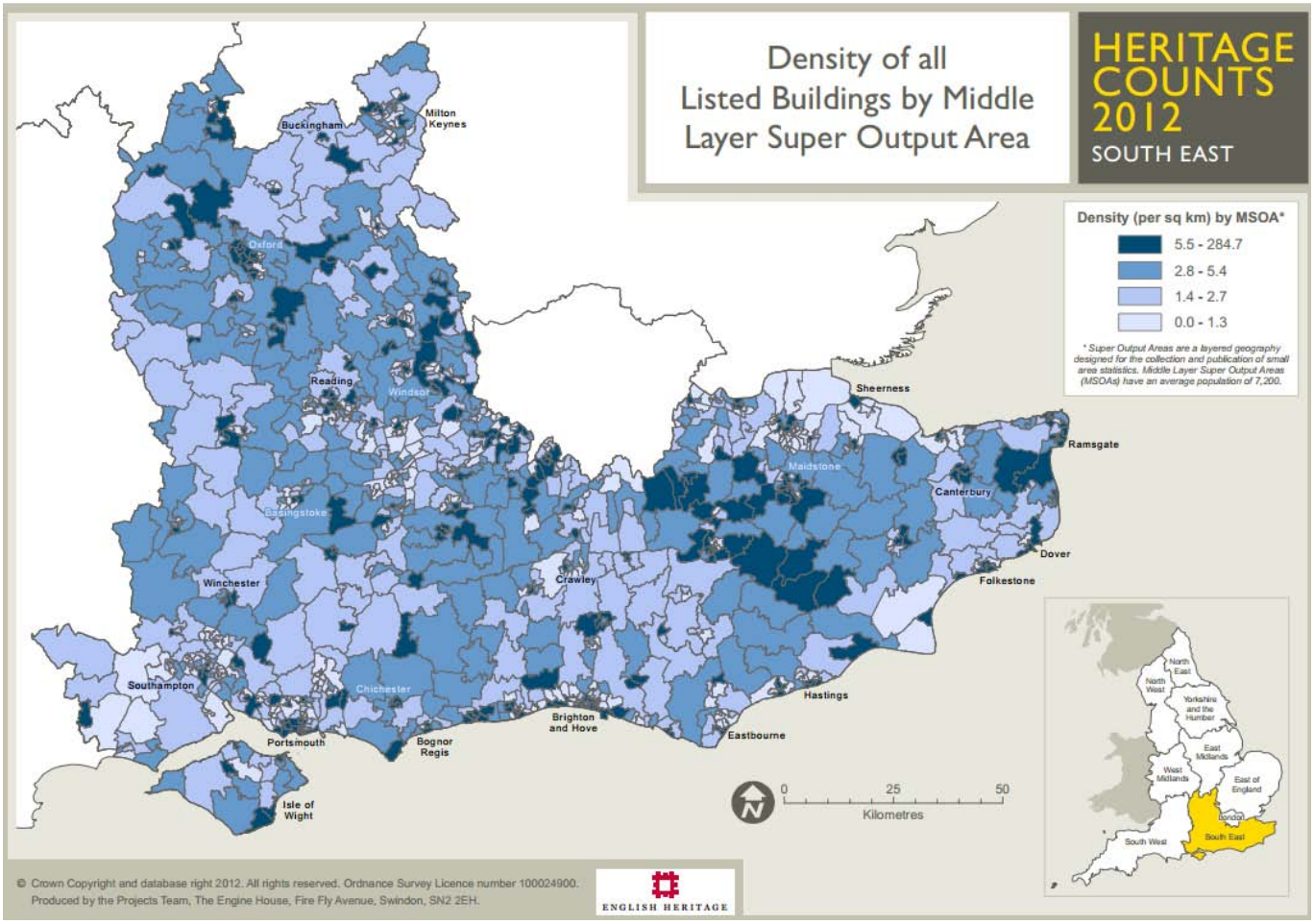
The density and distribution of listed buildings in the South West and the South East of England is illustrated in **Figure 9.14** and **Figure 9.15**.

**Figure 9.14 Density and Distribution of Listed Buildings in the South West** [12]




[12] *Note: only part of this administrative area resides within the SEA area*

**Figure 9.15 Density and Distribution of Listed Buildings in the South East**




The density and distribution of scheduled monuments in the South West and the South East of England is illustrated in **Figure 9.16** and **Figure 9.17**.

**Figure 9.16 Density and Distribution of Scheduled Monuments in the South West**

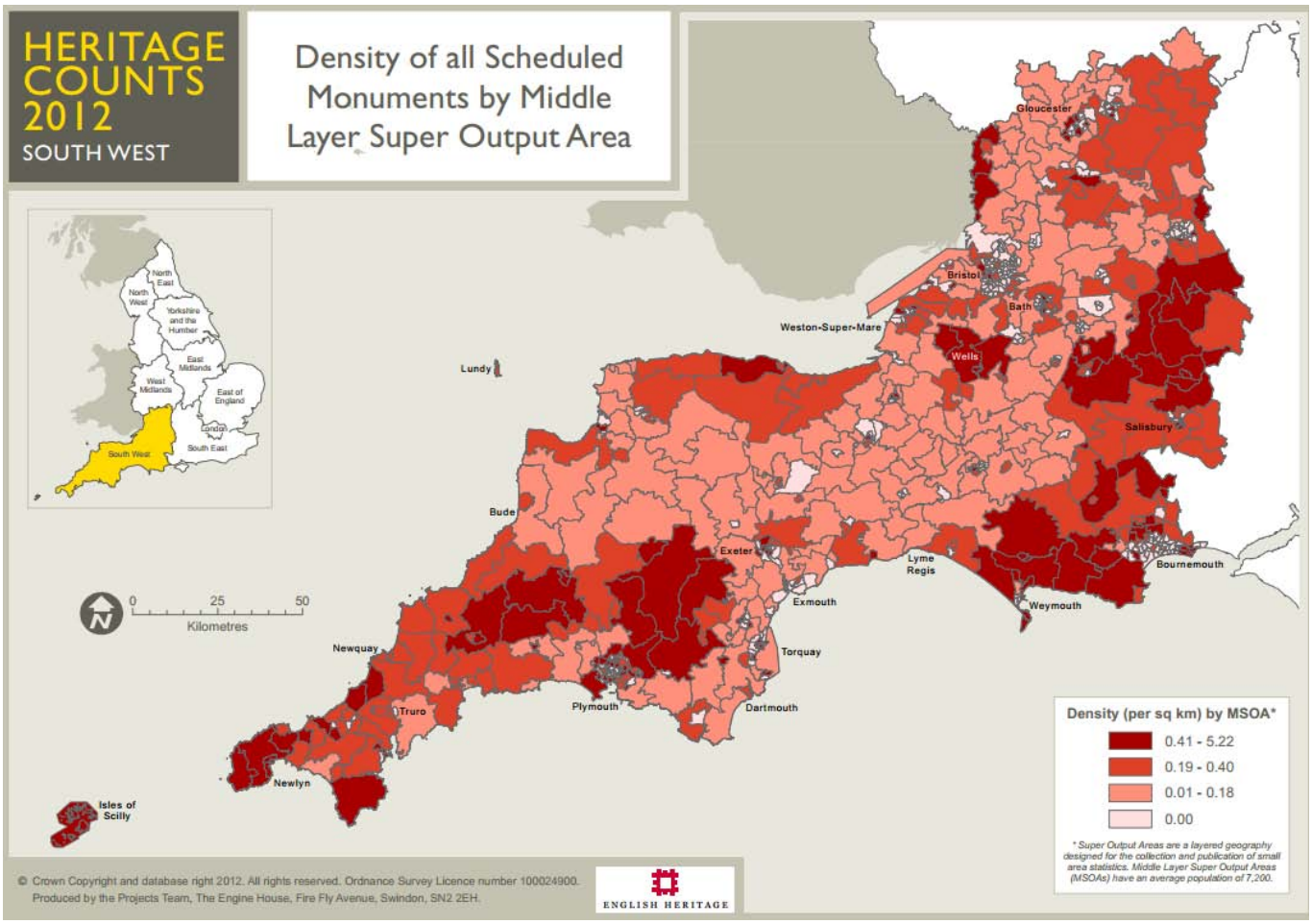
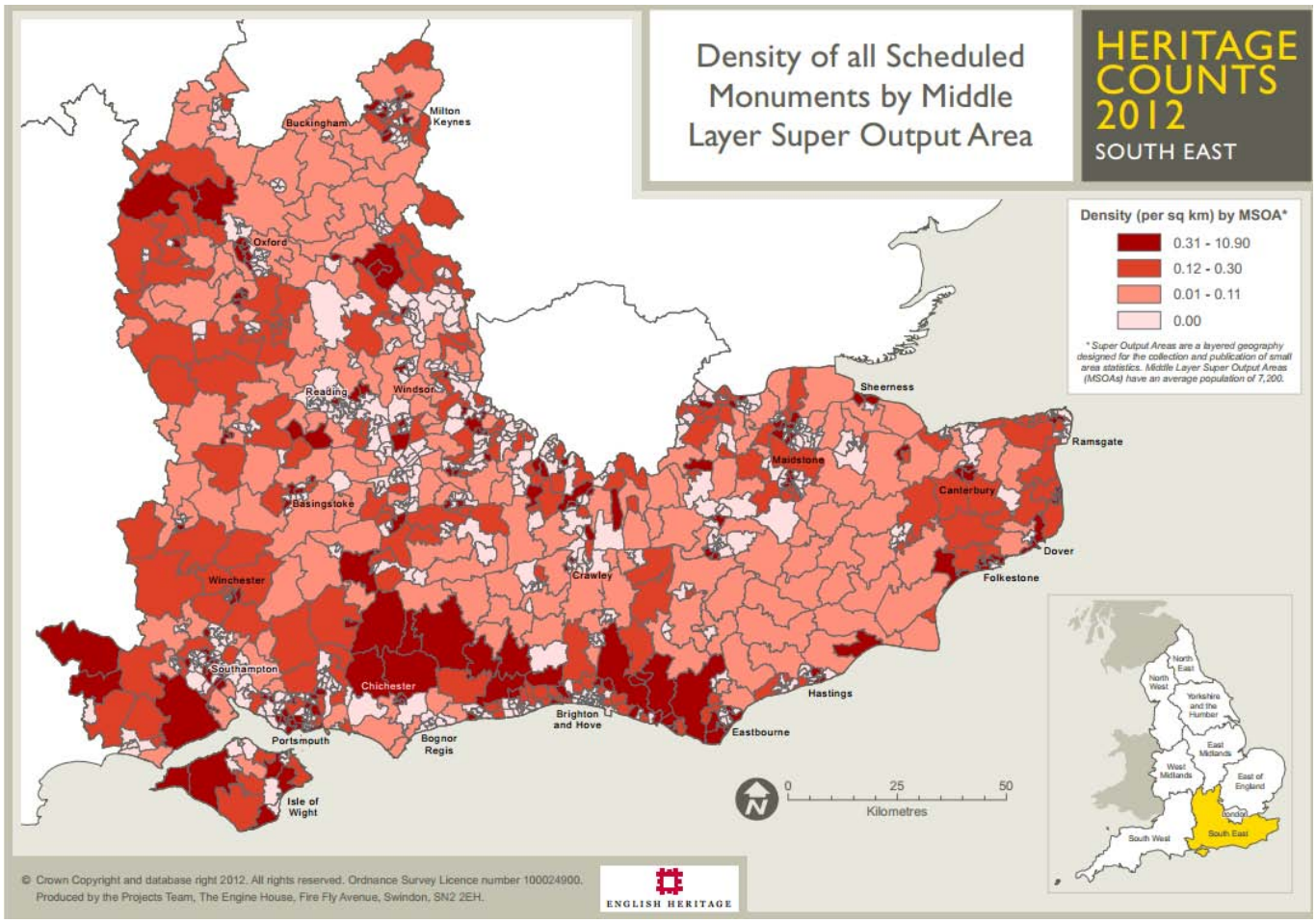


**Figure 9.17 Density and Distribution of Scheduled Monuments in the South East**[13]




## 9.5 Summary of Existing Problems Relevant to Onshore Oil and Gas Licensing

The following existing problems for cultural heritage have been identified:

- Scheduled Monuments in rural areas at risk from intensive grazing practices and unrestricted plant, scrub or tree growth;
- Challenging economic conditions are reducing the funds available to conserve and manage heritage assets; and
- The settings of heritage assets is at risk from new development.

[13] *Note: only part of this administrative area resides within the SEA area*

## 9.6 Likely Evolution of the Baseline

### 9.6.1 England

From 2000 to 2007 there was a steady decrease in the number of buildings identified at risk. This trend was interrupted in 2007 as there was a rise in the number of entries on the Buildings at Risk Register. The 2012 Heritage at Risk National Summary Report[14] identifies some positive trends, such as:

- Buildings at risk: 85 entries have been removed from the 2011 Register because their futures have been secured, but another 66 have been added;
- Scheduled Monuments: 157 scheduled monuments have been removed from the 2011 Register for positive reasons;
- Registered Parks and Gardens: five sites have been removed from the 2011 Register and one site has been added;
- Protected Wrecks: four sites have been removed from the 2011 Register, and one site has been added. Of the 10 sites on the 2008 baseline, nine have been removed; and
- Conservation Areas: 97 (17.7%) of sites have been removed from the 2010 Register for positive reasons.

### 9.6.2 Scotland

Despite the difficult economic climate, there was a reduction in the percentage of A-listed entries on the Buildings at Risk Register from 8.7% in 2009 to 8.2% in 2011 [15]. Almost 40% of all A-listed entries were in the 'Critical' or 'High' category of risk which suggests that a high proportion of these buildings are in such a condition that unless remedial action is carried out the building's condition will sharply deteriorate.

### 9.6.3 Wales

In Wales there has been a small increase in the number of listed buildings (29,866 to 29,889), scheduled monuments (3,909 to 4,111) and conservation areas (511 to 519) between 2006 and 2008. A 2008 report for Cadw found that for a sample percentage of listed buildings in Wales between 2007 and 2008, those classed as 'at risk' fell slightly from 10.2% to 9.6% ; those classed as 'vulnerable' fell slightly from 17.5% to 17.3%; and those classed as 'not at risk' increased slightly from 72.4% to 73.2%[16].

[14] English Heritage (2012) Heritage at Risk 2012 National Summary Leaflet
[15] Historic Scotland (2011) Buildings at Risk Register (BARR): survey of A-Listed entries in Scotland National Report 2011 (http://www.historic-scotland.gov.uk/barrnationalreport2011.pdf)
[16] StatsWales, 2008, State of the Environment Indicator 26
http://www.statswales.wales.gov.uk/TableViewer/document.aspx?ReportId=6001

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## 9.6.4 SEA Areas

### SEA Area 1: Scottish Midlands (including the Inner Forth)

No trend data for this area has been identified. The Glasgow and Clyde Valley Strategic Development Planning Authority note that although there are no significant trends in terms of the loss on built heritage, it is a reasonable assumption to assume that away from the main historic monuments, there will be a loss of historic sites to development and a damaging of the setting of others.

### SEA Area 2: West Midlands, North West England and Southern Scotland

The types of historic buildings that are most at risk on a national level are defence (15%), agriculture (8%) and manufacturing industry (13%). These types of buildings would be expected to feature in SEA Area 2. The 2012 Heritage at Risk Report for the West Midlands identified a steady increase in the proportion of buildings that are capable of beneficial re-use but have become redundant due to the economic climate. This trend is likely to be reflected in North West region also.

In rural areas of the West Midlands, the greatest threat to scheduled monuments is from arable cultivation. However, almost half of all scheduled monuments in the North West are at risk from unrestricted plant, scrub and tree growth.

### SEA Area 3: East Midlands and Eastern England

In common with SEA Area 2, the greatest threat to scheduled monuments in SEA Area 3 is arable cultivation in the southern part of this area (70% in the East of England and 78% in the East Midlands) but this risk factor decreases to only 10% in the North East.

Over the past five years, the percentage of Grade I and Grade II* Listed Buildings at risk has fallen from 7.4% to 6.1%. However, at 6.1% (compared to the national average of 3.0%), the North East still has the biggest percentage of its Grade I and II* buildings at risk.

### SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

Approximately 9.6% of Listed Buildings are at risk in Wales. Regional figures from ‘North East Wales’ and ‘South East Wales’ (9.93% and 8.65% respectively) suggest that the number of buildings at risk in SEA Area 4 is consistent with trends in Wales overall.

Only 1.3% of Listed Buildings in South East Wales are in a ‘Very bad’ condition but this proportion is roughly doubled in the North East (2.3%). Figures from Cadw also illustrate that a higher amount of Listed Buildings are vacant in the North East (4.6%), than in the South East (3.6) and Wales overall (4.4%).

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### SEA Area 5: Southern and South West England

New development is likely to be focused in existing urban areas and although this will relieve pressure on historic assets in the countryside (in particular stately homes and historic parks in the arc around London), it will place additional pressure on the historic core of some of the region's towns and cities.

The South East has a much lower percentage of Grade I and II* Listed Buildings at risk, only 1.7% compared to 3.0% nationally. This is likely due to housing shortages in the region which promote the use of existing buildings.

There is a higher percentage of scheduled monuments at risk in the South West (20%) than compared to the national figure (15%).

## 9.7 Assessing Significance

The objectives and guide questions related to cultural heritage which have been identified for use in the appraisal of the effects of Licensing Plan proposals are set out in **Table 9.2,** together with reasons for their selection.

