Department of Energy & Climate Change

Department of Energy and Climate Change

Strategic Environmental Assessment for Further Onshore Oil and Gas Licensing

Environmental Report

AMEC Environment & Infrastructure UK Limited

December 2013

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Department of Energy and Climate Change

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UK Limited

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Non-Technical Summary

This **Non-Technical Summary** ('NTS') provides an overview of the **Environmental Report** produced as part of the Strategic Environmental Assessment (SEA) of the **Further Onshore Oil and Gas Licensing Round** which the Department of Energy and Climate Change (DECC) is proposing to conduct for unlicensed areas in parts of England, Scotland and Wales (hereafter referred to as the 'draft Licensing Plan'). The licences would give exclusive rights to explore for, and exploit, hydrocarbons within a specific area, although further authorisations would be required under the licence and from other agencies such as the Environment Agency, Natural Resources Wales, Scottish Environment Protection Agency, the Health and Safety Executive and planning authorities for any of these activities to take place. The types of activities covered would comprise:

- conventional oil and gas exploration and production;
- shale oil and gas exploration and production;
- virgin coalbed methane exploration and production; and
- natural gas storage in hydrocarbon reservoirs.

The assessment, Environmental Report and NTS have been completed by AMEC E&I UK Ltd on behalf of DECC.

Onshore Hydrocarbon Licensing - An Overview

The UK Government's 2011 Carbon Plan [1] set out how the UK will make the transition to a low carbon economy. By moving to a more efficient, low carbon economy with a more diverse range of energy sources, the Government aims to increase energy security and reduce exposure to fluctuating and uncertain fossil fuel prices, as well as to cut greenhouse gas emissions and minimise costs to consumers.

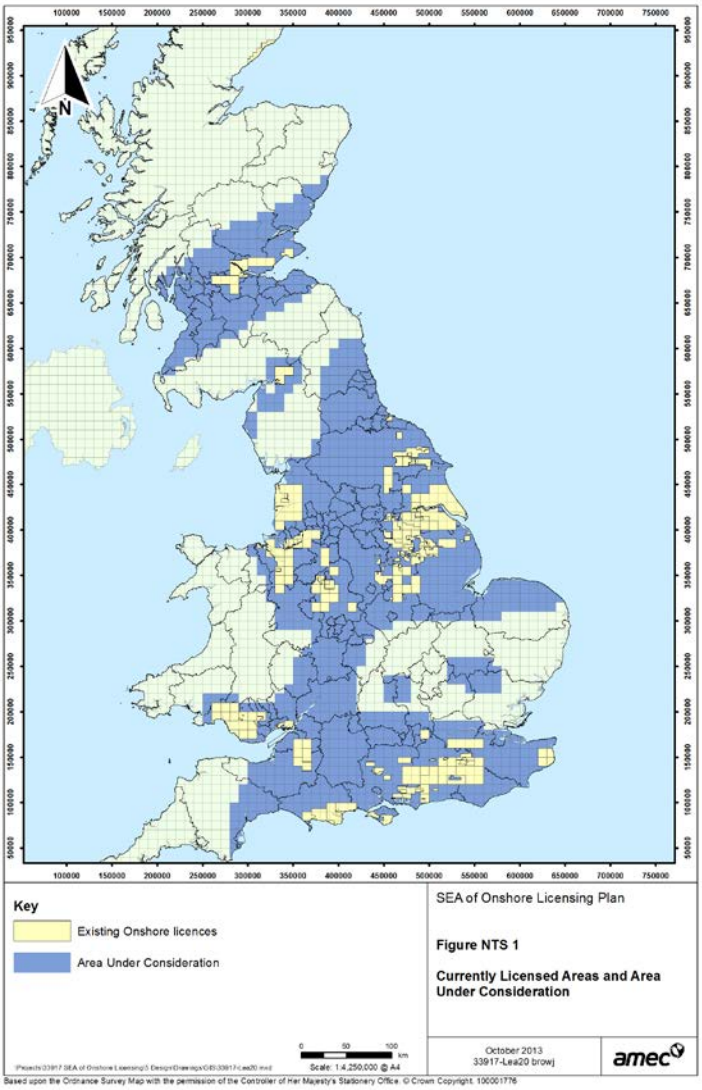
The draft Licensing Plan is set within the context of these energy supply and greenhouse gas reduction efforts; however, even as decarbonisation proceeds, oil and gas will continue to provide an important contribution to UK energy supplies for years to come. In this context, the main objectives of the draft Licensing Plan are to make a further contribution towards the comprehensive exploration and appraisal of UK oil and gas resources and the economic development of identified reserves, together with developing further gas storage capacity in hydrocarbon reservoirs, without compromising the biodiversity, ecosystem functioning and the interests of nature and heritage conservation, and other material assets and users. The draft Licensing Plan to which this SEA relates is the plan to hold a

[1] HM Government (2011) *The Carbon Plan: Delivering our low carbon future*, available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47621/1358-the-carbon-plan.pdf [Accessed May 2013]

landward licensing round, inviting applications for oil and gas licences in certain areas of England, Scotland and Wales, so far as not already licensed.

DECC is responsible for administering the oil and gas licensing system in Great Britain. All rights and ownership of the hydrocarbon resources of Great Britain (and the UK territorial waters) are vested in the Crown by the Petroleum Act 1998. The Secretary of State for Energy and Climate Change periodically offers licences to search for, and extract, these resources. With the exception of two estuarine areas, that of the Dee/Afon Dyfrdwy and the Forth, only landward areas above the low water line are included in the draft Licensing Plan. The currently licensed areas and the areas under consideration in the draft Licensing Plan are shown in **Figure NTS 1.** The areas under consideration have not changed since the previous licensing round.

Figure NTS 1 Currently Licensed Areas and Areas under Consideration in the Draft Licensing Plan



What is Strategic Environmental Assessment?

SEA became a statutory requirement following the adoption of European Union Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment. The objective of SEA, as defined in Directive 2001/42/EC is:

> ***'To provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to contributing to sustainable development.'***

Throughout the course of the development of a plan or programme, the SEA should seek to identify, describe and evaluate the likely significant effects on the environment of implementing the plan or programme and to propose measures to avoid, manage or mitigate any significant adverse effects and to enhance any beneficial effects.

In this context, the purposes of the SEA of the draft Licensing Plan are to:

- identify and quantify the potentially significant environmental effects of the draft Licensing Plan including alternatives;
- help identify appropriate measures to avoid, reduce or manage adverse effects and to enhance beneficial effects associated with the implementation of the draft Licensing Plan wherever possible;
- give the statutory SEA bodies [2], stakeholders and the wider public the ability to see and comment upon the effects that the draft Licensing Plan may have on them, their communities and their interests, and encourage them to make responses and suggest improvements to the draft Licensing Plan; and
- inform the UK Government's decisions on the draft Licensing Plan.

The main requirements and stages of SEA are:

- setting the context and objectives, establishing the baseline and deciding on the scope in consultation with the statutory SEA bodies (**Stage A**);
- developing and refining alternatives, assessing the likely direct, indirect and cumulative effects of proposed options and identifying mitigating and monitoring measures (**Stage B**);

2 Environment Agency; English Heritage; Natural England; Scottish Natural Heritage; Historic Scotland; Scottish Environment Protection Agency; Scottish Government; Natural Resources Wales; Cadw (Welsh Government historic environment service); Welsh Government; Department of the Environment's 'Environment and Heritage Service', Northern Ireland.

- completing an Environmental Report to present the predicted environmental effects of the plan or programme, including alternatives, in a form suitable for public consultation and use by decision-makers (**Stage C**);
- consulting on the draft plan or programme and the Environmental Report (**Stage D**);
- assessing the environmental implications of any significant changes to the draft plan or programme (**Stage D**);
- providing information in a Post Adoption Statement on how the Environmental Report and consultees' opinions were taken into account in deciding the final form of the plan or programme to be adopted (**Stage D**); and
- undertaking suitable monitoring of the associated impacts of the implementation of the selected options (**Stage E**).

The main output of the SEA of the draft Licensing Plan is the revised **Environmental Report** (for which this is the NTS), which has been issued for public consultation between **17th December 2013** and **28th March 2014** (**Stage D** above).

As part of the SEA in support of a draft plan for future onshore oil and gas licensing, DECC published an initial Environmental Report in July 2010 and consulted on it for a period of 12 weeks [3]. However, following two seismic events in Lancashire in 2011, caused by hydraulic fracturing for shale gas at Preese Hall near Blackpool, DECC suspended all hydraulic fracturing operations for shale gas pending an investigation. Work on the SEA was also suspended. As part of the announcement by the Secretary of State for Energy and Climate Change ending the suspension, it was confirmed that work on the SEA would be recommenced [4]. This included revision of the Environmental Report to ensure it reflected the latest information on potential effects, including learning from the events in 2011; and a fresh public consultation.

Applying Strategic Environmental Assessment to the Draft Licensing Plan - What has been Assessed?

The SEA of the draft Licensing Plan has been undertaken by assessing, in the first instance, those potential activities that could follow on from the licensing round and which may have environmental effects. More specifically, the assessment has considered, for conventional oil and gas, shale gas and oil, virgin coalbed methane and gas storage in-turn, the effects associated with the six exploration and production stages set out in **Table NTS 1**. Please note that Stages 1, 2 and 4 do not necessarily apply to gas storage, depending on the development history of the particular site.

[3] Department of Energy and Climate Change (2010) *Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds Environmental Report*, available from https://www.gov.uk/oil-and-gas-licensing-rounds [Accessed May 2013]

[4] http://webarchive.nationalarchives.gov.uk/20121217150421/http:/www.decc.gov.uk/en/content/cms/news/wms_shale/wms_shale.aspx

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

To give some sense of scale to the effects considered, low and high activity scenarios were developed, informed by industry practice and research literature. For conventional oil and gas this meant considering the effects of:

- between 50 and 150 licences being awarded;
- between 5 and 30 test boreholes being drilled; and
- between 3 and 6 well pads being developed (each having two wells and occupying up to 3 hectare of land per pad).

For unconventional oil and gas, this meant considering the effects of:

- between 50 and 150 licences being awarded;
- between 20 and 240 test boreholes being drilled;
- between 30 and 120 well pads being developed (each having between 6-24 wells and occupying up to 3 hectare of land per pad);
- between 10,000 and 25,000 cubic metres of water being required for hydraulic fracturing of each well and each well being re-fractured once;
- between 30% to 75% of the water injected during fracturing returning as flowback;
- between 14-51 vehicle movements a day during Stages 2-3; and
- an assumed production of 3 billion cubic feet of gas per well (over the lifetime of the well which is assumed to be 20 years).

Virgin coalbed methane exploration and production activity has not been modelled separately from shale gas and oil. This is on the basis that after over a decade of exploration work in the UK, it is considered unlikely that there will be any large increase in the current, relatively moderate, levels of activity.

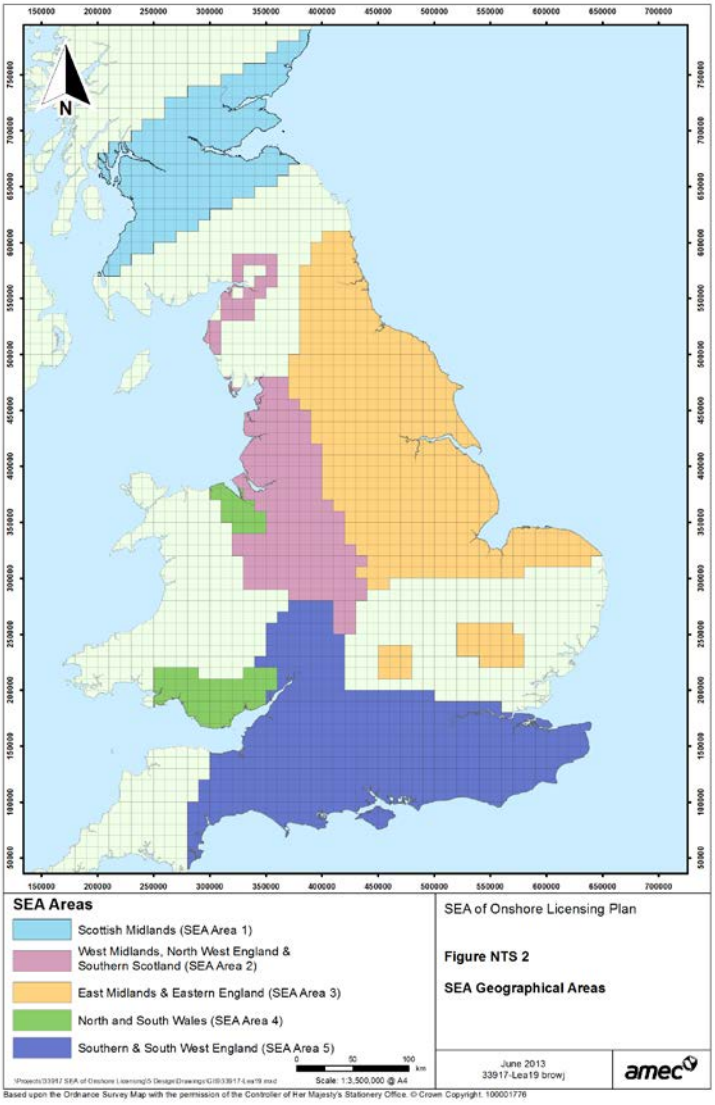
The effects of activities that could follow on from licensing have been considered both generically and, in order to help better inform the assessment, in the context of five broad geographic areas (SEA Areas), which due to geology are most likely to contain hydrocarbons. The five SEA Areas are as follows:

- SEA Area 1: Scottish Midlands (including the Inner Forth);
- SEA Area 2: West Midlands, North West England and Southern Scotland;
- SEA Area 3: East Midlands and Eastern England;
- SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy); and

- SEA Area 5: Southern and South West England.

The SEA Areas are shown in **Figure NTS 2**.

Figure NTS 2 SEA Areas



Consideration of those activities that could follow on from licensing also helped inform the subsequent assessment of the following draft Licensing Plan alternatives:

1. To proceed with the licensing programme as proposed.
2. To restrict the area licensed.
3. Not to offer any areas for licensing.

Which Environmental Topics have the Draft Licensing Plan been Assessed Against?

The proposals for the draft Licensing Plan have been assessed against the 10 topic areas identified below. These include all of the topics set out in the SEA Directive. The methodology used within the assessment is detailed in **Section 4** of the Environmental Report.

1. **Biodiversity & Nature Conservation**
2. **Population** including demographics, socio-economics
3. **Health**
4. **Land Use, Geology & Soils**
5. **Water & Flood Risk**
6. **Air Quality**
7. **Climate Change**
8. **Waste & Resource Use**
9. **Cultural Heritage** including architectural and archaeological heritage
10. **Landscape**

The baseline data and information required under the SEA Directive for each of these topics is presented in **Appendix B** to the Environmental Report. The baseline information was used to establish a number of SEA objectives - essentially guiding sustainable development principles which the draft Licensing Plan should seek to accommodate - and guideline questions against which the draft Licensing Plan activities and alternatives were assessed. The assessment objectives are shown in **Table NTS 2** with the full assessment matrix detailed in **Section 4** of the Environmental Report.

Table NTS 2 Assessment Objectives

Topic Area	SEA Objectives	SEA Topics
Biodiversity and Nature Conservation	To protect and enhance biodiversity (habitats, species and ecosystems) working within environmental capacities and limits.	Biodiversity, Flora and Fauna
Population	To promote a strong, diverse and stable economy with opportunities for all; minimise disturbance to local communities and maximise positive social impacts.	Population
Health	To protect and enhance health, safety and wellbeing of workers and communities and minimise any health risks associated with onshore oil and gas operations.	Health
Land Use, Geology and Soils	To conserve and enhance soil and geology and contribute to the sustainable use of land.	Soil, Material Assets
Water and Flood Risk	To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive.	Water
Water and Flood Risk	To minimise the risks of coastal change and flooding to people, property and communities.	Water, Climatic Factors
Air Quality	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.	Air
Climate Change	To minimise greenhouse gas emissions as a contribution to climate change, ensure resilience to any consequences of climate change.	Climatic Factors
Waste and Resource Use	To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities.	Material Assets

Topic Area	SEA Objectives	SEA Topics
Waste and Resource Use	To contribute to the sustainable use of natural and material assets.	Material Assets
Cultural Heritage	To protect and where appropriate enhance the historic environment including cultural heritage resources, historic buildings and archaeological features.	Cultural Heritage, including Architectural and Archaeological Heritage
Landscape	To protect and enhance landscape and townscape quality and visual amenity.	Landscape

What are the Likely Significant Effects[5] of the Draft Licensing Plan and the Reasonable Alternatives?

The activities that could follow on from the draft Licensing Plan could lead to a range of effects across the different SEA objectives. The assessment identified the potential for activities to have a significant positive effect in respect of **population** and **resource use** and the potential for significant negative effects in relation to **climate change and waste,** either as compared to the effects of the existing oil and gas sector or at the local community level, although no negative effects were identified for any objective which would be significant at the national level**.** Minor negative effects were also identified on **population, health**, **land use, geology and soils**, **water**, **air**, **resource use** and **landscape;** however, these were found to be potentially significant under the high activity scenario depending on the many factors that are uncertain at this stage, including:

- the location, distribution and phasing of sites and any associated infrastructure; and
- the nature, quality and proximity of sensitive receptors (communities, habitats, landscapes).

Likely Significant Positive Effects

The assessment of the draft Licensing Plan identified that no significant positive environmental effects are expected under conventional oil and gas exploration and production or gas storage lifecycles given the assumed level of activity that is to occur.

Likely significant positive effects were identified for unconventional oil and gas on the population assessment objective (from additional employment and community benefits) and the resource assessment objective (from identification of the additional hydrocarbon reserves) when compared to the effects from the existing oil and gas sector or at the local community level.

Stage 3 (production development) and **Stage 4** (production, operation and maintenance) of the unconventional oil and gas exploration and production lifecycle **could have significant positive effects on population under the high activity scenario**. This reflects the potential for activities to generate substantial direct and indirect employment opportunities as well as jobs induced by employed staff. It is

[5] This includes consideration of the effects in the short, medium and long term and permanent and temporary and positive and negative effects.

estimated that at its peak, some 16,000-32,000 full time equivalent (FTE) positions (including direct, indirect and induced jobs) could be created which would represent an increase of between 3.5% and 7% in the level of employment supported by the UK oil and gas industry sector[6]. However, the potential for these jobs to directly benefit those local communities in which sites are located 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 required skills and relevant experience.

Under the United Kingdom Onshore Operators' Group (UKOOG) (2013) 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. Under the high activity scenario, total UK contributions could be between £3 and £12 million. During **Stage 4**, it is estimated that community benefits to the value of 1% of revenue from production could amount to a total of £2.4 million to £4.8 million per site (equivalent to between £0.3 billion and £0.6 billion across all sites) under the high activity scenario, assuming each well is productive for 20 years[7].

Exploratory drilling during **Stage 2** of the unconventional oil and gas exploration and production lifecycle is generally undertaken to estimate the amount of oil and gas that can be technically and economically produced from a geological formation. Where sufficient information exists from earlier work, the amount which can be produced from oil and gas accumulations can be estimated, conventionally divided into proven, probable and possible 'reserves'. However, a recent report by the British Geological Survey (BGS)[8] noted that the assessment of shale gas resources in the UK is in its infancy. DECC has subsequently stated that while shale gas has potential in the UK, it is not yet possible to make meaningful estimates of how much shale gas may be practically and commercially recoverable[9]. If the volume of gas anticipated by the high activity scenario were realised, this would generate in total some 0.12 to 0.24 trillion cubic metres (4.32 to 8.64 trillion cubic feet) of gas, more than six times the 0.037 trillion cubic metres (1.31 trillion cubic feet) of gas produced in the UK in 2012[10], or more than twice the approximate 0.1 trillion cubic metres (3.52 trillion cubic feet) of gas consumed in the UK per annum[11]. During **Stage 2**, estimates of reserves would be expected to develop and improve in-line with increased exploratory drilling. This would have a significant positive effect on the **resource use** objective.

[6] Oil and Gas UK (2012), *2012 Economic Report,* http://www.oilandgasuk.co.uk/cmsfiles/modules/publications/pdfs/EC029.pdf
[7] Based on revenue estimates of approximately £1.0 million per well per annum, assuming gas wholesale price of £0.22/m^3 (taken from DECC (2013) *UK energy sector indicators 2013: energy prices and competition dataset*
[8] DECC (2013) *The Carboniferous Bowland Shale Gas Study: Geology and Resource Estimation*. Available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/226874/BGS_DECC_BowlandShaleGasReport_MAIN_REPORT.pdf [Accessed September 2013]
[9] 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 September 2013]
[10] DECC (2012) *Gross Gas Production Figures 2012*, https://www.gov.uk/oil-and-gas-uk-field-data.
[11] House of Commons Energy and Climate Change Committee (2013) *The Impact of Shale Gas on Energy Markets: Seventh Report of Session 2012–13*, Volume I.

Likely Significant Negative Effects

It is not anticipated that there would be significant negative effects arising from conventional oil and gas exploration and production or gas storage.

For unconventional oil and gas, no significant negative effects were identified at the national level, but as compared to the effects from the existing oil and gas sector or at the local community level, likely significant negative effects were identified in relation to the climate change and waste SEA objectives.

Stages 2, 3 and 4 of the unconventional oil and gas exploration and production lifecycle were assessed as having a significant negative effect on **climate change** (under the high activity scenario), at the sectoral level (i.e. as compared to the effects from the existing oil and gas sector). However, these effects are unlikely to be significant in terms of emissions at the national level. The increase in domestic supplies is expected to result in substitution for imported Liquefied Natural Gas (LNG), with a negligible effect on overall national emissions.

The effects arise from greenhouse gas emissions associated with: pad preparation and drilling; emissions of carbon dioxide (CO_2) and methane associated with disturbance to soils; the potential loss of carbon sequestration (i.e. of carbon absorbed in soils and growing plants); and in particular the volume of emissions arising from hydraulic fracturing and well completion. It is estimated that greenhouse gas emissions associated with Stages 2 and 3 could be up to 0.96 million tonnes of carbon dioxide equivalent (M tCO_2eq) per annum under the high activity scenario[12]. During Stage 4, emissions are likely to be associated with gas production and arising from power generation, the use of machinery, transportation, fugitive emissions and from flaring and venting. Emissions per annum are estimated as between 0.71M and 1.42M tCO_2eq under the high activity scenario for the peak period when all wells are productive. This is equivalent to between 7.6% and 15.3% of the 9.3 M tCO_2eq 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)[13].

As compared to the UK inventory of GHG emissions, however, these emissions would be less than 0.3% of the current total. The extent to which domestic production and consumption of shale gas would in practice affect total GHG emissions in the UK is more uncertain, but the principal effect is expected to be a displacement of imported LNG, or possibly pipeline gas, and the net effect on total UK GHG emissions is likely to be small[14]. If LNG or other fossil fuel displaced from the UK is used elsewhere, that could

[12] Assuming up to a maximum of 360 wells per annum.

[13] DECC (2013) *2011 Final UK Greenhouse Gas Emission Figures*, available from https://www.gov.uk/government/publications/final-uk-emissions-estimates [Accessed May 2013].

[14] MacKay and Stone (2013) 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)).

lead to an increase in global GHG emissions[15] (although this is dependent on global energy policy and market demand).

There would be a range of wastes generated during the oil and gas exploration and production lifecycle (for example, construction and demolition wastes, drill cuttings and drilling muds). However, the largest and most significant waste stream would be likely to be flowback associated with hydraulic fracturing for shale gas (and also produced water generated through de-watering as part of virgin coalbed methane exploration and production). Flowback can have elevated levels of salinity and mineral content [16] from contact with the rock formation that is being fracked. The volume of flowback from shale gas wells could range from 3,000 cubic metres to 18,750 cubic metres per well[17]. Flowback can be recycled for use, with treatment involving a mixture of settlement, anti-bacteriological treatment and blending with clean water. However, it is assumed that flowback water, once it is intended for disposal, is not permitted to be re-injected into the geological formation and will need to be treated. For the purposes of the assessment, the conservative assumption is made that this treatment has to be offsite. Under the high activity scenario, up to 108 million cubic metres of wastewater would require treatment (approximately 3% of the UK's total annual wastewater). Depending on where this treatment occurs, this volume could place a substantial burden on existing wastewater treatment infrastructure capacity. This has been assessed as having a significant negative effect on the **waste** objective. However, on site treatment and reuse could reduce the volumes of wastewater generated and lessen any effects on offsite treatment infrastructure capacity.

In addition, scrutiny through the planning system and cooperation between operators and the water industry under the Water UK and UKOOG MoU can be assumed to ensure that these effects will not be unacceptable in the local context. It is also noteworthy that the industry is not expected to be at substantial scale before the 2020s and this will allow time for further investment and development in treatment infrastructure.

Negative Effects with the Potential to be Significant under the High Activity Scenario

Stage 3 of the unconventional oil and gas exploration and production lifecycle has the potential to have a locally significant negative effect on the **population** and **health** SEA objectives under the high activity scenario, although any such effects can be expected to be mitigated through planning controls. The potential is due to the adverse effect the generation of noise, dust and vibrations during construction, drilling and associated HGV movements could have on community disturbance and the health of some people in communities living close to well pads and/or HGV routes. During Stage 3, vehicle movements could range from 16 to 51 per day for up to 145 weeks, although this will be dependent on a number of factors including: the number of wells drilled and their phasing; the volumes of water needed; how water

[15] MacKay and Stone (2013) highlight that the switch to shale gas in the US has increased exports of coal, increasing the carbon intensity of electricity production in other countries.

[16] Environment Agency (2011) *Shale Gas North West - Monitoring of Flowback Water*, December 2011

[17] 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 European Commission DG Environment and http://www.total.com/en/special-reports/shale-gas/environmental-challenges-201958.html

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 effects on the local community will also 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, although it can be expected that actual effects at any location will be mitigated by planning scrutiny and controls. Public Health England has recently published a review of the available evidence on potential public health impacts of shale gas extraction[18]. 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.

Stages 2 and 3 of the unconventional oil and gas lifecycle have the potential to have a locally significant negative effect on **land use, geology and soils** under the high activity scenario. Pad preparation and provision of associated infrastructure such as pipelines and road connections during this stage are likely to require the clearance of vegetation and loss of soil layers and compaction. Associated adverse effects in terms of soil function and processes are likely to be minor but where development is located on land that is of high agricultural quality, or in other sensitive areas, effects could be more significant and permanent.

The substantial volumes of water required, principally for hydraulic fracturing, under **Stages 2, 3 and 4** of the unconventional oil and gas lifecycle have the potential to have a significant negative effect on the **water** objective under both low and high activity scenarios (as compared to current water requirements of the oil and gas sector). The assessment has identified that total water consumption under these stages could be between 57.6 million and 144 million cubic metres under the high activity scenario and between 7 million and 18 million cubic metres under the low activity scenario [19]. For the high activity scenario, annual water use could be up to 9 million cubic metres, 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[20], but substantially less than 1% of total UK annual non domestic mains water usage. The potential impacts this could have on, for example, water resource availability, aquatic habitats and ecosystems and water quality is, however, more uncertain. Water would typically be sourced from either a mains water supply or an abstraction from groundwater or surface water and would require an abstraction licence. For either source, additional supplies would not be permitted if they were not deemed to be sustainable or posed a risk to the security of supply to existing customers. In this context, Water UK, which represents the water industry, and UKOOG have signed a Memorandum of

[18] 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]

[19] Based on the assumption that 10,000-25,000 cubic metres of water will be required per well for hydraulic fracturing (from 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 European Commission DG Environment)

[20] WRAP (2011) *Freshwater availability and use in the United Kingdom. A review of freshwater availability and non-household (consumptive) use in the UK*

Understanding[21] (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.

Demand 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%[22] which if applied to the high activity scenario, could lower total demand for water to between 13.2 million and 33.1 million cubic metres.

There is potential for locally significant negative effects on **air quality** during **Stage 2** (under the high activity scenario) and **Stage 3** (under both low and high activity scenarios). This principally reflects emissions to air from on-site machinery, HGV movements, drilling and hydraulic fracturing which could result in air quality impacts on sensitive receptors including residents and biodiversity. Additionally, there could also be emissions from flaring during exploration activities, which would primarily result in the production of CO_2 but could also result in the production of NO_x, SO_2, CO and Particulate Matter, and of methane from flowback water.

The extraction of hydrocarbon reserves during **Stage 4** would result in the direct loss of a primary natural resource that is non-renewable and has the potential to have a significant negative effect on **resource use**. However, the determination as to whether it would be significant cannot be made currently as: the determination of total UK shale gas resource is still at an early stage; the precise geology of host formations is unknown; and the likely yield per well is not yet possible to ascertain.

There is potential for a significant negative effect on **landscape** associated with onshore oil and gas activities. This principally reflects the potential landscape and visual impact of construction activities and associated machinery such as drilling rigs. However, the significance of the effect would be dependent on the distribution patterns of the exploration and production 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.

More generally, scrutiny through the planning system (and other regulatory regimes), and where relevant the imposition of appropriate planning conditions, can be assumed to ensure that these potentially significant effects will in practice not be unacceptable in the local context.

Effects of the Reasonable Alternatives to the draft Licensing Plan

Reasonable alternatives to the draft Licensing Plan have been considered as part of the assessment.

21 See http://www.water.org.uk/home/policy/positions/shale-gas/water-uk-shale-gas-briefing-paper-update-nov-2013.pdf for further information.

22 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.

An alternative based on limiting the area of land available to be licensed is assumed to lead to a reduction in the level of associated activity. This will in-turn lessen the magnitude of both positive and negative effects, such that it is unlikely that they would be considered significant when compared to existing oil and sector activities. However, there remains the potential for effects from licensing to be clustered in certain areas, where geological conditions are more favourable, meaning that such effects could be locally significant for the communities that host licensed oil and gas activities.

An alternative based on offering no areas for licensing under this round will have no effects on the environment. However, and in common with all options for the draft Licensing Plan, it should be borne in mind that licensed activities will still take place as developers have already been licensed under the previous (13th) onshore licensing round.

When reviewing the effects of each alternative considered, the alternative that seeks to restrict the licensing area, provided that it does affect the scale of activity, could lead to a reduction in the magnitude of the environmental effects identified. As such, it does present advantages when considering the objectives of the draft Licensing Plan that seek to avoid compromising the biodiversity, ecosystem functioning and the interests of nature and heritage conservation, and other material assets and users. However, given the importance of achieving the other objectives of the plan, and that the activities that follow licensing will need to meet a range of regulatory requirements (which, when applied and enforced, will ensure that effects at the project level will be identified, assessed and mitigated to an acceptable level), the unrestricted alternative (i.e. the draft Licensing Plan as proposed) may prove to be the preferable alternative.

What are the Secondary, Cumulative and Synergistic Effects of the Draft Licensing Plan?

In determining the significance of effects of a plan or programme, the SEA Directive requires that consideration is given to the secondary, cumulative, synergistic effects on the environment. The following table summarises these effects by assessment topic.

Table NTS 3 outlines the secondary, cumulative and synergistic effects.

Table NTS 3 Summary of Secondary, Cumulative and Synergistic Effects

SEA Objective	Score	Summary
1. To protect and enhance biodiversity (habitats, species and ecosystems) working within environmental capacities and limits.	**-/?**	Construction activities associated with well pad preparation and drilling (for conventional and unconventional oil and gas and virgin coalbed methane (VCBM) exploration)) and the construction of gas storage facilities and pipeline works may have a negative effect on biodiversity, principally as a result of the loss or fragmentation of habitat or disturbance from both activities on site and HGV movements, such as noise, light or human presence. The discharge of the produced water from de-watering (from VCBM), and the risk of accidental spillage of flowback arising from hydraulic fracturing (associated with shale gas) and pollutants, could have an adverse impact on aquatic environments, although it is assumed that any discharge would be subject to licence and that risks of spillage would be controlled (through planning requirements, regulatory controls and implementation of good practice in construction and management).

SEA Objective	Score	Summary
		Given the combined intensity of onshore oil and gas activities that could follow on from the draft Licensing Plan, there is the potential for negative effects on biodiversity to be significant. Notwithstanding the assumed 5km minimum distance between well pad sites, these effects would be dependent on the sensitivity of the receiving environments and the extent to which activities are undertaken in relative close proximity to one another and/or in close succession, which is currently uncertain. However, the operation of the Habitats Regulations can be assumed to protect the conservation status of European designated nature conservation sites. Effects on biodiversity would also be a key consideration in the determination of applications for planning consent for onshore oil and gas exploration and production and in gaining permits, licences, consents and/or authorisations under environmental regulations implemented in England by the Environment Agency, Wales by Natural Resources Wales and in Scotland by the Scottish Environment Protection Agency (SEPA). **Overall, cumulative effects have been assessed as minor negative, although the potential for significant negative effects is acknowledged.**
2. To promote a strong, diverse and stable economy with opportunities for all; minimise disturbance to local communities and maximise positive social impacts.	**++/-/--**	The activities that could follow the further onshore oil and gas licensing round are likely to generate substantial direct and indirect employment opportunities as well as jobs induced by employed staff. For unconventional oil and gas, at peak there could be between 16,000 and 32,000 jobs (direct, indirect and induced) created under the high activity scenario, and 2,500-5,000 for the low activity scenario. These will be in addition to those jobs created from existing licensed exploration and production activities. The number of jobs likely to be generated would constitute a significant boost to employment in the UK oil and gas sector and there may also be the potential creation of training opportunities (for example, 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). However, the potential for these jobs to directly benefit those local communities in which sites are located 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 required skills and relevant experience. As identified in **Section 2 of Appendix B** of the Environmental Report, under the United Kingdom Onshore Operators' Group (UKOOG) (2013) Community Engagement Charter, benefits for shale gas exploration and production would be provided to host local communities and county/unitary authorities, the total value of which, under the high activity scenario, could be significant. It is expected that significant volumes of domestic oil and gas could be produced following the licensing round. If the volume of gas anticipated by the high activity scenario were realised, this would generate some 0.12 to 0.24 trillion cubic metres (4.32 to 8.64 trillion cubic feet) of gas, more than six times the 0.037 trillion cubic metres (1.31 trillion cubic feet) of gas produced in the UK in 2012 or more than twice the approximate 0.1 trillion cubic metres (3.52 trillion cubic feet) of gas consumed in the UK per annum. 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) and associated vehicle movements, which could range from 16-51 vehicles per day during Stage 3 of the unconventional oil and gas exploration and production lifecycle (under the high activity scenario). There is potential for these activities to have a significant effect on those communities close to development sites and/or living/working directly adjacent to minor roads during the pad preparation and development stages. Whilst these effects would occur at the local level, given the number of pads envisaged under the high activity scenario (120), collectively the magnitude of effect, if concentrated could be significant in a local or sub-regional context, although any such effects can be expected to be mitigated through planning controls. **Overall, in view of the potential significant economic benefits associated with activities that could follow on from the draft Licensing Plan, there are likely to be a sectorally significant positive cumulative effects on this objective. However, it is recognised that there is the potential for construction and operational activities to have a minor negative effect on communities which could be locally significant, though the operation of the planning system can be expected to ensure that these effects remain acceptable.**
3. 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 construction of multiple well pad sites and gas storage facilities and drilling activities (for conventional and unconventional oil and gas and VCBM exploration) could give rise to locally significant negative cumulative effects on health. These could be related to, for example, emissions to air and noise from machinery, associated HGV movements, hydraulic fracturing (for unconventional oil and gas exploration) and flaring. If it occurred, the contamination of groundwater or surface water from exploration and production activities could have a negative effect on human health, if the water were consumed untreated. However, provided that regulatory requirements are followed, the wells are robustly designed and the casing appropriately constructed to ensure integrity, the risk of contamination of groundwater from surface or groundwater release associated with drilling muds, additives and naturally occurring chemicals in well cuttings, fracturing fluids and produced water is considered to be very low.

SEA Objective	Score	Summary
		Furthermore, if a leakage from the well or an accidental spill were to occur, it is considered that adoption of pollution control management procedures consistent with relevant regulatory controls would help to mitigate this risk. **Taking into account the potential scale of construction activities in particular, there could be minor negative cumulative effects on health, with the potential for effects to be locally significant**. However, this would be dependent on the location of development sites, including the proximity to sensitive receptors, existing background levels of noise/air pollutants and prevailing health issues as well as the extent to which activities are undertaken in relative close proximity to one another and/or in close succession, which is currently uncertain. Notwithstanding, any such effects can be expected to be mitigated through planning controls including by the imposition of relevant planning conditions (e.g. restrictions to noise levels).
4. To conserve and enhance soil and geology and contribute to the sustainable use of land.	**-/--**	Pad preparation and provision of associated infrastructure such as pipelines and road connections in particular (for conventional and unconventional oil and gas and VCBM exploration) is likely in the short to medium term to have negative cumulative effects on this objective due to direct landtake, soil loss and compaction over a large area. For conventional oil and gas production, total land take could be around 12-18ha, whilst for unconventional oil and gas production total land take could be between 240-360ha. However, the effects are likely to be minor. Notwithstanding, should development result in the large scale loss of land that is of high agricultural quality or be located in other sensitive areas, the effects could be more significant (although due to national planning policy, this is considered unlikely). The risk of contamination associated with the implementation of the draft Licensing Plan (for example, due to the disturbance of contaminated sites or accidental spillage) is considered to be low. This reflects the expectation that works would be undertaken in accordance with relevant regulations and appropriate mitigation would be implemented at the project stage. The construction and operation of multiple onshore oil and gas sites could have a potentially significant effect on local land use. Effects may be positive where development utilises previously developed land or negative where productive land uses on-site such as agriculture or uses adjacent to sites are adversely affected. However, 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 all sites would be restored such that any adverse effects would be reduced in longer term. 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 would have a minor positive effect on this objective by restoring, and potentially enhancing, soil quality and prospects for beneficial land use. Based on the findings of research published by Green *et al* (2012), AEA (2012) and Davies *et el* (2013) in particular, and taking into account the controls introduced by Government to reduce the risk of undesirable seismic activity, the assessment has concluded that the risk of hydraulic fracturing causing felt seismicity (of magnitude >3) is very small. **Overall, the cumulative effects on this objective have been assessed as a minor negative, although it is recognised that effects could be locally significant depending on the location of sites which would be determined at the project stage.**
5. To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive.	**-/--**	The total volume of water required for all onshore oil and gas activities that could follow on from the draft Licensing Plan would be substantial (as compared to current water requirements of the oil and gas sector). However, this principally reflects the volume of water that would be required under the high activity scenario for unconventional oil and gas exploration and production (up to 9 million cubic metres per annum over the combined terms of Petroleum Exploration and Development Licences (PEDLs), related to hydraulic fracturing)). The demand for water would be in addition to that from existing licensed exploration and production activities. Overall, it is considered that the volume of water that could be required to support onshore oil and gas activities that could follow on from the draft Licensing Plan could be significant at the oil and gas 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. Water would typically be sourced from either a mains water supply with the agreement of the water utility company or an abstraction from groundwater or surface water and would require an abstraction licence that would only be granted where the additional demands are assessed as sustainable by the regulator. Demand 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).

SEA Objective	Score	Summary
		The Memorandum of Understanding (MoU) between the water industry and UKOOG will support cooperation throughout the shale gas exploration and extraction process in order minimise adverse effects on water resources and the environment. The risk of surface water contamination is considered to be low. Construction activities 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. There is also the potential risk of groundwater contamination from, for example, the loss of well integrity, or the accidental discharge of drilling and hydraulic fracturing fluids or produced water where there are pollutant pathways from the surface to the groundwater body. However, taking into account the requirements for discharge consents/permits and Environment Agency/SEPA policy in respect of groundwater protection, it is considered reasonable to suggest that such risks would be appropriately managed. **In consequence, the draft Licensing Plan has been assessed as having a minor negative effect with the potential to be a sectorally significant cumulative negative effect on this objective.**
6. To minimise the risks of coastal change and flooding to people, property and communities.	**?**	**Cumulative effects on flood risk and coastal change are considered to be uncertain at this stage.** Conventional and unconventional oil and gas and VCBM exploration activities could increase flood risk, for example, as a result of the removal of vegetation and laying of impermeable surfaces which could increase runoff rates. Sites may also be at risk of flooding particularly if they are located in areas with a high probability of fluvial or coastal flooding. As the location of sites vis-à-vis areas with a high probability of flooding is unknown at this stage, it has not been possible to determine the likelihood or magnitude of effects on this objective. However, it can be assumed that flood risk would be fully considered at the project level and as part of the Town and Country Planning and Environmental Impact Assessment (EIA) processes.
7. 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.	**-/--**	For conventional and unconventional oil and gas and VCBM exploration, emissions to air from on-site machinery, HGV movements, drilling and hydraulic fracturing could result in cumulative negative effects on sensitive receptors including local residents and biodiversity. Additional cumulative effects could result from the flaring of gases associated with the production process, although this operation is confined to the testing phases only. Although it is assumed that there would be at least 5km between well pad sites and that activities would not be undertaken simultaneously (which could reduce localised impacts), cumulative effects could be locally significant where sites are located within or in close proximity to areas where there are existing air quality issues that could be exacerbated (such as Air Quality Management Areas) and/or sensitive receptors. However, any such effects can be expected to be mitigated through planning and regulatory controls. **Overall, the draft Licensing Plan has been assessed as having a cumulative minor negative effect on this objective, with the potential for effects to be locally significant in certain localities, although it is recognised that effects can be expected to be mitigated through planning and regulatory controls**
8. To minimise greenhouse gas emissions as a contribution to climate change, ensure resilience to any consequences of climate change and establish measures which limit flood risk.	**--**	For conventional and unconventional oil and gas and VCBM exploration, significant negative effects in respect of greenhouse gas emissions (GHG) at the sectoral level (i.e. as compared to the effects from the existing oil and gas sector) are to be expected during Stage 2 (exploration drilling with coring and hydraulic fracturing) and Stage 3 (production development). However, these effects are unlikely to be significant in terms of emissions at the national level. The effects arise from: emissions associated with pad preparation and drilling (e.g. the direct and indirect combustion of fossil fuels from construction traffic and plant and the embodied carbon within construction materials); emissions of CO_2 and methane associated with disturbance to soils; the potential loss of soil carbon sequestration; and in particular the volume of emissions arising from hydraulic fracturing and well completion. It is estimated that GHG emissions associated with Stage 2 and Stage 3 of the unconventional oil and gas exploration and production lifecycle could be up to 0.96M tCO_2eq per annum (assuming up to a maximum of 360 wells per annum under the high activity scenario). Significant negative cumulative effects are also associated with Stage 4 (production/operation/maintenance) at the sectoral level where there are emissions associated with gas production and arising from power generation, the use of machinery, transportation, fugitive emissions and from flaring and venting. Emissions per annum under the high activity scenario would be between 0.71M and 1.42M tCO_2eq per annum for the peak period when all wells are productive (assuming that GHG emissions during production would be similar to those associated with conventional gas production). This is equivalent to up to 15.3% of the 9.3 M tCO_2eq 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). As compared to the UK inventory of GHG emissions, however, these emissions would be less than 0.3% of the current total. The extent to which domestic production and consumption of shale gas

SEA Objective	Score	Summary
		would in practice affect total GHG emissions in the UK is more uncertain, but the principal effect is expected to be a displacement of imported LNG, or possibly pipeline gas, and the net effect on total UK GHG emissions is likely to be small. If LNG or other fossil fuel displaced from the UK is used elsewhere, that could lead to an increase in global GHG emissions (although this is dependent on global energy policy and market demand). Whilst under the low activity scenario the number of wells would be lower (between 180 and 360 wells), GHG emissions would be up to 0.18M tCO_2eq per annum. This is equivalent to up to 2% of the 9.3 M tCO2eq of sectoral emissions from the exploration, production and transport of oil and gas in the UK in 2011 or 0.04% of UK GHG inventory. In total, over the assumed lifetime of the wells, a total of up to 3.6M tCO_2eq could be generated from the low activity scenario and a total of up to 28.5M tCO_2eq could be generated from the high activity scenario. GHG emissions would be in addition those from existing licensed exploration and production activities. 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. However, there is considered to be sufficient regulations in place in the UK that leakage of gas into aquifers is unlikely to occur. **Overall, the cumulative effects on this objective have been assessed as a significant negative at the sectoral level (i.e. when compared to the existing oil and gas sector), although it is recognised that effects would need to be set against the substitution of the extracted hydrocarbons for existing fuels.**
9. To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities.	--	A range of wastes are associated with all stages of production, including construction and demolition wastes, drill cuttings and drilling muds. The total volume of drill cuttings per pad for conventional oil and gas production is assumed to be around 1,500 cubic metres whilst for unconventional oil and gas, this could range from 3,240 to 6,480 cubic metres per pad. The largest and most significant waste stream would be likely to be flowback. Volumes of flowback are assumed to be between 3,000 cubic metres to 18,750 cubic metres per well (each well requiring 10,000 to 25,000 cubic metres of water, and the percentage of flowback assumed to be 30-75 %). Under the high activity scenario, there would be the potential production of 108 million cubic metres of wastewater that would require treatment during Stages 2, 3 and 4. Flowback has the potential to have increased salinity and mineral content including NORM (naturally occurring radioactive material). Whilst there is the potential to recycle a proportion of the flowback fluid, the remaining volume and nature of the fluid is considered to be of sufficient scale to place a substantial burden on existing wastewater treatment infrastructure capacity, particularly where this would occur at treatment works already receiving wastewater from existing licensed exploration and production activities and therefore all three stages have been assessed as having a significant negative effect on waste. **Consequently, there are likely to be significant negative cumulative effects at the local level associated with this objective, indicating that additional water treatment capacity would need to be considered in particular localities in light of the likely volumes of wastewater, implying that new or further investment might be required.**
10. To contribute to the sustainable use of natural and material assets.	++/-/--	Exploratory drilling is generally undertaken to estimate the amount of oil and gas that can be technically and economically produced from a geological formation. This quantity is known as 'reserves'. DECC has stated that while shale gas clearly has potential in the UK, limited drilling or testing has taken place and therefore it is not yet possible to make meaningful estimates of how much shale gas may be practically and commercially recoverable. If the level of activity anticipated by the high scenario were realised, this might be expected to generate in total some 0.12 to 0.24 trillion cubic metres (4.32 to 8.64 trillion cubic feet) of gas in total, more than six times the 0.037 trillion cubic metres (1.31 trillion cubic feet) of gas produced in the UK in 2012 or more than twice the approximate 0.1 trillion cubic metres (3.52 trillion cubic feet) of gas consumed in the UK per annum. During Stage 2, estimates of reserves would be expected to develop and improve in-line with increased exploratory drilling which has been assessed as having a significant positive effect on the resource use objective, if the scale of activity within the high scenario was realised. However, during Stage 4, the extraction and use of hydrocarbon reserves would result in the direct loss of a primary natural resource that is non-renewable. Significant effects would be more likely under the high activity scenario as it could be reasonably assumed that more reserves would be extracted. However, the determination as to whether it would be significant cannot be made currently as: the determination of total UK shale gas resource is still at an early stage; the precise geology of host formations is unknown; and the likely yield per well is not yet possible to ascertain. **Overall, reflecting the differing effects of the differing Stages of the draft Licensing Plan, it has been assessed as having a cumulative significant positive effect and potentially significant negative effect on this objective.**

SEA Objective	Score	Summary
11. To protect and where appropriate enhance the historic environment including cultural heritage resources, historic buildings and archaeological features.	-/?	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 assumed construction density of a minimum of 5km between well pad sites would help to reduce likely visual effects on the setting of cultural 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 activities 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; and that these issues are duly addressed through the planning process. **Overall, the draft Licensing Plan has been assessed as having a cumulative minor negative effect on this objective with uncertainties over localised effects.**
12. To protect and enhance landscape and townscape quality and visual amenity.	-/--	Pad preparation during Stage 2 and Stage 3 of the unconventional oil and gas exploration and production lifecycle has been assessed as having a minor negative effect on landscape but with the potential for adverse effects to be significant, dependent on the location and setting of well pad sites. Construction activity associated with pad preparation, road access, well construction and (during Stage 3) pipeline works would have temporary, short-term effects on visual amenity and landscapes. Further temporary visual impacts could result from the presence of drilling rigs (over a period of approximately four weeks per well), as well as chemical storage tanks and plant associated with hydraulic fracturing. The height of the drilling rig could be approximately 26m and could result in locally significant effects depending on the setting, screening and extent to which a site would be overlooked. Flaring associated with testing may also result in visual impacts. The effect would be dependent on location, height, duration and timing of the flare. However, regulations require that flaring must be kept to the minimum that is technically and economically justified. Furthermore, it is assumed that effects would be minimised through the use of best available technology (BAT), which would include the use of a stack design which minimises visual intrusion effects. The assumed construction density of a minimum of 5km between well pad sites would help to reduce likely visual effects. Whilst it is generally anticipated that landscape and visual effects would be minor, should well pad sites be located in sensitive areas including, for example, Areas of Outstanding Natural Beauty (AONBs) or National Parks, or in close proximity to a number of sensitive receptors then effects have the potential to be significant. The probability of significant landscape effects would be greater under the high activity scenario, commensurate with the area of land take required to accommodate up to 2,880 wells (for unconventional oil and gas exploration and production) and the density/duration of activity (for the high activity scenario it is anticipated that up to 24 wells could be drilled per pad which could require a drilling rig to be on site for more than two years, assuming that it takes four weeks to drill each well). **Overall, the draft Licensing Plan has been assessed as having a cumulative minor negative effect on this objective with potential to have significant negative effects in certain localities, although it is recognised that landscape and visual impacts would be a key consideration as part of the EIA (where appropriate) and planning application processes and it is anticipated that appropriate mitigation would be implemented where possible to minimise adverse effects so that these are not unacceptable in specific locations.**

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.

Proposed Mitigation Measures

The assessment has identified a range of measures which could be implemented to avoid or minimise any potential negative effects, and to enhance positive effects. These measures are included within each of the topic-based assessments in **Appendix B** of the Environmental Report and can be broadly categorised as those that are targeted at operators (e.g. measures related to site selection or design at the project level) and those that are to be considered by DECC.

Those measures that are proposed to address the likely to significant negative effects outlined above are summarised in **Table NTS 4.**

Table NTS 4 Mitigation Measures Proposed to Address the Likely Significant Negative Effects of the draft Licensing Plan

Measure*	Resource Type	Stage(s)	SEA Objective	Responsibility
During the site selection process, careful consideration should be given by the operator to the avoidance of carbon sinks (e.g. peats) in order to minimise loss of carbon sequestration.	Unconventional, VCBM	Stage 2, Stage 3	Climate Change	Operator#
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, use of construction materials with low embodied carbon, limiting the volume of construction waste on site.	Unconventional, VCBM	Stage 2, Stage 3, Stage 4	Climate Change	Operator#
Operators should adopt the principle of reducing emissions to as low a level as reasonably practicable (ALARP). In particular, “reduced emissions completions” (RECs) or “green completions” should be adopted.	Unconventional, VCBM	Stage 2, Stage 3, Stage 4	Climate Change	Operator (and DECC for use of RECs)
Research should be undertaken with a view to developing more effective extraction techniques for shale gas which would minimise whole-life cycle GHG emissions including techniques such as improved REC and self-healing cements, reduced water consumption and vehicle demand.	Unconventional	Stage 2, Stage 3	Climate Change	DECC
The feasibility of measures to reduce GHG emissions through and related to the licensing process should be considered. These measures may include, for example, development of guidance and discussion with regulators on appropriate mandatory requirements.	Unconventional, VCBM	Stage 2, Stage 3, Stage 4	Climate Change	DECC
It is envisaged that the use of Best Available Techniques (BAT) will be adopted as part of a Waste Management Plan to transport and treat flowback (generated during hydraulic fracturing) and produced water to minimise negative effects from the significant volumes of wastewater produced following hydraulic fracturing. If treatment is required at a regional waste water treatment centre, early discussion should take place with the relevant water company to ensure there is adequate capacity to accommodate the additional demand.	Unconventional VCMB	Stage 2, Stage 3, Stage 4	Waste	Operator

Measure*	Resource Type	Stage(s)	SEA Objective	Responsibility
Best practice construction techniques should be used in order to minimise visual effect. Techniques may include minimising the vertical height of drilling equipment and site screening through existing features or use of planting and landscaping.	Conventional Unconventional, VCBM	Stage 2, Stage 3	Landscape	Operator#
Light pollution effects should be mitigated by use of screening, shielding and down lighting and where practical minimising working practices that require lighting.	Conventional, Unconventional, VCBM	Stage 2, Stage 3	Landscape	Operator#
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. Locational criteria should be used to avoid sensitive sites such as European designated conservation sites or Groundwater Source Protection Zone 1 locations.	Unconventional, VCBM	Stage 2, Stage 3	Land Use	Operator#
Options to consider the treatment and re-use of flowback back should be considered as part of an overall Water Management Plan.	Unconventional	Stage 2, Stage 3, Stage 4	Water	Operator#
Given the relatively high consumption of water during hydraulic fracturing, the timing of water consumption should be considered in light of local conditions so as to reduce the risk of abstractions occurring during low flow periods. Discussion should take place with the relevant water company regarding the effects on existing mains supply and consideration given to the future demands in the relevant water resource zone.	Unconventional	Stage 2, Stage 3, Stage 4	Water	Operator
Measures should be taken to reduce the emissions from vehicles and machinery. For example: the use of transport plans, shut down engines when not in use, the use of low emissions vehicles and low suphur fuels for electricity generators and and fracturing equipment where possible.	Unconventional, VCBM	Stage 2, Stage 3	Air quality	Operator#
Careful consideration should be given to the effects of vehicle movements arising during well site construction and development on local communities adjacent to sites or on routes to sites. Mitigation could include, for example: the preparation of Transport Plans; the identification of alternative routes; the phasing and timing of movements; the optimisation of movements to/from the site.	Conventional, Unconventional, VCBM	Stage 2, Stage 3	Population	Operator#

*It should be noted that many of the measures outlined above could also be adopted to address identified minor negative effects that could arise from the exploration and production of conventional oil and gas.
#It is envisaged that the operator's approach to these issues will be scrutinised as appropriate during the planning process.

Where relevant, the mitigation measures proposed above should be drawn to the attention of licence applicants, and they should be invited to indicate, in the environmental awareness statements which are already required as part of their applications, to indicate how they intend to incorporate these measures into their planning and operations.

Proposals for Monitoring

It is a requirement of the SEA Directive to establish how the significant effects of implementing the Licensing Plan will be monitored. As set out in ODPM Guidance, *"it is not necessary to monitor everything or monitor an effect indefinitely. Instead, monitoring needs to be focused on significant sustainability effects."*

Of the 10 topics considered in this SEA, it is proposed that monitoring should focus on the following indicators and sources of information, as set out in **Table NTS 5**.

Table NTS 5 Proposed Monitoring Indicators and Sources of Information

SEA Topics	Proposed Monitoring Indicators	Possible Source(s) of Information
Biodiversity	Annual (where information allows) trends in: • Condition of designated sites • Threatened habitats and species	Joint Nature Conservancy Committee (JNCC) Department for Environment, Food and Rural Affairs (Defra) Operator Independent Expert
Population	Employment Information (number of jobs, sector, e.g. – construction/oil and gas) Number of apprenticeships offered Value of payments made to local communities under the (UKOOG) community engagement charter Traffic activity levels around sites (annual average daily traffic flows)	Operator Office of National Statistics (ONS) UK Onshore Operators' Group (UKOOG)
Human Health	Monitoring of noise levels during hydraulic fracturing, drilling, construction and decommissioning Number of nuisance complaints received Traffic activity levels around sites (annual average daily traffic flows) National statistics – respiratory illness etc	Operator Relevant local authority's environmental health department/Annual Monitoring Report Department for Transport, Local Authority
Land Use, Soil and Geology	Seismic monitoring, before, during and after hydraulic fracturing Area of vegetation and soil layers cleared	Operator
Water & Flood Risk	Volumes of water consumption during hydraulic fracturing Consented/permitted aqueous discharges Groundwater quality monitoring	Operator Environment Agency (EA), Scottish Environment Protection Agency (SEPA), Natural Resources Wales(NRW)
Air	Air quality monitoring (including NOx, hydrocarbons, CO, PM and methane) Traffic activity levels around sites (annual average daily traffic flows)	Operator Local Authority
Climate Change	Energy consumption Emissions of greenhouse gases	Operator

SEA Topics	Proposed Monitoring Indicators	Possible Source(s) of Information
Waste & Resource Use	Volume of construction waste and proportions recycled Volume of hazardous waste Volume of controlled wastes and proportions recycled Volumes of wastewater (including from flowback) Quantity of materials ordered by sites	Operator, EA, NRW and/or SEPA
Cultural heritage	Condition of historic assets	Operator English Heritage, Historic Scotland, Cadw
Landscape	Annual (where information allows) trends in: • Change in AONB (area, threats and quality) • Changes in conservation areas	National Association of AONB English Heritage

The Next Steps

This Environmental Report is presented for consultation until **28th March 2014**. Feedback received from consultees will be documented and considered in reviewing the proposals for the Licensing Plan. A Post Adoption Statement will summarise how the SEA and the consultation responses have been taken into account and how environmental considerations have been integrated into the final decisions regarding the Licensing Plan.

Please visit www.gov.uk/oil-and-gas-licensing-rounds for further information on oil and gas licensing rounds.

This Consultation: How to Give Us Your Views

We would welcome your views on any aspect of this Environment Report. We are particularly interested to receive your views on the following questions:

1. Do you think that the Environmental Report has identified the significant environmental effects of the activities that could follow the licensing round? If not, what other significant effects do you think we have missed, and why?
2. Do you agree with the conclusions of the Environmental Report and the recommendations for avoiding, reducing or off-setting significant effects of the activities that could follow the licensing round? If not, what do you think should be the key recommendations and why?
3. Do you agree with the proposed arrangements for monitoring the significant effects of the activities that could follow the licensing round, as detailed in the Environmental Report? If not, what measures do you propose?

Please provide your comments by **28th March 2014**. Comments should be sent to:

Post: Oil and Gas Policy Unit, Department of Energy and Climate Change, Area 3B, 3 Whitehall Place, London, SW1A 2AW

Email: ogSEA@decc.gsi.gov.uk

Contents

1. Introduction

1.1 Overview

1.1.1 Context

The Department of Energy and Climate Change (DECC) is responsible for administering the oil and gas licensing system in the UK. All rights and ownership of the hydrocarbon resources of Great Britain (and the UK territorial waters) are vested in the Crown by the Petroleum Act 1998. The Secretary of State for Energy and Climate Change periodically offers licences which give exclusive rights to search for, and extract, these resources, within specified areas.

DECC is proposing to conduct a further onshore oil and gas licensing round for unlicensed landward areas in parts of England, Scotland and Wales (hereafter referred to as the 'draft Licensing Plan'). The types of activities covered would comprise:

- conventional oil and gas exploration and production;
- shale oil and gas exploration and production;
- virgin coalbed methane (VCBM) exploration and production; and
- natural gas storage in hydrocarbon reservoirs.

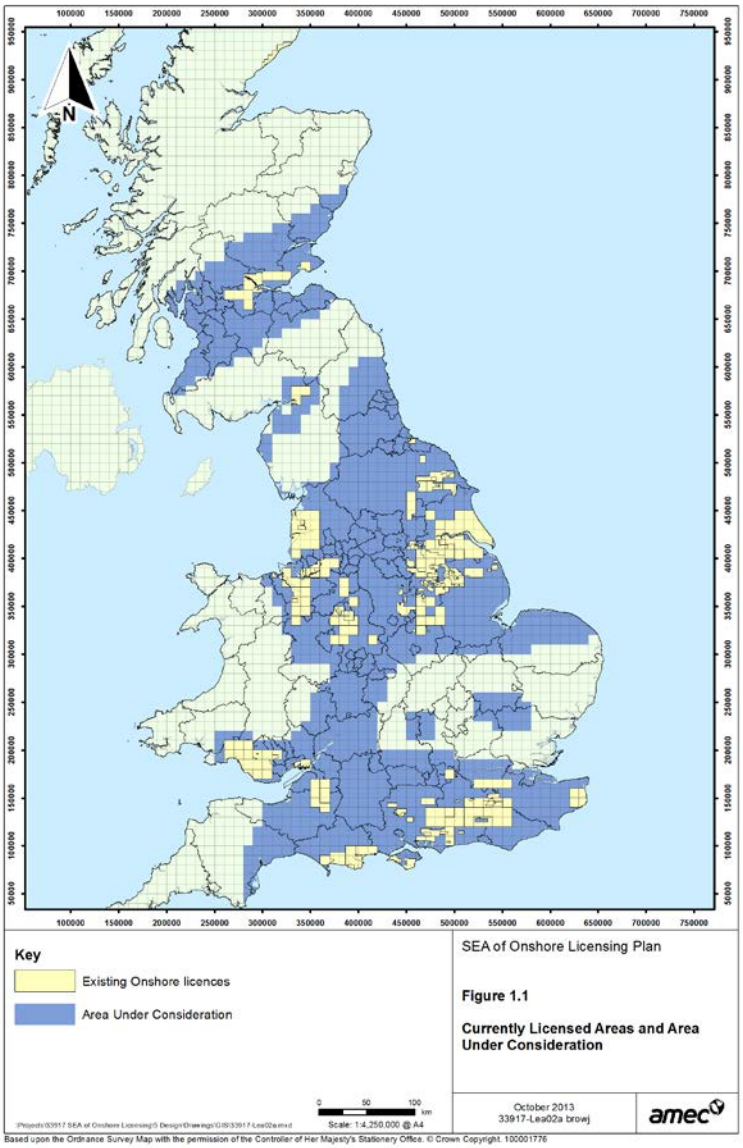
The area under consideration in the draft Licensing Plan is shown in **Figure 1.1**. In addition, areas which are already licensed for oil and gas are also presented. With the exception of two estuarine areas, that of the Dee/Afon Dyfrdwy and the Forth, only landward areas above the low water line are included in the draft Licensing Plan.

DECC, which in respect of offshore oil and gas activities is the principal environmental regulator as well as the licensing authority, has taken a proactive stance on the use of Strategic Environmental Assessment (SEA) as a means of striking a balance between promoting economic development of the UK's energy resources and effective environmental protection. Although the Strategic Environmental Assessment Directive (Directive 2001/42/EC) was not incorporated into UK law until 2004 (The Environmental Assessment of Plans and Programmes Regulations 2004, and equivalent Regulations of the devolved administrations), SEAs have been carried out by DECC of licensing rounds since 1999 in accordance with its requirements. In 2010, DECC published and consulted on a SEA Environmental Report in preparation for the 14th onshore licensing round, but the SEA process was suspended following the seismic tremors encountered during hydraulic fracturing operations at Preese Hall in Lancashire. In his statement to Parliament on 13th December 2012 [23] announcing the introduction of

[23] See https://www.gov.uk/government/speeches/written-ministerial-statement-by-edward-davey-exploration-for-shale-gas [Accessed May 2013]

new controls to mitigate against seismic risks, the Secretary of State for Energy and Climate Change confirmed that the SEA process would be restarted in the light of new information arising since the 2010 consultation.

Figure 1.1 Areas under Consideration (SEA Areas) and Currently Licensed Areas



1.1.2 Purpose of this Report

The purpose of this Environmental Report is to:

- present relevant environmental baseline information, including a review of plans and programmes to provide sufficient context for the assessment;
- identify, describe and assess the likely significant environmental effects associated with the draft Licensing Plan and reasonable alternatives;
- propose measures to avoid, reduce and/or offset any potentially significant adverse effects and, where appropriate, to enhance any potential positive effects from the draft Licensing Plan;
- outline and describe the measures envisaged for monitoring any significant effects identified by the Environmental Report;
- to give the statutory consultees, stakeholders and the wider public the ability to see and comment upon the effects that the draft Licensing Plan may have on them, their communities and their interests, and encourage them to make responses and suggest improvements to the draft Licensing Plan;
- demonstrate that the draft Licensing Plan has been developed in a manner consistent with the requirements of the SEA Regulations; and
- to inform the UK Government's decisions on the draft Licensing Plan.

1.2 Strategic Environmental Assessment

SEA became a statutory requirement for certain plans or programmes following the adoption of European Union Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment. This was transposed into UK legislation on the 20 July 2004 as Statutory Instrument No.1633 - The Environmental Assessment of Plans and Programmes Regulations 2004 (SI2004/1633). The objective of SEA, as defined in Directive 2001/42/EC (the SEA Directive) is:

> *'To provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to contributing to sustainable development.'*

Throughout the course of the development of a plan or programme, the SEA should seek to identify, describe and evaluate the likely significant effects on the environment of implementing the plan or programme and to propose measures to avoid, manage or mitigate any significant adverse effects and to enhance any beneficial effects.

1.2.1 Applying SEA to Onshore Oil and Gas Licensing Rounds

Case law has established that oil and gas licensing rounds are plans or projects for the purpose of the SEA Directive 2001/42/EC, and the 13th round of onshore licensing was subject to SEA.

As noted in **Section 1.1,** as part of the SEA in support of the draft Licensing Plan, DECC published an initial Environmental Report in July 2010 and consulted on it for a period of 12 weeks [24]. A consultation of the scoping report for the current Environment Report was also conducted in July and August 2013. Public consultation on the Scoping Report and the initial Environmental Report generated many helpful and informative responses and a summary of those received is provided at **Appendix A**.

1.3 Consultation and Stakeholder Engagement

1.3.1 Public Consultation on the Previous Environmental Report

Detailed responses to the initial Environmental Report published in July 2010 were provided by consultees. Responses were received from Natural England, Environment Agency, English Heritage, Scottish Environment Protection Agency, Scottish Natural Heritage, Historic Scotland, Countryside Council for Wales and an individual consultee.

A high level overview of the key issues raised by consultees is provided in **Table 1.1** below. A more detailed summary is set out at **Appendix A**.