**Table 9.2 Approach to Assessing the Effects of the Licensing Plan on Cultural Heritage**

| Objective/Guide Question | Reasoning |
|---|---|
| **Objective: Protect and where appropriate enhance the historic environment including cultural heritage resources, historic buildings and archaeological features.** | The SEA Directive requires that the likely significant effects on cultural heritage including architectural and archaeological heritage should be taken into account in the Environmental Report. |
| Will the Licensing Plan proposals affect designated or locally-important archaeological features? | A number of legislative provisions require the protection of sites designated for archaeological or cultural heritage importance including Ancient Monuments and Archaeological Areas Act and Planning (Listed Buildings and Conservation Areas) Act. |
| Will the Licensing Plan proposals affect the fabric and setting of historic buildings, places or spaces that contribute to local distinctiveness, character and appearances? | NPPF, SPP and PPW all require the protection of the most important components of historic landscapes and encourage development that is consistent with maintaining its overall historic character. |

**Table 9.3** sets out guidance that will be utilised during the assessment to help determine the relative significance of potential effects on the cultural heritage objective. It should not be viewed as definitive or prescriptive; merely illustrative of the factors that may be considered as part of the assessment process.

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**Table 9.3 Illustrative Guidance for the Assessment of Significance for Cultural Heritage**

| Effect | Description | Illustrative Guidance |
|---|---|---|
| ++ | Significant Positive | • Option would make a significant positive and long-term contribution to the setting and conservation of designated and locally important cultural heritage features (e.g. – through enhancement of setting, permanent removal of a structure creating a negative visual impact, large scale enhancement of designated features). |
| + | Minor Positive | • Option would bring minor short-term improvements to the setting and conservation of designated cultural heritage features (e.g. - temporary removal of structure creating a negative visual impact). |
| 0 | Neutral | • Option would not have any significant effects on any cultural heritage sites or assets. |
| - | Minor Negative | • Option would bring minor short-term degradation to the setting and conservation of designated cultural heritage features (e.g. – temporary use of equipment/structures creating a negative visual impact). |
| -- | Significant Negative | • Option would cause long-term degradation to the setting and conservation of designated and locally important cultural heritage features (e.g. – through direct and permanent loss or damage to designated sites, introduction of a structure that will have a considerable and permanent negative visual impact). |
| ? | Uncertain | • From the level of information available the effects the impact that the option would have on this objective is uncertain. |

## 9.8 Assessment of Effects

This section comprises the assessment of the potential activities that could follow on from the licensing round on the cultural heritage objective. There are a total of six main stages of oil and gas exploration and production (including gas storage) that are the subject of the assessment. These are highlighted in **Table 9.4** for both conventional and unconventional oil and gas together with an overview of the associated key activities at each stage. Please note that Stages 1, 2 and 4 do not necessarily apply to gas storage, depending on the history of the particular site.

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**Table 9.4 Oil and Gas Exploration and Production Lifecycle and Key Activities**

| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| 1. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. |
| 2. | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring.* | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. |
| 3. | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring* | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. |
| 4. | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring.* | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. |
| 5. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. |
| 6. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. |

Note: Exploration wells most usually move from Stage 2 to Stage 5, though some may be used for long-term production testing (which would require new consents including planning permission) and some may be retained and their sites redeveloped as a production project (this would also require new consents including planning permission). For the purposes of this assessment, the appraisal stage (a term commonly used in industry) spans Stages 2 and 3.

*Conventional oil and gas exploration and production activities (stages 2 to 4 above) can occasionally include hydraulic fracturing. However, the need to undertake hydraulic fracturing is relatively uncommon and has therefore not been considered in the assessment of conventional oil and gas activities as part of this SEA.

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### 9.8.1 Conventional Oil and Gas

The assessment of the six main stages of conventional oil and gas production is contained in **Table 9.5**. The first two columns describe the exploration and production stage. The third and fourth columns summarise the expected effects on the cultural heritage objective for both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report). The rationale for this relationship is explained in more detail in the final column and includes:

- the nature and scale of the potential effects on the cultural heritage objective;
- when the effect could occur (timing) and its degree of permanence;
- what mitigation measures might be appropriate for potentially significant negative effects on the cultural heritage objective;
- what options there are to enhance positive effects; and
- assumptions and uncertainties that underpin the assessment.

**Table 9.5 Assessment of Effects: Conventional Oil and Gas**

| **Objective 11: Cultural Heritage** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0/?** | **0/?** | **Assessment of Effects:**<br>Stage 1 of the oil and gas exploration and production lifecycle would comprise non-intrusive activities. Site identification, selection and characterisation and the securing of development and operation permits would be expected to be largely desk-based and in consequence, no significant effects on cultural heritage would be anticipated from these activities.<br>However, there potentially could be disturbance effects associated with seismic testing, such as on fragile above or below ground buildings and artefacts. However, the potential impacts of these activities on cultural heritage assets remains untested and therefore has uncertain impacts in the short or longer term.<br>Vibroseis is the most common method of seismic survey and typically involves 3-5 large vibrator units which sub-sonically vibrate the ground while a number of support vehicles record the returning shock waves for analysis. As highlighted in the 2010 Environmental Report[17], surveys tend to be spatially restricted due to the requirement for roads or other hard surfaces accessible by vehicle. Where roads have to be constructed to facilitate access to sites, any adverse effects would be temporary with land restored following completion of the surveys. |

[17] DECC (2010) *Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds: Environmental Report*

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| Objective 11: Cultural Heritage | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Where shot-hole techniques are utilised (which involve the use of explosions as a source of seismic energy), the requirement for large vehicular access would be likely to be reduced whilst it would be expected that shot holes would be infilled after use.<br>**Low and High Activity Scenarios:**<br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed). In consequence, the total volume of greenfield land that may be required to support new site access may be greater whilst adverse impacts on land uses may be more widespread. However, given that any adverse effects associated with seismic surveys are likely to be minor, temporary and localised, there is not expected to be any substantial difference in the type and magnitude of effects between low and high activity scenarios. Further, it is anticipated that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible thus reducing the potential for adverse effects.<br>**Mitigation:**<br>• Regular monitoring of the effects of seismic survey activity on cultural heritage assets should be undertaken.<br>• Sites selected should be of no cultural heritage value, and the presence of any sensitive assets in the vicinity identified through desk-based assessment and surveys as required.<br>• Planning for operational site design and layout, in liaison with local and national experts, should take account of potentially vulnerable cultural heritage assets and their settings, including historic landscapes, which could be affected by construction and operational activities. Forward planting to screen the site could be required to reduce potential visual impacts on cultural heritage assets.<br>• Identification of appropriate access routes would help to minimise potential negative effects on historic or archaeological features such as listed buildings, cause d by transport pollution and vibration.<br>**Assumptions:**<br>• It is assumed that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible.<br>• It is assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>**Uncertainties:**<br>• The effect of seismic surveys on cultural heritage assets above and below ground, particularly in the immediate vicinity of the operations, in the short and longer term. |

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| Objective 11: Cultural Heritage | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 2 | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring. | **0** | **-/?** | **Assessment of Effects:**<br>There would be the potential for the loss or damage to cultural heritage features and landscapes associated with preparation for drilling, although site investigation should have largely anticipated these effects. The introduction of new elements into existing views could also have a negative effect on the setting of above-ground historic or archaeological features or landscapes.<br>There would be the potential for well pad construction and drilling activities to result in the loss or damage to subsurface or buried archaeology.<br>The potential for effects would depend upon the proximity of any investigations or works to cultural heritage or archaeological sites, features or landscapes, and their current condition and sensitivity.<br>At this stage no sites have been selected and the potential effects would be dependent upon local cultural heritage characteristics, and the results of preliminary investigations.<br>**Low and High Activity Scenarios:**<br>There would potentially be a difference between the effects associated with low and high activity scenarios, where a greater density of exploration activity across the license area means a greater likelihood of disturbance of cultural heritage assets because of more sites being active as well as cumulative impacts associated with their development. This could be particularly important for the settings of heritage assets and for historic landscapes.<br>However, the likely area of land-take under the high scenario is 12-18ha and therefore, even in the most densely drilled areas where the minimum pad distance is 5km, overall there are unlikely to be any significant effects on cultural heritage interests as a whole.<br>**Mitigation:**<br>• Prior to any works on site, a desk study and site walkover should be undertaken to determine the historic and archaeological value of the sites and potential need for further site evaluation through trial trenching or more specific geophysical surveys;<br>• Close monitoring during topsoil stripping and excavation works should be undertaken to identify unexpected features or artefacts;<br>• Where potential impacts are identified the construction should be altered to minimise impacts, and if retention is not possible, consideration should be given to moving features or undertaking detailed excavation and recording.<br>**Assumptions:**<br>• It is assumed that well pad site identification and construction and exploration activity is undertaken in light of good knowledge of local cultural heritage attributes and liaison with local and national expertise.<br>**Uncertainties:**<br>• None identified at this stage. |

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| Objective 11: Cultural Heritage | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 3 | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring. | **0** | **-/?** | **Assessment of Effects:**<br>There would be the potential for the loss or damage to cultural heritage features and landscapes associated with preparation for drilling, although site investigation should have anticipated these effects. The introduction of new elements into existing views could also have a negative effect on the setting of above-ground historic or archaeological features or landscapes[18].<br>There would be the potential for well pad construction and drilling activities to result in the loss or damage to subsurface or buried archaeology, although the potential for effects would depend upon the proximity of any investigations or works to cultural heritage or archaeological sites, features or landscapes, and their current condition and sensitivity.<br>At this stage no sites have been selected and the potential effects would be dependent upon local cultural heritage characteristics, and the results of preliminary investigations.<br>**Low and High Activity Scenarios:**<br>There would potentially be a difference between the effects associated with low and high activity scenarios, where a greater density of exploration activity across the license area means a greater likelihood of disturbance of cultural heritage assets because of more sites being active as well as cumulative impacts associated with their development. This could be particularly important for the settings of heritage assets and for historic landscapes. However, the scale of operations, even under the high scenario of 6 pads covering 12-18ha, means that any adverse effects are likely to be localised and relatively minor in character.<br>**Mitigation:**<br>• Prior to any works on site, a desk study and site walkover should be undertaken to determine the historic and archaeological value of the site s and potential need for further site evaluation through trial trenching or more specific geophysical surveys.<br>• Close monitoring during topsoil stripping and excavation works should be undertaken to identify unexpected features or artefacts.<br>• Where potential impacts are identified the construction should be altered to minimise impacts, and if retention is not possible, consideration should be given to moving features or undertaking detailed excavation and recording.<br>**Assumptions:**<br>• It is assumed that well pad site identification and construction and exploration activity is undertaken in light of good knowledge of local cultural heritage attributes and liaison with local and national expertise. |

[18] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed May 2013] p.xi

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| Objective 11: Cultural Heritage | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Uncertainties:**<br>• None identified at this stage. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0/?** | **Assessment of Effects:**<br>Subject to appropriate mitigation identified as part of Stages 1-3, no effects on above-ground cultural heritage or archaeological sites or features are anticipated as a result of operational activities as no further surface disturbance will occur.<br>Over time, the growth of visual screening could help to reduce visibility into the site and hence potential impacts on cultural heritage assets and their settings as well as historic landscapes.<br>**Low and High Activity Scenarios:**<br>There could be some differences between the effects associated with the low and high activity scenarios, whereby a greater density of activity has cumulatively greater impacts such as through the impacts of vehicle movements[19]. However, the predicted scale of operations, being a maximum of 6 pads covering 2-18ha under the high scenario, means that any cumulative impacts are unlikely to be significant.<br>**Mitigation:**<br>• The effects of production activities should be closely monitored for adverse and cumulative impacts, particularly under the high activity scenario if there are likely to concentrations of activity in a locality.<br>**Assumptions:**<br>• That mitigation measures identified in stages 1-3 have been implemented.<br>**Uncertainties:**<br>• Potential cumulative impacts of traffic movements. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>No effects on cultural heritage features or landscapes are anticipated as a result of decommissioning, including subsurface and buried archaeological remains as these will have been identified in previous stages.<br>**Low and High Activity Scenarios:**<br>There are no anticipated differences between low and high activity scenarios.<br>**Mitigation:**<br>• Prior to decommissioning, opportunities for landscape enhancement should be investigated, particularly if operations are in the vicinity of historic landscapes.<br>**Assumptions:**<br>• None. |

[19] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed May 2013] p.viii

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| Objective 11: Cultural Heritage | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Uncertainties:**<br>• None. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>No effects on cultural heritage features or landscapes are anticipated as a result of decommissioning, including subsurface and buried archaeological remains as these will have been identified in previous stages.<br>As part of site restoration, there could be opportunities to enhance the setting of heritage features and landscapes through landscape design.<br>**Low and High Activity Scenarios:**<br>There are no anticipated differences between low and high activity scenarios.<br>**Mitigation:**<br>• Prior to decommissioning, opportunities for landscape enhancement should be investigated.<br>**Assumptions:**<br>• None.<br>**Uncertainties:**<br>• None. |

***Summary***

The effects of conventional oil and gas activity on cultural heritage interests are considered to range from neutral to minor negative, according to the stages and scale of operation. Notwithstanding early survey work to avoid direct impacts on designated sites, there could still be negative effects associated with production development activity associated with unanticipated effects on cultural heritage assets (such as through vibration testing or the impacts of road traffic), although the precise effects would depend upon the receiving context such as the density and type of heritage assets. However, the impacts are unlikely to widespread or significant given the maximum scale of operations, even under the high activity scenario. The application of mitigation in terms of the identification of cultural heritage assets at the start of the site investigation process and liaison with local and national experts will assist in anticipating potential issues which might arise. Other stages of the process are likely to produce no overall effect, assuming that suitable knowledge of locally and nationally important cultural heritage assets exists to anticipate and/or avoid any impacts. The following mitigation is recommended:

- **Site investigation & Exploration:**
  - Regular monitoring of the effects of seismic survey activity on cultural heritage assets should be undertaken.
  - Sites selected should be of no cultural heritage value, and the presence of any sensitive assets in the vicinity identified through desk-based assessment and surveys as required. This should include consideration of historic landscapes and any related potential effects on tourism.
  - Planning for operational site design and layout, in liaison with local and national experts, should take account of potentially vulnerable cultural heritage assets and their settings, including historic landscapes, which could be affected by construction and operational activities. Forward planting to screen the site could be required to reduce potential visual impacts on cultural heritage assets.
  - Identification of appropriate access routes would help to minimise potential negative effects on historic or archaeological features such as listed buildings, caused by transport pollution and vibration.
  - Prior to any works on site, a desk study and site walkover should be undertaken to determine the historic and archaeological value of the sites and potential need for further site evaluation through trial trenching or more specific geophysical surveys.
  - Close monitoring during topsoil stripping and excavation works should be undertaken to identify unexpected features or artefacts.
  - Where potential impacts are identified the construction should be altered to minimise impacts, and if retention is not possible, consideration should be given to moving features or undertaking detailed excavation and recording.

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| Objective 11: Cultural Heritage | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| • **Site Construction:**<br>o Prior to any works on site, a desk study and site walkover should be undertaken to determine the historic and archaeological value of the site s and potential need for further site evaluation through trial trenching or more specific geophysical surveys.<br>o Close monitoring during topsoil stripping and excavation works should be undertaken to identify unexpected features or artefacts. The disposal of any excavated rock and spoil should be sited to avoid impacts on cultural artefacts.<br>o Where potential impacts are identified the construction should be altered to minimise impacts, and if retention is not possible, consideration should be given to moving features or undertaking detailed excavation and recording.<br>• **Site production:**<br>o The effects of production activities should be closely monitored for adverse and cumulative impacts, particularly under the high activity scenario.<br>• **Site Decommissioning & Restoration:**<br>o Prior to decommissioning, opportunities for landscape enhancement should be investigated. | | | | |

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 9.8.2 Unconventional Oil and Gas

The assessment of the six main stages of unconventional oil and gas production is contained in **Table 9.6** under both low activity and high activity scenarios (as described on **Section 2.5** of the main Environmental Report).

**Table 9.6 Assessment of Effects: Unconventional Oil and Gas**

| Objective 11: Cultural Heritage | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0/?** | **0/?** | **Assessment of Effects:**<br>It is assumed that the activities associated with this stage are the same as for conventional oil and and gas exploration, namely that oil and gas exploration and production lifecycle would comprise non-intrusive activities. Site identification, selection and characterisation and the securing of development and operation permits would be expected to be largely desk-based. |

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| Objective 11: Cultural Heritage | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | In consequence, no significant effects on cultural heritage would be anticipated from these activities.<br>However, there potentially could be disturbance effects associated with seismic testing, such as on fragile above or below ground buildings and artefacts. However, the potential impacts of these activities on cultural heritage assets remains untested and therefore has uncertain impacts in the short or longer term.<br>Vibroseis is the most common method of seismic survey and typically involves 3-5 large vibrator units which sub-sonically vibrate the ground while a number of support vehicles record the returning shock waves for analysis. As highlighted in the 2010 Environmental Report[20], surveys tend to be spatially restricted due to the requirement for roads or other hard surfaces accessible by vehicle. Where roads have to be constructed to facilitate access to sites, any adverse effects would be temporary with land restored following completion of the surveys. Where shot-hole techniques are utilised (which involve the use of explosions as a source of seismic energy), the requirement for large vehicular access would be likely to be reduced whilst it would be expected that shot holes would be infilled after use.<br>**Low and High Activity Scenarios:**<br>It can be reasonably assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed) being 60-90ha compared to 240-360ha. Consequently, the total volume of greenfield land that may be required to support new site access may be greater whilst adverse impacts on land uses may be more widespread. However, given that any adverse effects associated with seismic surveys are likely to be minor, temporary and localised, there is not expected to be any substantial difference in the type and magnitude of effects between low and high activity scenarios. Further, it is anticipated that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible thus reducing the potential for adverse effects.<br>**Mitigation:**<br>• Regular monitoring of the effects of seismic survey activity on cultural heritage assets should be undertaken.<br>• Sites selected should be of no cultural heritage value, and the presence of any sensitive assets in the vicinity identified through desk-based assessment and surveys as required.<br>• Planning for operational site design and layout, in liaison with local and national experts, should take account of potentially vulnerable cultural heritage assets and their settings, including historic landscapes, which could be affected by construction and operational activities. |

[20] DECC (2010) Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds: Environmental Report.

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| Objective 11: Cultural Heritage | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | Forward planting to screen the site could be required to reduce potential visual impacts on cultural heritage assets.<br>• Identification of appropriate access routes would help to minimise potential negative effects on historic or archaeological features such as listed buildings, caused by transport pollution and vibration associated with lorry movements[21].<br>**Assumptions:**<br>• It is assumed that well pad site identification and construction and exploration activity is undertaken in light of good knowledge of local cultural heritage attributes and liaison with local and national experts.<br>• It is assumed that existing roads/hard standing would be used for the purposes of seismic surveys wherever possible.<br>• It is assumed that the number of seismic surveys undertaken would be greater under the high activity scenario (commensurate with the number of licences granted and the area to be licensed).<br>**Uncertainties:**<br>• The effect of seismic surveys on cultural heritage assets above and below ground, particularly in the immediate vicinity of the operations, in the short and longer term. |
| 2 | **Exploration drilling,** including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. | **0** | **-/?** | **Assessment of Effects:**<br>There would be the potential for the loss or damage to cultural heritage features and landscapes associated with preparation for drilling, although site investigation should have largely anticipated these effects. The introduction of new elements into existing views could also have a negative effect on the setting of above-ground historic or archaeological features or landscapes[22].<br>There would be the potential for well pad construction and drilling activities to result in the loss or damage to subsurface or buried archaeology.<br>The potential for effects would depend upon the proximity of any investigations or works to cultural heritage or archaeological sites, features or landscapes, and their current condition and sensitivity.<br>At this stage no sites have been selected and the potential effects would be dependent upon local cultural heritage characteristics, and the results of preliminary investigations.<br>**Low and High Activity Scenarios:**<br>There would potentially be a difference between the effects associated with low and high activity scenarios, where a greater density of exploration activity across the license area |

[21] See: IOD (2012) Getting Shale Gas Working http://www.iod.com/influencing/policy-papers/infrastructure/infrastructure-for-business-getting-shale-gas-working Table 34 p.117
[22] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed May 2013] p.xi

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| Objective 11: Cultural Heritage | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | means a greater likelihood of disturbance of cultural heritage assets because of more sites being active as well as cumulative impacts associated with their development. This could be particularly important for the settings of heritage assets and for historic landscapes[23]. However, it must be noted that construction density would be limited by the minimum distance (5km) required between pads. This applies to both, the low and high density scenarios. Additionally, cultural heritage impacts would also be considered during the Town and Country planning and, where appropriate, Environmental Impact Assessment (EIA) processes.<br>The total number of well pad sites ranges from 30 to 120 under the low and high activity scenarios respectively, with direct land-take being between 60 and 360ha. Whilst overall there are unlikely to be any significant effects on cultural heritage there could be some localised disturbance effects, resulting from traffic movements[24] and associated pollution[25], although the the precise impacts are uncertain and dependent upon mitigation such as routeing of traffic.<br>**Mitigation:**<br>• Prior to any works on site, a desk study and site walkover should be undertaken to determine the historic and archaeological value of the sites and potential need for further site evaluation through trial trenching or more specific geophysical surveys.<br>• Close monitoring during topsoil stripping and excavation works should be undertaken to identify unexpected features or artefacts.<br>• Where potential impacts are identified the construction should be altered to minimise impacts, and if retention is not possible, consideration should be given to moving features or undertaking detailed excavation and recording.<br>**Assumptions:**<br>• It is assumed that well pad site identification and construction and exploration activity is undertaken in light of good knowledge of local cultural heritage attributes and liaison with local and national experts.<br>**Uncertainties:**<br>• None identified at this stage. |

[23] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed May 2013] p.xi
[24] See: IOD (2012) Getting Shale Gas http://www.iod.com/influencing/policy-papers/infrastructure/infrastructure-for-business-getting-shale-gas-working Table 34 p.117
[25] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed May 2013] p.viii

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| Objective 11: Cultural Heritage | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 3 | **Production development,** including:<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. | **0** | **-/?** | **Assessment of Effects:**<br>There would be the potential for the loss or damage to cultural heritage features and landscapes associated with preparation for drilling, although site investigation should have anticipated these effects. The introduction of new elements into existing views could also have a negative effect on the setting of above-ground historic or archaeological features or landscapes[26].<br>There would be the potential for well pad construction and drilling activities, such as the disposal of drill cuttings[27], to result in the loss or damage to subsurface or buried archaeology.<br>The potential for effects would depend upon the proximity of any investigations or works to cultural heritage or archaeological sites, features or landscapes, and their current condition and sensitivity.<br>At this stage no sites have been selected and the potential effects would be dependent upon local cultural heritage characteristics, and the results of preliminary investigations.<br>**Low and High Activity Scenarios:**<br>There would potentially be a difference between the effects associated with low and high activity scenarios (ranging from 30-120 pad sites and land-take of 60-360ha), where a greater density of exploration activity across the license area means a greater likelihood of disturbance of cultural heritage assets because of more sites being active as well as cumulative impacts associated with their development, particularly where there is a concentration of activity, spatially or temporally. This could be particularly important for the settings of heritage assets and for historic landscapes[28]. However, it must be noted that construction density would be limited by the minimum distance (5km) required between pads. This applies to both, the low and high density scenarios. Additionally, cultural heritage impacts would also be considered during the Town and Country planning and, where appropriate, Environmental Impact Assessment (EIA) processes.<br>Overall, differences in the effects between low and high activity scenarios are unlikely to be significant.<br>**Mitigation:**<br>• Prior to any works on site, a desk study and site walkover should be undertaken to determine the historic and archaeological value of the sites and potential need for further site evaluation through trial trenching or more specific geophysical surveys. |

[26] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed May 2013] p.xi
[27] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed May 2013] p.37/38
[28] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed May 2013] p.xi

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| Objective 11: Cultural Heritage | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Close monitoring during topsoil stripping and excavation works should be undertaken to identify unexpected features or artefacts.<br>• Where potential impacts are identified the construction should be altered to minimise impacts, and if retention is not possible, consideration should be given to moving features or undertaking detailed excavation and recording.<br>**Assumptions:**<br>• It is assumed that well pad site identification and construction and exploration activity is undertaken in light of good knowledge of local cultural heritage attributes and liaison with local and national experts.<br>**Uncertainties:**<br>• None identified at this stage. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0/?** | **Assessment of Effects:**<br>Subject to appropriate mitigation identified as part of Stages 1-3, no effects on above-ground cultural heritage or archaeological sites or features are anticipated as a result of operational activities as no further surface disturbance will occur. Nevertheless, risks have been cited[29] relating to potential negative effects on unrecorded cultural heritage artefacts (archaeological deposits and areas of high paleoenvironmental potential) as well as building foundations and fabric as a result of water abstraction and consequent depletion of groundwater, particularly in periods of water stress. However, local abstraction is considered unlikely due to regulatory requirements related to abstraction within the UK (such as the Water Act 2003 and Water Resources Regulations 2006) as the assumption that 90% of operations will have access to mains water for the refracturing process. Therefore the likelihood of such effects are also considered unlikely.<br>Over time, the growth of visual screening could help to reduce visibility into the site and hence potential impacts on cultural heritage assets and their settings as well as historic landscapes.<br>**Low and High Activity Scenarios:**<br>There could be some differences between the effects associated with the low and high activity scenarios, whereby a greater density of activity has cumulatively greater impacts such as through the impacts of vehicle movements[30].. Although, vehicle movements during the majority of production and operation are estimated to be minimal, the vehicle movements associated with re-fracturing (which is assumed to occur once per well during this stage) are estimated to be greater, although this will depend on the source of water, how it is transported to the site and management of any resulting flowback. |

[29] English Heritage (2013) *Hydro-fracturing Issues Report* (Unpublished Draft)
[30] See: AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe: AEAT, report for the European Commission, 2012*, available from http://ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf [Accessed May 2013] p.viii

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| Objective 11: Cultural Heritage | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | **Mitigation:**<br>• The effects of production activities should be closely monitored for adverse and cumulative impacts, particularly under the high activity scenario if there are likely to concentrations of activity in a locality.<br>**Assumptions:**<br>• That mitigation measures identified in stages 1-3 have been implemented.<br>**Uncertainties:**<br>• Potential cumulative impacts of traffic movements.<br>• Impacts on groundwater levels of abstraction of water for fracturing. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>No effects on cultural heritage features or landscapes are anticipated as a result of decommissioning, including subsurface and buried archaeological remains as these will have been identified in previous stages.<br>**Low and High Activity Scenarios:**<br>There are no anticipated differences between low and high activity scenarios.<br>**Mitigation:**<br>• Prior to decommissioning, opportunities for landscape enhancement should be investigated, particularly if operations are in the vicinity of historic landscapes.<br>**Assumptions:**<br>• None identified at this stage.<br>**Uncertainties:**<br>• None identified at this stage. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0** | **0** | **Assessment of Effects:**<br>No effects on cultural heritage features or landscapes are anticipated as a result of decommissioning, including subsurface and buried archaeological remains as these will have been identified in previous stages.<br>As part of site restoration, there could be opportunities to enhance the setting of heritage features and landscapes through landscape design.<br>**Low and High Activity Scenarios:**<br>There are no anticipated differences between low and high activity scenarios.<br>**Mitigation:**<br>• Prior to decommissioning, opportunities for landscape enhancement should be investigated.<br>**Assumptions:**<br>• None identified at this stage.<br>**Uncertainties:**<br>• None identified at this stage. |

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## Objective 11: Cultural Heritage

| *Stage* | *Description* | *Score* | | *Commentary* |
|---|---|---|---|---|
| | | *Low Activity Scenario* | *High Activity Scenario* | |

### *Summary*

The effects of unconventional oil and gas activity on cultural heritage interests are considered to range from neutral to potentially minor negative, according to the stages and scale of operation, particularly under the high scenario where the risks of the accidental release of pollutants, for example, are greater by virtue of the scale of activity. Notwithstanding early survey work to avoid direct impacts on designated sites, there could be negative effects associated with production development activity associated with unanticipated effects on cultural heritage assets (such as through vibration testing, the impacts of road traffic and effects on the setting of cultural heritage assets), although the precise effects would depend upon the receiving context such as the density and type of heritage assets. The application of mitigation in terms of the identification of cultural heritage assets at the start of the site investigation process and liaison with local and national experts will assist in anticipating potential issues which might arise. Other stages of the process are likely to produce no overall effect, assuming that suitable knowledge of locally and nationally important cultural heritage assets exists to anticipate and/or avoid any impacts and regular monitoring of potential impacts is undertaken. The following mitigation is recommended:

- **Site investigation & Exploration:**
  - Regular monitoring of the effects of seismic survey activity on cultural heritage assets should be undertaken.
  - Sites selected should be of no cultural heritage value, and the presence of any sensitive assets in the vicinity identified through desk-based assessment and surveys as required.
  - Planning for operational site design and layout, in liaison with local and national experts, should take account of potentially vulnerable cultural heritage assets and their settings, including historic landscapes, which could be affected by construction and operational activities. Forward planting to screen the site could be required to reduce potential visual impacts on cultural heritage assets.
  - Identification of appropriate access routes would help to minimise potential negative effects on historic or archaeological features such as listed buildings, caused by transport pollution and vibration.
  - Prior to any works on site, a desk study and site walkover should be undertaken to determine the historic and archaeological value of the site s and potential need for further site evaluation through trial trenching or more specific geophysical surveys.
  - Close monitoring during topsoil stripping and excavation works should be undertaken to identify unexpected features or artefacts.
  - Where potential impacts are identified the construction should be altered to minimise impacts, and if retention is not possible, consideration should be given to moving features or undertaking detailed excavation and recording.
- **Site Construction:**
  - Prior to any works on site, a desk study and site walkover should be undertaken to determine the historic and archaeological value of the site s and potential need for further site evaluation through trial trenching or more specific geophysical surveys.
  - Close monitoring during topsoil stripping and excavation works should be undertaken to identify unexpected features or artefacts. The disposal of any excavated rock and spoil should be sited to avoid impacts on cultural artefacts.
  - Where potential impacts are identified the construction should be altered to minimise impacts, and if retention is not possible, consideration should be given to moving features or undertaking detailed excavation and recording.
- **Site production:**
  - The effects of production activities (such as groundwater levels) should be closely monitored for adverse and cumulative impacts such as impacts on building foundations and fabric, particularly under the high activity scenario.
- **Site Decommissioning & Restoration:**
  - Prior to decommissioning, opportunities for landscape enhancement should be investigated.

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

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## 9.9 Virgin Coal Bed Methane

The effects of exploration and production activities associated with VCBM are similar to those described in the assessment of effects of unconventional oil and gas (Stages 1-6) although hydraulic fracturing is not normally required. No attempt has been to provide an indication of low and high levels of activity.

## 9.10 Gas Storage

The development of gas storage capacity is likely to entail the following activities:

1. Construction & Installation of Pipelines and Storage Facilities
2. Storage operations
3. Decommissioning

The likely effects of these activities are appraised in **Table 9.7**.

**Table 9.7 Assessment of Effects: Gas Storage**

| **Objective 11: Cultural Heritage**<br>***Stage Description*** | ***Score*** | ***Commentary*** |
|---|---|---|
| **Construction & Installation of Pipelines and Storage Facilities** | **-/?** | **Assessment of Effects:**<br>There could be a range of direct effects on cultural heritage interests associated with gas transmission and storage development activity, including disruption to and loss of unsurveyed buried artefacts and visual effects on historic landscapes (associated with road and pipeline construction, for example).<br>**Mitigation:**<br>• Sites selected should be of no cultural heritage value, and the presence of any artefacts identified through desk-based assessment, walk-over surveys, and detailed site surveys as required. Site design and layout should retain or minimise loss of identified cultural heritage assets, whilst avoiding visual disturbance to historic landscapes, particularly associated with road, rail and pipeline infrastructure. Opportunities for the enhancement of the landscape context of cultural heritage assets could be taken during construction, operation and decommissioning phases.<br>**Assumptions:**<br>• It is assumed construction development activity is undertaken in light of good knowledge of local cultural heritage assets.<br>**Uncertainties:**<br>• The precise effects of operations and their cumulative impacts on cultural heritage assets. |

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| Objective 11: Cultural Heritage | | |
|---|---|---|
| ***Stage Description*** | ***Score*** | ***Commentary*** |
| **Storage Operations** | **0** | **Assessment of Effects:**<br>No effects identified<br>**Mitigation:**<br>• None identified at this stage.<br>**Assumptions:**<br>• It is assumed that all operational activities are carried under HSE/PADHI guidelines.<br>**Uncertainties:**<br>• None identified. |
| **Decommissioning** | **0/?** | **Assessment of Effects:**<br>All activities associated with site restoration would take place within the existing site area and therefore no further effects on cultural heritage assets are anticipated. Following closure, it is assumed that the site would be restored to as near its preconstruction condition as possible.<br>**Mitigation:**<br>• None identified at this stage.<br>**Assumptions:**<br>• None identified at this stage.<br>**Uncertainties:**<br>• Changes in site character (such as mature screening planting) which may influence the visual character of the locality. |

***Summary***

The effects of gas storage activity on cultural heritage interests are considered to range from neutral to potentially minor negative, according to the stage of operation. Notwithstanding work to avoid direct impacts on designated sites, there could still be negative effects associated with the construction of pipelines and storage facilities, related to the direct effects on historic landscapes. The decommissioning of the facilities is likely to produce no overall effect, assuming that suitable knowledge of cultural heritage artefacts exists to avoid or mitigate any immediate impacts. The following mitigation is recommended:

- **Site Investigation and Construction:** The mitigation measures identified for site investigation and exploration should be continued as appropriate. In addition, the effects of production development activities should be closely monitored for adverse and cumulative impacts, particularly if a spatial intensity of activity might be expected.
- **Site operation:** Transport and storage activities should be closely monitored for adverse and cumulative impacts on cultural heritage assets (for example the impact of vibrations from vehicle movements on listed buildings).

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

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## 9.11 SEA Areas

The following sections consider in-turn the potential effects of Licensing Plan activities on the cultural heritage objective in the five SEA Areas. The assessment draws on the findings presented in **Tables 9.5, 9.6 and 9.7** above and takes account of the environmental characteristics of the areas as detailed in **Section 9.4**.