Table 1.1 Summary of Consultation Responses on the previous Environmental Report carried out in 2010

Issue	Summary of Consultation Responses to the Previous Environmental Report	How have these Comments been Addressed in the New Environmental Report
Alternatives	The **Scottish Environment Protection Agency (SEPA)** suggested that consideration should be given to potential synergies in terms of use of existing infrastructure across different exploration areas. Other options were also suggested including the prioritisation of areas for development that would allow such synergies.	Section 2.6 sets out the alternatives considered for the draft Licensing Plan. These reflect those proposed in the initial 2010 Environmental Report, the consultation responses, along with the response made to the 2013 Scoping Report. Each alternative is considered in turn, and the reasons given for selecting those considered reasonable and which are taken forward in the assessment. Reasons are also provided regarding those not taken forward.
	Scottish Natural Heritage (SNH) felt that the comparison of alternatives was too simplistic and the conclusions of the Environmental Report not justified. SNH commented that it would have been preferable to explore the differences between realistic spatial and temporal restrictions on licensing, and/or between realistic conditions that could be applied to the licences, to determine which would have given the best result.	The SEA has included consideration of the effects of in 5 broad geographic areas where the effects of the activities that follow licensing could take place. These are: • SEA Area 1: Scottish Midlands (including the Inner Forth); • SEA Area 2: West Midlands, North West England and Southern Scotland; • SEA Area 3: East Midlands and Eastern England; • SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy); • SEA Area 5: Southern and South West England.

[24] Department of Energy and Climate Change (2010) *Strategic Environmental Assessment for a 14th and Subsequent Onshore Oil & Gas Licensing Rounds Environmental Report*, available from https://www.gov.uk/oil-and-gas-licensing-rounds [Accessed May 2013]

Issue	Summary of Consultation Responses to the Previous Environmental Report	How have these Comments been Addressed in the New Environmental Report
		Baseline information is provided under each of the SEA topics considered for each of the 5 SEA areas. The Environmental Report contains an assessment of the effects against each of these 5 areas which is also presented in the topic chapters.
Environmental Baseline	A number of consultees highlighted a range of additional information for inclusion within the environmental baseline. A range of additional plans and programmes were also identified by **SEPA** and the **Environment Agency (EA)**.	Appendix B of the revised Environmental Report presents the updated baseline containing additional and updated information to the initial 2010 Environmental Report.
SEA Approach	Consultees including **Natural England**, the **EA** and **Countryside Council for Wales (CCW)** suggested a range of additional indicators and amendments to the wording of the SEA objectives used during the assessment.	Section 4.3.1 presents the assessment objectives and guide questions. These were revised following the completion of the initial 2010 Environmental Report and revisions to the contextual information. The revised assessment objectives and guide questions were then subject to further consultation as part of the consultation on the 2013 Scoping Report. These were then further amended with the outcomes discussed with consultees on the 25th September 2013.
Assessment of Effects	Consultees highlighted both topics (e.g. climate change) and different technologies/activities that, in their opinion, needed further consideration in terms of potential environmental effects. Consultees requested clarification of assessment findings in some instances. **CCW** noted that the impacts of different licensing activities were scored on magnitude and duration, with only those considered to have major negative or major positive impacts considered as significant. They requested that further consideration be given to this as an acceptable approach, as the cumulative impact of multiple minor negative impacts may also be significant but will not have been assessed. **CCW** also highlighted that many activities can adversely affect sites that would not be considered within or adjacent to those activities and that adverse effects can therefore be wider than was stated in the assessment.	Chapter 5 outlines the findings of the assessment of the effects of the activities that follow licensing. These are presented for conventional oil and gas, unconventional oil and gas and underground gas storage. Chapter 5 also details the cumulative effects of the plan for the scenarios considered. Appendix B presents the detailed findings of the assessment of effects of the licensed activities against each of the 10 topic areas considered.
Cumulative Effects	Consultees suggested that further consideration should be given to cumulative effects including in respect of potential interrelationships with other industrial activities and plans and programmes and the potential impacts of the grouping of several licences in one block.	Table 4.7, of the Environmental Report provides definitions of secondary, cumulative and synergistic effects that have been used in the assessment, and which then are reflected in Chapter 5. Effects of grouping some pads together have been considered in the assessment of effects against the 5 SEA areas (see Section 5 Water of Appendix B for example).
Hydraulic Fracturing	Concerns were raised by a number of consultees in relation to the potential impacts of shale gas exploration and production and in particular effects associated with hydraulic fracturing on, for example, water resources and public health. Consultees highlighted the need for further investigations in this regard with one respondent requesting that operations involving hydraulic fracturing should be removed from the draft Licensing Plan.	The revised Environmental Report includes a consideration of the effects from activities arising from licensing for the following: • conventional oil and gas; • shale oil and gas; • virgin coalbed methane; and • natural gas storage in hydrocarbon reservoirs.
Mitigation	The need to identify mitigation measures beyond existing planning controls and regulations was identified including in respect of strategic level mitigation.	Section 5.7 presents a summary of mitigation and enhancement measures, related to the significant effects identified, corresponding to the stages in exploration and production, along with identification of which party should action. Further mitigation measures are outlined in the topic chapters contained in Appendix B.

Issue	Summary of Consultation Responses to the Previous Environmental Report	How have these Comments been Addressed in the New Environmental Report
Habitats Regulations Assessment	**EA** and **CCW** were of the opinion that the draft Licensing Plan should be subject to Habitats Regulations Assessment.	See Section 1.4.

1.3.2 Revised Environmental Report Scoping Consultation

Following resumption of the SEA process, after the Secretary of State's announcement, the approach to scoping was reviewed and revised to reflect the more recent information available, following the completion of the 2010 Environmental Report. A Scoping Report containing the revised approach was sent directly to those UK statutory and other bodies identified in **Box 1.1** over a 6 week period in July and August 2013.

Box 1.1 SEA Scoping Consultees

- Environment Agency;
- English Heritage;
- Natural England;
- Scottish Natural Heritage;
- Historic Scotland;
- Scottish Environment Protection Agency;
- Scottish Government;
- Natural Resources Wales;
- Cadw (Welsh Government historic environment service);
- Welsh Government;
- Department of the Environment's 'Environment and Heritage Service', Northern Ireland;
- Royal Society for the Protection of Birds;
- Friends of the Earth;
- World Wide Fund for Nature; and
- Greenpeace.

A meeting was held on the 25 July 2013, to which all consultees were invited to discuss the approach to scoping and to help inform consultees' subsequent submissions. Detailed responses were received from 11 of the consultees. A summary of key points raised by the consultation are shown in **Table 1.2** below along with how these comments were addressed within the revised Environmental Report. A more detailed summary is set out in **Appendix A.**

Table 1.2 Overview of the Issues Raised in the Scoping Consultation

Issue	Summary of Scoping Report Consultation Responses	How has this been Addressed in this Revised Environment Report
Environmental Baseline	Suggestions were made for amendments and additional information for biodiversity and land use topic chapters	Where relevant, the amendents or additional baseline information were included within the topics chapters (Appendix B).
SEA Approach	Several respondants (including **Natural England, Environment Agency, Natural Resources Wales, WWF**) suggested that the Flood Risk objectives would be better represented either within the water topic or in its own topic chapter than within the climate change topic. Additions were suggested to the flood risk guide questions by **Environment Agency** to include additional factors. Several respondants suggested a suggested a review of water guide questions (including **Environment Agency, Greenpeace, Natural Resources Wales**) to ensure that issues are clearly defined. Concerns were raised by **Natural England** on the initial wording at the start of all guide questions was not clear. **RSPB** requested that the description for postive and negative should have the word minor inserted before them Minor amendments to the wording of the cultural heritage guide questions were suggested by **English Heritage** and an additional guide question was suggested related to historic landscape character. **Natural Resources Wales** suggested that biodiversity guide questions should make reference to habitat connectivity and suggested an additional guide question related to ancient woodlands.	Section 7 (The Climate Change and Flood Risk) topic of Appendix B has been split with the flood risk information transferred to the water topic (Section 5 of Appendix B). Changes were made to the flood risk guide questions to account for suggestions made. Changes were made to the guide questions to address these suggestions. The start of guide questions was changed from *Will the Licensing Plan proposals….* to *Will the activities that follow the licensing round …*Text was amended in line with the suggestion. Amendments to the wording of cultural heritage guide questions were made and an additional guide question was added. References to habitat connectivity were added to the biodiversity guide questions and an additional guide question was added.
Flowback	Several respondants were concerned that assumptions on water use and flowback were underestimated and that a range of estimates would be more appropriate to **Friends of the Earth** felt that the assumption that each well uses 10 ML of water per well was an underestimate.	Assumption was changed to 10-25 ML to reflect the uncertainty and range shown in the literature.
Alternatives	**Friends of the Earth** expressed concern that the range of alternatives included in the scoping report were too limited and suggested additional alternatives to consider.	Section 2.6 sets out the alternatives considered for the draft Licensing Plan. These reflect those proposed in the initial 2010 Environmental Report, the consultation responses, along with the response made to the 2013 Scoping Report. Each alternative is considered in turn, and the reasons given for selecting those considered reasonable and which are taken forward in the assessment. Reasons are also provided regarding those not taken forward.
Habitat Regulations Assessment	Several respondants (including **Natural England, RSPB, Friends of the Earth and Greenpeace**) were of the opinion that the draft licensing plan should be subject to a Habitat Regulations Assessment.	See Section 1.4.

1.4 Habitats Regulations Assessment

In addition to carrying out this Strategic Environmental Assessment on the Licensing Plan, DECC has considered the Plan in the context of the Habitats Directive and the Regulations which implement the Directive in the UK. The Directive and the Regulations provide for certain protections to be accorded to designated sites, including Special Areas of Conservation and Special Protection Areas, designated under the Habitats Directive and the Birds Directive respectively; and UK planning policy accords the same level of protection to sites designated under the Ramsar Treaty.

Among the protections accorded, certain plans or projects are required to be screened to determine whether they are likely to have a significant effect on a protected site. Where such effects are considered likely, an appropriate assessment of the implications of the plan or project for the conservation objectives of the site must be carried out, before that plan or project is agreed.

To the extent that the Licensing Plan is a "plan" within the scope of the Habitats Directive, DECC has therefore carried out screening of it and reached the conclusion that the early stage of inviting applications for licences and considering these applications will not have significant effects on sites.

So far as the licences which may then be issued are concerned, DECC notes that any effects on sites will be caused by activities, such as drilling, which are not authorised by the licences but instead are authorised separately under the planning system, and planning decisions will be subject to appropriate assessments wherever required by law and in the full environmental context of each proposal.

Nevertheless, DECC has decided to carry out such assessments as are appropriate before any licence is issued. Once applications for licences have been received and their geographical proximity to any protected site can be established, the appropriate statutory bodies will be consulted on the form and scope of the assessments which should be performed before any decision is made on the award of a licence.

1.5 Environmental Report Structure

This Environmental Report is structured as follows:

- **Non Technical Summary** - Provides a summary of the Environmental Report, including information on both the draft Licensing Plan and the proposed approach to assessment;
- **Section 1: Introduction** - Includes a summary of the draft Licensing Plan, an overview of SEA, an outline of the report contents and an outline of how to respond to the consultation;
- **Section 2: The Draft Licensing Plan** - Describes the background to the draft Licensing Plan, its objectives and regulatory context together with an overview of the potential effects that could arise from associated activities following licensing. This section also sets out the alternatives that will be assessed as part of the SEA;

- **Section 3: Context and Baseline** - Provides details of the review of the international, national and regional plans and programmes and baseline conditions for the environmental categories required by the SEA Directive and summarises the key environmental issues relevant to onshore oil and gas licensing. Further detailed information is contained at **Appendix B**;
- **Section 4: SEA Methodology** - Provides an outline the SEA objectives and guide questions used to assess the effects, the assumptions used, the approach used in relation to consideration of indirect, synergistic cumulative effects and any technical difficulties encountered in completing the assessment;
- **Section 5**: **Assessment of effects** - Outlines the likely significant environmental effects of the implementation of the draft Licensing Plan and the reasonable alternatives, including cumulative effects, mitigating measures, uncertainties and risks;
- **Section 6: Conclusions and Key Findings** - Summarises the main impacts and presents views on implementation and monitoring;
- **Appendix A: Summary of Consultation Responses -** Provides an overview of the responses received during consultation on the 2010 Environmental Report and the 2013 Scoping Report;
- **Appendix B: Baseline and Contextual Information and Assessment -** Sets out the collated contextual and baseline information and the assessment, on a topic-by-topic basis, for each of the assessment topics;
- **Appendix C: Species Used to Calculate Population Indicators;**
- **Appendix D: Natural Areas in England Relevant to SEA Areas 2, 3 and 5;**
- **Appendix E: International Designations in SEA Areas;** and
- **Appendix F: Quality Assurance Checklist.**

Table 1.3 details how the requirements of the SEA regulations have been addressed in this Environmental Report.

Table 1.3 SEA Information Requirements Addressed within this Environmental Report

SEA Information Requirements	Environmental Report Reference
Schedule 2 of the SEA Regulations (SI 2004 No. 1633) sets out the following information requirements:	***The following sections of this Environmental Report address the requirements of the SEA Regulations:***
1. An outline of the contents and main objectives of the plan or programme, and of its relationship with other relevant plans and programmes.	This requirement is addressed in **Section 2 (The draft Licensing Plan), Section 3 (Context and Baseline) and Section 4 (SEA Methodology)** and **Appendix B**.

SEA Information Requirements	Environmental Report Reference
2. The relevant aspects of the current state of the environment and the likely evolution thereof without implementation of the plan or programme.	This requirement is addressed in **Appendix B.**
3. The environmental characteristics of areas likely to be significantly affected.	This requirement is addressed in **Appendix B**.
4. Any existing environmental problems which are relevant to the plan or programme including, in particular, those relating to any areas of a particular environmental importance, such as areas designated pursuant to Council Directive 79/409/EEC on the conservation of wild birds [25] and Council Directive 92/43/EEC (the Habitats Directive [26]).	This requirement is addressed in **Section 3 (Context and Baseline) and Section 4 (SEA Methodology) and Appendix B.**
5. The environmental protection objectives, established at international, Community or Member State level, which are relevant to the plan or programme and the way those objectives and any environmental considerations have been taken into account during its preparation.	This requirement is addressed in **Section 3 (Context and Baseline) and Section 4 (SEA Methodology), Section 5 (Assessment of Effects)** and **Appendix B.**
6. The likely significant effects on the environment, including short, medium and long-term effects, permanent and temporary effects, positive and negative effects, and secondary, cumulative and synergistic effects, on issues such as: biodiversity; population; human health; fauna; flora; water; air; climatic factors; material assets; cultural heritage, including architectural and archaeological heritage; landscape; and the inter-relationship between the issues referred to in sub-paragraphs (a) to (l).	A summary of the likely significant effects of the draft Licensing Plan will be provided in **Section 5 (Assessment of Effects)** and detail of the assessment for each topic will be within **Appendix B.**
7. The measures envisaged to prevent, reduce and as fully as possible offset any significant adverse effects on the environment of implementing the plan or programme.	Mitigation measures are included within the assessment of each topic within **Appendix B** and a summary will be included in **Section 5 (Assessment of Effects)** of the report.
8. An outline of the reasons for selecting the alternatives dealt with, and a description of how the assessment was undertaken including any difficulties (such as technical deficiencies or lack of know-how) encountered in compiling the required information.	This requirement is addressed in **Section 2 (The Draft Licensing Plan)** and **Section 3 (Context and Baseline) and Section 4 (SEA Methodology).**
9. A description of the measures envisaged concerning monitoring of environmental conditions	Monitoring regimes will be identified through the assessments in **Appendix B** and a summary will be included within **Section 6 (Conclusions and Key Findings)** of the Environment Report.
10. A non-technical summary of the information provided under paragraphs 1 to 9.	A **Non-Technical Summary** is provided within this Environment Report.

[25] Council Directive 79/409/EEC on the conservation of wild birds. The Directive provides a framework for the conservation and management of, and human interactions with, wild birds in Europe. In the UK, the provisions of the Birds Directive are implemented through the Wildlife & Countryside Act 1981 (as amended) and The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).

[26] Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (EC Habitats Directive). In the UK the Directive has been transposed into national laws by means of the Conservation (Natural Habitats, & c.) Regulations 1994 (as amended). The 'Habitats Regulations' apply to the UK land area and its territorial sea (to 12 nautical miles from the coast), and are supported by government policy guidance.

1.6 Commenting on this Environmental Report

This Environment Report is being issued for public consultation between **17th December 2013** and **28th March 2014**. Details of how to respond to the consultation are provided overleaf.

This Consultation: How to Give Us Your Views

We would welcome your views on any aspect of this Environment Report. We are particularly interested to receive your views on the following questions:

1. Do you think that the Environmental Report has identified the significant environmental effects of the activities that could follow the licensing round? If not, what other significant effects do you think we have missed, and why?
2. Do you agree with the conclusions of the Environmental Report and the recommendations for avoiding, reducing or off-setting significant effects of the activities that could follow the licensing round? If not, what do you think should be the key recommendations and why?
3. Do you agree with the proposed arrangements for monitoring the significant effects of the activities that could follow the licensing round, as detailed in the Environmental Report? If not, what measures do you propose.

Please provide your comments by **28th March 2014**. Comments should be sent to:

Post: Oil and Gas Policy Unit, Department of Energy and Climate Change, Area 3B, 3 Whitehall Place, London, SW1A 2AW

Email: ogSEA@decc.gsi.gov.uk

2. The Draft Licensing Plan

2.1 Introduction

This section of the Environmental Report provides an overview of the draft Licensing Plan that is the subject of the SEA and of the context in which it is being prepared, in terms of overall energy and climate change policy and objectives, the regulatory context and prospectivity. A high level consideration of the potential activities that may follow licensing and the resulting effects and controls is also set out together with the activity scenarios that have been used to inform the SEA and the draft Licensing Plan alternatives that assessed.

2.2 Context and Draft Licensing Plan Objectives

2.2.1 Context

The draft Licensing Plan needs to be considered in the context of overall UK energy and climate change policy. The UK Government's 2011 Carbon Plan [27] sets out how the UK will make the transition to a low carbon economy. By moving to a more efficient, low carbon economy with a more diverse range of energy sources, the aim is to increase energy security and reduce exposure to international fuel price volatility in the long term, as well as cutting emissions and minimising costs to consumers.

UK energy policy is underpinned by the following aims:

- **Ensuring energy security**: to ensure that UK businesses and consumers have secure supplies of energy, for light and power, heat and transport;
- **Tackling climate change**: to lead the UK Government's efforts to prevent dangerous climate change, both through international action and through cutting greenhouse gas emissions. The UK has legally binding targets to cut emissions by at least 80% by 2050, and to source 15% of its energy from renewable sources by 2020;
- **Ensuring consumer affordability**: to deliver secure, low carbon energy at least cost to consumers, taxpayers, and the economy as a whole;
- **Supporting growth**: to deliver energy policies in a way that maximises the benefits to the economy in terms of jobs, growth and investment, including by making the most of UK oil and gas reserves and seizing the opportunities presented by the rise of the global green economy;

[27] HM Government (2011) *The Carbon Plan: Delivering our low carbon future*, available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47621/1358-the-carbon-plan.pdf [Accessed May 2013]

- **Fairness**: ensuring that costs and benefits are distributed fairly, so as to protect the most vulnerable and fuel poor consumers and address any competitiveness problems faced by energy intensive industries; and

- **Effectively manage the UK's energy legacy and resilience** safely, securely and cost effectively, whilst minimising the burden for taxpayers.

Critical to transitioning to a low carbon economy is the need for the power sector to reduce significantly its carbon emissions by the 2030s. The electricity market reforms, currently being taken through Parliament in the Energy Bill [28], will encourage investment in a range of low carbon technologies so that they generate an increasing proportion of UK electricity. Reform is also needed to attract the investment needed to replace ageing energy infrastructure and to meet the projected future increases in electricity demand as sectors such as transport and heat are decarbonised.

Even as decarbonisation proceeds, oil and gas will continue to provide a vital contribution to UK energy supplies for years to come. In 2012, UK oil and gas production provided 41% of total UK primary energy supply and, when combined with imported sources of oil and gas met 69% of total UK primary demand[29]. Even with the target to source 15% of UK energy from renewables in 2020, energy projections for the period 2020 to 2030 show continued reliance on oil and gas for over two thirds of the UK's total energy needs [30].

DECC's latest central projections show, that in absolute terms, natural gas demand is expected to remain at or above current levels over the period to 2030. However, indigenous production is likely to account for a decreasing share of demand for natural gas within the UK. Net gas production (i.e. excluding oil and gas producers' own use) from the UK Continental Shelf peaked in 2000 at 108 billion cubic metres (bcm). By 2012, production had fallen by two thirds to 37 bcm. By 2030, production is expected to have fallen to half of 2012 levels.

Investing in domestic oil and gas production is important for energy security as it helps to reduce the extent to which the UK is reliant on imported energy that increases UK exposure to potential fossil fuel price spikes in the international energy market. Government policies therefore aim to maximise economic recovery of indigenous hydrocarbon resources (onshore and offshore), where it is cost-effective and in line to safety and environmental regulations to help ensure security of supply. Demand for oil in the UK is set to decrease over the longer term as the UK transitions to a low carbon economy. However, in the medium term oil will retain an important role, especially in the transport sector.

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

[28] See http://services.parliament.uk/bills/2012-13/energy/documents.html [Accessed May 2013]

[29] DECC (2013) *Digest of United Kingdom Energy Statistics 2013: Table 1.1*.

[30] DECC (2013) *Updated Energy and Emissions Projections September 2013*.

Generation Strategy [31] 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 [32]. The Government expects a continued need for new investment in gas plant and the objective of the Strategy was to reduce the uncertainty around gas generation for investors.

In the longer term, the development of cost-competitive Carbon Capture and Storage (CSS) technology should ensure gas can continue to play a full role in a decarbonised electricity sector by enabling the use of existing fossil fuel supplies more cleanly. Power plant with CCS could reduce carbon dioxide (CO_2) emissions to the atmosphere by approximately 80–90% compared to a plant without CCS [33].

Continued use of gas implies an on-going need for more gas infrastructure, as set out in the 2011 National Policy Statements for energy infrastructure [34]. As indigenous offshore production declines, there will be an increasing need for alternative gas supply infrastructure capacity, which could be either gas storage or gas import infrastructure.

More detail on energy policy is set out in the Government's Annual Energy Statement 2013, published on 31 October 2013 [35].

2.2.2 Draft Licensing Plan Objectives and Scope

Within this broader policy framework, the main objectives of the draft Licensing Plan are to enable a further contribution towards the comprehensive exploration and appraisal of UK oil and gas resources and the economic development of identified reserves, together with enabling further gas storage capacity in hydrocarbon reservoirs, without compromising the biodiversity, ecosystem functioning and the interests of nature and heritage conservation, and other material assets and users.

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[31] DECC (2012) *Gas Generation Strategy*, available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65654/7165-gas-generation-strategy.pdf [Accessed May 2013]

[32] See for further information https://www.gov.uk/government/policies/reducing-the-uk-s-greenhouse-gas-emissions-by-80-by-2050/supporting-pages/carbon-budgets [Accessed May 2013]

[33] Intergovernmental Panel on Climate Change (2005) *Carbon Dioxide Capture and Storage*, available from http://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf [Accessed May 2013]

[34] The energy National Policy Statements designated on 19th July 2011include: EN-1 Overarching Energy; EN-2 Fossil Fuel Electricity Generating Infrastructure; EN-3 Renewable Energy Infrastructure; EN-4 Gas Supply Infrastructure & Gas and Oil Pipelines; EN-5 Electricity Networks Infrastructure; EN-6 Nuclear Power Generation (Volume I); EN-6 Nuclear Power Generation (Volume II). See https://www.gov.uk/consents-and-planning-applications-for-national-energy-infrastructure-projects#national-policy-statements-for-energy-infrastructure [Accessed May 2013]

[35] https://www.gov.uk/government/speeches/annual-energy-statement-2013

As set out in **Section 1.1**, licences under this and subsequent rounds may be offered for the exploration and production of the following resources:

- conventional oil and gas;
- shale oil and gas; and
- virgin coalbed methane.

Additionally, licences could cover natural gas storage in hydrocarbon reservoirs.

Table 2.1 provides a high level overview of the resources listed above and activities involved in their exploration and production (including gas storage).

Table 2.1 Resources Overview [36]

Resource Type	Overview
Conventional Oil and Gas	Prospective areas for onshore oil and gas in the UK, as elsewhere, are confined to geologically appropriate sedimentary basins with adequate source and/or reservoir rocks, and source rock maturity. A suitable cap rock and migration pathways (permeability) are also key factors in determining reservoir viability and ease of extraction.
Virgin Coalbed Methane	Virtually all coals contain some methane as the result of coal formation which either adsorbs into coal micropores (<2nm) or is dispersed in pore spaces surrounding it, with gas sorption being related to the pore and structure development of coal, which is largely influenced by coal type and rank. As pressure is reduced, gas is released from the coal, diffuses through the coal matrix and flows through the fracture system of the coal. Virgin Coalbed Methane is coalbed methane derived from coal seams which have otherwise been untouched (i.e. they have not been previously mined), and is worked from surface boreholes. The quantity of gas released depends on gas content, and the permeability and thickness of the coal seam. There may be some trade-off whereby a coal seam of good thickness and permeability can compensate for low gas content, though seams of high permeability may have increased water disposal problems. In coalbed methane production, a well is drilled into the coal seam and water is pumped out to lower the pressure in the seam. This allows methane to desorb from the internal surfaces of the coal and diffuse into the cleats (fissures in the coal), where it is able to flow, either as free gas or dissolved in water, towards the production well. Permeability (imparted mainly by the cleats) is necessary to achieve coalbed methane production, and hydraulic fracturing has been tested in some areas to improve connectivity between the borehole and the cleat system. Virgin Coalbed Methane extraction generally requires seams thicker than 0.4m at depths between 200 and 1,500m (the limit of conventional mining). Any shallower and the coal is likely to have lost its gas by natural leakage while at depths greater than 1,500m the yield is unlikely to cover drilling costs, though new technologies may eventually permit the use of deep coal resources. Permeability is of key importance, and in general, UK coals exhibit low permeability, reducing the potential for Virgin Coalbed Methane.
Shale Gas	Natural gas produced from shale is often referred to as ‘unconventional’ and this refers to the type of rock in which it is found. ‘Conventional’ oil and gas refers to hydrocarbons which have been sought in permeable formations such as sandstone or limestone, as opposed to tight sands, shale or coal which are now the focus of “unconventional” exploration. However, the range of techniques used to prove and extract hydrocarbons are essentially the same. What has changed are advancements in technology over the last decade which have made ”unconventional” development economically viable.

[37] Petroleum is defined in Part I of the Petroleum Act as including “any mineral oil or relative hydrocarbon and natural gas existing in its natural condition in strata; but does not include coal or bituminous shales or other stratified deposits from which oil can be extracted by destructive distillation”. However the Crown owns any oil and gas that “exists in its natural condition” in coal strata.

Resource Type	Overview
	Shale gas is part of a range of unconventional gas prospectivity, from tight gas sands, gas shales to coalbed methane in which the combination of horizontal drilling and fracture stimulation technology can enable economic extraction of oil or gas from rocks with low permeability. Exploration for shale gas and Virgin Coalbed Methane is currently underway in the UK.
Gas Storage in Hydrocarbon Reservoirs	There are three types of large-scale underground natural gas storage facilities: salt caverns; depleted/depleting gas or oil fields; and aquifers. Note that the current SEA only covers licensing for gas storage in depleted gas or oil fields since the other options do not require petroleum licences. Depleted reservoir formations must have high permeability and porosity. The porosity of the formation determines the amount of natural gas that it may hold, while its permeability determines the rate at which natural gas flows through the formation, which in turn determines the rate of injection and withdrawal of working gas. In certain instances, the formation may be stimulated to increase permeability. Gas storage in depleted fields is the most widespread method and often the least expensive. Along with aquifer storage, they are capable of storing very large volumes of gas and are particularly suitable for strategic storage and storage to meet seasonal changes in demand. An advantage of using depleted natural gas or oil fields for underground storage is that they are known to be capable of storing natural gas or oil for geological time-scales, and they can often require less "cushion gas" (volume of gas that must remain in the storage facility to provide the required pressurisation to extract the remaining gas) than other underground storage scenarios. Furthermore, they have commonly been well characterised as a result of the gas or oil extraction programme.

2.3 Onshore Licensing Regulatory Context and Background

The Petroleum Act 1998, which consolidated a number of earlier pieces of primary legislation, vests all rights to the petroleum [37] (oil and gas) resources of Great Britain in the Crown. The Secretary of State for Energy and Climate Change, on behalf of Her Majesty, may grant licences over a limited area and period of time that confer exclusive rights to "*search and bore for and get*" petroleum. The oil and gas licensing system is administered by DECC (the Responsible Authority for this SEA).

Current onshore oil and gas production licences are called Petroleum Exploration and Development Licences (PEDLs). PEDLs are generally offered in Licensing Rounds. PEDLs were first issued in the 8th Licensing Round in 1996 to reduce the bureaucratic burden of issuing separate licences for each stage of an onshore field's life (previously separate Exploration, Appraisal, Development and Production Licences were issued). Before a licence can be awarded, the applicant must satisfy DECC of the competence of its proposed operator, and each member of the applicant group must satisfy DECC of its financial viability and financial capacity. Applications which meet these requirements are then subject to assessment, on the basis of published criteria, of the geological understanding displayed, and the exploration effort proposed. Where two or more applications are for the same area, the application with the highest ranking is selected.

Onshore licence co-ordinates use the National Grid referencing system. For DECC's oil and gas licensing purposes each 10km square is referred to as a block. A licence may cover a whole block, part of a block, or several blocks or part-blocks. Further information on onshore licensing can be found on

[37] Petroleum is defined in Part I of the Petroleum Act as including "any mineral oil or relative hydrocarbon and natural gas existing in its natural condition in strata; but does not include coal or bituminous shales or other stratified deposits from which oil can be extracted by destructive distillation". However the Crown owns any oil and gas that "exists in its natural condition" in coal strata.

the DECC onshore oil and gas website via the following link: https://www.gov.uk/oil-and-gas-licensing-rounds.

While the award of a PEDL gives exclusivity in respect of exploration or production in the licensed area, it does not waive any other statutory or legal requirement necessary for these activities. In particular, the licensee has to obtain access rights from landowners (e.g. a wayleave) and his activities are subject to statutory planning [38], environmental [39] and other permitting regimes.

In addition, the licences provide that licensees may not conduct activities such as the drilling of wells, installation of facilities or production of hydrocarbons without the authorisation of the Secretary of State for Energy and Climate Change. Licensees are required to provide proof to DECC that the relevant planning and other permissions and consent(s) have been obtained, before such consents are granted.

PEDLs are valid for a sequence of periods, called Terms which are designed to follow the typical lifecycle of a field: exploration, appraisal, and production. Each licence expires automatically at the end of each Term, unless the licensee has made enough progress to earn the chance to move into the next Term (see **Table 2.2**).

Table 2.2 Terms of 13th Round Petroleum Exploration and Development Licences

Term	Length (years)	Phase	Expiry of Licence
Initial	6	Exploration	At end of the Initial Term unless the Licensee has completed the agreed Work Programme.
Second	5	Appraisal and development	At end of the Second Term unless Secretary of State (SoS) has approved a Development Plan.
Third	20	Production	SoS has discretion to extend Licence if production is likely to continue past 20 years.

In England and Wales, the underground storage of gas at quantities of greater than 43 million standard cubic metres or with a flow rate exceeding 4.5 million standard cubic metres per day, is covered under Part 3 (Nationally Important Infrastructure Projects), section 14 of the Planning Act 2008 and fall within a framework provided by National Policy Statements. Gas transporter and other pipelines associated with any facilities relating to this and other similar plans/programmes may also lie within the remit of this legislation, and this includes pipelines which have one end in Scotland.

[38] See, for example, Communities and Local Government (2013) *Planning practice guidance for onshore oil and gas*, available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/224238/Planning_practice_guidance_for_onshore_oil_and_gas.pdf. This document provides a relevant policy framework for the development of oil, gas, coalbed methane and underground gas storage facilities in England.

[39] See for example, Environment Agency (2013), *Onshore oil and gas exploratory operations: technical guidance Consultation Draft*, August 2013 from https://consult.environment-agency.gov.uk/portal/ho/climate/oil/gas?pointId=2582509#document-2582509

When an operator proposes to drill a well, the following factors will have to be addressed:

- access to the land (either on the surface or underground), by negotiating access with landowners;
- the need for planning permission from the relevant Planning Authority (in England, the Minerals Planning Authority); the need for permits and authorisations under environmental regulation implemented in England by the Environment Agency (EA), Wales by the Natural Resources Wales (NRW) and in Scotland by the Scottish Environment Protection Agency (SEPA);
- health and safety legislation implemented by the Health & Safety Executive (HSE);
- permission from the Coal Authority if the drilling entails encroachment on coal seams; and
- well consent pursuant to the Licence by DECC.

The key planning and environmental legislation affecting the onshore hydrocarbon industry is found at the following link:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/15749/onshoreleg1.doc

2.4 Prospectivity

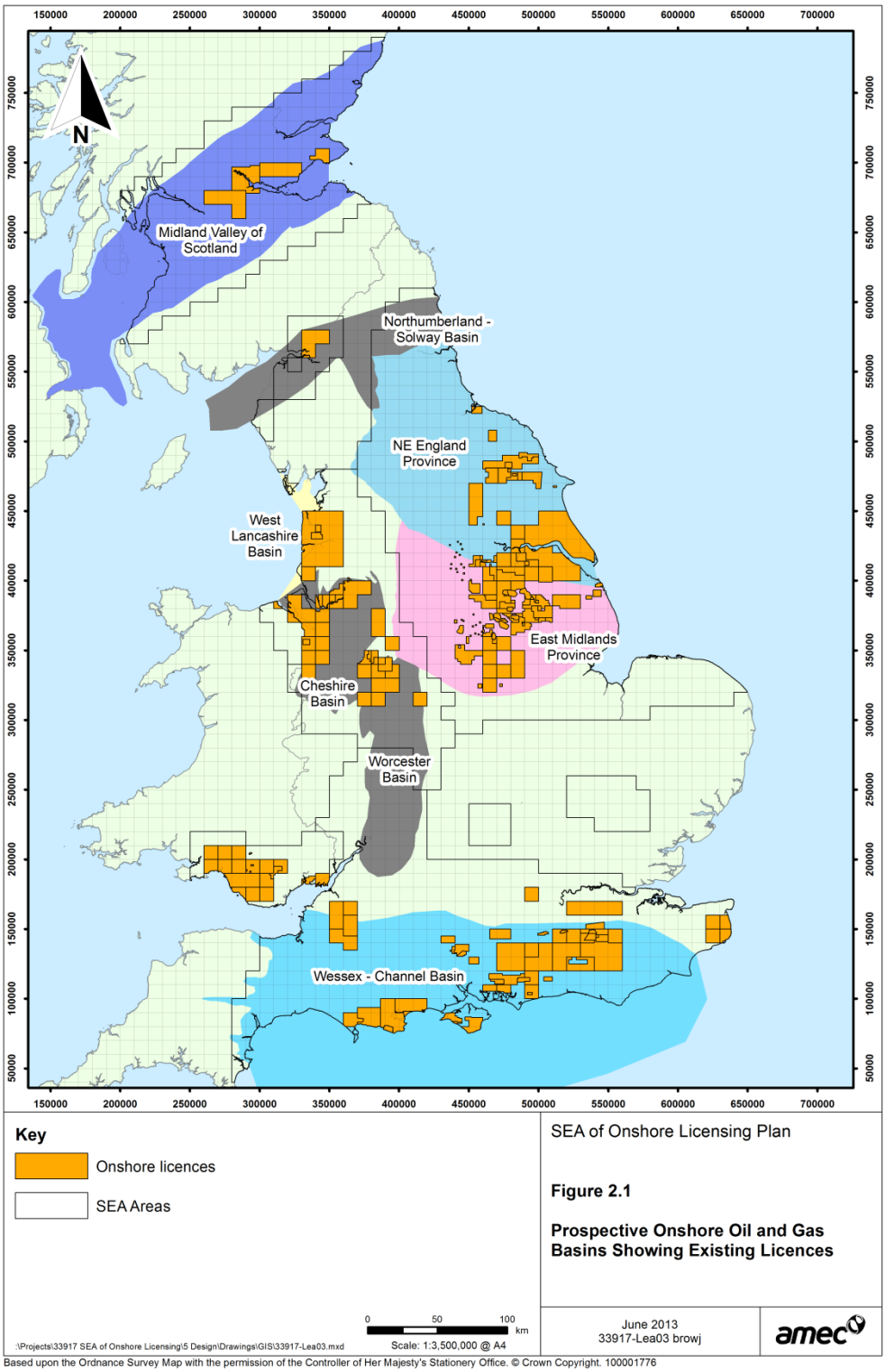
The purpose of exploration activity is to identify commercially viable resources of oil and gas. The conditions necessary for such reserves to have developed or accumulated are complex and largely dependent on past geological history and present geological formations and structures.

For conventional hydrocarbon resources to occur in commercial quantities, a number of geological features have to coincide, including:

- the presence of suitable source rocks with an appreciable organic content;
- adequate depth of burial to allow the conversion of organic material to oil or gas through the action of temperature and pressure;
- the presence of rocks with sufficient porosity to provide storage for economic volumes of oil or gas;
- migration pathways which permit oil and gas formed from the source rocks to move to reservoir formations (permeability); and
- cap or seal rocks to prevent the oil or gas from escaping from the reservoir rocks.

A number of prospective areas occur in the UK, due mainly to the presence of mature source rocks. The age of these mature source rocks and reservoir rocks, and the type of hydrocarbons found (oil or gas) varies, which naturally defines a series of 'provinces' (see **Figure 2.1**).

Figure 2.1 Prospective Onshore Oil and Gas Basins showing Existing Licences



The East Midlands oil province comprises Carboniferous source and reservoir rocks deposited in a series of major fault-bounded basins. The Midland Valley of Scotland is also prospective, with Carboniferous source and reservoir rocks. The Wessex-Channel (including the Weald) Basin arises from the presence of both Triassic and Jurassic (Mesozoic) source and reservoir rocks. Other oil and gas fields in North West and North East England arise from the presence of older (Carboniferous-Silesian) source rocks and younger Permian and Mesozoic reservoir rocks. They include the West Lancashire Basin and North East England Province (including the Cleveland Basin). Although they have not so far yielded commercial quantities of hydrocarbons, the presence of Carboniferous and Permo-Triassic reservoirs lead to other potentially productive basins/provinces including the Cheshire Basin and Northumberland-Solway Basin.

Many of these provinces are not entirely onshore, with the Wessex and Weald basins extending offshore into the English Channel. Similarly, the West Lancashire Basin is the eastern, onshore margin of the more extensive East Irish Sea Basin, and the East Midlands and Cleveland Basin link to the Southern North Sea gas basin. These offshore areas are subject to the seaward oil and gas licensing regime unless activities are being carried out from infrastructure in the landward area of UK as set out in the Petroleum (Production) (Seaward Areas) Regulations 1988, Regulation 3(1). However, the landward regime also extends to two estuarine areas, that of the Dee/Afon Dyfrdwy and the Forth, which are considered in this SEA.

Shale is present in all the basins depicted in **Figure 2.1**, however it is only prospective for shale gas and oil where there the depositional conditions are right (e.g. high organic content, kerogen type, mineralogy) and where the rocks have been buried deep enough for the maturation of the hydrocarbons under high temperature and pressure.

The 2010 DECC-commissioned British Geological Survey (BGS) report, *The unconventional hydrocarbon resources of Britain's onshore basins - shale gas* [40], identified the most prospective shale intervals. The shales which are thought to be prospective in Great Britain are described below:

- The Carboniferous Namurian and Dinantian Bowland and Hodder shales are the principal source rocks for conventional hydrocarbon fields in the East Midlands, Formby and in the offshore fields of the East Irish Sea Basin. These shales occur widely in northern England where the interval thickens to over 6000ft in syn-rift basins that are highly prospective for shale gas. Across most of southern England and Wales (except Cornwall) Namurian and Dinantian Lower Limestone Shales are likely to be present, but have had few well penetrations to confirm their prospectivity;

- In the Midland Valley of Scotland, Carboniferous shale of the West Lothian Oil-Shale Group were surface mined for hydrocarbons in the past and are thought to be prospective for shale gas where buried deeper in the basin;

[40] See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66172/uk-onshore-shalegas.pdf [Accessed May 2013]

- The Kimmeridge and Lias Jurassic shale intervals in the Weald and Wessex basins of southern England have sourced hydrocarbons in numerous shows and small fields along the northern and southern margins of the Weald Basin and at Wytch Farm oil field. The Kimmeridge is not mature for gas, but could contain oil shale. The Lias may be buried deep enough in some areas to have some gas generation; and

- Upper Cambrian shales that are thought to occur widely in the subsurface between the Caledonides and Variscan fold belts on the Midland Microcraton. Thick overlying Ordovician, Tremadoc shales are geochemically lean but may have reservoir attributes. However, no conventional hydrocarbon fields sourced from Lower Palaeozoic shales have been found in the UK, unlike on most of the other cratons of the world.

Coalbed methane and vent gas (gas drained from abandoned coal mines) are other types of 'unconventional' gas. The 2010 DECC-commissioned BGS report, *The unconventional hydrocarbon resources of Britain's onshore basins - coalbed methane* [41], describes the well known areas of coal distribution and highlighted the most prospective areas.

2.5 Potential Activities Following Licensing

As noted above, the draft Licensing Plan will not itself permit any exploration or production activities, which require planning permission and other regulatory permissions or controls in order to proceed. Based on previous Licence Rounds, the uptake of blocks would be expected to be limited; however, current increased interest in unconventional gas is noted and may lead to a rise in the numbers of applications. Levels of exploration and development activity and their timing would depend on a range of factors such as the number of blocks licensed, work programme commitments by licensees, exploration success, and economic and commercial factors, in addition to the regulatory clearances already mentioned.

2.5.1 Summary of Potential Activities, Resulting Effects and Controls

There are a total of six main stages of oil and gas exploration and production (including gas storage). These are highlighted in **Table 2.3** 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 development history of the particular site.

[41] See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66171/promote-uk-cbm.pdf [Accessed May 2013]

Table 2.3 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: • Site identification, selection, characterisation; • Seismic surveys; • Securing of necessary development and operation permits.	**Non-intrusive exploration,** including: • Site identification, selection, characterisation; • Seismic surveys; • Securing of necessary development and operation permits.
2.	**Exploration drilling,** including: • Pad preparation, road connections and baseline monitoring; • Well design construction and completion; • Well testing including flaring.*	**Exploration drilling and hydraulic fracturing**, including: • Pad preparation road connections and baseline monitoring; • Well design and construction and completion; • Hydraulic fracturing; • Well testing including flaring.
3.	**Production development,** including: • Pad preparation, road connections and baseline monitoring; • Facility construction and installation; • Well design construction and completion; • Provision of pipeline connections; • Well testing, possibly including flaring.*	**Production development,** including : • Pad preparation and baseline monitoring; • Facility construction and installation; • Well design construction and completion; • Hydraulic fracturing; • Well testing, possibly including flaring; • Provision of pipeline connections; • (Possibly) re-fracturing.
4.	**Production/operation/maintenance,** including: • Gas/oil production; • Production and disposal of wastes/emissions; • Power generation, chemical use and reservoir monitoring; • Environmental monitoring and well integrity monitoring.*	**Production/operation/maintenance,** including: • Gas/oil production; • Production and disposal of wastes/emissions; • Power generation, chemical use and reservoir monitoring; • Environmental monitoring and well integrity monitoring.
5.	**Decommissioning of wells,** including: • Well plugging and testing; • Site equipment removal; • Environmental monitoring and well integrity monitoring.	**Decommissioning of wells,** including: • Well plugging and testing; • Site equipment removal; • Environmental monitoring and well integrity monitoring.
6.	**Site restoration and relinquishment,** including: • Pre-relinquishment survey and inspection; • Site restoration and reclamation.	**Site restoration and relinquishment,** including: • Pre-relinquishment survey and inspection; • 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.

All the major stages of onshore oil and gas operation are covered by environmental regulations including, where appropriate, requirements for Environmental Impact Assessment. DECC's licensing system covers all oil and gas exploration and production in the UK, though coal reserves are managed by the Coal Authority, and access to coal formations for any purpose (including for coalbed methane developments) requires their consent. As part of the onshore licensing regime, a series of Petroleum Operation Notices (PONs) cover operations associated with conventional oil and gas (see **Table 2.4**).

Table 2.4 Petroleum Operation Notices (PONs) Required for Onshore Operations

Title	Related Activities
PON4	Application for consent to drill exploration, appraisal, and development wells
PON5	Application to abandon or temporarily abandon a well
PON7	Reporting of petroleum production
PON8	Application to complete and/or workover a well
PON14b	Notification of onshore seismic survey (also see Supplementary Seismic Survey Licences [SSSL])

Any depleted oil or gas field used for gas storage operations must be within an existing licensed area and have a revised development plan consent [42]. The drilling of any gas injection/production wells is also subject to PON requirements. These requirements do not however apply to gas storage in salt caverns or aquifers (see **Table 2.1**).

2.5.2 Potential Activity Scenarios

For assessment purposes, activity scenarios have been developed for those oil and gas exploration and production activities identified in **Table 2.3**. The indicative scenarios (based in the first instance on past activity and trends) have been used as the basis for consideration of the environmental effects of the draft Licensing Plan (see **Section 4** for further information).

Past Activity and Trends

Information on past activity and trends comes from analysis of Work Programmes committed to in previous licence rounds (see **Table 2.5**) as well as historic onshore drilling activity data [43].

[42] See Department of Energy and Climate Change (2009) *Field Development Plan Guidance Notes for Gas Storage in Onshore Oil and Gas Fields*. Department of Energy and Climate Change June 2009, 15pp.
[43] See https://www.gov.uk/oil-and-gas-wells#drilling-activity [Accessed June 2013]

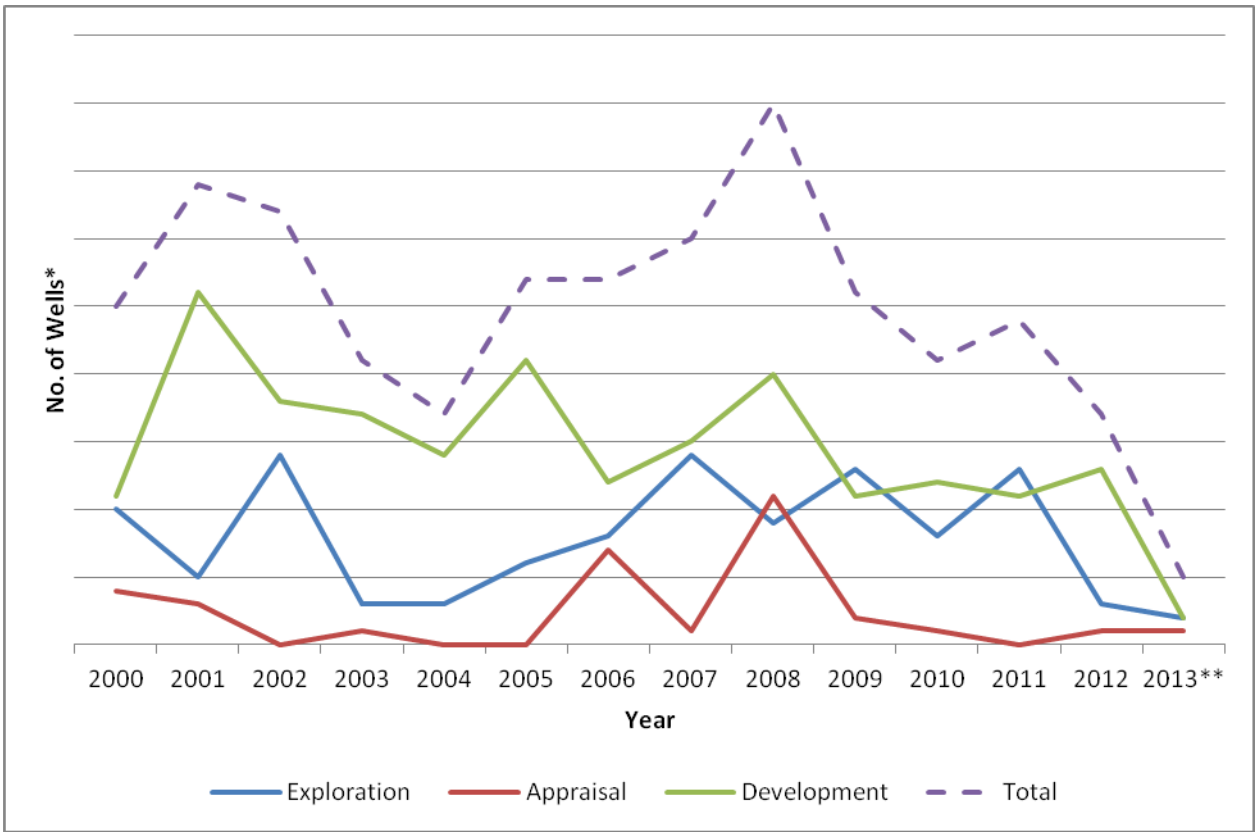
Table 2.5 Work Programme Commitments in Previous Rounds

Licence Round	Wells to be Drilled				New Seismic Survey
	Firm	*Drill or Drop*	*CBM/Drill or Drop*	*Total*	
10th (2001)	4	16	12 (+1)	33	1 (100km of 2D)
11th (2003)	-	8	-	8	1 (20km of 2D) 2 (evaluate mines gas potential)
12th (2004)	1	21	-	22	-
13th (2007)	8	41	63	112	15 (994km of 2D) 2 (80km^2 of 3D)

In the previous (13th) round of onshore licensing, 60 applications for PEDLs were made for 182 blocks by 54 companies, 20 of which were for CBM. Subsequently, on 28 May 2008, the Secretary of State offered 93 PEDLs. **Figure 2.2** provides details of onshore drilling activity over the last 12 years. Between 2000 and 2012, 341 onshore oil and gas wells have been drilled in the UK (including exploration, appraisal and development wells) [44]. An average of 26 wells were drilled in each year during this period, peaking in 2008 when 40 wells were drilled. Provisional second quarter figures for 2013 (also shown in **Figure 2.2**) indicate that a total of five wells were drilled.

[44] The year in which a well is drilled is determined by its start date.

Figure 2.2 Onshore Wells Drilled 2000-2013



*The total number of wells including geological sidetracks
**2013 figures are for quarter 2 only

Activity Scenarios

Based on the past activity and trends highlighted above, two scenarios of potential activity following a licensing round have been developed - one describing a low level of activity and the other a higher level. So far as conventional activity and VCBM is concerned, the scenarios are based on what might be expected from a continuation of past activity levels and trends; for shale gas, however, the high level scenario assumes an unprecedented expansion of onshore activity, such as might be prompted by very high levels of interest in shale gas motivated by its rapid development and current salience in the US. These scenarios are outlined in **Table 2.6** (for conventional oil and gas exploration and production) and **Table 2.7** (for unconventional oil and gas exploration and production).

The scenarios do not give locations of potential activity. However, given the description of basin prospectivity in **Section 2.4** and our current understanding, it is likely that most activity will be targeted close to existing licensed areas. The scenarios described are also illustrative and purely for the purposes of the assessment to enable determination of effects arising from differing levels of activity. They should not be interpreted as a forecast of likely activity or an expectation of the levels that will occur following adoption of the final Licensing Plan.

Table 2.6 Quantification of Activity Scenarios for Conventional Oil and Gas Exploration and Production (scenarios are illustrative and for assessment purposes only)

Stage	Activities: Conventional Oil and Gas	Parameter	Scenario	
			Low Activity	High Activity
1.	**Non-intrusive exploration,** including: • Site identification, selection, characterisation; • Seismic surveys; • Securing of necessary development and operation permits.	Number of licences granted	50	150
		Approximate total area of new licences	4,000 km^2	20,000 km^2
2.	**Exploration drilling,** including: • Pad preparation, road connections and baseline monitoring; • Well design construction and completion; • Testing including flaring.	Average number of boreholes drilled per licence	0.1	0.2
		Total # boreholes	5	30
		Average area covered by exploration well pad	1 hectare	
		Depth of well	Variable – 500m to 2000m or more.	
		Average volume of drill cuttings per well (based on total length of 2,100m well)	117 cubic meters (m^3) per well [45]	
		Vehicle movements	6-7 a day	
		Duration of vehicle movements	7-8 weeks	
3.	**Production development,** including: • Pad preparation, road connections and baseline monitoring; • Facility construction and installation; • Well design construction and completion; • Provision of pipeline connections.	Total # of (possible) well pad sites	3	6
		Average area covered by well pad	2-3 ha for production pads	
		Total area covered by well pads	6-9ha	12-18ha
		Average # wells per pad	2	2
		Total number of wells	6	12
		Average volume of drill cuttings per well (based on total length of 2,100m well)	117m^3 per well [46]	
		Minimum distance between well pad sites	5 km in most densely developed areas	
		Vehicle movements	5-6 a day	
		Duration of vehicle movements	7-8 weeks	

[45]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]

[46]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]

Stage	Activities: Conventional Oil and Gas	Parameter	Scenario	
			Low Activity	High Activity
4.	**Production/operation/maintenance,** including: • Gas/oil production; • Production and disposal of wastes/emissions; • Power generation, chemical use and reservoir monitoring; • Environmental monitoring and well integrity testing.	Total # of (possible) well pad sites	3	6
		Estimated quantity of fugitive emissions per well	50,000m^3 of methane per production well (7,140 tonnes of carbon dioxide equivalent per well)	
5.	**Decommissioning of wells,** including: • Well plugging and testing; • Site equipment removal; • Environmental monitoring and well integrity testing.	Well lifetime to well closure	20 years	
6.	**Site restoration and relinquishment,** including: • Pre-relinquishment survey and inspection; • Site restoration and reclamation.	None	None	

Table 2.7 Quantification of Activity Scenarios for Unconventional Oil and Gas Exploration and Production (scenarios are illustrative and for assessment purposes only)

Stage	Activities: Unconventional Oil and Gas	Parameter	Scenario	
			Low Activity	High Activity
1.	**Non-intrusive exploration,** including: • Site identification, selection, characterisation; • Seismic surveys; • Securing of necessary development and operation permits.	Number of licences granted	50	150
		Approximate total licensed area	4,000 km^2	20,000 km^2
2.	**Exploration drilling and hydraulic fracturing**, including: • Pad preparation road connections and baseline monitoring; • Well design and construction and completion;	Average number of boreholes drilled per licence	0.5	2
		Total borehole activity (number of fractured wells)	20	240
		Average area covered by well pad	1 hectare	
		Depth of well	Variable – 500m to 3000m or more.	

Stage	Activities: Unconventional Oil and Gas	Parameter	Scenario	
			Low Activity	High Activity
	• Hydraulic fracturing; • Testing including flaring.	Average volume of drill cuttings per well (based on total length of 5,500m including lateral drilling)	270m^3 per well [47]	
		Estimated emissions from flaring per well	500,000 m^3 of methane flared per fractured exploration well [48] (981tonnes of carbon dioxide equivalents per well)	
		Quantity of water used per well	10,000-25,000m^3 per well [49]	
		Assumed % of wells with access to water from the mains	50%	
		Assumed percentage of flowback recovery rate per well	30-75%	
		Vehicle movements	14-36 a day	
		Duration of vehicle movements	12-13 weeks	
3.	**Production development,** including : • Pad preparation and baseline monitoring; • Ancillary infrastructure construction and installation; • Well design construction and completion; • Hydraulic fracturing; • Provision of pipeline connections (possibly) re-fracturing.	Total # of (possible) well pad sites	30 – 120	
		Average area covered by well pad	2-3 ha for production pads	
		Total area covered by well pads	60-90ha	240 – 360ha
		Average wells per pad	6 - 12	12 - 24
		Total number of wells	180-360	1440 – 2880
		Minimum distance between well pad sites	5 km in most densely developed areas	
		Average volume of drill cuttings per well (based on total length of 5,500m including lateral drilling)	270m^3 per well [50]	
		Quantity of water used per well	10,000-25,000m^3 per well [48]	
		Assumed % of wells with access to water from the mains	90%	
		Assumed percentage of flowback recovery rate per well	30-75% [51]	
		Vehicle movements	16-51 a day	
		Duration of vehicle movements	32-73 weeks	73-145 weeks

[47] 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]

[48] AEA (2012) *Climate Impact of Potential Shale Gas Production in the EU*: *Report for European Commission DG CLIMA*, available from http://ec.europa.eu/clima/policies/eccp/docs/120815_final_report_en.pdf [Accessed June 2013]

[49] http://www.total.com/en/special-reports/shale-gas/environmental-challenges-201958.html [Accessed June 2013]

[50] 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]

[51] AEA (2012) *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing. A report for the EC*

Stage	Activities: Unconventional Oil and Gas	Parameter	Scenario	
			Low Activity	High Activity
4.	**Production/operation/maintenance,** including: • Gas/oil production; • Hydraulic refracturing; • Production and disposal of wastes/emissions; • Power generation, chemical use and reservoir monitoring; • Environmental monitoring and well integrity testing.	Total # of (possible) well pad sites	30 - 120	
		Estimated quantity of fugitive emissions per well	50,000m^3 of methane per production well (7,140 tonnes ofcarbon dioxide equivalent per well)	
		Re-fracturing frequency	1 refracturing per production well	
		Quantity of water used per well	10,000-25,000m^3 per well	
		Assumed % of wells with access to water from the mains	90%	
		Assumed percentage of flowback recovery rate per well	30-75%	
		Vehicle movements	10-45 a day (dependent on the assumed duration of fracturing per site and management of flowback)	
5.	**Decommissioning of wells,** including: • Well plugging and testing; • Site equipment removal; • Environmental monitoring and well integrity testing.	Well lifetime to well closure	20 years	
6.	**Site restoration and relinquishment,** including: • Pre-relinquishment survey and inspection; • Site restoration and reclamation.	None	None	

2.6 Alternatives to the Draft Licensing Plan

Under the Petroleum Act 1998, the PEDLs awarded by the Secretary of State for Energy and Climate Change confer exclusive rights to explore, drill and produce within a specified area. The draft Licensing Plan concerns the offer and award of PEDLs for unlicensed landward areas in parts of England, Scotland and Wales. The main objectives of the draft Licensing Plan are to enable a further contribution towards the comprehensive exploration and appraisal of UK oil and gas resources and the economic development of identified reserves, together with enabling further gas storage capacity in hydrocarbon reservoirs, without compromising the biodiversity, ecosystem functioning and the interests of nature and heritage conservation, and other material assets and users.

PEDLs awarded under the draft Licensing Plan may be offered for the exploration and production of the following resources:

- conventional oil and gas;
- shale gas; and
- virgin coalbed methane (VCBM).

Additionally, licences could cover natural gas storage in hydrocarbon reservoirs.

Schedule 6 of the Petroleum Licensing (Exploration and Production) (Seaward and Landward Areas) Regulations 2004 provides model clauses for PEDLs. These include the duties of the licensee to provide information on the volumes of oil or gas produced, the provision of a production programme, responsibilities regarding well abandonment and plugging and responsibilities and adherence to good oilfield practice. Each licence carries an annual rental and is valid for a sequence of terms. These terms are designed to follow the typical lifecycle of a field: exploration, appraisal and production. The first term is for six years, the second for five years and the third for 20 years.

A PEDL grants no permission for specific operations. The award of a PEDL does not waive the requirement for the licensee to obtain access rights from landowners (e.g. a wayleave) and PEDLs do not confer any exemption from other legal/regulatory requirements.

As part of the SEA process, environmental reports are required to present specific information concerning reasonable alternatives to the plan or programme. Article 5 (1) of the SEA Directive 2001/42/EC requires that "*an environmental report shall be prepared in which the likely significant effects on the environment of implementing the plan or programme, and reasonable alternatives taking into account the objectives and the geographical scope of the plan or programme, are identified, described and evaluated".* Information to be provided includes "*an outline of the reasons for selecting the alternatives dealt with*" (Annex I (h)).

The European Commission guidance on the SEA Directive discusses possible interpretations of handling 'reasonable alternatives' as required by Article 5(1). It states that "*The alternatives chosen should be realistic. Part of the reason for studying alternatives is to find ways of reducing or avoiding the significant adverse effects of the proposed plan or programme*".

The development of reasonable alternatives to the Licensing Plan has been an iterative and consultative process, drawing on the views of consultees through the assessment process. The initial 2010 Environmental Report suggested three alternatives for the 14th round of onshore oil and gas licensing, which were then subject to assessment. These were:

1. Not to offer any blocks for licensing;
2. To proceed with the licensing programme as proposed; and
3. To restrict the area licensed temporally or spatially.

Following consideration of the potential implications of relevant activities associated with the draft Licensing Plan, the initial Environmental Report concluded that Alternative 2: to proceed with the licensing programmes as proposed, should be adopted but with licensing conditions. It was recommended that DECC place an explicit expectation on licence applicants to demonstrate an excellent understanding of the environmental sensitivities and potential constraints on blocks both at the application stage and during any subsequent operations.

The alternatives from the initial Environmental Report were proposed again as the basis of the revised assessment of the draft Licensing Plan, outlined in the 2013 Scoping Report [52]. Responses to the scoping consultation suggested that a number of additional alternatives could be considered (see **Appendix A**). These were:

- Not to place any limit on the licences awarded under the 14th onshore oil and gas round;
- Not to award any licences under the 14th onshore oil and gas round;
- To restrict the number of licences or area licensed, to reflect Government's climate change commitments;
- To restrict the number of licences to a limited number of pilot unconventional oil and gas sites, so as to enable monitoring and assessment of the impacts before committing to a large scale roll-out;
- To restrict the areas available to licensing based on certain criteria;
- To restrict the areas available to licensing to those areas previously available; and
- To use locational criteria within the Licensing Plan to identify and avoid/reduce significant impacts on sensitive environments.

A number of alternatives are therefore considered, as follows:

- **Unlimited award of licences (the draft Licensing Plan as proposed)**
  - To place no restriction on the number of licences awarded or the area subsequently covered by licensing blocks, other than necessitated by the requirements of the Petroleum Act 1998 with regard to PEDLs; or
- **Restrictions on the award of licences either by:**
  - Reflecting the Government's climate change commitments; or
  - Phasing licence awards, enabling a number of pilot unconventional oil and gas sites first, so as to enable monitoring and assessment of the impacts before committing to a large scale roll-out; or

[52] AMEC (2013), Strategic Environmental Assessment for a 14th and Subsequent Onshore Hydrocarbon Licensing Rounds Scoping Report, report for DECC July 2013

- Limiting the area of land available to be licensed in any one round of licensing by establishing a 'ceiling' figure; or
- Limiting the area available to be licensed to that previously available in the 13th round; or
- Limiting the areas in which licences can be awarded by establishing and applying locational criteria relating to proximity to sensitive environmental receptors; or

- **No award of licences** under this onshore licensing round.

Each alternative is discussed below in regard to its reasonableness.

2.6.1 Unlimited Award of Licences

The main objectives of the draft Licensing Plan include the need to enable further steps towards the comprehensive exploration and appraisal of UK oil and gas resources and the economic development of identified reserves. Ensuring that there is no upper limit to the number of applications received and the number of licences subsequently awarded is consistent with these objectives and DECC aims to maximise licence take-up. However, as noted earlier any activities under the licence have to meet regulatory conditions including planning permission, environmental permitting and scrutiny by the HSE.

In the previous (13th) round of onshore licensing, 60 applications for PEDLs were made for 182 blocks by 54 companies, 20 of which were for coalbed methane (CBM). Subsequently, on 28 May 2008, the Secretary of State offered 93 PEDLs.

Currently then, whilst licensing is not 'unlimited', it is still aimed at maximising the recovery of an economic resource recognised as being of value to the country, with activities taking place within a framework of regulatory control designed to secure the safety of operations and the protection of the environment. As such, this option **is considered to be a reasonable alternative to be taken forward for the assessment.**

2.6.2 Restrictions on the Award of Licences

Restriction Reflecting the Government's Climate Change Commitments

This option would seek to restrict the award of licences to reflect the Government's climate change commitments that will reduce UK carbon emissions over time. This option would support those main objectives of the draft Licensing Plan that aim to protect the biodiversity, ecosystem functioning and the interests of nature and heritage conservation, and other material assets and users. However, proposals to restrict licences are more difficult to reconcile with the other objectives of the Plan (the comprehensive exploration and appraisal of UK oil and gas resources and the economic development of identified reserves).

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.

DECC's energy projections suggest that over the next two decades, overall primary energy demand in the UK is expected to remain roughly stable with gas and oil accounting for over a third each of the UK's primary energy demand, a figure which, similar to oil, is expected to remain roughly constant over the next 20 years. The energy mix will however change for the other sources, with renewables and nuclear energy increasing to more than 10% each, with coal's contribution declining significantly from 15% to 4%. These energy demand projections are consistent with DECC's central forecasts for greenhouse gas emissions, which project the net UK carbon account to fall, relative to 1990 levels, by 37% by 2020 and 45% by 2025 [53].

In the light of Government's commitment to mitigate climate change, and to promote early adoption of low carbon technologies including carbon capture and storage, onshore licensing does not appear to be incompatible with current carbon trajectories to meet the Climate Change Act 2008 obligations.

There are however, further effects of 'onshoring' emissions from any oil and gas produced in the UK. UK based production will reduce any carbon emissions associated with transportation of oil and gas from overseas (e.g. tankers for oil and liquefied natural gas). The production of oil and gas in the UK could also increase global cumulative greenhouse gas (GHG) emissions if the fossil fuels displaced by indigenous oil and gas are used elsewhere. In conclusion, the long-term effects of oil and gas '*exploitation in the UK on global emissions rates are complex to predict and depend strongly on global climate policies*' [54].

Implicit in this option is the concept of using licensing to reduce and restrict future oil and gas exploration and production, based on the carbon intensity of the energy generated. There are practical considerations to using licensing in this sense. Licences are offered for prospecting with no certainty that strata will contain oil and gas, or that if they do, that it would be recoverable. Restrictions based on an assessment of carbon intensity and quantity cannot then be applied before licence award but only at the point of the extent of a reserve being determined. This degree of uncertainty would prove difficult to address adequately or equitably at licence award. However, restrictions could apply in theory to term 3 under the licence when the size of the reserve was known. Again, it is unclear how this would work although it is envisaged that it could limit the amount of oil or gas extracted, or could require carbon offsets proportional to the amount of oil or gas extracted. Such approaches are unclear at this stage, could be subject to challenge and would require amendments to the Petroleum Licensing (Exploration and Production) (Seaward and Landward Areas) Regulations 2004.