### 9.11.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

There are three World Heritage Sites in SEA Area 1 which are designated due to their historic cultural attributes. The Antonine Wall was the most northerly frontier of the Roman army in the years following AD140. The wall was built for 60km, running from Bo'ness to Old Kilpatrick. Forts and fortlets were built along its length to provide accommodation and crossing points. The Edinburgh New and Old Towns have been designated as they fulfil criteria c (ii) [to exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design] and c (iv) [to be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history]. New Lanark comprises of a small 18$^{th}$ Century village where the philanthropist and Utopian idealist Robert Owen created a model industrial community in the early 19$^{th}$ Century. It was designated as a WHS in 2001. There are approximately 2,600 scheduled monuments in the area.

#### Conventional Oil and Gas

Where there are concentrations of cultural heritage assets (notably across the lowlands between Edinburgh and Glasgow), buffer areas could be required around individual assets or clusters of assets which potentially reducing exploration/production areas, particularly under the high scenario. Historic landscapes, which can be spatially extensive, could require particular attention to ensure that their integrity is not compromised. For both the low and high activity scenarios, the scale of activity is unlikely to have a significant negative impact under any stage of the process.

#### Unconventional Oil and Gas

The effects of unconventional oil and gas exploration in the area are similar to those resulting from conventional exploration. However, additional infrastructure (i.e. chemical and water storage tanks) would be required during the exploration and production development phases. For the low activity scenario, the scale of activity is unlikely to have a significant negative impact under any stage of the process. Under the high scenario, the cumulative impacts associated with spatial concentrations of activity could be an issue, for example in relation to the visual impacts of new roads and pipelines in proximity to historic landscapes or the setting of listed buildings. These effects would have to be assessed in relation to the character of specific localities.

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### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 1 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

No potential effects on cultural heritage resulting from gas storage have been identified.

## 9.11.2 SEA Area 2: West Midlands, North West England and Southern Scotland

There are two World Heritage Sites in SEA Area 2 which are designated due to their historic cultural attributes. Ironbridge Gorge WHS is known throughout the world as the symbol of the Industrial Revolution. The bridge at Ironbridge, the world's first bridge constructed of iron, had a considerable influence on developments in the fields of technology and architecture. The Liverpool Maritime Mercantile City WHS consists of six areas of the historic centre and docklands of Liverpool that was a pioneer in the development of modern dock technology, transport systems and port management. There are approximately 1,660 scheduled monuments in the area, and around 200 historic parks and gardens.

English Heritage[31] note that there are wetlands and areas of high paleoenvironmental potential with significant archaeological deposits preserved by high water tables in the area of medieval 'inning' in the Fylde of Lancashire, as well as rare surviving areas of mossland unaffected by 18$^{th}$-20$^{th}$ Century enclosure and drainage in Shropshire, Cheshire, Staffordshire and Lancashire plain. Generally, the uplands of northern England have high concentrations of nationally significant archaeological sites (from extensive field systems to medieval and prehistoric settlements) which have been revealed through survey and also are not designated through scheduling.

### Conventional Oil and Gas

Where there are concentrations of cultural heritage assets (notably in Shropshire, Warwickshire, Staffordshire and Cumbria in the case of Scheduled Monuments and surrounding the conurbations of Birmingham and Manchester for Listed Buildings), buffer areas could be required around individual assets or clusters of assets which potentially reducing exploration/production areas, particularly under the high scenario. Historic landscapes, which can be spatially extensive, could require particular attention to ensure that their integrity is not compromised. For both the low and high activity scenarios, the scale of activity is unlikely to have a significant negative impact under any stage of the process.

[31] English Heritage (2013) *Hydro-fracturing Issues Report* (Unpublished Draft)

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### Unconventional Oil and Gas

Where there are concentrations of cultural heritage assets (notably in Shropshire, Warwickshire, Staffordshire and Cumbria in the case of Scheduled Monuments and surrounding the conurbations of Birmingham and Manchester for Listed Buildings), buffer areas could be required around individual assets or clusters of assets which potentially reducing exploration/production areas, particularly under the high scenario. Historic landscapes, which can be spatially extensive, could require particular attention to ensure that their integrity is not compromised. Under the high scenario, the cumulative impacts associated with spatial concentrations of activity could be an issue, for example in relation to the visual impacts of new roads and pipelines in proximity to historic landscapes or the setting of listed buildings. These effects would have to be assessed in relation to the character of specific localities.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 2 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

No potential effects on cultural heritage resulting from gas storage have been identified.

## 9.11.3 SEA Area 3: East Midlands and Eastern England

There are five World Heritage Sites in SEA Area 3 which are designated due to their historic cultural attributes. Three of these (Hadrian's Wall, Saltaire and Derwent Valley Mills) have been discussed in the landscape baseline for SEA Area 3. The two remaining are Durham Castle and Cathedral and Studley Royal Park. The latter is a landscape that was created around the ruins of the Cistercian Fountains Abbey and Fountains Hall Castle, in Yorkshire. The former was built in the late 11$^{th}$ and early 12$^{th}$ Centuries to house the relics of St Cuthbert (evangelizer of Northumbria) and the Venerable Bede. It is the largest and finest example of Norman architecture in England. There are approximately 6,000 scheduled monuments and around 350 historic parks and gardens. According to English Heritage[32], this Area contains a variety of extensive historically significant landscapes including wetlands and areas of high paleoenvironmental potential with significant archaeological deposits preserved by high water tables, which are also of national significance for their resulting ecologies. These include the Humber Estuary and Humberhead Levels where there some rare surviving areas of mossland unaffected by 18$^{th}$-20$^{th}$ Century enclosure and drainage.

[32] English Heritage (2013) *Hydro-fracturing Issues Report* (Unpublished Draft)

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### Conventional Oil and Gas

Where there are concentrations of cultural heritage assets (notably in across Northumberland, the Pennines, the North York Moors and Staffordshire in the case of Scheduled Monuments and across the Pennines, in the vicinity of Newcastle upon Tyne, and to the North East of London for Listed Buildings), buffer areas could be required around individual assets or clusters of assets which potentially reducing exploration/production areas, particularly under the high scenario. Historic landscapes, which can be spatially extensive, could require particular attention to ensure that their integrity is not compromised. For both the low and high activity scenarios for, the scale of activity is unlikely to have a significant negative impact under any stage of the process.

### Unconventional Oil and Gas

Where there are concentrations of cultural heritage assets (notably in across Northumberland, the Pennines, the North York Moors and Staffordshire in the case of Scheduled Monuments and across the Pennines, in the vicinity of Newcastle upon Tyne, and to the north east of London for Listed Buildings), buffer areas could be required around individual assets or clusters of assets which potentially reducing exploration/production areas, particularly under the high scenario. Historic landscapes, which can be spatially extensive, could require particular attention to ensure that their integrity is not compromised. For the low activity scenario, the scale of activity is unlikely to have a significant negative impact under any stage of the process. Under the high scenario, the cumulative impacts associated with spatial concentrations of activity could be an issue, for example in relation to the visual impacts of new roads and pipelines in proximity to historic landscapes or the setting of listed buildings. These effects would have to be assessed in relation to the character of specific localities.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 3 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

No potential effects on cultural heritage resulting from gas storage have been identified.

## 9.11.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

There are two World Heritage Sites in SEA Area 4 which are designated due to their historic cultural attributes. These are the Blaenavon Industrial Landscape in South Wales and the Pontcysyllte Aqueduct and Canal in the north east of Wales. There are approximately 1,500 Scheduled Monuments and 184 Parks and Gardens of Special Historic Interest in SEA Area 4.

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Of the 58 landscapes identified in the Historic Landscape Characterisation of Wales, 18 are located within SEA Area 4. Some 180 historic parks and gardens are located in the SEA area.

### Conventional Oil and Gas

Where there are concentrations of cultural heritage assets (notably in respect of historic landscapes to the north and south of Wales) buffer areas could be required around individual assets or clusters of assets which potentially reducing exploration/production areas, particularly under the high scenario. Historic landscapes, which can be spatially extensive, could require particular attention to ensure that their integrity is not compromised. For both the low and high activity scenarios, the scale of activity is unlikely to have a significant negative impact under any stage of the process.

### Unconventional Oil and Gas

Where there are concentrations of cultural heritage assets (notably in respect of historic landscapes to the North and South of Wales) buffer areas could be required around individual assets or clusters of assets which potentially reducing exploration/production areas, particularly under the high scenario. Historic landscapes, which can be spatially extensive, could require particular attention to ensure that their integrity is not compromised. For the low activity scenario, the scale of activity is unlikely to have a significant negative impact under any stage of the process. Under the high, the cumulative impacts associated with spatial concentrations of activity could be an issue, for example in relation to the visual impacts of new roads and pipelines in proximity to historic landscapes or the setting of listed buildings. These effects would have to be assessed in relation to the character of specific localities.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 4 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

### Gas Storage

No potential effects on cultural heritage resulting from gas storage have been identified.

## 9.11.5 SEA Area 5: Southern and South West England

There are six World Heritage Sites in SEA Area 5 which are designated due to their historic cultural attributes:

- Stonehenge;
- the City of Bath;

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- Cornwall and West Devon Mining Landscape;
- the Jurassic Coast;
- Canterbury Cathedral, St Augustine's Abbey and St Martin's Church; and
- Blenheim Palace and Park.

Significant stretches of the coast are designated as Heritage Coast. There are approximately 7,800 scheduled monuments and around 700 historic parks and gardens in the SEA area. According to English Heritage[33], this Area contains a variety of extensive historically significant landscapes including the following.

- Lowland wood pasture areas which are typically areas of dispersed settlement and medieval fields, such as the Kent and Sussex Weald, where archaeological evidence is similarly scattered and hard to identify except through new technologies (notably LIDAR) and ground survey. Areas of high archaeological potential also coincide with areas of wood pasture and ancient woodlands with high ecological significance.
- Chalk and limestone uplands and other areas with deep aquifers, characterised by large farms and arable agriculture, aerial survey revealing some of the highest densities of cropmark evidence for medieval and earlier land use and settlement in England. There are also high numbers of identified medieval shrunken and deserted settlements and prehistoric sites within the context of some of the most intensively farmed landscapes and large-scale farms in Europe.
- Lowland vales and scarps which can (particularly in areas of village-based settlement and along the scarps of upland areas such as the Cotswolds) retain some of the best-surviving evidence for medieval farmed landscapes (evident through ridge and furrow) in northern Europe, overlying the evidence for earlier settlement and land use mostly visible as cropmarks. There are some rare surviving blocks of heathland.

## Conventional Oil and Gas

Where there are concentrations of cultural heritage assets (notably in across Wiltshire, Dorset, Devon and the South Downs in the case of Scheduled Monuments and across the Bath and Avon and the North Downs for Listed Buildings), buffer areas could be required around individual assets or clusters of assets which potentially reducing exploration/production areas, particularly under the high scenario. Historic landscapes, which can be spatially extensive, could require particular attention to ensure that their integrity is not compromised. For both the low and high activity scenarios, the scale of activity is unlikely to have a significant negative impact under any stage of the process.

[33] English Heritage (2013) *Hydro-fracturing Issues Report* (Unpublished Draft)

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## Unconventional Oil and Gas

Where there are concentrations of cultural heritage assets (notably in across Wiltshire, Dorset, Devon and the South Downs in the case of Scheduled Monuments and across the Bath and Avon and the North Downs for Listed Buildings), buffer areas could be required around individual assets or clusters of assets which potentially reducing exploration/production areas, particularly under the high scenario. Historic landscapes, which can be spatially extensive, could require particular attention to ensure that their integrity is not compromised. For the low activity scenario, the scale of activity is unlikely to have a significant negative impact under any stage of the process. Under the high scenario, the cumulative impacts associated with spatial concentrations of activity could be an issue, for example in relation to the visual impacts of new roads and pipelines in proximity to historic landscapes or the setting of listed buildings. These effects would have to be assessed in relation to the character of specific localities.

## Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 5 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although hydraulic fracturing is not normally required.

## Gas Storage

No potential effects on cultural heritage resulting from gas storage have been identified.

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# 10. Landscape

## 10.1 Introduction

Landscape in this context is defined by **The European Landscape Convention** as 'an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors'. This definition is stated as covering natural, rural, urban and peri-urban (i.e. the urban-rural fringe) and includes land, inland water and marine areas. For the purposes of this appraisal though, landscape is taken to apply to rural areas and townscape to urban areas. Visual effects are those effects that influence how people see a landscape or townscape, such as the erection of a building.

## 10.2 Review of Plans and Programmes

### 10.2.1 International

The ***European Landscape Convention*** is principally directed at the national level, but emphasises the importance of landscape as a cultural as well as an aesthetic asset. The convention also calls for improved public involvement in landscape matters. The UK became a signatory to the European Landscape Convention in 2006.

### 10.2.2 UK

In the UK, there are numerous Acts governing the protection of the countryside, landscape and natural environment. The ***National Parks and Access to the Countryside Act 1949*** makes provision for National Parks, confers powers for the establishment and maintenance of nature reserves, makes provision for the recording, creation, maintenance and improvement of public paths and for securing access to open country and confers further powers for preserving and enhancing natural beauty. National Parks are areas of relatively undeveloped and scenic landscape. Designation as a national park may include substantial settlements and human land uses which are often integral parts of the landscape. Land within a national park remains largely in private ownership. Each National Park is operated by its own national park authority, with two 'statutory purposes':

- to conserve and enhance the natural beauty, wildlife and cultural heritage of the area; and
- to promote opportunities for the understanding and enjoyment of the parks.

AONBs are areas of high scenic quality that have statutory protection in order to conserve and enhance the natural beauty of their landscapes. AONB landscapes range from rugged coastline to water meadows to gentle lowland and upland moors. Natural England has a statutory power to designate land as Areas of Outstanding Natural Beauty.

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The ***Countryside and Rights of Way Act 2000*** increased the duty of provision of public access to the countryside and strengthened legislation relating to Sites of Special Scientific Interest (SSSIs). In particular, it requires public bodies to further the conservation and enhancement of SSSIs both in carrying out their operations, and in exercising their decision making functions.

The ***Marine and Coastal Access Act 2009*** seeks to ensure clean healthy, safe, productive and biologically diverse oceans and seas, by putting in place better systems for delivering sustainable development of marine and coastal environment.

Other relevant Acts include:

- The ***1967 Forestry Act (as amended 1999)*** restricts and regulates the felling of trees. The ***1968 Countryside Act*** enlarges the function of the Agency established under the National Parks and Access to the Countryside Act 1949, to confer new powers on local authorities and other bodies for the conservation and enhancement of natural beauty and for the benefit of those resorting to the countryside;
- The ***1986 Agriculture Act (with numerous revisions)*** covers the provision of agricultural services and goods, agricultural marketing compensation to tenants for milk quotas, conservation and farm grants; and
- The ***Commons Act 2006***, which protects common land and promotes sustainable farming, public access to the countryside and the interests of wildlife.

### 10.2.3 England

The ***Natural Environment and Rural Communities (NERC) Act 2006*** implements key elements of the Government's Rural Strategy published in July 2004. The NERC Act is designed to help achieve a rich and diverse natural environment and thriving rural communities through modernised and simplified arrangements for delivering Government policy. The NERC Act established a new independent body - Natural England - responsible for conserving, enhancing, and managing England's natural environment for the benefit of current and future generations. The Act made amendments to both the Wildlife and Countryside Act 1981 and the Countryside and Rights of Way Act 2000, which further enhance provisions to biodiversity generally and SSSIs in particular.

The ***National Planning Policy Framework (2012)*** includes strong protections for valued landscapes and townscapes as well as recognising the intrinsic character and beauty of the countryside. The importance of planning positively for high quality design is underlined and local and neighbourhood plans are expected to "*develop robust and comprehensive policies that set out the quality of development that will be expected for the area*". Planning policies and decisions are expected to respond to local character and history, and reflect the identity of local surroundings and materials, while not preventing or discouraging appropriate innovation. The Framework states (paragraph 64) that: "*Permission should be refused for development of poor design that fails to take the opportunities available for improving the character and quality of an area and the way it functions*".

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The Framework has a number of specific requirements relating to planning and landscape including a clear expectation that the planning system should contribute to and enhance the natural and local environment by protecting and enhancing valued landscapes. Local planning authorities are expected to set criteria based policies against which proposals for any development on or affecting protected landscape areas will be judged. In doing so, distinctions should be made between the hierarchy of international, national and locally designated sites and "*great weight*" should be given to "*conserving landscape and scenic beauty in National Parks, the Broads and Areas of Outstanding Natural Beauty*". Local planning authorities in their plan-making are expected to take account of climate change and changes to landscape and contain a clear strategy for enhancing the natural, built and historic environment. Where appropriate, "*landscape character assessments should also be prepared, integrated with assessment of historic landscape character, and for areas where there are major expansion options assessments of landscape sensitivity*".

With regard to mineral extraction, the Framework notes that when determining planning applications, local planning authorities should give great weight to the benefits of the mineral extraction, including to the economy. However, the Framework also places a duty on local planning authorities to ensure that there are no unacceptable adverse impacts on the natural and historic environment and to take into account the cumulative effect of multiple impacts from individual sites and/or from a number of sites in a locality. The Framework makes explicit reference to unconventional hydrocarbons; it states that mineral planning authorities should clearly distinguish between the three phases of development (exploration, appraisal and production) and address constraints on production and processing within areas that are licensed for oil and gas exploration or production.

***Planning Practice Guidance for Onshore Oil and Gas (2013)*** provides advice on the planning issues associated with the extraction of hydrocarbons. It will be kept under review and should be read alongside other planning guidance and the NPPF. The guidance identifies a range of issues that mineral planning authorities may need to address. Those particularly relevant to landscape include: visual intrusion into the local setting and the wider landscape caused by the placement of any building or structure within the application site area; lighting; landscape character; and site restoration and aftercare.

### 10.2.4 Scotland

The ***Countryside (Scotland) Act 1967*** makes provision for the better enjoyment of the Scottish countryside, the establishment of a Countryside Commission for Scotland and for the improvement of recreational and other facilities. The ***National Parks (Scotland) Act 2000*** provides the legislative framework for National Park designations in Scotland.

***Scottish Planning Policy (SSP) 2010***, a statement of the Scottish Government's policy on nationally important land use planning matters, sets out several broad principles with regard to landscape, including taking a broader approach to landscape and natural heritage, considering the natural and cultural components of the landscape together and promoting opportunities for enhancement or restoration of degraded landscapes, safeguarding the character of the most sensitive landscapes, and considering potential effects on the landscape, including the cumulative effect of incremental changes,

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when deciding planning applications. SPP requires local authorities to apply the precautionary principle where the impacts of a proposed development on nationally or internationally significant landscape or natural heritage resources are uncertain but there is sound evidence for believing that significant irreversible damage could occur.

In April 2013, the Scottish Government published its Main Issues Report on the National Planning Framework 3 (NPF3) and the draft Scottish Planning Policy. NPF3 notes that there are sources of shale gas and coal bed methane in the Central Belt which have the potential to contribute to Scottish energy supplies. NPF3 continues on to note that there are emerging opportunities to utilise onshore reserves of 'unconventional' gas in ways which are compatible with the protection of the environment.

***Planning Advice Note 60 (PAN60): Planning for Natural Heritage*** provides advice on how development and the planning system can contribute to the conservation, enhancement, enjoyment and understanding of Scotland's natural environment and encourages developers and planning authorities to be positive and creative in addressing natural heritage issues.

### 10.2.5 Wales

***Planning Policy Wales (2012)*** sets out several objectives regarding landscape, including promoting the conservation of landscape and biodiversity, ensuring that Wales contributes to meeting international responsibilities and obligations and ensuring that statutorily designated sites are properly protected and managed. It also notes that it is important that landscape considerations are taken into account at an early stage in both development plan preparation and development management.

***Technical Advice Note 6: Planning for Sustainable Rural Communities (2010)*** provides practical guidance on the role of the planning system in supporting the delivery of sustainable rural communities. The TAN seeks to protect and enhance Wales' landscapes.

## 10.3 Overview of the Baseline

### 10.3.1 England

There are nine National Parks in England; the most recently designated National Park being the South Downs National Park on 31 March 2010). Together with The Broads (which has similar protection to a National Park) they cover 9.3% of the land area in England.

There are 34 AONBs in England, one of which straddles England and Wales (the Wye Valley AONB). AONBs cover 18% of England and Wales[1]. The East Hampshire and Sussex Downs AONB

[1]See http://www.aonb.org.uk/wba/NAAONB/naaonbpreview.nsf/Web%20Default%20Frameset?OpenFrameSet&Frame=Main&Src=%2F__80256cd200319c8e.nsf%2FPublishedContent%2F2fc3012a30357bea80256ce9003f3713!OpenDocument%26AutoFramed (accessed 09.05.2013)

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designations were revoked on the 31 March 2010 when the South Downs National Park Designation Order came into effect. In all, AONB designation covers approximately 15% of the land area of England.

England has been divided into areas with similar landscape character, which are called National Character Areas (NCAs). A total of 159 NCAs have been identified in England[2]. The boundaries of the NCAs are not precise and that many of the boundaries should be considered as broad zones of transition.

Natural England are currently re-writing and re-designing all of England's 159 NCA profiles and aim to publish all the revised profile by April 2014.

Heritage Coasts are areas defined (they are not statutorily designated) for the beauty and undeveloped nature of the coastline. They represent 33% (1,057km) of England's coastline and are managed to conserve their natural beauty and, where appropriate, to improve accessibility for visitors. Most Heritage Coasts are within the boundaries of National Parks or AONBs, although some including Lundy, the Durham Coast, and Flamborough Head stand alone.

A national record of nearly 1,450 Registered Historic Parks and Gardens which contribute to the landscape is maintained by English Heritage. It is a non-statutory designation but the designation is a material planning consideration.

There are 17 World Heritage Sites in England, the most recent of these to be recognised as such is the Cornwall and West Devon mining landscape which was inscripted by UNESCO in 2006[3].

### 10.3.2 Scotland

Scotland has been assessed as having 365 types of distinctive landscape character which are divided into 52 groupings [4].

Scotland has 40 National Scenic Areas (NSAs) covering more than one million hectares (12.7 % of Scotland) [5]. Other areas designated for their landscape include two National Parks and three Regional Parks together with a number of Special (local) Landscape Areas[6].

There are five World Heritage Sites in Scotland: St. Kilda; Old and New Towns of Edinburgh; the

[2] http://www.naturalengland.org.uk/ourwork/landscape/englands/character/areas/default.aspx
[3] http://whc.unesco.org/en/list/
[4] Scottish Natural Heritage , 2002, Natural Heritage Zones: A national assessment of Scotland's landscapes http://www.snh.gov.uk/docs/B464892.pdf
[5] Scottish Government, 2010, Land Use Strategy, Strategic Environmental Assessment Screening and Scoping Report, http://www.scotland.gov.uk/Resource/Doc/1051/0095735.pdf
[6] The term used for such local landscape designations varies from one local authority to another. For example, they are termed ''Areas of Great Landscape Value' in Moray, 'Special Landscape Areas' in Dumfries and Galloway, and 'Sensitive Landscape Character Areas' in Ayrshire. However, guidance published by Scottish Natural Heritage and Historic Scotland suggests the name be standardised to Special Landscape Area (SLA).

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Frontiers of the Roman Empire; Heart of Neolithic Orkney; and New Lanark.

SNH have produced a map which illustrates 'wild land' in Scotland. 'Wildness' in this context depends on four physical attributes, namely: the perceived naturalness of the land cover; the ruggedness of the terrain which is therefore difficult to cross; remoteness from public roads of ferries; and the visible lack of buildings, roads, pylons and other modern artefacts.

### 10.3.3 Wales

There are five AONBs in Wales, one of which straddles England and Wales (the Wye Valley AONB).[7] Other areas designated for their landscape include three National Parks covering 20% of Wales (Brecon Beacons, Snowdonia and Pembrokeshire Coast National Park); 495km of Heritage Coast, and 58 landscapes of outstanding/special historic interest.

There are three World Heritage Sites in Wales; Castles and Town Walls of King Edward in Gwynedd, Blaenavon Industrial Landscape and Pontcysyllte Aqueduct & Canal.

The Landscape Map of Wales recognises 49 sub-regional Landscape Character Areas across Wales.

## 10.4 Characteristics of those Areas most likely to be Significantly Affected

### 10.4.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

The northern section of the Scottish Midlands stretches into the Loch Lomond and the Trossachs National Park. The park features rolling lowland landscapes to the south with high mountains and deep valleys to the north. The park is in close proximity to a large percentage of Scotland's population and is therefore of high recreational value.

There are five NSAs in this SEA Area, two of which are within the boundaries of the National Park (Loch Lomond NSA and Trossachs NSA). The Kyle of Bute NSA lies in the west of the Area, on the western fringe of the Cowal peninsula. The other two NSAs (River Tay and the Upper Tweeddale) are on the northern and southern boundaries of the Area.

There are two World Heritage Sites in the Area; the Edinburgh Old & New Towns and the Antonine Wall which runs from Old Kilpatrick to Bo'ness.

[7] See http://www.ccgc.gov.uk/landscape--wildlife/protecting-our-landscape/special-landscapes--sites/protected-landscape/aonbs.aspx [Accessed September 2013]

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### 10.4.2 SEA Area 2: West Midlands, North West England and Southern Scotland

Much of Cumbria is designated as the Lake District National Park. The park features 16 lakes and is predominately characterised by moorland and fell. To the West of the National Park, lies St Bees Head Heritage Coast, the only section of Heritage Coast between Wales and Scotland.

There are six AONBs in the Area, the largest of which is the Forest of Bowland AONB. The Forest of Bowland is a highly diverse area, with over 82 Landscape Character Areas in 803 square kilometres.

Hadrian's Wall WHS is also within the Area. Hadrian's Wall is the most well known surviving frontier of the Roman Empire and is the most important monument built by the Romans in Britain. A National Trail Path follows the route of the Wall and is a major recreational attraction.

### 10.4.3 SEA Area 3: East Midlands and Eastern England

There are five National Parks in this Area: the Broads; the Peak District; the Yorkshire Dales; the North York Moors; and Northumberland. A total of six Heritage Coasts feature in this Area. The longest is the North Yorkshire and Cleveland Heritage Coast which acts as the seaward boundary to the North York Moors National Park.

SEA Area 3 also features three World Heritage Sites. Hadrian's Wall travels across the Area and also SEA Area 2. The Saltaire WHS is located near the city of Bradford and comprises of a well-preserved industrial village. The Derwent Valley Mills WHS spans a 24km stretch of the Derwent Valley from Matlock Bath to Derby city centre. It consists of a series of 18$^{th}$ and 19$^{th}$ Century cotton mills and an industrial landscape of high historical and technological interest.

There are five AONBs in the Area. Four of these share boundaries with National Parks (Nidderdale AONB, North Pennies AONB, Howardian Hills AONB, and the Norfolk Coast AONB).

### 10.4.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

The southern reaches of the Brecon Beacons National Park falls within SEA Area North 4. The Brecon Beacons is characterised by grassy moorland, with scattered forestry plantations and pastures in lower valleys. The Park is popular for many recreational activities, including walking, cycling, fishing and horse riding.

The south coast of SEA Area 4 features two Heritage Coasts. Glamorgan Heritage Coast runs from Aberthaw and Porthcawl and enjoys a high degree of coastal landscape diversity. Gower Heritage Coast provides the coastal boundary for the Gower AONB and features limestone cliffs.

In addition to the Gower AONB, there are two other AONBs in this SEA Area. The Clwydian Range and Dee Valley AONB in the North East of Wales is a 35km long chain of undulating hills, rising between the

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Vale of Clwyd to the West and the Dee Valley to the East. The Wye Valley AONB lies in the South East corner of the SEA Area and features sheer limestone cliffs where the river has cut into the rock.

There are two World Heritage Sites in SEA Area 4, one in the South Wales and one in North Wales. The Pontcysyllte Aqueduct and Canal WHS is a navigable aqueduct that carries the Llangollen Canal over the valley of the River Dee in Wrexham in North East Wales. It was completed in 1805 and is the longest and highest aqueduct in Britain. Blaenavon Industrial Landscape WHS provides an extraordinarily comprehensive picture of the South Wales coal and iron industry in its heyday in the 19th and early 20th Centuries, when it was one of the world's largest iron and steel producers.

### 10.4.5 SEA Area 5: Southern and South West England

The eastern fringes of the Exmoor and Dartmoor National Park fall within the boundary of SEA Area 5. In addition, the New Forest and South Downs National Parks fall wholly within the boundary of SEA Area 5.

The south coast of England contains eight Heritage Coasts in total. Three of these are related to the chalk cliffs of Dover (South Foreland, Dover Folkstone and Sussex).

There are 18 AONBs in SEA Area 5. Over half of all AONBs in England fall within this Area. Several of these AONBs (such as for example the North Wessex Downs, Kent Downs and the Cotswolds) have irregular and ADD WORD boundaries, often as a result of the geological features they are based upon.

There are seven World Heritage Sites in SEA Area 5. Five of these seven sites are in urban areas (Canterbury Cathedral, City of Bath, Royal Botanic Gardens of Kew, Westminster Palace and Abbey and Tower of London). The remaining two, are Stonehenge and Avebury and the Dorset and East Devon Coast.

## 10.5 Summary of Existing Problems Relevant to Onshore Oil and Gas Licensing

The following existing problems for landscape have been identified:

- As part of the most recent Countryside Quality Counts (2007) survey, 29% of National Character Areas in England were identified as having a changing landscape character, many of which were altering in a direction which could be regarded as inconsistent with the traditional landscape vernacular of the area. A similar study of landscape change is not available for Scotland or Wales, though changes have undoubtedly taken place in areas relevant to the SEA in these countries also;
- Light pollution appears to have increased considerably over the last 30-40 years over much of the UK. The growth of urban areas, road networks and industrial areas are all major contributors to increased light levels; and

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- The Scottish landscape is vulnerable to a variety of pressures. Key threats and opportunities to landscape character include the development of new infrastructure, agriculture, the loss and expansion of woodland and natural processes [8]. Wind energy development is placing a pressure on landscape character, in particular in Southern Scotland where there are 63 windfarms installed or approved.

## 10.6 Likely Evolution of the Baseline

### 10.6.1 National

#### UK

Over the last century the following landscape character trends have been experienced [9]:

- a gradual erosion of local distinctiveness in some areas, through a process of standardisation and simplification of some of the components that make up landscape character;
- a loss of some natural and semi-natural features and habitats such as ancient woodlands and unimproved grassland;
- a decline in some traditional agricultural landscape features such as farm ponds and hedgerows, and a loss of archaeological sites and traditional buildings;
- increased urbanisation, often accompanied by poor design standards and a decline in the variety of building materials, and the importation of urban and suburban building styles into rural areas; and
- a loss of remoteness and reduced tranquillity because of built development and traffic growth.

#### England

There are a number of pressures and risks outlined in the ***State of the Natural Environment 2008*** Report that may affect the quality of landscapes in England. These include[10]:

- **Sea-level rise:** Over the next few decades it is anticipated that there will be major sea incursions inland during storms, particularly on the south and east coasts of England. If measures such as managed retreat are not adopted in low-lying areas, there may be widespread losses of intertidal and coastal habitats. In the coastal zone, sea-level rise may also result in the direct loss of freshwater habitats such as reedbeds and wet grasslands;

[8] Scottish Natural Heritage, 2002, Natural Heritage Zones: A National Assessment of Scotland's Landscapes, http://www.snh.gov.uk/docs/B464892.pdf
[9] Natural England, State of the Natural Environment 2008, Landscape Characterisation and Change, http://www.naturalengland.org.uk/publications/sone/sections.aspx
[10] Natural England (2008) State of the Natural Environment http://www.naturalengland.org.uk/publications/sone/default.aspx

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- **Fire:** More droughts in the future will make the countryside increasingly vulnerable to wildfire, with potential for heathland, grassland, broadleaved woodlands and bogs to undergo major change in their structure;

- **Grazing management:** More summer droughts may mean that grazing is no longer possible in some open habitats such as fens, grasslands and heathlands due to die-back of vegetation and a lack of drinking water for animals. The spread of diseases (e.g. bluetongue) related to climate change may also reduce livestock numbers and restrict movement, altering grazing patterns and landscapes;

- **Energy production:** The production of biofuels in the countryside may result in changes to landscapes. Wind energy developments are likely to be more common; and

- **Development pressure:** Within rural England, the area of developed land has increased by about 4% since 1990. It is expected that the pace of development within England will increase in the future to make up for the current shortfall in housing provision. The effect of this increase pressure for development is likely to be felt most acutely in central and southern England, particularly around identified Growth Areas and Growth Points.

Natural England report that in 2008 existing landscape character was being maintained in 51% of England's landscapes, whilst in a further 10% existing character was being enhanced. However, 20% of landscapes were showing signs of neglect[11].

Data from 1990 to 2003 indicates that in England the number of Character Areas with patterns of change that either maintain or enhance character has increased from 36% to 61%. The number of Character Areas with evidence of neglect or erosion of character has decreased. This evidence suggests that the character of the majority of English landscapes, at Character Area scale, is being sustained.

Forestry Commission England seeks to maintain the area of certified woodland and to ensure that 95% of woodland SSSIs are in favourable condition by 2011[12].

The protected nature of National Park and AONB landscapes make it less likely that these landscapes will be affected by some of the risks outlined (e.g. development pressure) although those protected landscapes nearest to existing urban areas are more likely to be at risk.

## Scotland

Forestry Commission Scotland aimed to see Scotland's woodlands increase from 17.1% of land area to about 25% and bring 80% of the special features on Scotland's nationally important nature sites into favourable condition by March 2008.

[11] Natural England, State of the Natural Environment 2008, Landscape Characterisation and Change, http://www.naturalengland.org.uk/publications/sone/sections.aspx
[12] Forestry Commission England, 2008, Delivery Plan 2008-2012: England's Trees, Woods and Forests

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### Wales

The distinctive character of the Welsh landscape has been, and remains, under threat and is declining. Future changes to the farming subsidy regime have the potential to result in significant changes to the landscape[13]. In addition, climate change, new roads, other developments, over-fishing are combining to present a powerful threat to the Welsh environment and landscapes[14].

## 10.6.2 SEA Areas

### SEA Area 1: Scottish Midlands (including the Inner Forth)

There is a trend of increasing development pressure on landscape in the Scottish Midlands. Between 2008 and 2025, the population of the Clyde Valley is expected to increase by 66,000 people. Towards the east of the Area, a total of 1,000 hectares of land is allocated for employment land.

The Scottish Government has set a target of generating the equivalent of at least 100% of gross electricity consumption from renewable by 2020 and has identified around 14-16 GW of capacity to be deployed over the next seven years. The further deployment of onshore wind will remain a key strand in the effort to reach this additional capacity. The draft NPF3 notes that the draft Scottish Planning Policy makes it clear that the Scottish Government does not want to see new windfarms in National Parks and National Scenic Areas. In addition, it notes that it is highly likely that SNH will continue to resist new wind energy development in core areas of wild land.