In consequence, restricting licences based on climate change obligations is of uncertain value. Given current GHG forecasts and the Government's targets and policies for reducing CO_2 emissions, together with the practical difficulties of implementation, it is concluded that **it is not a reasonable alternative to be taken forward for consideration in the assessment.**

[53] DECC (2012), Updated Energy and Emissions Projections – October 2012, Annex H – Central Scenario
[54] DECC (2013), Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use

Phasing Licence Awards

Licence awards could be so phased as to enable only a limited number of pilot unconventional oil and gas sites to be completed. This would enable monitoring and assessment of the impacts before committing to a large scale roll-out. This option would support those main objectives of the draft Licensing Plan that aim to protect the biodiversity, ecosystem functioning and the interests of nature and heritage conservation, and other material assets and users. However, proposals to restrict licences are more difficult to reconcile with the other objectives of the plan (the comprehensive exploration and appraisal of UK oil and gas resources and the economic development of identified reserves).

This option could only be effective in the absence of other opportunities for unconventional oil and gas activity, so that only as a result of this licensing round would unconventional oil and gas licensing begin. However, under the previous licensing round a significant number of licences have been awarded and are still in force. For example, 20 licences were awarded for CBM and 17 awarded for shale gas. Development of some sites is advanced and all sites are receiving an elevated level of attention and public scrutiny. The total area under licence can be seen in **Figure 1.1**.

The regulatory system which applies to these activities is also continuing to move forward and address arising or novel issues. For example, incidents of induced seismicity arising from Cuadrilla's Resources drilling activities at the Preese Hall site, near Blackpool resulted in a moratorium and detailed investigations. DECC has subsequently imposed a series of additional requirements which have now been placed on hydraulic fracturing for unconventional gas or oil. Operators are now required to:

- Conduct a prior review of information on seismic risks and the existence of faults;
- Submit to DECC a fracking plan showing how any seismic risks are to be addressed;
- Carry out seismic monitoring before, during and after the fracking stages; and
- Implement a 'traffic light' system which will be used to identify unusual seismic activity requiring reassessment, or halting, of operations.

In addition, the Environment Agency and SEPA have issued guidance [55] on the permits required (for drill cuttings, spent drill muds and drill fluids, flowback fluids, waste gases and wastes left underground). The HSE has also reconfirmed the regulations that apply to unconventional gas and DCLG has issued planning guidance to local authorities for onshore oil and gas (July 2013).

Given therefore the current exploration activity resulting from PEDLs awarded under earlier licensing rounds, and the likelihood that activities on these licences will secure regulatory permissions and proceed earlier than activities on any new licences, the extent to which the phasing of the awards of licences in this licensing round could effectively constitute a piloting phase is unclear. It is evident that

[55] http://www.environment-agency.gov.uk/business/topics/133885.aspx and SEPA (undated), Regulatory guidance: Coal bed methane and shale gas, see http://www.sepa.org.uk/customer_information/energy_industry/unconventional_gas/regulatory_roles.aspx

policy and regulatory responses to new and emerging issues relating to unconventional gas and oil development in the UK are being developed and refined now and as such, it is not considered of any additional benefit to phase awards of licences in the 14th round.

Furthermore, this alternative is inconsistent with Hydrocarbons Licensing Directive (94/22/EC) on the grounds that phasing of awards would be discriminatory and inconsistent with the requirements of Article 5 (1) of the Directive.

In consequence, restricting licensing by a phased approach to award appears unproductive, when account is taken of activities being pursued under current licences and ongoing developments in the regulatory system. Taking account of the requirements of the Hydrocarbon Licensing Directive, **this option is not considered a reasonable alternative and has not been taken forward into the assessment.**

Limiting the Area of Land Available to be Licensed

This option would seek to limit the area of land available to be licensed in the 14th Round by establishing a 'ceiling' figure for the total area of land beyond which licences could not be granted. For example, DECC might restrict the total area of new licences to 10,000 square kilometres, which would represent an addition of approximately 50% to the aggregate area of current licences. Procedurally, this could be affected by awarding the licences in merit order, until the specified limit had been reached. DECC's assessment procedure for licence applications normally includes an assessment of their geological merit, which could readily provide an overall merit ranking.

This option would support those main objectives of the draft Licensing Plan that aim to protect the biodiversity, ecosystem functioning and the interests of nature and heritage conservation, and other material assets and users. However, proposals to restrict licences are more difficult to reconcile with the other objectives of the Plan (the comprehensive exploration and appraisal of UK oil and gas resources and the economic development of identified reserves).

The underlying intent of the option would be to reduce the amount of exploration activity following on from the 14th Round (achieved by limiting for which rights would be awarded). However, licensing (or the area available) does not necessarily affect the scale of exploration activity per se. This is ultimately determined by where the land is and the size of the hydrocarbon reserve, once ascertained, as well as the acceptability of these activities in the relevant areas. As a result, it is not possible to estimate in advance just what impact on activity any restriction of area may have. There is a further practical concern that the choice of a suitable 'ceiling' area of land appears essentially arbitrary and lacking in inherent justification.

Notwithstanding the uncertainties associated with this alternative, given that it is consistent with the Article 2 (1) of the Hydrocarbon Directive (94/22/EC) that "*Member States retain the right to determine the areas within their territory to be made available for the exercise of the activities of prospecting, exploring for and producing hydrocarbons"* and appears to be simple to implement, it does provide a

means by which it is highly likely that the scale of overall activity, and the effects resulting from this activity can be lessened. As such, it is an alternative that is realistic and can provide a means to reduce any significant adverse effects arising from the licensed activities.

In consequence, **this option is considered a reasonable alternative and has been taken forward into the assessment.**

Limiting the Area Available to be Licensing to that Previously Available in the 13th Round

This option would seek to limit the area of land available to be licensed in the 14th round by referring applicants to the area covered by the 13th licensing round. This option would support those main objectives of the draft Licensing Plan that avoid compromising the biodiversity, ecosystem functioning and the interests of nature and heritage conservation, and other material assets and users. However, proposals to restrict licences are more difficult to reconcile with the other objectives of the Plan (the comprehensive exploration and appraisal of UK oil and gas resources and the economic development of identified reserves).

It is understood that this option was suggested in the belief that this would restrict the land available for licensing. However, in practice, the area offered for the 14th round is almost the same as that offered under the 13th round [56] and as such, the option offers no meaningful difference.

In consequence, **this option is not considered a reasonable alternative and will not be taken forward into the assessment.**

Limiting the Areas in which Licences can be Awarded by Establishing and Applying Locational Criteria

This option would seek to restrict the award of licences by establishing and applying locational criteria. The underlying intent of the option would be to ensure that licences should not be issued in respect of areas where exploration or production activities might be undesirable because of its environmental (or other) impacts on that location. This option would support those main objectives of the draft Licensing Plan that avoid compromising the biodiversity, ecosystem functioning and the interests of nature and heritage conservation, and other material assets and users. However, proposals to restrict licences are more difficult to reconcile with the other objectives of the plan.

Locational criteria could include a range of factors, which could be positive or negative or which could operate individually or collectively, for example:

- Avoidance of awarding licences within or adjacent to sensitive receptors (whether local communities or European designated sites);

[56] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/63941/13r-acreage-on-offer.pdf

- Avoidance of awarding licences within close proximity to sensitive receptors (whether local communities, European designated sites, surface water resources or ground water bodies). A precautionary distance of up to 15km could be used (depending on the receptor); and

- Preference for awarding licences given to areas within Water Resource Zones in surplus, with good connectivity to the water mains, good connectivity to the gas network and with good transport links.

Excluding sensitive receptors and using a precautionary distance may have the unintended consequence of significantly reducing the area that is available for licensing, depending on the locational criteria used, which would make it difficult for the alternative to contribute towards the objectives of the licensing plan (to make comprehensive exploration and appraisal of UK oil and gas resources and the economic development of identified reserves). In addition, an approach based on broad criteria does not reflect the reasons for a specific site designation and the extent to which any licensing activity will have an effect.

Rather than representing a meaningful option in the context of the draft Licensing Plan objectives, locational criteria do however provide a means to mitigate effects, which reflects DCLG planning guidance, local authority planning policy and approaches to project level HRA. In consequence, **this option is not considered a reasonable alternative and has not been taken forward into the assessment;** however, the material benefits of considering locational criteria will be addressed through inclusion in the mitigation measures section**.**

2.6.3 No Award of Licences

This option proposes that no award of licences would take place during the licensing round. Such an option is incompatible with the main objectives of the Plan.

In the absence of the award of licences, all exploration and development activity would be undertaken by developers who had been awarded PEDLs in the previous round and so some exploration and development activity would still take place (albeit that it was a legacy from the previous round).

The option however, does provide one of the elementary alternatives to the Plan, and one that is consistent with many other assessments, DCLG guidance [57] and the hierarchy of alternatives. In addition, as it was proposed previously in the 2010 Environmental Report and was also suggested by consultees, **this option is considered an alternative that has been taken forward into the assessment to provide a comparison of effects arising from other reasonable alternatives considered.**

[57] ODPM (2005), A Practical Guide to the Strategic Environmental Assessment, Appendix 6 'Developing and Assessing Alternatives

2.6.4 Summary

Following the application of the reasonableness test in compliance with Article 5(1) of the SEA Directive, the following alternatives have been taken forward for assessment within the SEA:

- **Unlimited award of licences (the draft Licensing Plan as proposed):**
  - To place no restriction on the number of licences awarded or the area subsequently covered by licensing blocks, other than necessitated by the requirements of the Petroleum Act 1988 with regard to PEDLs; or
- **Limited the area of land available to be licensed:**
  - To limit the area of land available to be licensed in any one round of licensing by establishing a 'ceiling' figure for the total area of land equivalent to 50% of the aggregate area of current licences. PEDLs would then be awarding in merit order; or
- **No award of licences** under this onshore licensing round.

Each alternative has been assessed using the approach outlined in **Section 4**. The results of the assessment are presented in **Section 5**.

3. Context and Baseline

3.1 Introduction

This section and associated appendices provide an overview of the context and baseline information that has informed the development of the SEA methodology (see **Section 4**). It includes details of the review of other relevant plans and programmes (**Section 3.2**) and baseline data (**Section 3.3**) and culminates in the identification of key issues to be considered by the draft Licensing Plan and SEA.

Annex I of the SEA Directive requires that the subsequent assessment (to be contained in the Environmental Report) should include information on the "*likely significant effects on the environment, including on issues such as: biodiversity; population; human health; fauna; flora; soil; water; air; climatic factors; material assets; cultural heritage, including architectural and archaeological heritage; landscape; and the inter-relationship between the issues referred to*". These topics have formed the basis for the collection and analysis of contextual and baseline information. **Table 3.1** presents how the categories in this report are consistent with the SEA Directive requirements.

Table 3.1 Categories Considered in this Report

Annex I SEA Directive Effects	Categories Considered in this Environmental Report
Biodiversity, Flora and Fauna	Biodiversity and Nature Conservation
Population	Population
Human Health	Health
Soil	Land Use, Geology and Soils
Water	Water
Air	Air
Climatic Factors	Climate Change and Flood Risk
Material Assets	Resource Use and Waste
	Land Use, Geology and Soils
Cultural Heritage, including architectural and archaeological heritage	Cultural Heritage
Landscape	Landscape

Consistent with the requirements of Annex 1 (b), (c) and (d) of the SEA Directive, **Appendix B** sets out the collated contextual and baseline information, on a topic-by-topic basis, for each of the 10 assessment topics above, structured as follows:

- **Introduction**: provides an overview and definition of the topic;
- **Review of Plans and Programmes**: provides an overview of the international/European, UK and national (England, Scotland and Wales) policy context in which the draft Licensing Plan sits;
- **Overview of the Baseline**: summarises the baseline for each of the topic areas at the UK and national (England, Scotland and Wales) level;
- **Key Environmental Characteristics of those Areas most likely to be Significantly Affected**: provides an overview of the baseline for each SEA Area;
- **Summary of Existing Problems Relevant to Onshore Oil and Gas Licensing**: identifies the key topic specific issues which will need to be considered as part of the assessment;
- **Likely Evolution of the Baseline**: describes the likely evolution of baseline conditions without the implementation of the draft Licensing Plan, an understanding of this is key to understanding the effects of the Plan on the topic area; and
- **Assessing Significance**: outlines the objectives and guide questions related to the topic area which have been identified for use in the assessment of the effects of draft Licensing Plan alongside guidance that will be utilised during the assessment to help determine the relative significance of potential effects on the objectives.

3.2 Review of Plans and Programmes

One of the first steps in undertaking the SEA is to identify and review other relevant plans, programmes, policies and strategies (herein after referred to as 'plans and programmes') that could have an effect on the draft Licensing Plan. These may be plans and programmes at an International/European, UK, national, regional or sub-regional level, as relevant to the scope of the Plan. The summary within each topic section in **Appendix B** identifies the relationships between the draft Licensing Plan and these other documents; i.e. how the Plan could be affected by the other plans' and programmes' aims, objectives and/or targets, or how it could contribute to the achievement of any environmental and sustainability objectives and targets set out in these plans and programmes.

The review of plans and programmes also informed the environmental baseline and helped determine the key issues. It will also provide the policy context for the assessment contained within the Environmental Report.

From the review of these plans and programmes, a number of key environmental protection objectives have been identified. These are summarised in **Table 3.2**, along with an indication of where the policy objectives are reflected in the SEA assessment objectives (discussed further in **Section 4**). The key objectives and policy messages have been structured around the environmental categories set out in **Table 3.1**.

Table 3.2 Key Environmental Protection Objectives

Topic	Summary Objectives and Policy Messages	SEA Objectives link (see Section 4)
Biodiversity and Nature Conservation	**International** • To protect international/European protected wildlife areas (including Special Areas of Conservation, Special Protection Areas and Ramsar sites); • To contribute to the conservation of global biodiversity; • To ensure the conservation and enhancement of natural heritage including wetland conservation; • To ensure the conservation of biodiversity in order to continue to harness the derived health and wellbeing benefits for the population; • To identify where operators are financially liable for threats of or actual damage to the environment under the "polluter pays" principle; • To anticipate, prevent and act on causes of significant reduction or loss of biodiversity. **UK, England, Scotland and Wales** • To conserve and enhance biological diversity within the UK; • To ensure that the quality of habitats and biodiversity is enhanced or at least conserved and take account of key priority habitats and species in decision making; • To protect the network of nationally protected wildlife areas (including Sites of Special Scientific Interest); • To create an ecological network which is resilient to changing pressures; • To safeguard vulnerable non-renewable resources for future generations.	Objective 1: Biodiversity and Nature Conservation Objective 3: Health
Population	**International** • To achieve economic development and reduction of inequalities whilst adhering to the principles of social and environmental justice and sustainable development; • To promote full employment, quality and productivity at work and promote inclusion by addressing disparities in access to labour markets; • To promote the economic development of disadvantaged areas within the European Union; • To grant public rights to information, public participation and access to justice; • To undertake appropriate consultation with consultation bodies and the public during the SEA process. **UK, England, Scotland and Wales** • To create strong, prosperous and sustainable communities; • To narrow the gap between deprived neighbourhoods and the rest of the UK; • To remove barriers to growth; • To develop and support successful, thriving, safer and inclusive urban and rural communities whilst continuing to protect the open countryside for the benefit of all; • To support the transition to a low carbon economy; • To enhance educational attainment and skills; • To ensure the security of energy supplies within the UK and reduce volatile fluctuations in fuel prices; • To address constraints on production and processing within areas licensed for oil and gas development.	Objective 2: Population Objective 3: Health

Topic	Summary Objectives and Policy Messages	SEA Objectives link (see Section 4)
Health	**International** • To ensure children have safe water and clean air; • To ensure that measures to improve the health and wellbeing of the population are appropriately supported; • To preserve, protect and improve the quality of the environment and to protect human health; • To promote good health throughout the lifespan of the population; • To reduce inequities in health; • To prevent critical health effects as a result of high levels of noise in and around dwellings; • To avoid, prevent or reduce the harmful effects including annoyance due to exposure to environmental noise. **UK, England, Scotland and Wales** • To reduce and where possible avoid the effects and causes of statutory nuisance and to secure compliance with all relevant UK environmental legislation; • To minimise the adverse impact of noise without placing unreasonable restrictions on development or adding unduly to the costs and administrative burdens of business; • To ensure noise reduction occurs where there may be adverse impacts of noise on human health; • To protect and enhance the quality of the environment, including the availability of green space; • To promote good health and good quality of life through the effective management of noise in the context of Government policy on sustainable development; • To maintain and enhance public and worker safety.	Objective 2: Population Objective 3: Health
Land Use, Geology and Soils	**International** • To ensure that soil resources are protected and that expansion of organic farmland and adoption of sustainable farming techniques can be facilitated; • To protect soil on the basis of the principles of: preservation of soil functions; prevention of soil degradation; mitigation of its effects; restoration of degraded soils and the fact that degraded soil can result in the release of carbon to the atmosphere; • To take precautionary measures where soil function may be affected; • To identify areas at risk of erosion, organic matter decline, salinisation, compaction and landslides; • To limit the introduction of dangerous substances into the soil, to avoid accumulation in soil that would hamper soil functions and create a risk to human health and the environment. **UK, England, Scotland and Wales** • To ensure contaminated land is identified and remediated where appropriate; • To protect and preserve the environment and guard against pollution to land; • To preserve, where possible, the best and most versatile agricultural land; • To promote more sustainable patterns of development; • To adopt a sustainable approach to land use though consideration of: economic development, social inclusion, environmental protection and prudent use of resources;	Objective 1: Biodiversity and Nature Conservation Objective 3: Health Objective 4: Land Use, Geology and Soils Objective 5: Water

Topic	Summary Objectives and Policy Messages	SEA Objectives link (see Section 4)
	• To promote development of previously developed land; • To protect and enhance geological conservation interests and soils; • To recognise the continuing role of indigenous coal, oil and gas in maintaining a diverse energy mix and improving energy security; • To safeguard workable resources and ensure that an adequate and steady supply is available to meet the needs of the construction, energy and other sectors; • To minimise the impacts of extraction on local communities, built and natural heritage, and the water environment; • To secure the sustainable restoration of sites to a relevant use after working has ceased.	
Water and Flood Risk	**International** • To ensure that the water and ecological quality of freshwater and marine environments is enhanced and at least conserved; • To ensure sustainable use of water resources and reduced pollution and physical impacts; • To facilitate the integrated management of both the coastal zone and River Basin Districts to ensure sustainable use and protection of resources; • To encourage the sustainable use of water resources and protect aquatic ecology, drinking water, and bathing waters; • To protect the environment from the adverse effects of urban wastewater discharges and discharges from industrial processes; • To prevent the pollution of groundwater; • To protect the health of European water consumers. • To reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity; • To reduce the threat of flooding to people and their property; avoid inappropriate development in areas at risk of flooding; and sustainably manage risks from flooding and coastal erosion; • To ensure that policies and decisions in coastal areas are based on an understanding of coastal change over time; • To prevent new development from being put at risk from coastal change. **UK, England, Scotland and Wales** • To protect the water environment in a way that allows it to adjust flexibly to a changing climate; • To reduce pressure on the environment caused by water taken for human use; promote water use efficiency; and protect vital water supply infrastructure; • To improve quality of the UK water environment and the ecology which it supports; • To prevent against the potential impact of a loss of hydrological functionality and connectivity.	Objective 1: Biodiversity and Nature Conservation Objective 3: Health Objective 4: Land Use, Geology and Soils Objective 5: Water Objective 6: Flood Risk
Air	**International** • To promote cleaner transport technologies and manage the demand for transport to prevent detrimental effects to human health from air pollution; • To ensure that air quality is enhanced or at least maintained and ensure that measures are adopted to support continued air quality standards; • To monitor and reduce trans-boundary atmospheric pollution; • To maintain air quality where it is good and improve it in other cases; • To attain levels of air quality that do not give rise to significant negative impacts on and risks to human health and the environment;	Objective 1: Biodiversity and Nature Conservation Objective 3: Health Objective 4: Land Use, Geology and Soils Objective 5: Water

Topic	Summary Objectives and Policy Messages	SEA Objectives link (see Section 4)
	• To reduce emissions from industrial processes. **UK, England, Scotland and Wales** • To improve air quality by reducing the impact of air pollution on human health and ecosystems; • To ensure new development is appropriate for its location and takes into account 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.	Objective 6: Flood Risk Objective 7: Air
Climate Change	**International** • To prevent "dangerous" human interference with the climate system, namely through reductions in the emissions of greenhouse gases; • To promote renewable energy sources; • To promote sustainable development with regards to energy development, efficiency and consumption, transportation, industrial development, terrestrial and marine resource development and land use; • To reduce emissions of carbon dioxide and combat the serious threat of climate change; • To help transform Europe into a low-carbon economy and increase its energy security; • To ensure that energy efficiency measures are put in place and, where possible, renewables are employed to contribute to appropriate climate change targets; **UK, England, Scotland and Wales** • To improve carbon management and help the transition towards a low carbon economy ensuring that the net UK carbon emissions for the year 2050 are at least 80% lower than the 1990 baseline; • To promote climate change risk management in all aspects of business to ensure future resilience for communities, businesses and the environment; • To pursue new development in places that are resilient to climate change; and in ways that are consistent with social cohesion and inclusion; • To conserve and enhance biodiversity, recognising that the distribution of habitats and species will be affected by climate change; • To reduce energy consumption, minimise detrimental effects on the climate from greenhouse gases and maximise resilience to climate change.	Objective 1: Biodiversity and Nature Conservation Objective 2: Population Objective 3: Health Objective 5: Water Objective 6: Flood Risk Objective 7: Air Objective 8: Climate Change Objectives 9: Waste Objective 10: Resource Use
Waste and Resource Use	**International** • To ensure that waste reduction is at the forefront of waste management and where disposal is unavoidable, ensure a high level of protection for the environment and human health; • To adopt waste management principles such as the "polluter pays principle" and the "waste hierarchy"; • To protect human health and the environment against harmful effects caused by the collection, transport, treatment, storage and tipping of waste; • To help Europe become a recycling society that seeks to avoid waste and uses waste as a resource; • To ensure the prudent use of resources.	Objective 1: Biodiversity and Nature Conservation Objective 3: Health Objective 5: Water Objective 7: Air Objective 8: Climate Change Objectives 9: Waste Objective 10: Resource Use

Topic	Summary Objectives and Policy Messages	SEA Objectives link (see Section 4)
	UK, England, Scotland and Wales • To decouple waste growth (in all sectors) from economic growth and put more emphasis on waste prevention and re-use; • To increase diversion from landfill of municipal and non-municipal waste and secure better integration of treatment for all waste; • To increase recycling of resources and recovery of energy from residual waste using a mix of technologies; • To ensure waste is disposed of as near as possible to the place of production; • To ensure the layout and design of new development should support sustainable waste management; • 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; • To safeguard workable resources and ensure that an adequate and steady supply is available to meet the needs of the construction, energy and other sectors; • To minimise the impacts of extraction on local communities, built and natural heritage, and the water environment.	
Cultural Heritage	**International** • To identify, protect and preserve World Heritage Sites; • To protect and sustain the historic environment for the benefit of current and future generations; • To identify and protect important heritage features; • To collect and disseminate scientific information on cultural and archaeological heritage to aid conservation and public awareness. **UK, England, Scotland and Wales** • To protect listed buildings, scheduled monuments and buildings within conservation areas; • To protect and promote stewardship of the historic environment; • To promote positive planning and management to bring about sensible solutions to the treatment of sites with archaeological remains and to reduce the areas of potential conflict between development and preservation; • To protect heritage assets and their wider settings; • To safeguard internationally and nationally-designated historically or culturally significant sites.	Objective 1: Biodiversity and Nature Conservation Objective 2: Population Objective 4: Land Use, Geology and Soils Objective 5: Water Objective 10: Resource Use Objective 12: Landscape
Landscape	**International** • To ensure that development is 'appropriate' particularly in relation to protected landscapes; • To protect, manage and plan for landscape change throughout Europe. **UK, England, Scotland and Wales** • To provide public access to the countryside and promote sustainable farming and protection of wildlife; • To retain attractive landscapes, and enhance landscapes near to where people live; • To improve damaged and derelict land around towns; • To work within the framework of landscape to help shape future places and manage change everywhere; • To retain land in agricultural, forestry and related uses.	Objective 1: Biodiversity and Nature Conservation Objective 2: Population Objective 3: Health Objective 4: Land Use, Geology and Soils Objective 11: Cultural Heritage Objective 12: Landscape

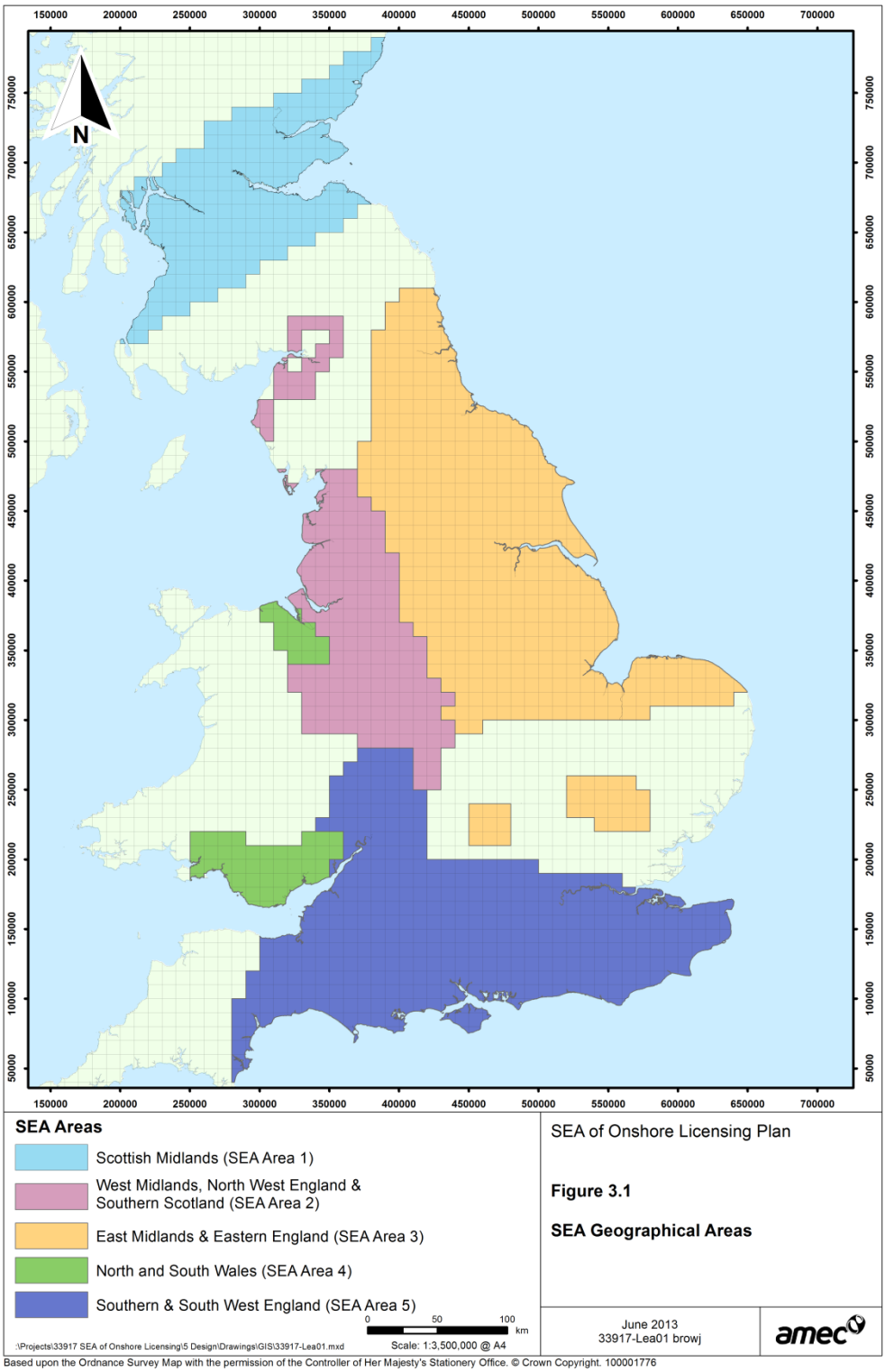
3.3 Collecting Baseline Evidence

An essential part of the SEA process is to identify the current state of the environment and its likely evolution under a 'business as usual' scenario. Only with sufficient knowledge of the existing baseline conditions can the likely significant effects of the draft Licensing Plan be identified and assessed. The SEA also requires that the actual effects of implementing the Plan on baseline conditions are monitored.

Baseline information has been collected for each topic at the UK and national (England, Scotland and Wales) level, reflecting the study area. Consistent with the initial Environmental Report, baseline information has also been presented at a sub-national (SEA Area) level in order to help better inform the assessment of the Plan and a total of 5 SEA Areas have been identified. These SEA Areas are listed below and shown in **Figure 3.1**:

- SEA Area 1: Scottish Midlands (including the Inner Forth);
- SEA Area 2: West Midlands, North West England and Southern Scotland;
- SEA Area 3: East Midlands and Eastern England;
- SEA Area 4: North and South Wales (including the Dee/Afon Dyfrdwy); and
- SEA Area 5: Southern and South West England.

Figure 3.1 SEA Areas



Information has been used from a variety of sources, including (amongst others) the previous Environmental Report, the Department for Environment, Food and Rural Affairs (Defra), DECC, the Environment Agency, Natural England, the Office of National Statistics, Welsh Government, Natural Resources Wales and the Scottish Environment Protection Agency.

3.3.1 Key Issues Relevant to Onshore Oil and Gas Licensing

From the analysis of current and projected baseline conditions, a number of issues have been identified as being relevant to the draft Licensing Plan. These are summarised in **Table 3.3**. Under each topic, the reference to the assessment objectives indicates how these issues have been reflected within the assessment framework (see **Section 4**).

Table 3.3 Key Issues Relevant to Onshore Oil and Gas Licensing

Topic	Summary of Key Issues	SEA Objectives link (see Section 4)
Biodiversity and Nature Conservation	• 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; • 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 SSSI sites were reported in favourable condition, with 37% of SACs, 86% of Ramsar site and 73% of SPAs reported as favourable; Key pressures and risks in respect of biodiversity and nature conservation that are particularly relevant to onshore oil and gas licensing include, inter-alia: o habitat destruction and fragmentation by development; o direct (e.g. - disturbance, displacement, direct mortality) and indirect (e.g. – through reduced numbers of prey species) impacts on features of protected sites o water abstraction, drainage and hydrological functionality; o inappropriate coastal management; o lack of appropriate habitat management; o atmospheric pollution (acid precipitation, nitrogen deposition); o water pollution; o climate change and sea level rise.	Objective 1: Biodiversity and Nature Conservation Objective 3: Health
Population	• There are current uncertainties over market conditions and the range of economic forecasts available indicate a number of future scenarios; • 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 could increase the likelihood of operations having, or being perceived to have, a negative impact on communities; • There is a need to maximise the local employment benefits of oil and gas development.	Objective 2: Population Objective 3: Health
Health	• Health inequalities exist in many communities, often exacerbated by poor access to or use of health services. Any future funding constraints on health services are likely to affect this situation.	Objective 2: Population Objective 3: Health

Topic	Summary of Key Issues	SEA Objectives link (see Section 4)
Land Use, Geology and Soils	• Mining activities in all of the SEA Areas have left a legacy of hazards such as landslips, subsidence, contamination of ground and surface water sources from metals such as tin, copper and arsenic, and radon gas and flooding; • 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; • Significant areas across the UK carry a burden of contamination from industrial activity, although this is progressively being addressed 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; • 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.	Objective 1: Biodiversity and Nature Conservation Objective 3: Health Objective 4: Land Use, Geology and Soils Objective 5: Water
Water & Flood Risk	• There is considerable pressure on water resources in many parts of the UK; • 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 standards 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; • 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. 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); • Many coastal sites (especially in the south and east of the country) are already prone to erosion, due to their underlying geology, coupled with rising sea levels and increased storm intensity; • Increasing development pressures on and around the coastal environment are conflicting with the need for their effective management in the face of climate change. Shoreline Management Plans are being implemented across the country to assess and manage these risks.	Objective 1: Biodiversity and Nature Conservation Objective 3: Health Objective 4: Land Use, Geology and Soils Objective 5: Water Objective 6: Flood Risk
Air	• Air quality has improved in the UK over the last sixty years as a result of the switch from coal to gas and electricity for heating of domestic and industrial premises, stricter controls on industrial emissions, higher standards for the composition of fuel and tighter regulations on emissions from motor vehicles. However, poor air quality - particularly from vehicles - remains a significant issue for community health and for biodiversity, especially in/downwind of urban areas and major transport networks; • Air pollution continues to cause significant damage to peoples' health. Air pollution is also a significant cause of decline in the condition of several of the UK's SSSIs.	Objective 1: Biodiversity and Nature Conservation Objective 3: Health Objective 4: Land Use, Geology and Soils

Topic	Summary of Key Issues	SEA Objectives link (see Section 4)
		Objective 5: Water Objective 7: Air
Climate Change	• The UK's carbon dioxide (CO_2) 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. Although UK CO_2 emissions have declined to ~8% below 1990 levels they are still the largest at 85% of all greenhouse gas emissions; • Energy security is becoming a significant emerging issue for the UK as national fossil fuel resources are depleted; • The UK's Climate Projections (UKCP09) show that the country as a whole is likely to experience hotter drier summers, warmer wetter winters and rising sea levels, particularly in the South East of England. This is likely to have a significant effect on a range of environmental conditions, including the water environment; • Sea levels are rising, with worst case scenarios of a 1.9m increase in sea level by 2100 (with up to 0.76m more likely). The south and east of England will experience the greatest effective increases, due to the effects of post-glacial rebalancing; • Sensitive ecosystems and UK water resources are likely to come under increasing pressure as a result of climate change.	Objective 1: Biodiversity and Nature Conservation Objective 2: Population Objective 3: Health Objective 5: Water Objective 6: Flood Risk Objective 7: Air Objective 8: Climate Change
Waste and Resource Use	• Reuse and recycling rates for industrial wastes are increasing, due to the combined effects of statutory, reputational and financial drivers.	Objective 1: Biodiversity and Nature Conservation Objective 3: Health Objective 4: Land Use, Geology and Soils Objective 5: Water Objective 6: Air Objective 7: Climate Change Objectives 9: Waste Objective 10: Resources Use
Cultural Heritage	• In England, there has been a steady decrease in the number of assets identified as being at risk compared to a slight decline in Scotland in Wales; • Scheduled Monuments in rural areas are at risk from agricultural practices, land disturbance and unrestricted plant, scrub or tree growth; • Challenging economic conditions are reducing the funds available to conserve and manage heritage assets; • The settings of heritage assets are at risk from new development.	Objective 1: Biodiversity and Nature Conservation Objective 2: Population Objective 4: Land Use, Geology and Soils Objective 5: Water Objectives 9: Waste Objective 10: Resources Use Objective 12: Landscape
Landscape	• Over the last century the following landscape character trends have been experienced in the UK:	Objective 1: Biodiversity and Nature Conservation

Topic	Summary of Key Issues	SEA Objectives link (see Section 4)
	o 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; o a loss of some natural and semi-natural features and habitats such as ancient woodlands and unimproved grassland; o a decline in some traditional agricultural landscape features such as farm ponds and hedgerows, and a loss of archaeological sites and traditional buildings; o 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. • A loss of remoteness and reduced tranquillity because of built development and traffic growth. 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 those key characteristics which contribute to the character and local distinctiveness of an 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.	Objective 2: Population Objective 3: Health Objective 4: Land Use, Geology and Soils Objective 11: Cultural Heritage Objective 12: Landscape

3.4 Limitations of the Data

Data has generally been sourced from national bodies to enable comparison between baseline information for England, Scotland and Wales. However, in some cases baseline information collected by national bodies differs, therefore data is not directly comparable.