Only four areas of 'wild land', out of a total of 43 are in the SEA Area 1. Similarly, only a small percentage of SEA Area 1 is designated as a National Park or National Scenic Area. It is therefore likely that there will be significant new wind energy development in SEA Area 1. Figures from SNH corroborate this view; as of August 2012 there were 116 windfarms in scoping or planning application stage in Southern Scotland[15]. This wind energy development will place a significant burden on local landscapes and is expected to have a significant cumulative impact across the region.

### SEA Area 2: West Midlands, North West England and Southern Scotland

The North West of England was identified in the now revoked Regional Spatial Strategy as an area that could deliver significant new development. The Regional Spatial Strategy directed much of this development to existing urban areas and brownfield land. However, it also identified a need for development in rural areas.

[13] ERM, 2009, Sustainability Appraisal of the Wales Waste Strategy: Sustainability Appraisal Report, http://wales.gov.uk/topics/environmentcountryside/epq/waste_recycling/zerowastebackground/appraisals/?lang=en
[14] http://www.wildlifepartnerships.org/aims.htm
[15] Scottish Natural Heritage, Onshore Windfarms in Scotland August 2012, http://www.snh.gov.uk/docs/A763435.pdf

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Analysis of changes in key elements of the landscape of the West Midlands indicate[16]:

- 63% of Landscape Character Areas (LCAs) are neglected or diverging from existing character;
- None of our LCAs was assessed as enhancing;
- National Parks and Areas of Outstanding Natural Beauty have largely maintained their character; and
- The region has a major concentration of agricultural landscapes that are neglected or showing diverging patterns of change, particularly in the eastern valleys and floodplains.

Landscapes in the West Midlands face pressure from changes in farming systems, climate change and development. Natural England works with stakeholders and partners to ensure that landscapes continue to evolve in ways that are distinctive and remain highly valued. They must be managed, protected and planned to deliver the goods and services that sustain the region's biodiversity, quality of life, prosperity and cultural identity and to allow for adaptation to climate change. Natural England is also working with farmers to ensure that agri-environment scheme options have the potential to reinforce the distinctive character of landscapes across the region.

## SEA Area 3: East Midlands and Eastern England

The characteristics associated with urban development (such as light pollution, traffic and noise pollution) are beginning to encroach on rural areas and the urban fringe due to development pressures in the East Midlands. Landscapes in rural areas may also be affected by the expansion of bio energy or new crops to help with renewable energy targets. Protected landscapes in the East Midlands, such as the Peak District and Lincolnshire Wolds AONB are under pressure due to intensive agricultural practices, recreational activities and residential development.

Along with a decrease in the tranquillity of landscapes in the East of England, local distinctiveness is being eroded by new large scale development.

## SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

TAN 8 has identified two Strategic Search Areas in South Wales where wind energy development would be supported[17]. Over 400 hectares of new native woodland is planted in Wales each year. This more or less balances the area of woodland which is permanently removed for habitat restoration or in the course of approved development[18]. There is likely therefore to be landscapes changes, particularly in the mid-

[16] Natural England (2009) State of the Environment Report West Midlands, http://publications.naturalengland.org.uk/publication/39008?category=118044

[17] Welsh Assembly Government (July 2005) Technical Advice Note 8: Planning for Renewable Energy

18 Forestry Commission (2009) Woodlands for Wales, The Welsh Assembly's Government Strategy for Woodlands and Trees,

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level valley's of South Wales as some woodland is removed and new areas are planted or existing areas expanded.

### SEA Area 5: Southern and South West England

There are significant pressures on landscapes in the South of England, in particular in the south east due to housing demands. Climate change is also expected to place additional pressures on landscapes in this region. Warmer, drier summers will impact on grazing patterns and crop production. Sea-level increases are also expected to result in major sea incursions which may have adverse effects on intertidal and coastal habitats.

The South West Future Landscapes Technical Report 2009[19] identifies significant challenges ahead if land management in the South West is to continue to deliver social and economic benefits whilst maintaining a high quality and distinctive landscape, including:

- competing demands for land and volatile commodity and fuel markets;
- food production, new forms of energy production, housing and related infrastructure increasing demand for recreational land use - equine, golf, hobby farming, garden centres,
- theme parks; and
- cumulative impacts of small scale development.

## 10.7 Assessing Significance

The objectives and guide questions related to landscape which have been identified for use in the appraisal of the effects of Licensing Plan proposals and alternatives are set out in **Table 10.1,** together with reasons for their selection.

**Table 10.1 Approach to Assessing the Effects of the Licensing Plan Landscape**

| Objective/Guide Question | Reasoning |
|---|---|
| **Objective: Protect and enhance landscape and townscape quality and visual amenity** | Considering the protection and enhancement of landscape and townscape character is a requirement of the NPPF, SPP and PPW. |
| Will the activities that follow the licensing round have significant visual impacts (including those at night)? | Visual impacts can influence how people perceive a landscape or townscape and can decrease the character and intrinsic value. |

http://www.forestry.gov.uk/pdf/EnglishWfWstrategy.pdf/$FILE/EnglishWfWstrategy.pdf

[19] Land Use Consultants (2009) South West Futures Landscape Programme, http://www.naturalengland.org.uk/Images/Phase%201%20Technical%20Report%20March%2009%20low%20res_tcm6-19385.pdf

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| Objective/Guide Question | Reasoning |
|---|---|
| Will the activities that follow the licensing round affect protected/designated landscapes or townscapes, such as National Parks, the Broads, Areas of Outstanding Natural Beauty, Heritage Coasts and Conservation Areas or affect Historic Landscapes? | Areas designated for their landscape value are important at a national level and should be protected from adverse effects and enhanced where possible. |
| Will the activities that follow the licensing round affect the intrinsic character of local landscapes or townscapes? | Considering the protection and enhancement of landscape and townscape character is a requirement of NPPF, SPP and PPW. |
| Will the activities that follow the licensing round affect public access to open spaces or the countryside? | *National Parks and Access to the Countryside Act 1949* and *Countryside and Rights of Way Act 2000* makes provision for National Parks, confer on the Nature Conservancy and local authorities powers for the establishment and maintenance of nature reserves, makes provision for the recording, creation, maintenance and improvement of public paths and for securing access to open country and confers further powers for preserving and enhancing natural beauty.<br><br>*Countryside and Rights of Way Act 2000* increased the duty of provision of public access to the countryside. |

**Table 10.2** sets out guidance that will be utilised during the assessment to help determine the relative significance of potential effects on the landscape objective. It should not be viewed as definitive or prescriptive; merely illustrative of the factors that may be considered as part of the assessment process.

**Table 10.2 Illustrative Guidance for the Assessment of Significance for Landscape**

| Effect | Description | Illustrative Guidance |
|---|---|---|
| ++ | Significant Positive | • Option would make a significant positive contribution to statutorily-designated landscapes or Historic Landscapes;<br>• Option would have a significant positive effect on the setting and attractiveness of local landscapes and townscapes (e.g. through the replacement of poorly designed/derelict buildings with high quality development);<br>• Option would enhance public access to the countryside and increase open space provision. |
| + | Minor Positive | • Option would serve to enhance statutorily-designated landscapes or Historic Landscapes;<br>• Option would have a positive effect on the setting and attractiveness of local landscapes and townscapes;<br>• Option would enhance public access to open spaces and the countryside. |
| 0 | Neutral | • Option would not have any effects on landscapes or visual amenity;<br>• Option would not enhance or restrict public access to open spaces and the countryside |
| - | Minor Negative | • Option would have short-term negative effects on statutorily-designated landscapes or Historic Landscapes;<br>• Option would have a negative effect on the intrinsic character of landscapes and townscapes; |

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| Effect | Description | Illustrative Guidance |
|---|---|---|
| | | • Option would affect the visual amenity of local communities;<br>• Option would temporally restrict public access to open spaces and the countryside. |
| -- | Significant Negative | • Option would have long-term negative effects on statutorily-designated landscapes or Historic Landscapes;<br>• Option would severely affect the intrinsic character of landscapes and townscapes;<br>• Option would severely affect the visual amenity of local communities;<br>• Option would result in the loss of open spaces and restrict public access to the countryside. |
| ? | Uncertain | • From the level of information available the effects the impact that the option would have on this objective is uncertain. |

## 10.8 Assessment of Effects

This section comprises the assessment of the potential activities that could follow on from the licensing round on the landscape objective. There are a total of six main stages of oil and gas exploration and production (including gas storage) that are the subject of the assessment. These are highlighted in **Table 10.3** for both conventional and unconventional oil and gas together with an overview of the associated key activities at each stage. Please note that Stages 1, 2 and 4 do not necessarily apply to gas storage, depending on the history of the particular site.

**Table 10.3 Oil and Gas Exploration and Production Lifecycle and Key Activities**

| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| 1. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. |
| 2. | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring.* | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. |
| 3. | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring; | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation; |

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| Stage | Activities: Conventional Oil and Gas | Activities: Unconventional Oil and Gas (Shale Gas and Virgin Coalbed Methane) |
|---|---|---|
| | • Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring* | • Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. |
| 4. | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring.* | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. |
| 5. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. |
| 6. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. |

Note: Exploration wells most usually move from Stage 2 to Stage 5, though some may be used for long-term production testing (which would require new consents including planning permission) and some may be retained and their sites redeveloped as a production project (this would also require new consents including planning permission). For the purposes of this assessment, the appraisal stage (a term commonly used in industry) spans Stages 2 and 3.

*Conventional oil and gas exploration and production activities (stages 2 to 4 above) can occasionally include hydraulic fracturing. However, the need to undertake hydraulic fracturing is relatively uncommon and has therefore not been considered in the assessment of conventional oil and gas activities as part of this SEA.

### 10.8.1 Conventional Oil and Gas

The assessment of the six main stages of conventional oil and gas production is contained in **Table 10.4**. The first two columns describe the exploration and production stage. The third and fourth columns summarise the expected effects on the landscape objective for both low activity and high activity scenarios (as described in **Section 2.5** of the main Environmental Report). The rationale for this relationship is explained in more detail in the final column and includes:

- the nature and scale of the potential effects on the landscape objective;
- when the effect could occur (timing) and its degree of permanence;
- what mitigation measures might be appropriate for potentially significant negative effects on the landscape objective;
- what options there are to enhance positive effects; and

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- assumptions and uncertainties that underpin the assessment.

**Table 10.4 Assessment of Effects: Conventional Oil and Gas**

| **Objective 12: Landscape** | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>Stage 1of the oil and gas exploration and production lifecycle would comprise non-intrusive activities. Site identification, selection and characterisation and the securing of development and operation permits would be largely desk-based and in consequence, no effects on landscapes are anticipated from this activity.<br>Vibroseis is the most commonly used method of seismic survey and involves the employment of large vibrator unit vehicles as well as support vehicles for data recording. Construction of temporary tracks/roads may be required to facilitate site access. However, tracks/roads would be of temporary nature and land would be restored following completion of surveys.<br>In some cases it may be necessary to fall back to the shot-hole survey method. This involves the drilling of a hole with a small diameter for the insertion of explosives which are infilled after use.<br>Public access to open spaces and the countryside is not likely to be restricted by these activities.<br>The effects on landscapes and visual amenity would be localised and of temporary nature, occurring only during seismic surveys. Public access to the countryside would not be restricted through non-intrusive exploration activities. In consequence, the effects of this stage of the activities on the objective have been assessed as being neutral.<br>**Low and High Activity Scenarios:**<br>This stage of the life cycle is non-intrusive and would have limited effects as site identification, selection and characterisation as well as obtaining development and operation permits would largely be desk-based.<br>The amount of seismic surveys required under the high activity scenario would be higher. Consequently, a larger number of access tracks/roads is likely to be required (albeit that it would still be a small scale). However, given the short-term and localised nature of survey activity, effects are not anticipated under either scenario.<br>**Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• Existing tracks/roads would be used where possible.<br>**Uncertainties:**<br>• None identified. |

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| Objective 12: Landscape | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 2 | **Exploration drilling,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Well design construction and completion;<br>• Well testing including flaring. | **-** | **-/?** | **Assessment of Effects:**<br>Stage 2 of the oil and gas exploration and production lifecycle is exploration drilling. The activity associated with this stage would mainly take place on site with some associated activity such as the construction of road connections located off-site.<br>Activity associated with pad preparation, road access and well construction would have short-term impacts on visual amenity and landscapes. Further visual impacts could result from the presence of well heads and drilling rigs (approximately 4 weeks per well). The height of the drilling rig could be approximately 26m and could result in locally adverse effects depending on the setting, screening and extent to which the site would be overlooked. However, due to the short duration of the phase, these effects would be temporary.<br>The average area covered by a pad for conventional oil and gas exploration is 1 hectare with site clearing (vegetation, soil layers) likely to be required at this stage. Additional clearing may be required for the provision of service roads.<br>Flaring associated with testing may result in visual impacts. The effect will be dependent on location, height, duration and timing of the flare. However, licence requirements ensure that flaring is kept to the economic minimum[20]. Furthermore, it is assumed that effects will be minimised through the use of best available technology (BAT), such as stack design which minimises visual intrusion effects. It is assumed that night pollution resulting from other construction activities would be mitigated through appropriate measures such as restricted working hours and shielding of emergency lighting to minimise disturbance.<br>Public access to open spaces and the countryside is unlikely to be affected from the activity due to the small area (1ha) of the site and the fact that activities would take place on the site.<br>The exploration phase would lead to adverse effects on the landscape and visual impacts. However, these would be short-term and of localised nature. Effects would be less where development would take place in an industrial setting.<br>**Low and High Activity Scenarios:**<br>A greater density of exploration activity associated with the high activity scenario could result in an increased magnitude of adverse effects as the intrinsic character of landscapes and townscapes may be affected due to the presence of a large number of pads under construction at the same (or similar time). The magnitude of the effect is uncertain as it will be dependent on several factors; |

[20] Department of Energy and Climate Change (2009) Guidance Notes for Onshore Oil and Gas Field Development Plans (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/15560/onshoreogfdpguide.doc) (last accessed 27/08/2013)

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| Objective 12: Landscape | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | including the distribution patterns of pads, their density, their phasing, the nature, quality and designations of the receiving landscape and the extent to which such landscape changes are visible to communities. It must be noted that construction density would be limited by the minimum distance (5km) required between pads. This applies to both, the low and high density scenarios.<br>**Mitigation:**<br>• Best practice construction techniques such as minimising the vertical height of drilling equipment and site hoarding.<br>• Periodical exploration to reduce cumulative effects, particularly under the high activity scenario.<br>• Light pollution should be mitigated by restricting the working hours and by screening emergency lighting.<br>**Assumptions:**<br>• Visual impacts resulting from flaring can be minimised through use of Best Available Technology (BAT).<br>• Exclusion and technical controls would be implemented under existing planning and consenting legislation.<br>**Uncertainties:**<br>None identified. |
| 3 | **Production development,** including:<br>• Pad preparation, road connections and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Provision of pipeline connections.<br>• Well testing, possibly including flaring. | **-** | **-/?** | **Assessment of Effects:**<br>The production development stage would include similar activities as under stage 2. This would include pad preparation; however, the average area covered by the well pad would be increased from 1 hectare to 2-3 hectares. The expansion of landtake associated with this phase would increase potential visual impacts, particularly where this would involve clearing of high standing vegetation such as trees and shrubs.<br>Additional construction activity would be required for facility provision and installation of pipeline connections. The effects on the landscape resulting from the construction of pipelines would be short term and are likely to be reversed once habitat restoration has been completed. Furthermore, the magnitude of effects would depend on the width of the development corridor (which in itself is dependent on the pipeline diameter), length and location. Effects are likely to be more pronounced if the pipeline would lead through designated landscapes such as AONB or National Parks.<br>Presence of the pipeline would have short-term adverse effects on the objective. The magnitude of effects would be dependent on routing, corridor length and width and the speed of restoration and re-vegetation.<br>Production development could lead to minor negative effects on landscape due to the development size of pads and the development of the associated infrastructure. The scale of effect is uncertain as it is dependent on a number of factors including; the |

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| Objective 12: Landscape | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | distribution and density of pads, the phasing of their development, the nature, quality and designations of the receiving landscape and the extent to which such landscape changes are visible to communities.<br>**Low and High Activity Scenarios:**<br>The total number of possible well pads per site would be 3 (low activity) to 6 (high activity), leading to an average area covered by well pads of 6-9 hectares/12-16 hectares respectively.<br>A minimum distance of 5km (in most densely developed areas) would be required between well pads and would minimise cumulative effects under both scenarios. Effects from this phase would be short-term and their magnitude would be dependent on the distribution and density of pads, the phasing of their development as well as the nature, quality and designations of affected landscapes and the extent to which changes would be visible to communities. The effect is likely to be greater with the higher activity scenario; however, will still be dependent on the factors outlined.<br>**Mitigation:**<br>• Best practice construction techniques such as minimising the vertical height of drilling equipment and site screening through existing features or use of planting and landscaping.<br>• Potential for the phasing of the development of well pads to minimise cumulative impacts.<br>• Design measures to minimise effects resulting from pipelines. This could include measures such as routing along existing roads, minimising corridor width and maximising the speed of restoration and re-vegetation as feasible.<br>**Assumptions:**<br>• Restrictions on activities and technical controls would be implemented under existing planning and consenting legislation.<br>**Uncertainties:**<br>• None identified. |