Given the geographical extent of the SEA Areas which do not follow exactly administrative boundaries, in some instances the availability of datasets is limited.

The information used has been sourced, so far as is possible, from the most recent datasets available utilising a wide range of authoritative and official sources. It is important to acknowledge that there are variable time lags between raw data collection and its publication. Consequently, at the time of this report's publication the baseline or predicted future trends may have varied from those described above.

4. SEA Methodology

4.1 Introduction

This section sets out how the SEA has been carried out. It draws on the information presented in Sections 2 and 3 and the associated appendices to define the scope of the assessment (in terms of what is to be assessed and the environmental issues to be considered) and develop the assessment framework. The assessment framework includes objectives and guide questions supported by definitions of significance that will help the reader understand how the effects of the draft Licensing Plan have been assessed against the SEA objectives.

4.2 Scope of the Assessment

4.2.1 Focus

The SEA of the draft Licensing Plan assesses those potential activities that could follow on from the licensing round and which may have environmental effects. More specifically, the assessment considers for conventional oil and gas, shale gas, virgin coalbed methane and gas storage in-turn, effects associated with the six exploration and production stages set out in **Table 2.5** (see **Section 2.5**) under low and high activity scenarios (as defined in **Section 2.5** and set out in **Tables 2.6 and 2.7**).

4.2.2 Environmental Topics

The range of potential environmental effects under consideration has been informed primarily by the SEA Directive and Regulations, using published government guidance. As discussed in **Section 3**, Annex I of the SEA Directive and Schedule 2 of the SEA Regulation requires that the assessment includes information on the "*likely significant effects on the environment, including on issues such as: biodiversity; population; human health; fauna; flora; soil; water; air; climatic factors; material assets; cultural heritage, including architectural and archaeological heritage; landscape; and the inter-relationship between the issues referred to*".

The scope of the draft Licensing Plan presented in **Section 2**, the findings of the previous Environmental Report and the outputs from the review of other relevant plans and programmes and baseline information have been used to define the scope of the assessment. In this instance none of the topics have been scoped out of the assessment.

4.2.3 Geographic Scope

The SEA considers potential effects at the UK and national level, including any trans-boundary effects. In order to help focus the assessment and disaggregate the findings, five SEA Areas have also been

identified covering Scottish Midlands, North and South Wales, and most areas of England (with the exception of the extreme South West). These areas are shown in **Figure 3.1** (see **Section 3**) and have been selected due to their coincidence with certain administrative areas and the main geological provinces of interest in this SEA. They also correspond with those areas used to gather and present the baseline information contained in **Appendix B**.

4.2.4 Short, Medium and Long-Term Timescales

When considering the timing of potential effects of the draft Licensing Plan, the commentary classifies effects as 'short,' 'medium' or 'long term.' This reflects an intention to capture the differences that could arise at different timescales, consistent with the requirements of the Annex II (2) of the SEA Directive where the assessment of the effects should have regard to 'the probability, **duration**, frequency and reversibility of the effects'. For the purposes of this assessment, 'short,' 'medium' or 'long term were defined in relation to the total length of activity under the PEDL terms (to some 32 years) and are detailed in **Table 4.1** below.

Table 4.1 Duration of Short, Medium and Long Term

Duration	Length (years)
Short	0 years to 3 years
Medium	3 years to 10 years
Long	>10 years to 32 years (and beyond (including decommissioning).

4.3 Approach to Assessing the Effects

4.3.1 Assessment Objectives and Guide Questions

Establishing appropriate SEA objectives and guide questions is central to assessing the effects of the draft Licensing Plan on the environment. The SEA objectives and guide questions reflect the topics included within the assessment and have been informed by:

- the review of plans and programmes and the associated environmental protection objectives (see **Section 3.2**);
- the baseline information and key issues (see **Section 3.3**); and
- SEA objectives contained within the previous 2010 Environmental Report.

Broadly, the SEA objectives present the preferred environmental outcome, which typically involves minimising detrimental effects and enhancing positive effects.

Associated guide questions have been developed for each SEA objective to provide a detailed framework against which the draft Licensing Plan can be assessed. As part of the scoping consultation process, consultees provided comments on the draft assessment objectives and guide questions. The revised assessment objectives and guide questions are presented in **Table 4.2.** Principal changes to the guide questions are in red.

Table 4.2 Revised Assessment Objectives and Guide Questions

Topic Area	SEA Objectives	Guide Questions	SEA Topics
Biodiversity and Nature Conservation	1. To protect and enhance biodiversity (habitats, species and ecosystems) working within environmental capacities and limits.	• Will the activities that follow the licensing round protect and/or enhance internationally designated nature conservation sites? e.g. SACs, SPAs and Ramsars? • Will the activities that follow the licensing round protect and/or enhance nationally designated nature conservation sites? e.g. SSSIs? • Will the activities that follow the licensing round affect animals or plants including protected species? • Will the activities that follow the licensing round affect the structure and function of natural systems (ecosystems)? • Will the activities that follow the licensing round affect public access to areas of wildlife interest? • Will the activities that follow the licensing round have an impact on fisheries? • Will the activities that follow the licensing round affect Ancient Woodlands?	Biodiversity, Flora and Fauna
Population	2. To promote a strong, diverse and stable economy with opportunities for all; minimise disturbance to local communities and maximise positive social impacts.	• Will the activities that follow the licensing round affect the social infrastructure and amenities available to local communities? • Will the activities that follow the licensing round affect local population demographics and/ or levels of deprivation in surrounding areas? • Will the activities that follow the licensing round affect opportunities for investment, education and skills development? • Will activities that follow the licensing round affect the number or types of jobs available in local economies? • Will the activities that follow the licensing round affect how diverse and robust local economies are? • Will the activities that follow the licensing round affect the affordability of gas for households?	Population
Health	3. To protect and enhance health, safety and wellbeing of workers and communities and minimise any health risks associated with onshore oil and gas operations.	• Will the activities that follow the licensing round protect and/or enhance the health and safety of workers, or other people working at the proposed sites? • Will the activities that follow the licensing round protect and/or enhance the health, safety and well-being of local communities?	Health

Topic Area	SEA Objectives	Guide Questions	SEA Topics
Land Use, Geology and Soils	4. To conserve and enhance soil and geology and contribute to the sustainable use of land.	• Will the activities that follow the licensing round have an effect on soil quality/function, variety, extent and/or compaction levels? • Will the activities that follow the licensing round increase the risk of significant land contamination? • Will the activities that follow the licensing round have an effect on any known and existing contamination? • Will the activities that follow the licensing round protect and/or enhance Geological Conservation Sites, important geological features and geophysical processed and functions? • Will the activities that follow the licensing round affect land stability? • Will the activities that follow the licensing round change patterns of land use?	Soil, Material Assets
Water and Flood Risk	5. To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive.	• Will the activities that follow the licensing round affect demand for water resources (availability)? • Will the activities that follow the licensing round affect the amount of pollution arising from wastewater and surface runoff produced? • 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? • Will the activities that follow the licensing round protect the geological/hydrological connection between prospective shale gas sequences and UK geothermal and mineral springs?	Water
	6. To minimise the risks of coastal change and flooding to people, property and communities.	• Will the activities that follow the licensing round be at risk of flooding or be affected by flooding, if it occurred? • Will the activities that follow the licensing round have the potential to cause or exacerbate flooding? • Will the activities that follow the licensing round have the potential to help alleviate flooding? • Will the activities that follow the licensing round have the potential to affect coastal processes and/or erosion rates? • Will the activities that follow the licensing round minimise the risks of coastal change and flooding to people, property and communities?	Water
Air	7. 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.	• Will the activities that follow the licensing round affect air quality? • Will the activities that follow the licensing round create a nuisance for people or wildlife (for example from dust or odours)?	Air
Climate Change	8. To minimise greenhouse gas emissions as a contribution to climate change, ensure resilience to any consequences of climate change and establish measures which limit flood risk.	• Will the activities that following the licensing round minimise greenhouse gas emissions as a contribution to climate change and ensure resilience to any consequences of climate change • Will the activities that follow the licensing round affect climate change • Will the activities that follow the licensing round be able to minimise the generation of greenhouse gases? • Will the activities that follow the licensing round be significantly affected by climate change (for example rising temperatures and more extreme weather events)?	Climatic Factors

Topic Area	SEA Objectives	Guide Questions	SEA Topics
Waste and Resource Use	9. To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities.	• Will the activities that follow the licensing round affect the amount of hazardous and non-hazardous wastes produced? • Will the activities that follow the licensing round affect the capacity of existing waste management systems, both nationally and locally? • Will the activities that follow the licensing round maximise re-use and recycling of recovered components and materials? • Will the activities that follow the licensing round help achieve government and national targets for minimising, recovering and recycling waste?	Material Assets
Waste and Resource Use	10. To contribute to the sustainable use of natural and material assets.	• Will the activities that follow the licensing round minimise the demand for mineral resources and other unsustainable construction materials? • Will the activities that follow the licensing round make best use of existing infrastructure and resources?	Material Assets
Cultural Heritage	11. To protect and where appropriate enhance the historic environment including cultural heritage resources, historic buildings and archaeological features.	• Will the activities that follow the licensing round affect designated or locally-important archaeological features? • Will the activities that follow the licensing round affect the fabric and setting of historic buildings, places or spaces that contribute to local distinctiveness, and historic landscape character? • How will the activities that following the licensing round affect historic landscape character in all areas?	Cultural heritage, including architectural and archaeological heritage
Landscape	12. To protect and enhance landscape and townscape quality and visual amenity.	• Will the activities that follow the licensing round have significant visual impacts (including those at night)? • 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? • Will the activities that follow the licensing round affect the intrinsic character of local landscapes or townscapes? • Will the activities that follow the licensing round affect public access to open spaces or the countryside?	Landscape

4.4 Completing and Recording the Assessment

In line with the ODPM (now CLG) Practical Guide to the SEA Directive, the assessment process seeks to predict the significant environmental effects of the draft Licensing Plan. This is done by identifying the likely changes to the baseline conditions as a result of implementing the proposed plan (or reasonable alternative). These changes are described (where possible) in terms of their geographic scale, the timescale over which they could occur, whether the effects would be temporary or permanent, positive or negative, likely or unlikely, frequent or rare. Where numerical information is not available, the assessment is based on professional judgement and with reference to relevant legislation, regulations and policy. More specifically, in undertaking the assessment, consideration has been given to:

- Baseline information including existing environmental problems and their evolution;

- The likely activities and potential sources of impact associated with oil and gas exploration and production;
- The regulatory framework;
- The evidence base regarding the relative risks and potential for significant effects from activities that may potentially arise following the licensing round including the findings of the previous Environmental Report;
- Consultation with statutory consultees and other stakeholders including responses to the previous Environmental Report;
- The SEA objectives and guide questions; and
- Definitions of significance (see **Section 4.4.3** below).

As set out in **Section 4.2.1** above, the assessment focuses on two elements, namely: the potential activities that could follow on from the licensing round; and the draft Licensing Plan alternatives. How the assessment has been completed and recorded in each case is discussed in-turn below.

4.4.1 Assessment of Activities

Table 4.3 sets out the framework that has been used to record the findings of the assessment of the potential activities that could follow on from the licensing round (by resource type) against each of the SEA objectives listed in **Table 4.2**. The first two columns describe the exploration and production stage. The third and fourth columns summarise the expected effects on the SEA objective under consideration for both low activity and high activity scenarios. The rationale for this relationship has been explained in more detail in the final column and includes:

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

Table 4.3 Assessment Framework (Activities Assessment)

Resource: Conventional Oil and Gas **Objective 1: Biodiversity and Nature Conservation**				
Stage	***Description***	***Score***		***Commentary***
		Low Activity Scenario	***High Activity Scenario***	
1	**Non-intrusive exploration,** including: • Site identification, selection, characterisation; • Seismic surveys; • Securing of necessary development and operation permits.	**0**	**0**	**Assessment of Effects:** *A description of effects of the activities associated with each resource type and for each stage on the SEA objective under consideration have been provided here, with reasoning and justification included.* **Low and High Activity Scenarios:** *Commentary is included here relating to any notable differences in the type and magnitude of effects between low and high activity scenarios.* **Mitigation:** *Measures to offset adverse effects and enhance positive effects have been identified.* **Assumptions:** *Any assumptions that have underpinned the assessment have been highlighted here.* **Uncertainties:** *Uncertainties encountered during the assessment have been noted.*
2…etc				

Summary
A brief summary of the effects of all the six stages for each resource type on the SEA objective under consideration have been provided.

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)

The assessment of effects is contained in Appendix B, at the end of each SEA topic chapter and summarised in Section 5.

4.4.2 Assessment of Plan Alternatives

As set out in **Section 2.6**, two reasonable alternatives to the draft Licensing Plan have been identified, namely:

- **Limited the area of land available to be licensed:**
  - To limit the area of land available to be licensed in any one round of licensing by establishing a 'ceiling' figure for the total area of land equivalent to 50% of the aggregate area of current licences. PEDLs would then be awarding in merit order; or
- **No award of licences** under this onshore licensing round.

The reasonable alternatives above were also assessed against each of the SEA objectives. **Table 4.4** sets out the framework that has been used to record the findings of the assessment of each alternative. The first column lists the respective SEA objective whilst the second column summarises the expected effects on the objective under consideration. The rationale for this relationship has been explained in more detail in the final column.

Table 4.4 Assessment Framework (Draft Licensing Plan Alternatives Assessment)

SEA Objective	Score	Summary
1. To protect and enhance biodiversity (habitats, species and ecosystems) working within environmental capacities and limits.	-	*A description of effects of the alternative against the SEA objective under consideration is provided here, with reasoning and justification included.*
2...etc		

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.

The assessment of effects of the draft Licensing Plan alternatives is contained in Section 5.6

4.4.3 Definitions of Significance

Topic-specific definitions have been developed for what constitutes a significant effect, a minor effect or a neutral effect for each of the SEA objectives. These definitions of significance have helped ensure a consistent approach to interpreting the significance of effects and will help the reader understand the decisions made by the assessor. These can be found in the relevant topic chapters in **Appendix B**.

Table 4.5 shows an example of these definitions along with the symbols used to record the effects within the assessment.

Table 4.5 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); • 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); • 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.
+	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); • 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); • 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); • Option would not affect public right of way or access to areas of wildlife interest.
-	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); • 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; • 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.

4.4.4 Mitigation

Identifying effective mitigation measures is also a fundamental part of the SEA and where significant negative effects have been identified, appropriate mitigation measures have been proposed. This has been presented by stage (for the different activities covered by the draft Licensing Plan) and with an indication whether the measure could be taken by the operator or by DECC. In some instances, mitigation measures are also proposed for minor negative effects and also, where appropriate, enhancement measures have also been identified.

4.4.5 Assessment of Secondary, Cumulative and Synergistic Effects

The SEA Directive, and its implementing regulations in the UK, requires that secondary, cumulative and synergistic effects are considered as part of the assessment (see definitions presented in **Table 4.6**).

Table 4.6 Definitions of Secondary, Cumulative and Synergistic Effects

Type of Effect	Definition*
Secondary (or indirect)	Effects that do not occur as a direct result of activities which may follow the issue of licences but occur at distance from the direct impacts or as a result of a complex pathway. Examples of a secondary effect of the draft Licensing Plan would include the materials (and embedded carbon) used in the development oil and gas exploration and production facilities, or health effects of changes to air quality.
Cumulative	Effects that occur where several individual activities which each may have an insignificant effect, combine to have a significant effect. Examples of a cumulative effect of exploration or production activities could include the potential effects on a European designated site, where a habitat or species is vulnerable and the cumulative effects of disturbance and pollutant emissions arising from development and operation causes a significant impact. Cumulative effects will also include the potential effects (if any) of any activity with effects due to any other proposed and consented developments.
Synergistic	Effects that interact to produce a total effect that is greater than the sum of the individual effects. For example, this can occur where the toxicity of two chemicals is greatly increased when they are combined.

*Adapted from SEA guidance, ODPM (2005)

As discussed in **Section 4.2**, different activity scenarios have been considered during the assessment which will help identify the potential effects associated with the collective implementation of oil and gas exploration and production licensed under draft Licensing Plan.

Additionally, the assessment has considered two further categories of cumulative effects, namely:

- the combined effects of all activities that could follow on from the licensing round, across all resource types; and
- the effects of all activities that could follow on from the licensing round in-combination with effects arising from the currently licensed activities under previous licensing rounds.

The findings of the cumulative effects assessment have been recorded using a similar framework to that adopted for the assessment of the draft Licensing Plan alternatives (see **Table 4.4**).

The assessment of the cumulative effects of the draft Licensing Plan is contained in Section 5.8

4.5 Technical Difficulties

4.5.1 Uncertainties

The following uncertainties have been encountered during the completion of the report which has influenced the findings of the assessment.

- The outcome of current exploration activities being implemented under existing licences, and the consequences this has on hydrocarbon reserves and the likelihood of recovery is currently unknown;
- The timing of when activities under the 14th Round licences may proceed is uncertain. It has been assumed that all of the wells under conventional and unconventional oil and gas exploration and production will be drilled and completed within the first 12 years. If this were to change then this may influence the magnitude or likelihood of certain effects;
- The location of where activities under the 14th Round licences may take place, how they may be distributed across each of the five SEA areas and the scale of activity (including the resulting gas produced) is uncertain;
- Likewise, if licences are awarded for adjacent areas, it is uncertain how closely any future operations may be located therefore the potential for cumulative effects is also uncertain; and
- Future changes to the environmental baseline beyond those discussed in **Appendix B**

4.5.2 Assumptions

It is assumed that current controls are enforced by regulators and followed by operators.

In order to explore the possible environmental impacts that could arise from activities under the 14th Round licences effectively, a series of assumptions have been made regarding the nature, scale and phasing of development (**Section 2.5, Tables 2.6 and 2.7**). Two scenarios are presented, one representing a low level of activity following on from the issue of new licences and the other representing a much higher level. These assumptions are based on the available evidence from literature. In several cases this is made on evidence from the United States with relevant adjustments made to be applicable to the UK. It should be noted that these assumptions do not represent any definitive view on any of the factors assumed, but rather a representative view based on present knowledge, for the purposes of this assessment. **Tables 4.7, 4.8** and **4.9** provide information and the assumptions used (based on the literature) to determine the level of employment that could be generated for the low and high activity scenarios. **Tables 4.10, 4.11** and **4.12** show the assumptions used to determine the number and frequency of vehicle movements for Stages 2 and 3 of the conventional and unconventional oil and gas lifecycles.

Table 4.7 Estimated Employment Numbers for Unconventional Oil and Gas Scenarios

Year	Low Activity Scenario		High Activity Scenario	
	No. of wells	Total FTE generated*	No. of wells	Total FTE generated*
1	12-24	1,100 – 2,100	24-28	2,100 – 4,200

Year	Low Activity Scenario		High Activity Scenario	
	No. of wells	Total FTE generated*	No. of wells	Total FTE generated*
2	18-36	1,600 – 3,200	36-72	3,200 – 6,400
3	18-36	1,600 – 3,200	60-120	5,300 – 10,600
4	18-36	1,600 – 3,200	120-240	11,000 – 22,000
5	18-36	1,600 – 3,200	120-240	11,000 – 22,000
6	24-28	2,100 – 4,200	180-360	16,000 – 32,000
7	30-60	2,600 – 5,300	180-360	16,000 – 32,000
8	30-60	2,600 – 5,300	180-360	16,000 – 32,000
9	12-24	1,100 – 2,100	180-360	16,000 – 32,000
10	0	-	120-240	11,000 – 22,000
11	0	-	120-240	11,000 – 22,000
12	0	-	120-240	11,000 – 22,000
13	0	-	0	-
14	0	-	0	-
15	0	-	0	-
16	0	-	0	-
17	0	-	0	-
18	0	-	0	-
19	0	-	0	-
20	0	-	0	-

*All values rounded up to the nearest 1000. FTE value includes direct, indirect and induced positions.

Table 4.8 Example of Detailed Employment Estimates for Unconventional Oil and Gas High Activity Scenarios

		Expenditure Split						Jobs Created from Cost of the Well Exploration and Development / Main Process						Jobs from Infrastructure/ Conversion		Maintenance Jobs		TOTAL
		Cost																
Year	No of Wells		Labour	Subsistence	Bought in Goods/Services	Overhead	Profit	Jobs with Developer/ First Round Suppliers	Jobs due to Subsistence Expenditure	Jobs with the Rest of the Supply Chain	Total	Jobs from Induced Impacts	Total	Total	Induced	Cumulative Wells	Maintenance Jobs	Total (inc induced but excluding maintenance)
1	48	£306,504,900	£101,146,617	£21,455,343	£113,406,813	£33,715,539	£36,780,588	1,839	358	1,042	3,239	445	3,684	486	67			4,236
2	72	£459,757,350	£151,719,926	£32,183,015	£170,110,220	£50,573,309	£55,170,882	2,759	536	1,563	4,858	667	5,525	729	100	48	19	6,354
3	120	£766,262,250	£252,866,543	£53,638,358	£283,517,033	£84,288,848	£91,951,470	4,598	894	2,605	8,097	1,112	9,209	1,215	167	120	48	10,590
4	240	£1,532,524,500	£505,733,085	£107,276,715	£567,034,065	£168,577,695	£183,902,940	9,195	1,788	5,211	16,194	2,224	18,418	2,429	334	240	96	21,181
5	240	£1,532,524,500	£505,733,085	£107,276,715	£567,034,065	£168,577,695	£183,902,940	9,195	1,788	5,211	16,194	2,224	18,418	2,429	334	480	192	21,181
6	360	£2,298,786,750	£758,599,628	£160,915,073	£850,551,098	£252,866,543	£275,854,410	13,793	2,682	7,816	24,291	3,337	27,627	3,644	501	720	288	31,771
7	360	£2,298,786,750	£758,599,628	£160,915,073	£850,551,098	£252,866,543	£275,854,410	13,793	2,682	7,816	24,291	3,337	27,627	3,644	501	1080	432	31,771
8	360	£2,298,786,750	£758,599,628	£160,915,073	£850,551,098	£252,866,543	£275,854,410	13,793	2,682	7,816	24,291	3,337	27,627	3,644	501	1440	576	31,771

Year	No of Wells	Cost	Expenditure Split					Jobs Created from Cost of the Well Exploration and Development / Main Process						Jobs from Infrastructure/ Conversion		Maintenance Jobs		TOTAL
			Labour	Subsistence	Bought in Goods/Services	Overhead	Profit	Jobs with Developer/ First Round Suppliers	Jobs due to Subsistence Expenditure	Jobs with the Rest of the Supply Chain	Total	Jobs from Induced Impacts	Total	Total	Induced	Cumulative Wells	Maintenance Jobs	Total (inc induced but excluding maintenance)
9	360	£2,298,786,750	£758,599,628	£160,915,073	£850,551,098	£252,866,543	£275,854,410	13,793	2,682	7,816	24,291	3,337	27,627	3,644	501	1800	720	31,771
10	240	£1,532,524,500	£505,733,085	£107,276,715	£567,034,065	£168,577,695	£183,902,940	9,195	1,788	5,211	16,194	2,224	18,418	2,429	334	2160	864	21,181
11	240	£1,532,524,500	£505,733,085	£107,276,715	£567,034,065	£168,577,695	£183,902,940	9,195	1,788	5,211	16,194	2,224	18,418	2,429	334	2400	960	21,181
12	240	£1,532,524,500	£505,733,085	£107,276,715	£567,034,065	£168,577,695	£183,902,940	9,195	1,788	5,211	16,194	2,224	18,418	2,429	334	2640	1056	21,181
13	0															2880	1152	

Table 4.9 Assumptions behind Employment Estimates

Assumptions*	
Cost per well	£8,970,000
Breakdown of costs	Labour = 33% Subsistence = 7% Bought in goods = 37% Overhead = 11% Profit = 12%
Proportion of investment in UK (excluding spend on specialist workers and suppliers outside UK e.g. onshore drill rigs and crews)	71%
All wage income Cuadrilla and tier 1 suppliers (per FTE)*	55,000
Subsistence expenditure (per FTE)	60,000
Induced expenditure (per FTE)	133,000
Supply chain expenditure (per FTE)	185,000
Input-output multiplier	1.7
% of wage income available after tax and saving	65%
% of income spent in the UK	90%

Source: All figures in the table are based on figures used in modelling used within Regeneris Consulting (2011) Economic Impact of Shale Gas Exploration & Production in Lancashire and the UK

Table 4.10 Assumptions on Vehicle Movements

Activity	No of vehicle movements	Relevance to conventional	Relevance to unconventional	Source/basis of assumption
PER WELL PAD				
Initial site access and drill pad construction	40	Stage 2	Stage 2	European Commission higher estimate [58]
Drill rig set up	40	Stage 2	Stage 2	
Well pad completion	10	Stage 2	Stage 2	
Pipe installation	50	Stage 3	Stage 3	

[58] http://www.europarl.europa.eu/document/activities/cont/201107/20110715ATT24183/20110715ATT24183EN.pdf [accessed September 2013]

Activity	No of vehicle movements	Relevance to conventional	Relevance to unconventional	Source/basis of assumption
Additional drill pad construction	10	Stage 3	Stage 3	Assume some construction will be completed already under Stage 2.
PER WELL – drilling and fracturing				
Drilling water	50	Stage 2 and 3	50% at Stage 2 10% at Stage 3 [59]	European Commission higher estimate
Casing	10	Stage 2 and 3	Stage 2 and 3	
Drill cutting	47 (Conventional) 108 (unconventional)	Stage 2 and 3	Stage 2 and 3	Assumes 117m^3 drill cuttings for conventional and 270m3 drill cuttings for unconventional Truck capacity of 5m^3 Each truck will require return journey (included)
Drilling wastewater	50	Stage 2 and 3	Stage 2 and 3	European Commission higher estimate
Fracturing fluid - water	667-1667	n/a	50% at Stage 2 10% at Stage 3	Assumes 10,000-25,000m^3 of water used per well Truck capacity of 30m^3 Each truck will require return journey (included)
Fracturing fluid - chemicals	2	n/a	Stage 2 and 3	European Commission higher estimate
Produced water	3	Stage 2 and 3	Stage 2 and 3	European Commission higher estimate
Fracturing fluid flowback	200-1250	n/a	Stage 2 and 3	Assumes 10,000-25,000m^3 of water used per well [60] 30-75% of water will return as flowback [61] Truck capacity of 30m^3 Each truck will require return journey (included)

Table 4.11 Estimated Vehicle Movements for Conventional Oil and Gas

Assumption	Stage 2	Stage 3
Vehicle movements per well pad (exc. Drilling and fracturing)	90	60
Total vehicle movements per well	160	160
Total no of wells per pad	1	1
Total vehicle movements per well pad (inc drilling and fracturing)	250	220
Duration of activities	Pad preparation = 3 weeks [62] Drilling per well = 4-5 weeks [63]	

[59] Based on 50% and 90% of water available from mains in Stage 2 and 3 respectively

[60] 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 European Commission DG Environment

[61] 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 European Commission DG Environment

[62] Assume the mid-estimate of time for pad preparation from *Regeneris (2011) Economic Impact of Shale Gas Exploration & Production in Lancashire and the UK* is split equally between stage 2 and 3. (i.e. – 6 weeks is the mid-estimate of 4-8 weeks and is divided 3 weeks in stage 2 and another 3 weeks in stage 3).

Assumption	Stage 2	Stage 3
Total duration of activities at well pad	**7-8 weeks**	**7-8 weeks**
Frequency of vehicle movements per well pad	**6-7 a day**	**5-6 a day**

Table 4.12 Estimated Vehicle Movements for Unconventional Oil and Gas

Assumption	Stage 2	Stage 3	
		Low Activity	High Activity
Vehicle movements per well pad (exc. Drilling and fracturing)	90	60	
Total vehicle movements per well	731-2,281	445-1,595	
Total no of wells per pad	1	5-11	23
Total vehicle movements per well pad (inc drilling and fracturing)	820– 2,370	4,950 – 17,600	10,290 – 36,735
Duration of activities	Pad preparation = 3 weeks [62] Drilling per well = 4-5 weeks [63] Hydraulic fracturing per well = 5 days [64] Flowback period = 20 days [65]		
Total duration of activities at well pad	**12-13 weeks**	**32–73 weeks**	**122–145 weeks**
Frequency of vehicle movements per well pad	**14-36 a day**	**16-48 a day**	**17-51 a day**

[63] Based on assumptions within AEA (2012) Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe.
[64] Tyndall Centre, University of Manchester (2011) Shale gas: a provisional assessment of climate change and environmental impacts.
[65] Accenture (2012) Water & Shale Gas Development.

5. Assessment of Effects of the draft Licensing Plan and Reasonable Alternatives

5.1 Overview

This chapter of the Environmental Report presents the results of the assessment of the draft Licensing Plan, which has been undertaken in accordance with the methodology described in **Section 4**. The findings are presented by resource-type (conventional oil and gas, unconventional oil and gas and VCBM, as well as gas storage). This chapter draws in particular on the detailed topic-based assessments contained in **Appendix B** and focuses on the significant positive and negative effects of those activities that could follow on from the licensing round. It provides information on the potential nature and scale of effects as well as proposed mitigation measures (where appropriate) and measures for enhancement.

This chapter also presents the findings of the assessment of the three draft Licensing Plan alternatives (unlimited award of licences, restricted area available for licensing and no award of licences), providing the reasoned justification for the selection of the preferred option and rejection of the alternatives identified and assessed.

Finally, consideration is given to the secondary, cumulative and synergistic effects of the draft Licensing Plan, in accordance with the requirements of the SEA Regulations.

5.2 The Environmental Effects of Conventional Oil and Gas Exploration and Production

Table 5.1 summarises the potential effects of the six stages of the conventional oil and gas exploration and production lifecycle under the low ('L') and high ('H') activity scenarios (as described in **Section 2.5**) against the 12 SEA objectives.

The following key has been used in completing the assessment.

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 5.1 Summary of the Environmental Effects of the Activities that Follow Licensing: Conventional Oil and Gas

Stage	Description	Biodiversity & Nature Conservation		Population		Health		Land Use, Geology & Soils		Water		Flood Risk		Air		Climate Change		Waste		Resource Use		Cultural Heritage		Landscape	
		L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
1	**Non-intrusive exploration,** including: • Site identification, selection, characterisation; • Seismic surveys; • Securing of necessary development and operation permits.	0/?	0/?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0/?	0/?	0	0
2	**Exploration drilling,** including: • Pad preparation, road connections and baseline monitoring; • Well design construction and completion; • Well testing including flaring.	0/?	-/?	+/-	+/-	-	-	-	-	0	0	0/?	0/?	0	0	-	-	-	-	-/+	-/+	0	-/?	-	-/?