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| Objective 12: Landscape | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 4 | **Production/operation/ maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | **0/-** | **0/-** | **Assessment of Effects:**<br>There would be no additional effects resulting from this stage under the assumption that production, operation and maintenance would take place on the existing site. This stage does not involve the introduction of additional infrastructure which could have implications on the landscape. However, it is likely that residual effects on the landscape would remain in the long-term and may result in a permanent change of landscape and visual amenity for many communities. The degree of perceived intrusion is likely to be lessened through growing maturity of landscaping and revegetation. In some cases it may be possible to minimise effects through mitigation measures, such as screening through existing features or planting and landscaping. Effects resulting from the construction of the pipeline have been assessed as neutral in the medium and long term as habitats recover and corridor vegetation matures.<br>**Low and High Activity Scenarios:**<br>No effects on landscape and visual impacts are anticipated under both scenarios.<br>**Mitigation:**<br>• Site screening (existing or through planting and landscaping) should be used to mitigate long-term residual adverse effects.<br>**Assumptions:**<br>• No additional infrastructure would be introduced at this stage.<br>**Uncertainties:**<br>• None identified. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>Decommissioning of wells and removal of site equipment would involve some construction activity. The activity would be short-term and take place on the existing site. Consequently no additional effects on landscape or visual impacts are anticipated.<br>**Low and High Activity Scenarios:**<br>There are no anticipated differences between low and high activity scenarios.<br>**Mitigation:**<br>• A study of the surrounding landscape character should be undertaken prior to decommissioning to identify measures which would allow efficient site restoration as well as opportunities for the enhancement of landscapes.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• None identified. |

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## Objective 12: Landscape

| *Stage* | *Description* | *Score* | | *Commentary* |
|---|---|---|---|---|
| | | *Low Activity Scenario* | *High Activity Scenario* | |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | 0/+ | 0/+ | **Assessment of Effects:**<br>Site restoration and reclamation would take place on the existing site with the aim to restore the site to the original condition.<br>It may not be possible to remove all well-equipment from the site, however, remaining structures would be small scale and would not affect the general landscape or have visual impacts.<br>Long-term effects on the landscapes have been anticipated to be neutral under the assumption that the original state of the site can be restored and that remaining structures would be negligible.<br>Potential for the enhancement of landscapes has been identified where the original site character is of low value.<br>**Low and High Activity Scenarios:**<br>There are no anticipated differences between low and high activity scenarios.<br>**Mitigation:**<br>• Remaining structures should be incorporated into site design during restoration and reclamation.<br>**Assumptions:**<br>• Site restoration to original condition is feasible.<br>• Opportunities for the enhancement of landscapes would be taken.<br>**Uncertainties:**<br>• Opportunities for the enhancement of sites with poor landscape character are unknown at this stage of the assessment. |

### *Summary*

Minor negative effects have been identified during exploration drilling and production development. The magnitude of effects is uncertain at this stage of the assessment and is dependent on the actual setting of the site. Development in an industrial setting is anticipated to have a lesser effect than sites located in less developed areas, particularly where those areas have nationally significant and designated landscapes, attract a significant number of visitors because of their tranquillity and beauty and where the effects are highly visible due to topography, the absence of existing screening and increased well pad density. Non-intrusive exploration would have a neutral effect on the objective due to the limited on-site activity. It must be acknowledged that some residual effects may remain during the production, operation and maintenance phase. These effects could be perceived as negative by communities as they could result in a permanent change of landscapes and visual amenity. The decommissioning of wells would not have an effect on the objective as activity would be taking place on the already existing site. Potential for landscape enhancement has been identified during site restoration and reclamation, particularly where the original site is of low value.

### Mitigation Summary

- **Exploration drilling:** Best practice construction techniques such as minimising the vertical height of drilling equipment and site screening through existing features or use of planting and landscaping should be in place. Exploration should take place periodically to minimise cumulative effects, particularly under the high activity scenario.
- **Production development:** Best practice construction techniques such as minimising the vertical height of drilling equipment and site screening through existing features or use of planting and landscaping should be in place. Production development should take place periodically to minimise cumulative effects. Design measures should aim to minimise effects on landscapes and visual impacts resulting from pipelines. This could include measures such as routing of pipelines along existing infrastructure (e.g. roads), minimising corridor width and maximising the speed of restoration and re-vegetation, as feasible.
- **Production/operation/maintenance:** Site screening through existing features or the use of planting and landscaping should be use to mitigate residual long term effects.

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| Objective 12: Landscape | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| • **Decommissioning of wells:** A study of the surrounding landscape character should be undertaken prior to decommissioning to identify measures which would allow efficient site restoration as well as opportunities for the enhancement of landscapes.<br>• **Site restoration and relinquishment:** Remaining structures should be incorporated into site design during restoration and reclamation. | | | | |

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 10.8.2 Unconventional Oil and Gas

The assessment of the six main stages of unconventional oil and gas production is contained in **Table 10.5** under both low activity and high activity scenarios (as described in **Section 2.5** of the main Environmental Report).

**Table 10.5 Assessment of Effects: Unconventional Oil and Gas**

| Objective 12: Landscape | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| 1 | **Non-intrusive exploration,** including:<br>• Site identification, selection, characterisation;<br>• Seismic surveys;<br>• Securing of necessary development and operation permits. | **0** | **0** | **Assessment of Effects:**<br>Stage 1of the unconventional oil and gas exploration and production lifecycle would comprise non-intrusive activities. Site identification, selection and characterisation and the securing of development and operation permits would be largely desk-based and in consequence, no effects on landscapes are anticipated from this activity.<br>Vibroseis is the most commonly used method of seismic survey and involves the employment of large vibrator unit vehicles as well as support vehicles for data recording. Construction of temporary tracks/roads may be required to facilitate site access. However, tracks/roads would be of temporary nature and land would be restored following completion of surveys.<br>In some cases it may be necessary to fall back to the shot-hole survey method. This involves the drilling of a hole with a small diameter for the insertion of explosives which are infilled after use.<br>Public access to open spaces and the countryside is not likely to be restricted by these activities. |

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| Objective 12: Landscape | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | The effects on landscapes and visual amenity would be localised and of temporary nature, occurring only during seismic surveys. Public access to the countryside would not be restricted through non-intrusive exploration activities. In consequence, the effects of this stage of the activities on the objective have been assessed as being neutral.<br>**Low and High Activity Scenarios:**<br>This stage of the life cycle is non-intrusive and would have limited effects on the objective as site identification, selection and characterisation as well as obtaining development and operation permits would largely be desk-based.<br>The amount of seismic surveys required under the high activity scenario would be higher. Consequently, a larger number of access tracks/roads is likely to be required. However, given the short-term and localised nature of survey activity, effects are not anticipated under either scenario.<br>**Mitigation:**<br>• None identified.<br>**Assumptions:**<br>• Existing tracks/roads would be used where possible.<br>**Uncertainties:**<br>• None identified. |
| 2 | **Exploration drilling and hydraulic fracturing**, including:<br>• Pad preparation road connections and baseline monitoring;<br>• Well design and construction and completion;<br>• Hydraulic fracturing;<br>• Well testing including flaring. | - | -/-- | **Assessment of Effects:**<br>Stage 2 of the oil and gas exploration and production lifecycle is exploration drilling. The activity associated with this stage would mainly take place on site with some associated activity such as the construction of road connections located off-site. Activity associated with pad preparation, road access and well construction would have short-term impacts on visual amenity and landscapes. Further visual impacts could result from the presence of well heads and drilling rigs (approximately 4 weeks per well). The height of the drilling rig would be approximately 26m and could result in locally significant effects depending on the setting, screening and extent to which the site would be overlooked. However, due to the short duration of the phase, these effects would be temporary.<br>The average area covered by a pad for unconventional oil and gas exploration is 1 hectare with site clearing (vegetation, soil layers) likely to be required at this stage. Additional clearing may be required for the provision of service roads.<br>Flaring associated with testing may result in visual impacts. The effect will be dependent on location, height, duration and timing of the flare. However, licence requirements ensure that flaring is kept to the economic minimum[21]. Furthermore, it is assumed that effects will be minimised through the use of best available technology (BAT), such as |

[21] Department of Energy and Climate Change (2009) Guidance Notes for Onshore Oil and Gas Field Development Plans (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/15560/onshoreogfdpguide.doc) (last accessed 27/08/2013)

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| Objective 12: Landscape | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | stack design which minimises visual intrusion effects. It is assumed that night pollution resulting from other construction activities would be mitigated through appropriate measures such as restricted working hours and shielding of emergency lighting to minimise disturbance.<br>Public access to open spaces and the countryside is unlikely to be affected from the activity due to the small area (1ha) of the site and the fact that activities would take place on the site.<br>Chemical storage tanks and plants associated with hydraulic fracturing would result in additional elements on site. Furthermore water storage tanks may be required, particularly in remote areas with limited or no connection to water mains. These elements would contribute to the visual intrusion associated with this stage.<br>The exploration phase would lead to adverse effects on the landscape and visual impacts. However, these would be short-term and of localised nature. Effects would be less significant where development would take place in an industrial setting.<br>**Low and High Activity Scenarios:**<br>A greater density of exploration activity associated with the high activity scenario could result in significant adverse effects as the intrinsic character of landscapes and townscapes may be affected due to the presence of a large number of pads under construction at the same (or similar time). For the high activity scenario that anticipates that 24 wells will be drilled per pad, this could mean that a drilling rig could be on site for more than two years (if the assumption that it takes 4 weeks to drill each well holds). The significance of the effect on landscape will depend on the number of wells per pad, the distribution patterns of the pads, their density, their phasing, the nature, quality and designations of the receiving landscape and the extent to which such landscape changes are visible to communities. It must be noted that construction density would be limited by the minimum distance (5km) required between pads. This applies to both, the low and high density scenarios. Additionally, landscape and visual impacts, including in respect of designated sites, would also be considered during the Town and Country planning and, where appropriate, Environmental Impact Assessment (EIA) processes.<br>**Mitigation:**<br>• Best practice construction techniques such as minimising the vertical height of drilling equipment and site screening through existing features or use of planting and landscaping.<br>• Periodical exploration to reduce cumulative effects, particularly under the high activity scenario.<br>• Light pollution should be mitigated by restricting the working hours and by screening emergency lighting.<br>**Assumptions:**<br>• 50 per cent of wells would have access to water from the mains. |

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| Objective 12: Landscape | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Visual impacts resulting from flaring can be minimised through use of Best Available Technology (BAT).<br>• Exclusion and technical controls would be implemented under existing planning and consenting legislation.<br>**Uncertainties:**<br>• None identified. |
| 3 | **Production development,** including :<br>• Pad preparation and baseline monitoring;<br>• Facility construction and installation;<br>• Well design construction and completion;<br>• Hydraulic fracturing;<br>• Well testing, possibly including flaring<br>• Provision of pipeline connections<br>• (Possibly) re-fracturing. | -/-- | -/-- | **Assessment of Effects:**<br>The production development stage would include similar activities as under stage 2. This would include pad preparation; however, the average area covered by the well pad would be increased from 1 hectare to 2-3 hectares. The expansion of landtake associated with this phase would increase potential visual impacts, particularly where this would involve clearing of high standing vegetation such as trees and shrubs.<br>Chemical storage tanks and plants associated with hydraulic fracturing would result in additional elements on site. Furthermore, as more wells are drilled, additional water storage tanks may be required, particularly in remote areas with limited or no mains connection. These elements would contribute to the visual intrusion associated with this stage.<br>Additional construction activity would be required for facility provision and installation of pipeline connections. The effects on the landscape resulting from the construction of pipelines could be significant but would be short term and are likely to be reversed once habitat restoration has been completed. Furthermore, the significance of effects would depend on the width of the development corridor (which in itself is dependent on the pipeline diameter), length and location. Effects are likely to be more significant if the pipeline would lead through designated landscapes such as AONB or National Parks.<br>Presence of the pipeline would have short-term adverse effects on the objective. Significant effects could occur, particularly in designated landscapes The significance of effects would be dependent on routing, corridor length and width and the speed of restoration and revegatation.<br>Production development could lead to minor negative effects on landscape due to the development size of pads and the development of the associated infrastructure. These effects could potentially be significant depending on the distribution and density of pads, the phasing of their development, the nature, quality and designations of the receiving landscape and the extent to which such landscape changes are visible to communities.<br>**Low and High Activity Scenarios:**<br>The total number of possible well pads per site would be 30 (low activity) to 120 (high activity), leading to an average area covered by well pads of 60-90 hectares/240-360 hectares respectively.<br>A minimum distance of 5km (in most densely developed areas) would be required between well pads and would minimise cumulative effects under both scenarios. Consequently the significance of effects is anticipated to be similar under both scenarios. Effects from this phase would |

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| Objective 12: Landscape | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | be short-term and their significance would be dependent on the distribution and density of pads, the phasing of their development as well as the nature, quality and designations of affected landscapes and the extent to which changes would be visible to communities. The probability of significant effects under the high activity scenario would be higher due to the number of pads envisaged, but would be dependent on the aforementioned factors. Landscape and visual impacts, including in respect of designated sites, would also be considered during the Town and Country planning and, where appropriate, Environmental Impact Assessment (EIA) processes.<br>**Mitigation:**<br>• Best practice construction techniques such as minimising the vertical height of drilling equipment and site screening through existing features or use of planting and landscaping.<br>• Potential for the phasing of the development of well pads to minimise cumulative impacts.<br>• Design measures to minimise effects resulting from pipelines. This could include measures such as routing along existing roads, minimising corridor width and maximising the speed of restoration and revegatation as feasible.<br>**Assumptions:**<br>• 90 per cent of wells would have access to water from the mains.<br>• Exclusion and technical controls would be implemented under existing planning and consenting legislation.<br>**Uncertainties:**<br>• None identified. |
| 4 | **Production/operation/maintenance,** including:<br>• Gas/oil production;<br>• Production and disposal of wastes/emissions;<br>• Power generation, chemical use and reservoir monitoring;<br>• Environmental monitoring and well integrity monitoring. | - | - | **Assessment of Effects:**<br>There would be no additional effects resulting from this stage under the assumption that production, operation and maintenance would take place on the existing site. This stage does not involve the introduction of additional infrastructure which could have implications on the landscape. However, there may be some short term effects associated with wells that are refractured. It is likely that residual effects on the landscape would remain in the long-term and may result in a permanent change of landscape and visual amenity for many communities. The degree of perceived intrusion is likely to be lessened through growing maturity of landscaping and revegetation. In some cases it may be possible to minimise effects through mitigation measures, such as screening through existing features or planting and landscaping. Effects resulting from the construction of the pipeline have been assessed as neutral in the medium and long term as habitats recover and corridor vegetation matures.<br>**Low and High Activity Scenarios:**<br>No effects on landscape and visual impacts are anticipated under both scenarios. |

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| Objective 12: Landscape | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • **Mitigation:**<br>• Site screening (existing or through planting and landscaping) should be used to mitigate long-term residual adverse effects.<br>**Assumptions:**<br>• No additional infrastructure would be introduced at this stage.<br>**Uncertainties:**<br>• None identified. |
| 5 | **Decommissioning of wells,** including:<br>• Well plugging and testing;<br>• Site equipment removal;<br>• Environmental monitoring and well integrity monitoring. | **0** | **0** | **Assessment of Effects:**<br>Decommissioning of wells and removal of site equipment would involve some construction activity. The activity would be short-term and take place on the existing site. Consequently no additional effects on landscape or visual impacts are anticipated.<br>**Low and High Activity Scenarios:**<br>There are no anticipated differences between low and high activity scenarios.<br>**Mitigation:**<br>• A study of the surrounding landscape character should be undertaken prior to decommissioning to identify measures which would allow efficient site restoration as well as opportunities for the enhancement of landscapes.<br>**Assumptions:**<br>• None identified.<br>**Uncertainties:**<br>• None identified. |
| 6 | **Site restoration and relinquishment,** including:<br>• Pre-relinquishment survey and inspection;<br>• Site restoration and reclamation. | **0/+** | **0/+** | **Assessment of Effects:**<br>Site restoration and reclamation would take place on the existing site with the aim to restore the original condition.<br>It may not be possible to remove all well-equipment from the site, however, remaining structures would be small scale and would not affect the general landscape or have visual impacts.<br>Long-term effects on the landscapes have been anticipated to be neutral under the assumption that the original state of the site can be restored and that remaining structures would be negligible.<br>Potential for the enhancement of landscapes has been identified where the original site character is of low value.<br>**Low and High Activity Scenarios:**<br>There are no anticipated differences between low and high activity scenarios.<br>**Mitigation:**<br>• Remaining structures should be incorporated into site design during restoration and reclamation.<br>**Assumptions:**<br>• Site restoration to original condition is feasible. |

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| Objective 12: Landscape | | | | |
|---|---|---|---|---|
| ***Stage*** | ***Description*** | ***Score*** | | ***Commentary*** |
| | | ***Low Activity Scenario*** | ***High Activity Scenario*** | |
| | | | | • Opportunities for the enhancement of landscapes would be taken.<br>**Uncertainties:**<br>• None identified. |

***Summary***

Minor to significantly negative effects have been identified during exploration drilling and production development. The significance of effects is uncertain at this stage of the assessment and is dependent on the actual setting of the site. Development in an industrial setting is anticipated to have a lesser effect than sites located in less developed areas, particularly where those areas have nationally significant and designated landscapes, attract significant a number of visitors because of their tranquillity and beauty and where the effects are highly visible due to topography, the absence of existing screening and increased well pad density. Non-intrusive exploration would have a neutral effect on the objective due to the limited on-site activity. Additional elements which could result in further effects on the landscape character (when compared to conventional oil and gas exploration) are chemical and water storage tanks associated with hydraulic fracturing. Some residual effects may remain during the production, operation and maintenance phase. These effects could be perceived as negative by communities as they could result in a permanent change of landscapes and visual amenity. The decommissioning of well would not have an effect on the objective as activity would be taking place on the already existing site. Potential for landscape enhancement has been identified during site restoration and reclamation, particularly where the original site is of low value.

**Mitigation Summary**

- **Exploration drilling:** Best practice construction techniques such as minimising the vertical height of drilling equipment and site screening through existing features or use of planting and landscaping should be in place. Exploration should take place periodically to minimise cumulative effects, particularly under the high activity scenario.
- **Production development:** Best practice construction techniques such as minimising the vertical height of drilling equipment and site screening through existing features or use of planting and landscaping should be in place. Production development should take place periodically to minimise cumulative effects. Design measures should aim to minimise effects on landscapes and visual impacts resulting from pipelines. This could include measures such as routing of pipelines along existing infrastructure (e.g. roads), minimising corridor width and maximising the speed of restoration and revegetation, as feasible.
- **Production/operation/maintenance:** Site screening through existing features or the use of planting and landscaping should be use to mitigate residual long term effects.
- **Decommissioning of wells:** A study of the surrounding landscape character should be undertaken prior to decommissioning to identify measures which would allow efficient site restoration as well as opportunities for the enhancement of landscapes.
- **Site restoration and relinquishment:** Remaining structures should be incorporated into site design during restoration and reclamation.

| **Score Key:** | **+ +** **Significant** positive effect | | **+** **Minor** positive effect | | **0** No overall effect | | **-** **Minor** negative effect | | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

*S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)*

## 10.9 Virgin Coalbed Methane

The effects of exploration and production activities associated with virgin coalbed methane (VCBM) are similar to those described in the assessment of effects of unconventional oil and gas (Stages 1-6) in **Table 10.4** and **Table 10.5** above although fracturing is not normally required. No attempt has been made to provide an indication of low and high levels of activity.

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Effects could be less significant due to the fact that exploration drilling and production sites are smaller (approximately 0.25 hectare). The significance of effects is dependent on the setting, screening, density and extent to which the site would be overlooked. Effects on nationally significant and designated landscapes could be significant as they attract a high number of visitors because their tranquillity and beauty. Decommissioning of wells and removal of associated infrastructure usually is speedy and is anticipated to take between two and six weeks. The removal of infrastructure associated with a multiwell development would likely be gradual and take place at the end of the lifetime of the development (up to 30 years). The spatial extend of physical disturbance associated with this stage is unlikely to exceed that of the construction and operation phase [22]. Effects resulting from site restoration and relinquishment are likely to be similar to those associated with conventional and unconventional oil and gas (see **Tables 10.4 and 10.5**). Potential for the enhancement of landscape and visual amenity has been identified, particularly where the original site is of low value.

## 10.10 Gas Storage

The development of gas storage capacity is likely to entail the following activities:

1. Construction & Installation of Pipelines and Storage Facilities
2. Storage operations
3. Decommissioning

The likely effects of these activities are appraised in **Table 10.6** below.

**Table 10.6 Assessment of Effects: Gas Storage**

| **Objective 12: Landscape**<br>***Stage Description*** | ***Score*** | ***Commentary*** |
|---|---|---|
| **Construction & Installation of Pipelines and Storage Facilities** | - | **Assessment of Effects:**<br>Gas storage projects considered under this SEA involve the use of depleted reservoirs and it has therefore been assumed that some existing infrastructure would be in place. Using existing oil and gas infrastructure would reduce the physical footprint of the development, however further wells may need to be drilled depending on the characteristics of the store. Furthermore, gas processing facilities involving above ground sites of approximately 2 hectares, as well as pipeline connections would be required. |

[22] DECC (2010) Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds: Environmental Report.

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| **Objective 12: Landscape**<br>***Stage Description*** | ***Score*** | ***Commentary*** |
|---|---|---|
| | | The development of gas storage facilities and associated infrastructure is likely to require site clearing and bears potential for adverse effects on landscapes and visual amenity. The significance of effects depends on the setting, screening, density and extent to which the site would be overlooked. Considering the average size of above ground sites and the likelihood that facilities would be located at existing oil and gas infrastructures sites, negative effects are likely to be minor.<br>Drilling of additional wells could have temporary adverse effects on the objective through the presence of associated drilling heads and rigs.<br>Effects associated with the construction of pipelines would be dependent on routing, corridor length and width (which in itself is dependent on the pipeline diameter), location and the speed of restoration and revegatation. Significant effects could occur should pipeline routing through designated or protected landscapes be required. However, all effects are likely to be temporarily restricted and lessened as corridor vegetation matures.<br>Overall the effects of this stage are likely to be minor significant. However, it must be noted that effects could be significant if development would take place on designated landscapes such as National Parks and AONBs.<br>**Mitigation:**<br>• Adverse effects resulting from the construction should be minimised through site screening (existing features or planting and landscaping). Additional effects from the provision of pipelines should be mitigated by routing along existing infrastructure (e.g. roads), minimising corridor length and width and the speedy restoration and revegetation of the corridor.<br>**Assumptions:**<br>• Existing infrastructure would be used and the physical footprint consequently reduced.<br>**Uncertainties:**<br>• None identified. |
| **Storage Operations** | - | **Assessment of Effects:**<br>Storage operations are not likely to result in additional adverse effects on the objective. However, it is possible that residual effects from the introduction of above ground infrastructure would remain. Considering the average size of above ground sites and the likelihood that facilities would be located at existing oil and gas infrastructures sites, negative effects are likely to be minor. However, it must be noted that effects could be significant if the development is located on designated or protected landscapes such as AONBs or National Parks.<br>**Mitigation:**<br>• Site screening (existing or through planting and landscaping) should be used to mitigate long-term residual adverse effects.<br>**Assumptions:**<br>• None identified. |

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## Objective 12: Landscape

| *Stage* / *Description* | *Score* | *Commentary* |
|---|---|---|
| | | **Uncertainties:**<br>• None identified. |
| **Decommissioning** | **0** | **Assessment of Effects:**<br>All activities associated with site restoration would take place within the existing site area and therefore no further effects on the landscape are anticipated. Removal of infrastructure associated with gas storage facilities can be carried out relatively quickly (2-6 weeks). Effects associated with restoration and relinquishment are expected to be similar to those identified in respect of conventional and unconventional oil and gas (see stages 5 and 6, Tables 10.4 and 10.5). Potential for the enhancement of landscapes has been identified where the original site character is of low value.<br>**Mitigation:**<br>• A study of the surrounding landscape character should be undertaken prior to decommissioning to identify measures which would allow efficient site restoration as well as opportunities for the enhancement of landscapes.<br>**Assumptions:**<br>• Site restoration to original condition is feasible.<br>• Opportunities for the enhancement of landscapes would be taken.<br>**Uncertainties:**<br>• None identified. |

### *Summary*

Construction and installation of pipelines and storage facilities would likely result in short-term adverse effects on the objective. Overall effects are likely to be minor significant. Although unlikely to occur, landscape effects could be significant if development takes place on designated landscapes such as National Parks and AONBs. Residual adverse effects from the introduction of infrastructure could remain during storage operation as this may result in permanent changes to the visual amenity of communities. Negative effects resulting during the construction and operation periods are likely to be minor, as above ground storage facilities are small (approximately 2 hectares) and there is a high likelihood that facilities would be located at existing oil and gas infrastructures sites. Decommissioning of storage facilities and pipelines could lead to positive effects on the objective, particularly where the original site character was of low value.

**Mitigation Summary**

- **Construction and Installation of Pipelines and Storage Facilities:** Adverse effects resulting from the construction should be minimised through site screening (existing features or planting and landscaping). Additional effects from the provision of pipelines should be mitigated by routing along existing infrastructure (e.g. roads), minimising corridor length and width and the speedy restoration and revegetation of the corridor
- **Storage Operations:** Site screening (existing or through planting and landscaping) should be used to mitigate long-term residual adverse effects.
- **Site Decommissioning:** A study of the surrounding landscape character should be undertaken prior to decommissioning to identify measures which would allow efficient site restoration as well as opportunities for the enhancement of landscapes.

| **Score Key:** | **+ +** **Significant** positive effect | **+** **Minor** positive effect | **0** No overall effect | **-** **Minor** negative effect | **- -** **Significant** negative effect | **?** **Score uncertain** |
|---|---|---|---|---|---|---|

*NB: where more than one symbol is presented in a box it indicates that the SEA has found more than one score for the category. Where a box is coloured but also contains a ?, this indicates uncertainty over whether the effect could be a minor or significant effect although a professional judgement is expressed in the colour used. A conclusion of uncertainty arises where there is insufficient evidence for expert judgement to conclude an effect.*

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| Objective 12: Landscape | | |
|---|---|---|
| ***Stage*** | | |
| ***Description*** | ***Score*** | ***Commentary*** |
| *S – short term (0-3 years), M – medium term (3-10 years) and L – long term (10-32 years and beyond)* | | |

## 10.11 SEA Areas

The following sections consider in-turn the potential effects of Licensing Plan activities on landscape objective in the five SEA Areas. The assessment draws on the findings presented in **Table 10.4, 10.5** and **10.6** above and takes account of the environmental characteristics of the areas as detailed in **Section 10.4**.

### 10.11.1 SEA Area 1: Scottish Midlands (including the Inner Forth)

The landscape of this SEA Area is complex and ranges from lowland coastal landscapes to estuarine intertidal flats, incised river gorges and loch basins to arable farmland and improved grassland. Furthermore, woodlands, grassland, heath and montane cover contribute to the setting of the area. The midland valley contains the majority of Scotland's population and is its industrial centre [23]. The SEA Area includes the Inner Forth which is considered to be a 'watery area'.

As shown in the baseline this area stretches into the Loch Lomond and the Trossachs National Park and includes five National Scenic Areas as well as two World Heritage Sites.

#### Conventional Oil and Gas

Infrastructure associated with conventional oil and gas exploration, such as well heads and drilling rigs, would have impacts on the mainly remote character of the landscape, including visual amenity. The significance of effects would be higher where development would be located in protected or designated landscapes or areas which attract a high number of visitors due to tranquillity and beauty. Effects on the landscape of the midland valley would be of lesser significance due to the existing urban and industrial character of the area.

#### Unconventional Oil and Gas

The effects of unconventional oil and gas exploration in the area are similar to those resulting from conventional exploration. However, additional infrastructure (i.e. chemical and water storage tanks) would be required during the exploration and production development phases. The likelihood of water

[23] DECC (2010) Onshore Oil & Gas Licensing: Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds: Environmental Report

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storage tanks being required due to lacking possibilities for connection to the water mains is higher in the more remote locations of the SEA Area.

The Inner Forth is only being considered for Virgin Coalbed Methane with associated drilling activity taking place onshore. The open landscape of the Inner Forth is predominantly flat and punctuated by a skyline of industrial chimneys, bridges and pylons [24]. Visual resulting from the presence of drilling equipment (well heads and rigs) would be more significant where no other existing infrastructure is visible.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 1 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although the effects could be less significant due to the fact that exploration drilling and production sites are smaller (approximately 0.25 hectare).

### Gas Storage

No potential effects on the landscape resulting from gas storage have been identified.

## 10.11.2 SEA Area 2: West Midlands, North West England and Southern Scotland

The Solway Basin and its intertidal areas, beaches and dunes contribute to the coastal landscape of the area with peatland, fields, hedgerows and managed pastures characterising the area towards the inland. The intertidal habitats of the Duddon Estuary further contribute to the coastal landscape. There are extensive urban fringe developments along the coast with some visible industrial buildings [23].

High open moorlands characterise the West Lancashire Moors, Rossendale Forest and the Western Pennines. Southern Lancashire is situated in low-lying plains. Agricultural land lies outside the urban centres of Birmingham, Liverpool and Manchester.

The SEA Area includes one National Park (Lake District NP), a Heritage Coast, six Areas of Outstanding Natural Beauty (AONBs), and one WHS.

### Conventional Oil and Gas

The high area covered by designated landscapes increases the likelihood of significant adverse effects resulting from conventional oil and gas. However, could be reduced where development is situated in the proximity of the urban and industrial centres.

[24] http://innerforthlandscape.files.wordpress.com/2012/10/simple-map-of-ifli-area.jpg (last accessed 05/09/2013)

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### Unconventional Oil and Gas

The effects of unconventional oil and gas exploration in the area are similar to those resulting from conventional exploration. However, additional infrastructure (i.e. chemical and water storage tanks) would be required during the exploration and production development phases. The likelihood of water storage tanks being required is higher due to the reduced likelihood of connection to the water mains in the more remote locations of the SEA Area.

This is applicable to shale gas and virgin coalbed methane, however, significant effects resulting from the latter are less likely as the associated pad size is smaller.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 2 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although the effects could be less significant due to the fact that exploration drilling and production sites are smaller (approximately 0.25 hectare).

### Gas Storage

There are two gas storage facilities located in this SEA Area: Hole House and Holford/Byley (Cheshire) **Error! Bookmark not defined.**.

No potential effects on the landscape resulting from gas storage have been identified.

## 10.11.3 SEA Area 3: East Midlands and Eastern England

The uplands of Northumberland, the North York Moors and the Pennines are characterised by expansive open moorlands. The Peak District contains areas of characteristic limestone ('White Peak') and gritstone ('Black Peak') whilst the Humber and Fens are intensively farmed. The area of Norfolk consists of large scale arable grassland and coastal landscapes. Urban and industrial centres lie in the North East, SW Yorkshire and the East Midlands [23].

As the baseline shows, there are five NPs, six Heritage Coasts, three WHSs and five AONBs in this SEA Area.

### Conventional Oil and Gas

As with the other SEA Area, significant effects are more likely to result in the more remote areas. The landscape includes some rare surviving areas of mossland unaffected by 18th-20th Century enclosure and drainage [25] on which development would lead to significant adverse effects.

[25] Scoping Response English Heritage

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### Unconventional Oil and Gas

The effects of unconventional oil and gas exploration in the area are similar to those resulting from conventional exploration. However, additional infrastructure (i.e. chemical and water storage tanks) would be required during the exploration and production development phases.

This is applicable to shale gas and virgin coalbed methane, however, significant effects resulting from the latter are less likely as the associated pad size is smaller.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 3 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although the effects could be less significant due to the fact that exploration drilling and production sites are smaller (approximately 0.25 hectare).

### Gas Storage

There are three gas storage facilities located in this SEA Area: Hatfield Moor, Hornsea, Aldbrough (Yorkshire).

The introduction of gas storage facilities and associated pipelines is likely to have effects on the landscape due to the generally remote setting of the area.

## 10.11.4 SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy)

The Wye Valley to the South on the border to England is characterised by pastoral and arable farmland and woodlands. Industrial and urban landscapes are located further West in the valleys of upland areas. South Wales is characterised by coastal landscapes which contribute to the pastoral character of the area, which also includes industrial and urban centres. The landscape character of North Wales ranges from high open moorlands, over ridges and valleys to coastal and estuarine flats with same regions characterised by remnants of previous mining activity [23].

The SEA Area includes parts of a NP, two Heritage Coasts, three AONBs and two WHSs.

### Conventional Oil and Gas

Infrastructure associated with conventional oil and gas exploration, such as well heads and drilling rigs, would have impacts on the mainly remote character of the landscape, including visual amenity. The significance of effects is more likely to be higher in remote areas of the North than in urban and industrialised areas of the South.

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### Unconventional Oil and Gas

The effects of unconventional oil and gas exploration in the area are similar to those resulting from conventional exploration. However, additional infrastructure (i.e. chemical and water storage tanks) would be required during the exploration and production development phases.

### Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 4 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although the effects could be less significant due to the fact that exploration drilling and production sites are smaller (approximately 0.25 hectare).

### Gas Storage

No potential effects on the landscape resulting from gas storage have been identified.

## 10.11.5 SEA Area 5: Southern and South West England

The Area includes open arable pastures, river valleys and estuarine plains in the central and eastern parts. The partly heavy developed coast includes natural harbours and notable cliffs. Furthermore dense ancient woodlands and a distinctive scarp/dip-slope topography characterise the area. The western parts of the include hills and uplands as well as vales, river valleys, levels, estuaries and coastal landscapes [23].

In addition to one complete NP the area encloses fringes of a further NP and contains eight Heritage Coasts as well as 18 AONBs and seven WHSs. Five WHSs are located in urban areas.

### Conventional Oil and Gas

Infrastructure associated with conventional oil and gas exploration, such as well heads and drilling rigs, would have impacts on the mainly remote character of the landscape, including visual amenity. The significance of effects is more likely to be higher in more remote areas.

### Unconventional Oil and Gas

The effects of unconventional oil and gas exploration in the area are similar to those resulting from conventional exploration. However, additional infrastructure (i.e. chemical and water storage tanks) would be required during the exploration and production development phases.

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## Virgin Coalbed Methane

The range and type of effects associated with the development of VCBM in SEA Area 5 are likely to be similar to those identified in respect of unconventional oil and gas exploration and production, although the effects could be less significant due to the fact that exploration drilling and production sites are smaller (approximately 0.25 hectare).

## Gas Storage

There is one gas storage facility located in this SEA Area: LNG Storage, Avonmouth.

No potential effects on the landscape resulting from gas storage have been identified.

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