Stage	Description	Biodiversity & Nature Conservation		Population		Health		Land Use, Geology & Soils		Water		Flood Risk		Air		Climate Change		Waste		Resource Use		Cultural Heritage		Landscape	
		L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
3	**Production development,** including: • Pad preparation, road connections and baseline monitoring; • Facility construction and installation; • Well design construction and completion; • Provision of pipeline connections. • Well testing, possibly including flaring.	0 ?	- /?	+/ -	+/ -	-	-	-	-	0	0	0/ ?	0/ ?	0	0/ -	-	-	-	-	-	-	0	- /?	-	- / ?
4	**Production/operation/maintenance,** including: • Gas/oil production; • Production and disposal of wastes/emissions; • Power generation, chemical use and reservoir monitoring; • Environmental monitoring and well integrity monitoring.	0	0	0	0	0	0	0	0	0	0	0/ ?	0/ ?	0	0/ -	-	-	-	-	-	-	0	0/ ?	0/ -	0/ -

Stage	Description	Biodiversity & Nature Conservation		Population		Health		Land Use, Geology & Soils		Water		Flood Risk		Air		Climate Change		Waste		Resource Use		Cultural Heritage		Landscape	
		L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
5	**Decommissioning of wells,** including: • Well plugging and testing; • Site equipment removal; • Environmental monitoring and well integrity monitoring.	0	0	+/-	+/-	0	0	0	0	0	0	0/?	0/?	0	0	-	-	0	0	0	0	0	0	0	0
6	**Site restoration and relinquishment,** including: • Pre-relinquishment survey and inspection; • Site restoration and reclamation.	0	0	0/+	0/+	0	0	+	+	0	0	0	0	0	0	+/-	+/-	0	0	0	0	0	0	0/+	0/+

5.2.1 Likely Significant and Other Environmental Effects

Conventional oil and gas exploration and production activities could lead to a range of potential effects across the different SEA objectives, the significance of which depends on the level of comparison (e.g. local, sectoral or national comparisons).

Likely Significant Effects

The assessment has not identified the potential for conventional oil and gas activities to have significant effects across any of the SEA objectives.

Other Environmental Effects

Stage 1 (non-intrusive exploration) is expected to have a neutral effect on all of the SEA objectives.

Stage 2 (exploration drilling with coring) is expected to have a minor negative effect on health, land use and climate change objectives. Short term emissions of noise, vibrations, dust and to air during pad preparation and from associated vehicle movements in addition to emissions to air and noise generation from drilling operations are expected to have a minor negative effect on health. Landtake during pad preparation and provision of associated infrastructure may result in clearance of vegetation and loss of soil levels leading to loss of soil function and processes. Furthermore, pad preparation and drilling may have an effect on land stability, geomorphology and soil erosion. These factors would have a minor negative effect on land use. Disturbance to soils may result in loss of carbon sequestration (i.e. of carbon absorbed in soils and growing plants) which may contribute to climate change. This, along with the generation of greenhouse gases from sources including the direct or indirect combustion of fossil fuels from construction traffic, drilling equipment, plant and generators and the embodied carbon within construction materials, result in a minor negative effect against the climate change objective. Exploratory drilling is expected to produce waste streams, including some small volumes of hazardous waste. Given the volume of waste produced and the opportunities available to recycle some materials this is expected to have a minor negative effect on the waste objective.

Stage 2 may have a minor negative effect on biodiversity and heritage objectives under the high activity scenarios. For biodiversity, minor negative effects may occur as a result of loss or fragmentation of habitat or disturbance, such as noise, light or human presence. For heritage, negative effects may occur as a result of loss or damage to cultural heritage features, landscape of sub-surface/buried archaeology. However in both cases this is uncertain as the potential for negative effects is dependent on local biodiversity and cultural heritage characteristics.

Stage 2 may have a negative effect on the landscape objective in the high activity scenario. Activities associated with pad preparation, road access and well construction and in particular drilling (due to the visual prominence of the rig) could result in temporary negative visual effects. However, the effect will be dependent on the distribution patterns of the exploration and production 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.

A mixed minor positive/minor negative effect is expected for the population and waste objectives under Stage 2. For population, the generation of construction jobs from pad preparation and highly skilled oil and gas jobs from well design, construction, completion and testing is expected to have a minor positive effect in the short term. On the other hand, the quality of life of local communities directly adjacent to the construction site and/or transport routes may be adversely affected through the generation of noise, vibration or increase in traffic congestion during construction and drilling activities. This would have a minor negative effect on the population objective. Exploratory drilling is expected to result in an increased estimate of hydrocarbon resource in the UK which has a positive effect on resource availability. However, activities in this stage would require the use of some non-renewable materials and energy use derived from fossil fuels which would have a minor negative impact on resource use.

The scale and type of activities under Stage 3 (production development) are expected to be largely similar to under Stage 2, with additional activities of provision of pipelines and facilities. Given the small scale of this additional work, the assessment of effects for the majority of objectives remains the same as Stage 2. One exception to this is air quality where the additional emissions associated with pipeline and facility construction may result in a minor negative effect under the high activity scenario. Another exception is resource use, where a negative score is expected for Stage 3, as the positive impact of discovering additional hydrocarbon resource under Stage 2 is not expected under this stage but non-renewable materials and energy use derived from fossil fuels will still be required.

Stage 4 (production/operation/maintenance) is expected to have a minor negative effect on climate change and waste objectives. The volume of waste generated, such as drill cuttings, is expected to be minor during this stage and as such has a minor negative effect on the waste objective. Greenhouse gas emissions associated with power generation, machinery, vehicle movements and leakage of fugitive methane and other hydrocarbons from on-site equipment are expected to have a minor negative effect on the climate change objective. The same stage may result in a negative effect on the landscape objective as 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 medium-term change of landscapes and visual amenity. However, the potential for any negative effects will depend on the location and the quality of the receiving landscape. A negative effect may be felt for the air quality objective for the high activity scenario for production sites which cannot be connected to the electricity grid and which require the use of diesel generators on site to provide power. Although the emissions from these combustion engines will not be significant, they will be long term.

Stage 5 (decommissioning of wells) is expected to have a neutral effect on all of the SEA objectives, with the exception of a minor negative impact expected for the climate change objective and a mixed minor negative/minor positive effect expected for the population objective. During decommissioning there would be emissions of greenhouse gases associated with the use of machinery and plant as well as from decommissioning 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. Collectively, these effects are

expected to have a minor negative effect on the climate change objective. Short term decommissioning jobs are expected to be created under this stage resulting in a minor positive impact on the population objective. However, vehicle movements associated with the decommissioning activities may have an adverse effect on quality of life of local communities (due to the generation of noise, vibrations and traffic congestion) which would have a minor negative effect on the population objective.

Stage 6 (site restoration and relinquishment) is expected to have a minor effect on several of the SEA objectives. A minor positive effect is expected for land use as this stage will restore, and potentially enhance, soil quality and prospects for beneficial land use. A mixed minor positive/minor negative effect is expected for the climate change objective. Emissions of greenhouse gases from plant and machinery use from invasive demolition techniques and land excavation as well as emissions from associated traffic and treatment of wastes is expected to have a minor negative effect on the climate change objective. However, depending on the end use of the well pad, there may also be opportunities to enhance carbon sequestration through rehabilitation and re-vegetation resulting in a minor positive effect on the climate change objective. A minor positive effect may occur for the population objective through the generation of a number of remediation and restoration jobs. However, this is dependent on the level of contamination experienced at site. Where the original site character is of low landscape value there is potential for Stage 6 to have a minor positive effect on landscape through localised improvements from landscaping, planting and habitat restoration.

5.3 The Environmental Effects of Unconventional Oil and Gas Exploration and Production

Table 5.2 summarises the potential effects of the six stages of the unconventional oil and gas exploration and production lifecycle under the low ('L') and high ('H') activity scenarios (as described in **Section 2.5**) against the 12 SEA objectives.

The following key has been used in completing the assessment.

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 5.2 Summary of the Environmental Effects of the Activities that Follow Licensing: Unconventional Oil and Gas

Stage	Description	Biodiversity & Nature Conservation		Population		Health		Land Use, Geology & Soils		Water		Flood Risk		Air		Climate Change		Waste		Resource Use		Cultural Heritage		Landscape	
		L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
1	**Non-intrusive exploration,** including: • Site identification, selection, characterisation; • Seismic surveys; • Securing of necessary development and operation permits.	0/ ?	0/ ?	0/ +	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0/ ?	0/ ?	0	0
2	**Exploration drilling and hydraulic fracturing,** including: • Pad preparation road connections and baseline monitoring; • Well design and construction and completion; • Hydraulic fracturing; • Well testing including flaring.	0/ ?	- /?	+/ -	+/ -	-	-	-	- /- -	- /- -	- /- -	?	?	-	- /- -	-	--	-	--	- /+ +	- /+ +	0	- /?	-	- /- -

Stage	Description	Biodiversity & Nature Conservation		Population		Health		Land Use, Geology & Soils		Water		Flood Risk		Air		Climate Change		Waste		Resource Use		Cultural Heritage		Landscape	
		L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
3	**Production development**, including : • Pad preparation and baseline monitoring; • Facility construction and installation; • Well design construction and completion; • Hydraulic fracturing; • Well testing, possibly including flaring • Provision of pipeline connections • (Possibly) re-fracturing.	- / ?	- /?	+/ -	+ +/ - /- -	-	- /- -	-	- /- -	- /- -	- /- -	?	?	- /- -	- /- -	-	--	--	--	-	-	0	- /?	- /- -	- /- -
4	**Production/operation/maintenance**, including: • Gas/oil production; • Production and disposal of wastes/emissions; • Power generation, chemical use and reservoir monitoring; • Environmental monitoring and well integrity monitoring.	-	-	+/ -	+ +/ -	-	-	0	0	- /- -	- /- -	?	?	- /- -	- /- -	-	--	--	--	- /- -	- /- -	0	0/ ?	-	-

Stage	Description	Biodiversity & Nature Conservation		Population		Health		Land Use, Geology & Soils		Water		Flood Risk		Air		Climate Change		Waste		Resource Use		Cultural Heritage		Landscape	
		L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
5	**Decommissioning of wells,** including: • Well plugging and testing; • Site equipment removal; • Environmental monitoring and well integrity monitoring.	0	0	+/-	+/-	0/-	-	0	-	0	0	?	?	-/0	-	-	-	0	0	0	0	0	0	0	0
6	**Site restoration and relinquishment,** including: • Pre-relinquishment survey and inspection; • Site restoration and reclamation.	0	0	0/+	0/+	0	0	+	+/-	0	0	0	0	0	0	+/-	+/-	0	0	0	0	0	0	0/+	0/+

5.3.1 Likely Significant and Other Environmental Effects

Unconventional oil and gas exploration and production activities could lead to a range of potential effects across the different SEA objectives, some of which may be significant at the local, national or sectoral level. The assessment detailed in **Appendix B** has identified **that it is likely that the activities that follow licensing will have a significant positive effect in respect of the population SEA assessment objective (from additional employment and community benefits) and the resource assessment objective (from identification of the additional hydrocarbon reserves) when compared to the effects from the existing oil and gas sector.** The assessment has also identified **likely significant negative effects in relation to climate change** and **waste** when compared to the effects from the existing oil and gas sector, **although no negative effects were identified for any assessment objective which would be significant at the national level**. Minor negative effects were also identified in respect of **population, health**, **land use, geology and soils**, **water**, **air**, **resource use** and **landscape;** however, these were found to be potentially significant under the high activity scenario depending on the many factors that are uncertain at this stage, including:

- the location, distribution and phasing of sites and any associated infrastructure; and
- the nature, quality and proximity of sensitive receptors (communities, habitats, landscapes).

Likely Significant Positive Effects

Population

During all stages of the unconventional oil and gas exploration and production lifecycle there would be both direct and indirect (within the supply chain) job creation as well as jobs induced via expenditure of employed staff. During Stage 3 (production development) it is anticipated that the scale of job creation has the potential to be significant. Under the high activity scenario, it is estimated that at its peak, some 16,000-32,000 full time equivalent (FTE) positions (including direct, indirect and induced jobs) would be generated [66]. This would represent an increase of 7% in the level of employment supported by the UK oil and gas industry sector [67]. For the high activity scenario, assuming a 12 year phasing of development, the period of peak job generation would last for a four year period, beginning 6 years after development started.

[66] It is recognised that this is considerably less than the 74,000 jobs estimated in the Institute of Directors report (2013): Getting Shale Gas Working Report; however, it is misleading to directly compare the figures. The estimates are based on different high activity scenarios (2,880 wells as opposed to 4,000 wells), different number of peak wells in a single year (360 compared to 400), different phasing of wells and different methods to determine employment levels. Whilst the estimates may vary, both conclude it is significant when compared to the current number employed in the UK oil and gas sector. **Section 4.5** of this report provides for detail in respect of how job estimates have been derived.

[67] Oil and Gas UK (2012), *2012 Economic Report,* http://www.oilandgasuk.co.uk/cmsfiles/modules/publications/pdfs/EC029.pdf

There may also be the potential creation of training opportunities (for example, 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).

Whilst the number of FTEs created during Stage 3 would constitute a substantial boost to employment in the oil and gas sector, the potential for these jobs to directly benefit those local communities in which sites are located would depend on the balance between the skilled and unskilled construction, oil and gas posts required and the availability of individuals in the local labour market with the required skills and the relevant experience. For example, just over half of 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) [68]. Many of these offshore skills would be transferable to the onshore oil and gas sector and in consequence there may be opportunities to source a considerable proportion of workers from the local labour market should unconventional oil and gas development take place in SEA Area 1 (Scottish Midlands including the Inner Forth). Notwithstanding, for existing activities within the UK (for example, Preese Hall, 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) [69].

Under the United Kingdom Onshore Operators' Group (UKOOG) (2013) Community Engagement Charter [70], 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. Under the high activity scenario, total UK contributions could be between £3 million and £12 million. During **Stage 4** it is estimated that community benefits to the value of 1% of revenue from production could amount to a total of £2.4 million to £4.8 million per site (equivalent to between £0.3 billion and £0.6 billion across all sites) under the high activity scenario, assuming each well is productive for 20 years[71]. This level of community benefit has also been assessed as having a locally significant positive effect on the population objective.

[68] UK Oil and Gas UK (2013) UK Continental Shelf Offshore Workforce Demographics Report 2013 http://publ.com/Gt7Tvqe#20

[69] Regeneris Consulting (2011) Economic Impact of Shale Gas Exploration & Production in Lancashire and the UK. Available from 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]

[70] See http://www.ukoog.org.uk/elements/pdfs/communityengagementcharterversion6.pdf [Accessed September 2013]

[71] Based on revenue estimates of approximately £1.0 million per well per annum, 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)

Resource Use

Exploratory drilling during **Stage 2** of the unconventional oil and gas exploration and production lifecycle is generally undertaken to estimate the amount of oil or gas that can be technically and economically produced from a geological formation. Estimates of producible oil and gas are conventionally presented as proven, probable and possible 'reserves'. A recent report by the British Geological Survey (BGS) [72], while estimating the gas in place within the Bowland Shale of northern England to be substantial (mid-point estimate 36.8 trillion cubic metres (1300 trillion cubic feet), noted that the assessment of shale gas resources in the UK is as yet still in its infancy. DECC has subsequently stated that while shale gas 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 [73], which is to say that it is not yet possible to estimate the size of the reserves. If the assumptions of the high activity scenario were realised, it could generate in total some 0.12 to 0.24 trillion cubic metres (4.32 to 8.64 trillion cubic feet) of gas, more than six times the 0.037 trillion cubic metres (1.31 trillion cubic feet) of gas produced in the UK in 2012 [74] or more than twice the approximate 0.1 trillion cubic metres (3.52 trillion cubic feet) of gas consumed in the UK per annum [75]. During **Stage 2**, estimates of reserves would be expected to develop and improve in-line with increased exploratory drilling. This would have a significant positive effect on the resource use objective.

No further significant positive effects were identified during the assessment.

[72] DECC (2013) *The Carboniferous Bowland Shale Gas Study: Geology and Resource Estimation*. Available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/226874/BGS_DECC_BowlandShaleGasReport_MAIN_REPORT.pdf [Accessed September 2013]

[73] 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 September 2013]

[74] DECC (2012) Gross Gas Production Figures 2012, https://www.gov.uk/oil-and-gas-uk-field-data

[75] House of Commons Energy and Climate Change Committee (2013), *The Impact of Shale Gas on Energy Markets: Seventh Report of Session 2012–13*, Volume I

Likely Significant Negative Effects

Climate Change

Stage 2 (exploration drilling with coring and hydraulic fracturing) and Stage 3 (production development) of unconventional oil and gas exploration and production activities have been assessed as having a significant negative effect on climate change (under the high activity scenario) at the sectoral level (i.e. as compared to the effects from the existing oil and gas sector). However, these effects are unlikely to be significant in terms of emissions at the national level. The increase in domestic supplies is expected to result in substitution for imported Liquefied Natural Gas (LNG), with a negligible effect on overall national emissions.

The effects arise from: pad preparation and drilling (e.g. the direct and indirect combustion of fossil fuels from construction traffic and plant and the embodied carbon within construction materials); emissions of CO_2 and methane associated with disturbance to soils; the potential loss of soil carbon sequestration; and in particular the volume of emissions arising during hydraulic fracturing and well completion. It is estimated that GHG emissions associated with Stage 2 and Stage 3 could be up to 0.96M tCO_2eq per annum (assuming up to a maximum of 360 wells are being drilled per annum under the high activity scenario). This estimate is based on the median values of GHG emissions from a range of source data, as detailed in a recent report by MacKay and Stone (2013) concerning potential GHG emissions associated with shale gas extraction and use [76], 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 in particular vary significantly and would depend on, for example, geology, well productivity and the well completion method. For example, during Stage 3 (and Stage 4), and once grid connection has been established, it could be possible to capture up to 100% of methane released from flowback and inject this into the grid, substantially reducing the total volume of GHG emissions. In this respect, a recent study by Allen *et al* (2013) concerning methane emissions at natural gas production sites in the United States [77] 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).

Stage 4 (production/operation/maintenance) has also been assessed as having a significant negative effect on the climate change objective at a sector level under the high activity scenario. This reflects the

[76] MacKay and Stone (2013) *Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use, report for DECC, September 2013*. Available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/237330/MacKay_Stone_shale_study_report_09092013.pdf [Accessed September 2013]

[77] 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.*

scale of potential GHG emissions associated with gas production and arising from power generation, the use of machinery, transportation, fugitive emissions and from flaring and venting.

Emissions per annum under the high activity scenario would be between 0.71M and 1.42M 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 tCO_2eq 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) [78]. However, this equates to around 0.75% of all GHG emissions from the energy supply sector in 2011 [79] whilst the addition to the UK inventory of GHG emissions would be less than 0.3% of the current total. In total, GHG emissions from Stage 4 for the high activity scenario have been estimated to be between 14.25M and 28.49M tCO_2eq [80]. 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 tCO_2eq 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 tCO_2eq.

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 [81]. 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 [82]. 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 note that UKOOG guidelines clearly set out good practice in well design. Future advances in self-healing cement are likely to mitigate this risk further.

Indirectly, the combustion of extracted hydrocarbons would generate approximately 190 gCO_2e/kWh (which represents combustion emissions for methane). The extent to which domestic production and consumption of shale gas would affect GHG emissions would vary subject to changes in the UK fuel mix and shifts between gas and coal usage. For the purposes of this assessment, it has been assumed that consumption of shale gas or oil would replace other currently imported hydrocarbons and that there

[78] DECC (2013), 2011 Final UK Greenhouse Gas Emission Figures, https://www.gov.uk/government/publications/final-uk-emissions-estimates

[79] Total emissions from the energy supply sector in 2011 were 190.9 million tCO_2eq. Total UK emissions from all sources were 550.7 million tCO_2eq. See https://www.gov.uk/government/publications/final-uk-emissions-estimates [Accessed September 2013]

[80] MacKay and Stone (2013) assume that GHG emissions during production 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 DECC's central estimate of well productivity (85 million m^3), it is assumed that GHG emissions per well would be 8,500 tCO_2e during production. It has also been assumed that each well would be re-fractured once during its operational lifetime with associated emissions likely to be similar to well completion during Stages 2 and 3 (1,394 tCO_2eq per well).

[81] 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.

82 Vidic *et al*. (2013) Impact of shale gas development on regional water quality. Science 17 May 2013: Vol. 340 no. 6134 1235009

would be no net change to the energy mix within the UK, other than those already anticipated by DECC in the 2050 pathways report [83]. In consequence, shale gas or oil 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 [84]. This would generate a positive effect on the climate change 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. However, if LNG or other fossil fuel displaced from the UK is used elsewhere, that could lead to an increase in global GHG emissions [85] (although this is dependent on global energy policy and market demand). This potential issue is not specific to shale gas and would apply to the exploitation of any new fossil fuel reserve. The MacKay and Stone (2013) report concluded:[86]

> "*The potential increase in cumulative emissions could be counteracted if equivalent and additional emissions-reduction measures are made somewhere in the world. Such measures are well established in the scientific and policy literature and include: carbon capture and storage; carbon offsetting through additional reforestation or negative emissions technologies that reduce CO_2 concentrations; and other measures that would lead to fossil fuel reserves, that would have been developed under business-as-usual, remaining in the ground. The view of the authors is that without global climate policies (of the sort already advocated by the UK) new fossil fuel exploitation is likely to lead to an increase in cumulative GHG emissions and the risk of climate change*."

Waste

There would be a range of wastes generated during the unconventional oil and gas exploration and production lifecycle (for example, construction and demolition wastes, drill cuttings and drilling muds). However, the largest and most significant waste stream would be likely to be flowback.

[83] 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.

[84] MacKay and Stone (2013) 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)).

[85] MacKay and Stone (2013) highlight that the switch to shale gas in the US has increased exports of coal, increasing the carbon intensity of electricity production in other countries.

[86] MacKay and Stone (2013) Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use, report for DECC, September 2013

Flowback is the fracturing fluid injected into the shale rock during hydraulic fracturing which returns to the surface. Flowback may have elevated concentrations of salinity and minerals dissolved from the rocks[87]. Flowback can be recycled for use, with treatment involving a mixture of settlement, anti-bacteriological treatment and blending with clean water. However, it is assumed that flowback water, once it is intended for disposal, is not permitted to be re-injected into the geological formation and will require treatment as a waste. For the purposes of the assessment, the conservative assumption is made that this treatment would take place offsite. It is assumed that the volume of flowback would range between 3,000 cubic metres to 18,750 cubic metres per well [88]. Under the high activity scenario, there would be the potential production of 108 million cubic metres of wastewater that would require treatment during Stages 2, 3 and 4 (approximately 3% of UK total annual wastewater). Depending on where this requires treatment, this volume of wastewater could place a substantial burden on existing wastewater treatment infrastructure capacity. In consequence, all three stages have been assessed as having a significant negative effect on the waste objective.

However, scrutiny through the environmental permitting system [89] 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 [90] (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 (and associated vehicle movements) could be reduced. Under the low activity scenario, the volume of flowback generated during Stage 2 would be less (commensurate with the number of wells) although negative effects during Stages 3 and 4 would still be expected to be significant (the total volume of flowback generated under the low activity scenario would be up to 13.5 million cubic metres).

[87] Flowback analysed by the Environment Agency (EA) from the Preese Hall exploratory well in Lancashire contained high levels of sodium, chloride, bromide, iron, lead, magnesium, zinc and low levels of Naturally Occurring Radioactive Material (NORM). According to the EA, the flowback 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 EA as capable of dealing with the levels of minerals contained in the flowback from the Preese Hall site. See Environment Agency (2011) Shale Gas North West- Monitoring of flowback and Environment Agency (2013) Onshore Oil and Gas Exploratory Operations: Technical Guidance, Consultation Draft for further information.

[88] As per the assumptions contained in **Table 2.7**, it is assumed that each well would require 10,000 to 25,000 cubic metres of water, and flowback rates are assumed to be 30-75 %.

[89] Environmental Permitting Regulations 2010 require an environmental permit from the Environment Agency to authorise the management of extractive waste, whether or not it involves a waste facility

[90] See http://www.water.org.uk/home/policy/positions/shale-gas/water-uk-shale-gas-briefing-paper-update-nov-2013.pdf for further information.

Minor Negative Effects with the Potential to be Significant under the High Activity Scenario

Population

There is the potential for activities associated with unconventional oil and gas exploration and production to have negative effects on the population objective through disturbance to local community, particularly during well site construction, exploration drilling and production development stages (Stages 2-3) arising from an increase in vehicle movements. However, any such effects can be expected to be mitigated through planning controls

Under the high activity scenario during Stage 3, 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 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.

Health

There is the potential for activities associated with unconventional oil and gas exploration and production to have negative effects on human health, particularly during the more intensive and intrusive stages (Stages 2-5). However, any such effects can be expected to be mitigated through planning controls

Effects on health are likely to be similar to those identified in respect of conventional oil and gas (see **Section 5.2.1**), although the scale, duration and magnitude of effects would be greater (commensurate with the number of wells, average well depth and also the requirement hydraulic fracturing) and could include air quality, noise and vibration impacts from construction works, HGV movements, drilling, fracturing and flaring. Taking into account expected regulatory controls, 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[91]. 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.

The assessment has identified the potential for negative effects on health to be locally significant during Stage 3, under the high activity scenario. This primarily reflects the need to drill, complete and hydraulically fracture a greater number of wells (between 1,440 and 2,880 wells) and the requirement for pipeline works which would further increase the scale and duration of activity during this stage. Assuming five weeks of continuous drilling per well, it is expected that each site would require 55-115 weeks of continuous drilling under the high activity scenario (compared to 30-55 weeks under the low activity scenario), assuming wells were drilled sequentially on the pad. Depending on the location of the sites, including the proximity to sensitive receptors, existing background levels of noise/air pollutants and prevailing health issues, this could have a significant negative effect on the health of some people in communities close to the pad (from elevated levels of stress and disturbance from noise nuisance, vehicle movements and particulates). However, it can be anticipated that regulatory controls, in particular through the Town and Country planning system, will ensure that these effects are not unacceptable [92].

Under the high activity scenario there would also be a requirement for up to 16-51 HGV movements per day per pad over a 73-145 week period during Stage 3, related in particular to the provision of water for hydraulic fracturing, where the site is not connected to the mains, or is not permitted to abstract water from local sources. 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 corridors within rural areas. Again, the potential adverse effects can be expected to be mitigated by planning controls. For urban areas and communities adjacent to major roads, and at a regional or national level, these effects are not expected to be significant.

Hydraulic fracturing would be required during Stages 2 and 3, and is assumed to be required during Stage 4. As noted above, there may be effects due to emissions to air and noise both directly from machinery used in fracturing and from associated HGV movements. There is also a potential risk of release of fracturing fluids or flowback water (the latter of which may include trace elements, naturally occurring radioactive materials (NORM) and organic material) to aquifer sources if, for example, the cementing of a well is inadequate or fails during high pressure under fracturing. This could have a negative effect on human health through the contamination of water supply. However, the risk of wells

[91] 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]

[92] ENDS (2013), UK Shale Gas and the Environment, which reported current noise limits and UK onshore operator's practices in 'New to the neighbourhood'.

failing if appropriately designed, constructed and maintained is very small and therefore under the current regulatory framework no significant risk to human health from this issue is anticipated.

Land Use, Geology and Soils

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. Associated adverse effects in terms of soil function and processes are likely to minor but where development is located on land that is of high agricultural quality (i.e. Agricultural Land Classification Grades 1, 2 or 3a in England and Wales or Class 1 to Class 3.1 in Scotland), or in other sensitive areas, effects could be more significant and permanent particularly if the nature of the sensitive area inhibits full site restoration following completion of production (i.e. during Stage 6). The risk of significant negative effects in this regard would be increased under the high activity scenario, commensurate with the area of land that would be required to accommodate exploration and production well pad sites (between 240 and 360ha). The assessment has also identified large areas of high agricultural quality across the SEA Areas and in particular in SEA Area 3 (East Midlands and Eastern England) that could be affected by development and which should be avoided. However, national planning policies such as those set out in the National Planning Policy Framework in England, Planning Policy Wales and Scottish Planning Policy seek to avoid development in areas that are sensitive, including those of high agricultural land quality.

During Stages 2 and 3 there would be a need for hydraulic fracturing, and this assessment assumes that hydraulic fracturing would also occur at Stage 4. On 01 April 2011, the Blackpool area in north-west England experienced seismicity of magnitude 2.3 ML shortly after Cuadrilla Resources hydraulically fractured a well at its Preese Hall site. Seismicity of magnitude 1.5 ML occurred on 27 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 [93]. DECC subsequently commissioned an independent review of these reports, which was published for public comment [94]. 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.

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

[93] See de Pater H. and Pellicer M. (2011) *Geomechanical Study of Bowland Shale Seismicity – Fracture Geometry and Injection Mechanism*, StrataGen report for Cuadrilla.

[94] Green, A.C. Styles, P. Baptie, J.B. (2012) Preese Hall Shale Gas Fracturing Review & Recommendations for Induced Seismic Mitigation. Available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48330/5055-preese-hall-shale-gas-fracturing-review-and-recomm.pdf [Accessed September 2013]

hydraulic fracturing causing felt seismicity (M_L>3) is "*very small*" [95]. Similarly, an AEA (2012) report for the European Commission concerning the potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe [96] concludes (at page 54):

> "*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".*

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, the 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 [97], the Secretary of State for Energy and Climate Change subsequently stated that appropriate controls are available to mitigate the risks of undesirable seismic activity and that 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) [98]. New controls announced in the Written Ministerial Statement that will be implemented and enforced by DECC include the requirement for operators to:

- conduct a prior review of information on seismic risks and the existence of faults;
- submit to DECC a hydraulic fracturing plan showing how any seismic risks are to be addressed;
- carry out seismic monitoring before, during and after hydraulic fracturing; and
- implement a 'traffic light' system which will be used to identify unusual seismic activity requiring reassessment, or halting, of operations.

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 immediate effect.

Based on the findings of research published by Green *et al* (2012), AEA (2012) and Davies *et el* (2013) in particular, and taking into account the measures proposed by Government to reduce the risk of

[95] Davies, R.J., Foulgar, G., Bindley, A., Styles, P. (2013) *What size of earthquakes can be caused by fracking? DEI Briefing Note April 2013*. Durham University: Durham

[96] 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*.

[97] Written Ministerial Statement by Edward Davey: '*Exploration for Shale Gas'*. 13th December 2012.

[98] The Royal Society and The Royal Academy of Engineering (2012) *Shale Gas Extraction in the UK: a Review of Hydraulic Fracturing*. Available from http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/projects/shale-gas/2012-06-28-Shale-gas.pdf [Accessed September 2013]

undesirable seismic activity, the assessment has concluded that the risk of hydraulic fracturing causing felt seismicity (M>3) is very small.

Water

Stage 2 (exploration drilling), Stage 3 (production development) and Stage 4 (production) of the unconventional oil and gas exploration and production lifecycle would require substantial volumes of water (as compared to current water requirements of the oil and gas sector). This principally reflects water consumption associated with hydraulic fracturing and it has been assumed that between 10,000 cubic metres and 25,000 cubic metres 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 57.6 million and 144 million cubic metres (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 7.0 million and 18 million cubic metres under the low activity scenario (assuming a total of 20 boreholes and 360 wells). Under the high activity scenario, this equates to water consumption at a rate of up to 9 million cubic metres per annum, 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 [99] but substantially less than 1% of total UK annual non domestic mains water usage.

The potential impacts this could have on, for example, water resource availability, aquatic habitats and ecosystems and water quality is uncertain. The AEA (2012) report on behalf of the European Commission (EC) [96] highlights a range of potential effects associated with increased water consumption, including:

- reduced stream flow affecting the availability of resources for downstream use, such as for public water supply;
- adverse impacts on aquatic habitats and ecosystems from effects 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;
- 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; and
- impacts on water quality, affecting the use which can be made of surface waters.

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; and the volume of wastewater that can be recycled and used as fracturing fluid. In this context, it is noted that there are a

[99] WRAP (2011), Freshwater availability and use in the United Kingdom. A review of freshwater availability and non-household (consumptive) use in the UK

number of Water Resource Zones (WRZs) across the SEA Areas that are subject to current or future water resource constraints and in particular WRZs in the Anglian Water supply area (in SEA Area 3) and the Thames Water and Southern Water supply areas (in SEA Area 5) (see **Appendix B, Section 5** for further information). 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. If, alternatively, water is abstracted by the operator from a surface water or groundwater body, this would require an abstraction licence from the relevant regulator (either the EA, NRW or SEPA). 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. Licences will only be granted where such effects are acceptable to the regulator and any net addition to demand or abstraction does not exceed sustainable levels. In this respect, cooperation between the water industry and operators under the Water UK and UKOOG MoU is expected to help identify and address any potentially locally significant effects on water resources with discussions focusing on:

- baseline monitoring requirements to assess impacts of onshore oil and gas development on the quality and quantity of local water resources;
- plans relating to site water management, especially water reuse, to improve understanding of local impacts;
- 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.

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% [100] 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.

In consequence, whilst the cumulative total for demand from the high activity scenario is significant, the risk of a significant adverse effect actually occurring at the individual pad level or within any WRZ is considered to be low.

The assessment has identified the risk of surface water contamination to be low. Construction activities during Stage 2 and Stage 3 could result in the run-off of contaminants, although it would be expected that appropriate spillage containment measures and surface water management would be put in place to reduce the likelihood of contamination occurring. There is a risk of hydraulic fracturing causing

[100] 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.

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. 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). 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.

Air

The assessment has identified negative effects in respect of the air quality objective during Stages 2 to 5 of the unconventional oil and gas exploration and production lifecycle with the potential for significant effects during Stage 2 (under the high activity scenario) and Stage 3 (under both low and high activity scenarios). This principally reflects emissions to air from on-site machinery, HGV movements [101], drilling and hydraulic fracturing which could result in air quality impacts on sensitive receptors including residents and biodiversity. Additionally, there would also be emissions from flaring, which would primarily result in the production of CO_2 but also NO_X, SO_2, CO and Particulate Matter, and from methane within flowback water, although methane emissions will vary depending on the completion method.

Whilst it is assumed that there would be a 5km distance between well pad sites (as per the assumptions set out in **Table 2.5**) and activities would not be undertaken simultaneously, which may reduce the potential for localised impacts on air quality arising from multiple well pad sites, effects could be significant where sites are located within or in close proximity to areas where there are existing air quality issues (such as Air Quality Management Areas) and/or sensitive receptors. However, 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.

Resource Use

The extraction of hydrocarbon reserves would result in the direct loss of a primary natural resource that is non-renewable. However, a determination as to whether the extraction would give rise to significant effects cannot be made as:

- the determination of total UK resources is still at an early stage;
- the precise geology of host formations is unknown; and
- the likely yield per well is not possible to ascertain.

[101] During Stage 2 HGV movements are estimated to be 14-36 per day per pad. These would take place over a period between 12 and 13 weeks. During Stage 3, HGV movements are estimated to be 16-51 per pad per day over a 32-145 week period depending on whether it is a low or 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.

Landscape

Pad preparation during Stage 2 and Stage 3 of the unconventional oil and gas exploration and production lifecycle have been assessed as having a minor negative effect on the landscape objective but with the potential for adverse effects to be significant, dependent on the location and setting of well pad sites.

Construction activity associated with pad preparation, road access, well construction and (during Stage 3) pipeline works would have temporary, short-term effects on visual amenity and landscapes. Further visual impacts could result from the presence of drilling rigs (over a period of approximately five weeks per well), as well as chemical storage tanks and plant associated with hydraulic fracturing. The height of the drilling rig could be approximately 26m and could result in locally significant effects depending on the setting, screening and extent to which a site would be overlooked. Flaring associated with testing may also result in visual impacts. The effect would be dependent on location, height, duration and timing of the flare. However, licence requirements require that flaring must be kept to the minimum that is technically and economically justified. Furthermore, it is assumed that effects would be minimised through the use of best available technology (BAT), such as stack design, which would minimise the effects from visual intrusion arising from flaring.

Whilst it is generally anticipated that landscape and visual effects would be minor, should well pad sites be located in sensitive areas including, for example, Areas of Outstanding Natural Beauty (AONBs) or National Parks, or in close proximity to a number of sensitive receptors then effects have the potential to be significant. In this respect, the SEA Areas include a large number of designated landscape assets including, inter alia, the following National Parks, or parts of them:

- SEA Area 1: Loch Lomond and the Trossachs National Park;
- SEA Area 2: Lake District National Park;
- SEA Area 3: the Broads, the Peak District, the Yorkshire Dales, the North York Moors, and Northumberland National Parks;
- SEA Area 4: Brecon Beacons National Park; and
- SEA Area 5: Exmoor, Dartmoor, New Forest and South Downs National Parks.

The probability of significant landscape effects would be greater under the high activity scenario, commensurate with the area of land take required to accommodate up to 2,880 wells and the density/duration of activity (for the high activity scenario it is anticipated that 24 wells would be drilled per pad which could require a drilling rig to be on site for more than two years, assuming that it takes four weeks to drill each well). However, it should be noted that construction density would be limited by the minimum distance (5km) required between pads. 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.

Other Environmental Effects

A range of further minor positive and minor negative effects have been identified against all of the SEA objectives with the majority of these effects being similar to those identified in respect of conventional oil and gas (see **Section 5.2.1 above**).

The assessment findings do, however, indicate that there is the potential for activities during Stage 2 (exploration drilling with coring and hydraulic fracturing) and Stage 3 (production development), to have significant negative effects on biodiversity and cultural heritage, particularly under the high activity scenario. However, this would be dependent on the location and distribution of well pad sites and any associated infrastructure and the sensitivity of the receiving environment (e.g. the proximity of designated conversation assets such as Natura 2000 sites or cultural heritages assets such as scheduled monuments and listed buildings), which is currently uncertain. It is also expected that these issues would be fully addressed during the planning process.

Effects associated with flood risk and coastal change are considered to be uncertain at this stage. Exploration and production activities could both affect and be affected by flooding, for example, as a result of the removal of vegetation and laying of impermeable surfaces which could increase runoff rates. However, as the location of sites vis-à-vis areas with a high probability of fluvial or coastal flooding is unknown at this stage, it has not been possible to determine the likelihood or magnitude of effects on this objective. Notwithstanding, it would be expected that flood risk would be fully considered at the project level and as part of the Town and Country Planning and, where appropriate, EIA processes.

Neutral effects are largely confined to Stage 1 (non-intrusive exploration), reflecting the scale and nature of activities associated with this stage.

5.4 The Environmental Effects of Virgin Coalbed Methane Exploration and Production

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 to 6) above, although hydraulic fracturing is not normally required. Unlike shale gas or oil, for which exploration in the UK has only just begun, VCBM in the UK has been the subject of active exploration for over a decade, and a number of small-scale production projects already exist. The levels of activity however remain broadly comparable with those for conventional oil and gas. There seems no reason to expect any substantial change in outlook, and no attempt has been made in the assessment to provide a separate indication of low and high levels of activity for VCBM.

Notwithstanding, there are a number of important distinctions to be made between VCBM and unconventional oil and gas exploration and production activities. These are summarised below:

- **Scale and duration of activities**: VCBM exploration drilling and production sites are usually smaller than unconventional oil and gas drilling sites whilst commercially viable VCBM containing formations tend to be shallower (200-1,500m depth) and drilling times may also be relatively shorter. In consequence, it is likely that negative effects on SEA objectives relating to, for example, biodiversity, health, land use, geology and soils, air quality, waste and climate change due to emissions to air, waste generation and noise arising from construction activities and drilling would be less. However, it is recognised that this is dependent on site specific characteristics which are currently uncertain; and

- **Water**: 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 to 4 would be reduced compared to unconventional oil and gas exploration and production. In consequence, effects on SEA objectives including water are likely to be less. However, during well stimulation large volumes of water are 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 concentrations of metals and other contaminants that might require treatment prior to discharge. However, taking into account the requirements for discharge consents/permits to be obtained from regulators (the EA, SEPA or NRW) prior to works commencing, it is considered reasonable to assume that any potential adverse effects would be appropriately managed.

5.5 The Environmental Effects of Gas Storage

Table 5.3 summarises the potential effects of the three main stages of gas storage against the 12 SEA objectives. No attempt has been made to provide an indication of low and high levels of activity.

The following key has been used in completing the assessment.

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 5.3 Summary of the Environmental Effects of Gas Storage

Stage	Description	Biodiversity & Nature Conservation	Population	Health	Land Use, Geology & Soils	Water	Flood Risk	Air	Climate Change	Waste	Resource Use	Cultural Heritage	Landscape
1	**Construction and Installation of Pipelines and Storage Facilities**	-/?	+	-	-	0	?	-	-	+	+	-/?	-
2	**Storage Operations**	0	0	0	0	0	?	-	-/?	0	0	0	-
3	**Decommissioning**	0	+	-	0	0	0	-	-	0	0	0/?	0

5.5.1 Likely Significant and Other Environmental Effects

Likely Significant Positive and Negative Effects

There are no significant positive or negative effects associated with gas storage across any of the SEA objectives.

Other Effects

Stage 1 (construction and installation of pipeline and storage facilities) is expected to have a minor effect on most of the SEA objectives. A minor positive effect is expected for the population objective due to the creation of short term construction and specialised gas jobs. The re-use of underground structures and surface infrastructure will minimise the need for use of further natural resources, resulting in a positive effect on the waste and resource use objectives.

Minor negative effects are expected for the health, land use, climate change and landscape assessment objectives under Stage 1. For health, construction activities and associated vehicle movements have the potential to negatively affect residents' health in areas directly adjacent to the site or transport routes through the generation of noise, vibration and dust. Stage 1 may require the clearance of vegetation and loss of soil layers and compaction which results in a negative effect on the land use objective. However, in view of average site size (up to 2 ha) 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.

Stage 1 may have a minor negative effect on biodiversity and heritage objectives. For biodiversity, minor negative effects may occur as a result of loss or fragmentation of habitat or disturbance, such as noise, light or human presence. For heritage, a minor negative effect may occur as a result of loss or damage to cultural heritage features, landscape or sub-surface/buried archaeology. However, in both cases (biodiversity and cultural heritage) this is uncertain as the potential for negative effects is dependent on local biodiversity and cultural heritage characteristics.

Stage 2 (storage operations) is expected to have a minor negative effect on air quality and landscape objectives. Emissions associated with power generation and combustion plant, as well as the risk of fugitive emissions through the operation of the facility would have a minor negative effect on air quality. Residual visual impacts from the introduction of above ground infrastructure may have a negative effect on the landscape objective. 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 on landscape objective are likely to be minor.

A minor negative effect may occur for climate change due to risks of fugitive emissions of methane and other hydrocarbons via leakages from on-site equipment during Stage 2. Currently there are no estimates of the volume of emissions from this source although it is expected to be minimal given the scale of activity involved. Further uncertainties on these emissions exist particularly with respect to the number of gas storage facilities that might be operational.

Stage 3 (decommissioning) is expected to have a minor positive effect on the population objective through the generation of short term decommissioning jobs. A minor negative effect is expected on the health objective due to HGV movements associated with decommissioning and the associated effects from the generation of dust that could have on respiratory health and the effects that noise and vibration could have on stress/anxiety for residents situated directly adjacent to the routes of the decommissioning traffic. Greenhouse gas emissions would be generated from the direct or indirect combustion of fossil fuels from decommissioning traffic, plant and generators as well as the embodied carbon in concrete used to plug wells and, potentially, the treatment of any waste arisings. This would result in a minor negative effect on the climate change objective.

5.6 Environmental Effects of the Reasonable Alternatives to draft Licensing Plan

5.6.1 Limiting the Area of Land Available to be Licensed

As set out in **Section 2.6**, this reasonable alternative would restrict the area which might be covered by new licences. Procedurally, this could be affected by awarding the licences in merit order, until the specified limit had been reached. DECC's assessment procedure for licence applications normally includes an assessment of their geological merit, which could readily provide an overall merit ranking.

It has been assumed that in this alternative the area of new licences would be limited to a maximum of 10,000 square kilometres. For comparison, the UK occupies a total area of 243,610 km^2 and the area identified as available in the 13th licensing round was approximately 100,000km^2. Whilst it is acknowledged that there is not necessarily a direct, linear relationship between the total area covered by new licences and the level of activity that could come forward after licensing, it would be expected that this reasonable alternative would serve to constrain overall levels of activity.

For the purposes of this assessment, it has been assumed that levels of onshore oil and gas exploration and production activity would be substantially reduced compared to the high activity scenario but higher than would be envisaged under the low activity (as described in **Table 2.6** and **Table 2.7**). However, no attempt has been made to quantify levels of activity associated with this reasonable alternative.

The assessment of the reasonable alternative is presented in **Table 5.4**.

Table 5.4 Limiting the Area of Land Available to be Licensed: Assessment of Environmental Effects

SEA Objective	Score	Summary
2. To protect and enhance biodiversity (habitats, species and ecosystems) working within environmental capacities and limits.	-/?	It is assumed that restricting the area covered by new licences would limit the overall level of activity coming forward after licensing, in-turn reducing the scale of construction activity and landtake related to the onshore oil and gas exploration and production lifecycle (compared to levels of activity that could follow the implementation of the draft Licensing Plan without this constraint). Effects associated with onshore oil and gas exploration and production on biodiversity including, for example, the loss or fragmentation of habitat or disturbance from both activities on site and HGV movements. It is unclear whether this alternative would affect the potential for clustering of well pad sites in more prospective areas and associated cumulative effects on biodiversity. However. it is assumed that restricting the area covered by new licences would reduce levels of activity coming forward after licensing (which could in-turn reduce the potential for cumulative effects occurring). Notwithstanding, uncertainties over the location of activity, the significance of effects would also be dependent on the sensitivity of receiving environments and the extent to which activities are undertaken in relative close proximity to one another and/or in close succession, which is currently uncertain **Overall, this alternative has been assessed as having a minor negative effect on biodiversity, although the potential for significant negative effects is acknowledged.**
3. To promote a strong, diverse and stable economy with opportunities for all; minimise disturbance to local communities and maximise positive social impacts.	++/-	As highlighted in Sections 5.2 to 5.5 above, activities that could follow further onshore oil and gas licensing rounds are likely to generate substantial direct and indirect employment opportunities as well as jobs induced by employed staff. There may also be the potential creation of training opportunities (for example, apprenticeship schemes) for the benefit of the local community. Under the United Kingdom Onshore Operators' Group (UKOOG) (2013) Community Engagement Charter, benefits for shale gas exploration and production would also be provided to host local communities and county/unitary authorities. The potential for generation of socio-economic benefits would be reduced under this alternative (compared to levels of activity and associated economic benefits that could follow the implementation of the draft Licensing Plan without this constraint), assuming that restricting the area covered by new licences would also reduce the overall level of activity coming forward after licensing. However, it is considered that job creation and wider community benefits could still be significant within the context of the oil and gas sector, although the potential for jobs to directly benefit those local communities in which sites are located 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 required skills and relevant experience. Reducing onshore oil and gas exploration and production activity is likely to reduce the potential for adverse (including cumulative) effects on quality of life from construction and drilling activities (e.g. traffic, noise, vibration and air quality impacts). Notwithstanding, there remains the potential for local adverse effects on quality of life, although this is dependent on the location and proximity of local populations to well pad sites and transport corridors which is currently uncertain. Notwithstanding, any such effects can be expected to be mitigated through planning controls. **Overall, it is considered that this alternative has the potential to generate substantial additional economic benefits when compared to the existing oil and gas sector activity and, in consequence, it has been assessed as having a significant positive effect on this objective. However, it is recognised that there is the potential for construction and operational activities to have a minor negative effect on communities which could be locally significant, although any such effects can be expected to be mitigated through planning controls.**
4. 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 potential for negative effects on health arising from construction activities related to, for example, emissions to air and noise from machinery, associated HGV movements, hydraulic fracturing (for unconventional oil and gas exploration) and flaring may be reduced under this alternative, commensurate with the restriction in area covered by new licences and assumed reduction in activity. Limiting the total area to be licensed could serve to reduce the potential for cumulative negative effects on health arising from the simultaneous development of well pad sites in close proximity to one another (as it is assumed that the overall level of activity would be reduced) As highlighted in Sections 5.2 to 5.5, the contamination of groundwater or surface water from exploration and production activities could have a negative effect on human health. However, provided that regulatory requirements are followed, the wells are robustly designed and constructed to ensure integrity, the risk of contamination of groundwater from surface or subsurface release associated with drilling muds, additives and naturally occurring chemicals in

SEA Objective	Score	Summary
		well cuttings, fracturing fluids and produced water is considered to be 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 will help mitigate this risk. **Overall, this alternative has been assessed as having a minor negative effect on this objective (although there is the potential for effects to be locally significant). However, this would be dependent on the location of sites, including the proximity to sensitive receptors, existing background levels of noise/air pollutants and prevailing health issues as well as the extent to which activities are undertaken in relative close proximity to one another and/or in close succession, which is currently uncertain. Notwithstanding, any such effects can be expected to be mitigated through planning controls including by the imposition of relevant planning conditions (e.g. restrictions to noise levels).**
5. To conserve and enhance soil and geology and contribute to the sustainable use of land.	**-/--**	It is assumed that restricting the area covered by new licences would reduce the overall level of activity coming forward after licensing and, therefore, the landtake associated with pad preparation and the provision of associated infrastructure. In consequence, negative effects associated with, for example, soil loss and compaction may also be reduced. Notwithstanding, the significance of effects would be dependent on the characteristics of those sites ultimately taken forward for development which is currently uncertain. For example, should development result in the large scale loss of land that is of high agricultural quality or be located in other sensitive areas, the effects could be more significant (although due to national planning policy, this is considered unlikely). There is not considered to be a substantial risk of land contamination or induced seismicity associated with onshore oil and gas exploration and production. In consequence, effects in this regard are not expected to be significantly influenced by restricting the area covered by new licences. The land use implications of this alternative are largely unknown at this stage and would be dependent on individual site characteristics and the density of well pads in any one area. Effects may be positive where development utilises previously developed land or negative where productive land uses on-site such as agriculture or uses adjacent to sites are adversely affected). However, 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 all sites would be restored such that any adverse effects would be reduced in longer term. **Overall, this alternative has been assessed as having a minor negative on this objective, although it is recognised that effects could be locally significant depending on the location of sites which would be determined at the project stage.**
6. To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive.	**-/--**	The total volume of water required for all onshore oil and gas activities that could follow on from the licensing round would be expected to be reduced under this alternative (compared to levels of activity that could follow the implementation of the draft Licensing Plan without this constraint). This reflects the assumption that, in restricting the area covered by new licences, overall levels of activity coming forward after licensing and in particular the extent of hydraulic fracturing operations would be reduced. Commensurate with the lower volume of activity under this alternative, it is considered likely that the risk of surface water or groundwater contamination would be reduced. Regardless, the requirements for discharge consents/permits and Environment Agency/SEPA policy in respect of groundwater protection would continue to apply under this alternative. **Overall, this option has been assessed as having a minor negative effect on this objective, with the potential for effects to be significant (as compared to current water requirements of the oil and gas sector).**
7. To minimise the risks of coastal change and flooding to people, property and communities.	**?**	Conventional and unconventional oil and gas and VCBM exploration activities could increase flood risk, for example, as a result of the removal of vegetation and laying of impermeable surfaces which could increase runoff rates. Sites may also be at risk of flooding particularly if they are located in areas with a high probability of fluvial or coastal flooding. However, as the location of sites vis-à-vis areas with a high probability of flooding is unknown at this stage, it has not been possible to determine the likelihood or magnitude of effects arising from this alternative on this objective. Notwithstanding, it would be expected that flood risk would be fully considered at the project level and as part of the Town and Country Planning and Environmental Impact Assessment (EIA) processes. **This alternative has been assessed as having an uncertain effect on flood risk and coastal change.**

8.

SEA Objective	Score	Summary
9. 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.	-/--	Emissions to air associated with the use of on-site machinery, HGV movements, drilling and hydraulic fracturing would be expected to be lower than emissions that could follow the implementation of the draft Licensing Plan without this constraint. This reflects the assumption that in restricting the area covered by new licences, the overall level of activity coming forward after licensing and associated emissions would be reduced. However, the local significance of effects would be dependent on the exact location of well pad sites. **Overall, this alternative has been assessed as having a minor negative effect on air quality, with the potential for effect to be locally significant in certain localities, although it is recognised that effects can be expected to be mitigated through planning and regulatory controls.**
10. To minimise greenhouse gas emissions as a contribution to climate change, ensure resilience to any consequences of climate change and establish measures which limit flood risk.	--/?	Sources of GHG emissions associated with this alternative would be similar to those identified in respect of the implementation of the draft Licensing Plan without this constraint (as highlighted in Sections 5.2 to 5.5 above) and would include, for example, emissions arising from pad preparation and drilling (e.g. the direct and indirect combustion of fossil fuels from construction traffic and plant and the embodied carbon within construction materials); emissions of CO_2 and methane associated with disturbance to soils; the potential loss of soil carbon sequestration; and in particular the volume of emissions arising from hydraulic fracturing and well completion. The total volume of GHG emissions that could arise from the implementation of this alternative is uncertain. Whilst it is assumed that emissions could be lower than those that associated with the implementation of the draft Licensing Plan (commensurate with a reduction in onshore oil and gas exploration and production activities), total emissions could still be significant, particularly during Stage 4 (Production/operation/maintenance) when compared to existing sectoral GHG emissions from the exploration, production and transport of oil and gas in the UK. As with the implementation of the draft Licensing Plan (as proposed), the combustion of extracted hydrocarbons under this alternative would generate approximately 190 gCO_2e/kWh (which represents combustion emissions for methane). The extent to which domestic production and consumption of shale gas would affect GHG emissions is uncertain and would vary subject to changes in the UK fuel mix and shifts between gas and coal usage. However, the principal effect is expected to be a displacement of imported LNG, or possibly pipeline gas, and the net effect on total UK GHG emissions is likely to be small. Investment in shale gas is not expected to led to 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). In this respect, restricting the area covered by new licences could serve to reduce the potential for GHG reductions associated with the production of gas domestically. However, if LNG or other fossil fuel displaced from the UK is used elsewhere, that could lead to an increase in global GHG emissions (although this is dependent on global energy policy and market demand). **Although the quantum of GHG emissions associated with the implementation of this alternative is uncertain, it is considered that there is the potential for significant negative effects on this objective at the sector level. However, it is recognised that effects would need to be set against the substitution of the extracted hydrocarbons for existing fuels.**
11. To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities.	--/?	As highlighted in Sections 5.2 to 5.5, a range of wastes would be generated during all stages of the onshore oil and gas exploration and production lifecycle. Arisings would include, for example, construction and demolition wastes, drill cuttings and drilling muds, although the most significant waste stream would be likely to be flowback. The total volume of waste arisings including volumes of flowback under this alternative is uncertain. However, it is assumed that restricting the area covered by new licences would reduce the overall level of activity coming forward after licensing, and in turn would reduce arisings (compared to levels of activity that could follow the implementation of the draft Licensing Plan without this constraint). Notwithstanding, it is expected that volumes of flowback requiring treatment could still be of a scale that could place a substantial burden on existing wastewater treatment infrastructure capacity **In view of the volume of flowback requiring treatment that could potentially be generated under this alternative, negative effects on waste have been assessed as potentially significant, although water treatment capacity would need to be determined in particular localities in light of the likely volumes of wastewater.**

12.

SEA Objective	Score	Summary
13. To contribute to the sustainable use of natural and material assets.	++/-/--	During Stage 2 of the unconventional oil and gas exploration and production lifecycle estimates of reserves would be expected to develop and improve in line with increased exploratory drilling. This has been assessed as having a significant positive effect on the resource use objective when compared to existing UK oil and gas reserves. However, as identified in the assessment of the implementation of the draft Licensing Plan (as proposed), the extraction and use of hydrocarbon reserves during Stage 4 would result in the direct loss of a primary natural resource that is non-renewable. Whilst it would be expected that the volume of reserves extracted would be reduced under this alternative (as it is assumed that the overall level of activity coming forward after licensing would be reduced), there remains the potential for negative effects to be significant. **Overall, this alternative has been assessed as having a mixed effect on this objective, with the potential for effects to be significant depending on the size of the reserve identified.**
14. To protect and where appropriate enhance the historic environment including cultural heritage resources, historic buildings and archaeological features.	-/?	It is assumed that restricting the area covered by new licences would reduce the overall level of activity coming forward after licensing (compared to levels of activity that could follow the implementation of the draft Licensing Plan without this constraint). In consequence, the potential for adverse effects on cultural heritage assets (for example, as a result of the direct loss of, or disturbance to, assets or adverse effects on their settings) may also be reduced. However, the significance of effects would be dependent on the sensitivity of receiving environments which is currently uncertain and can only be assessed at the project stage. It is unclear whether this alternative would affect the potential for clustering of well pad sites in more prospective areas and associated cumulative effects on cultural heritage assets. However, it is assumed that restricting the area covered by new licences would reduce levels of activity coming forward after licensing (which could in-turn reduce the potential for cumulative effects occurring). **Overall, this alternative has been assessed as having a minor negative effect on this objective with uncertainties over localised effects.**
15. To protect and enhance landscape and townscape quality and visual amenity.	-/--	It is assumed that restricting the area covered by new licences would reduce the overall level of activity coming forward after licensing (compared to levels of activity that could follow the implementation of the draft Licensing Plan without this constraint) and, therefore, the potential for adverse, including cumulative, effects on landscape and visual amenity. However, the significance of effects would be dependent on the sensitivities of the receiving environments which is currently uncertain and can only be assessed at the project stage. It is unclear whether this alternative would affect the potential for clustering of well pad sites in more prospective areas and associated cumulative effects on landscape. However, it is assumed that restricting the area covered by new licences would reduce levels of activity coming forward after licensing (which could in-turn reduce the potential for cumulative effects occurring. **Overall, this alternative has been assessed as having a minor negative effect on this objective with potential to have locally significant negative effects in certain localities, although it is recognised that landscape and visual impacts would be a key consideration as part of the EIA (where appropriate) and planning application processes and it is anticipated that appropriate mitigation would be implemented where possible to minimise adverse effects so that these are not unacceptable in specific locations.**

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.

5.6.2 No Award of Licences

As set out in **Section 2.6**, this reasonable alternative would ensure that no licences would be awarded during the licensing round. In the absence of the award of further licences, no additional activity would come forward and so there are no environmental effects are anticipated.

However, an in common with all options for the draft Licensing Plan, licensed activities will still take place as some developers have already been awarded PEDLs in previous rounds. For the purposes of comparison, the following assessment of effects of the 13th licensing round is presented in **Table 5.5**.

Table 5.5 Assessment of Environmental Effects of the 13th Licensing Round

SEA Objective	Score	Summary
1. To protect and enhance biodiversity (habitats, species and ecosystems) working within environmental capacities and limits.	-/?	Construction of well pads, facilities and pipelines and exploration/production drilling that has or will follow the 13th licensing round could have a negative impact on this objective through direct effects of habitat loss as well as indirect effects associated with noise, human activity and light pollution. However, these effects are expected to be limited in their extent due to the relatively low level of activity that has followed licensing. As with any construction activities there is also a risk of accidental release of pollutants, however, the likelihood of this risk is considered low. The potential for negative effects will depend on the sensitivity of the receiving environment (e.g. the proximity of designated conversation assets such as Natura 2000 sites) therefore it is highly uncertain. However, sites selected should be of low biodiversity value and presence of any sensitive species should be identified through surveys to help mitigate and prevent against any significant effects. 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. **Overall this option may have a minor negative effect on this objective during construction, exploratory drilling and production activities due to habitat loss or fragmentation and disturbance effects. However, this is uncertain as it is highly dependent on the location of sites and the quality and importance of the surrounding biodiversity.**
2. To promote a strong, diverse and stable economy with opportunities for all; minimise disturbance to local communities and maximise positive social impacts.	+/-	The 13th round of licensing is expected to generate construction jobs during pad preparation, the construction of facilities and pipelines. Skilled oil and gas jobs will also be generated from activities such as well design, construction, completion and testing. The scale of work is such that this is expected to have a minor positive effect on the population objective in the short term. However, the quality of life of local communities directly adjacent to the construction site and/or transport routes may be adversely affected through the generation of noise, vibration or increase in traffic congestion during construction and drilling activities. This would be a more noticeable impact for rural communities or communities directly adjacent to minor roads during this period, who would tend to experience low levels of vehicle movement. The total number of vehicle movements will be greater for sites where shale gas operations occur due to the associated vehicle movements required for delivering water to site and transporting flowback fluid away from the site. Sites where shale gas operations occur will have the additional positive effect of payments to the local community and county/unitary authorities under the Community Engagement Charter of UKOOG. It is expected that communities will be paid £100,000 per shale gas well pad and 1% of revenue during production [102]. This could have a substantial benefit on the local community, depending on how the money is spent. **Overall this option is expected to have a mixed minor positive and negative impact on this objective. The positive score is due to the generation of construction and oil and gas jobs that are expected and payments to local communities at sites with shale gas operations.**

[102] Assuming that the production of a well would generate approximately £1.0 million per annum of revenue

SEA Objective	Score	Summary
		The negative score reflects the adverse effect on quality of life that may be experienced in local communities directly adjacent to the construction site and/or transport routes, although any such effects can be expected to be mitigated through planning controls.
3. To protect and enhance health, safety and wellbeing of workers and communities and minimise any health risks associated with onshore oil and gas operations.	-	Short term emissions of noise, vibrations, dust and to air during pad preparation, construction of facilities and pipelines and from associated vehicle movements in addition to emissions to air and noise generation from drilling operations are expected to have a minor negative effect on health. Sites where hydraulic fracturing takes place have a greater potential for negative impacts, due to the generation of significant noise levels over several days, the increase in vehicle movements to deliver significant volumes of water required and the potential for emissions from diesel fumes to have a negative effect on health in areas with high background levels of air pollution. 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. It is assumed that wider health issues will be effectively controlled by regulation of discharges, emissions and noise. Health and safety of local workforce and surrouding communities are stringently regulated under existing statutory controls and operator management systems. **Overall this option is expected to have a minor negative effect on this objective due to emissons of noise, vibrations, dust during construction, drilling and hydraulic fracturing. However any such effects can be expected to be mitigated through planning controls including by the imposition of relevant planning conditions (e.g. restrictions to noise levels).**
4. To conserve and enhance soil and geology and contribute to the sustainable use of land.	-	Landtake during pad preparation and provision of associated infrastructure such as pipelines and road connections may result in clearance of vegetation and loss of soil levels resulting in the loss of soil function and processes. Regulatory controls under existing legislation are expected to effectively minimise and mitigate potential effects to ensure they are not significant. These effects are expected to be minor and temporary as it is assumed that sites would be restored following either completion of exploration drilling or decommissioning of wells. However, it should be noted that where sites are located on land that is of high agricultural quality or in other sensitive areas or where full site restoration is inhibited then effects could be more significant. Research indicates that the risk of hydraulic fracturing resulting in felt seismicity (M>3) is very small.[103] Therefore, provided appropriate controls are followed, including geological surveys to review seismic risks and seismic monitoring before, during and after hydraulic fracturing, no negative effect is expected. **Overall, this option is expected to have a minor negative impact on this objective due to the landtake resulting in the loss of soil function and processes. Given that it is expected that sites will be restored during decommissioning stage, it is expected that these effects will be temporary and minor.**
5. To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive.	0/-?	Sites with conventional oil and gas or gas storage activities are expected to have a neutral impact on this objective. Although construction and decommissioning activities have the potential to affect surface water quality, it is considered that the effects are typical for construction projects and could be easily mitigated. During more technical activities (such as drilling, well completion, production, etc), there is the potential of water contamination occurring. However, such activities are regulated and require a robust analysis on the risk to groundwater based on geology and hydrology of the site to be carried out. Subject to this assessment and the appropriate mitigation of risk (through well design and operational procedures) it can be reasonably assumed that under normal operations, water quality would not be compromised. Sites where hydraulic fracturing takes place will require significant volumes of water; it is assumed that between 10,000 cubic metres and 25,000 cubic metres will be required per well. The potential effect this could have on water resource availability, aquatic habitats and ecosystems is uncertain and dependent on a number of factors such as timing of consumption of water, possibility of cumulative effects occurring due to multiple wells or pads in one area and availability of existing water resources.

[103] Davies, R.J., Foulgar, G., Bindley, A., Styles, P. (2013) *What size of earthquakes can be caused by fracking? DEI Briefing Note April 2013*. Durham University: Durham

SEA Objective	Score	Summary
		Furthermore, the number of shale gas wells under the 13th round is highly uncertain. However, given that it is assumed that there will be a small number of unconventional sites under the 13th licensing round, this is not expected to be significant. Virgin Coal Bed Methane sites may generate large volumes of water from dewatering of the coal seam, which may occur through the productive life of the well which will require management and disposal. However, taking into account the requirements for discharge consents/permits to be obtained from regulators prior to works commencing, it is considered reasonable to assume that any potential adverse effects at these sites would be appropriately managed. **Overall, this option may have a minor negative effect on this objective due to the significant volume of water required for hydraulic fracturing at unconventional oil and gas sites, although this is uncertain.**
6. To minimise the risks of coastal change and flooding to people, property and communities.	**0/?**	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. Should the site become flooded during exploratory drilling, production, operation or decommissioning, 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. **Overall a neutral effect is expected on this objective. Although if sites were to become flooded during certain stages there could be negative effects given that the location of sites are not known it is not possible to ascertain the probability of flooding.**
7. 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.	**0/-**	Emissions to air are expected during construction, exploration and development stages from on-site machinery, HGV movements and drilling which could result in air quality impacts on sensitive receptors including residents and biodiversity. Furthermore, there would also be emissions from flaring. This would primarily result in the production of CO_2 but would also emit NOx, SO_2, CO and Particulate Matter. However, it is assumed that this will be kept to the minimum that is technically and economically justified. During production fugitive emissions of methane may be realised, although this could vary depending on the completion method. Unconventional oil and gas sites will have a greater number of vehicle movements to and from the site during periods of hydraulic fracturing, as a result of the need for significant volumes of water and the transport of waste water. Due to the greater scale of HGV movements, these sites will be more likely to have a negative impact 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. **Overall, there may be a minor negative impact on this objective as a result of emissions to air from on-site machinery, HGV movements and drilling.**
8. To minimise greenhouse gas emissions as a contribution to climate change, ensure resilience to any consequences of climate change and establish measures which limit flood risk.	**-**	Exploratory drilling, construction of facilities and pipelines, production development, operation and maintenance and decommissioning of wells will emit greenhouse gases from a range of sources including the direct and indirect combustion of fossil fuels from construction traffic, drilling equipment, plant and generators and the embodied carbon within construction. It is expected that emissions will be controlled by a variety of operational management and technical measures (such as those described by relevant IPC guidance). Furthermore, disturbance to soils during pad preparation or construction of facilities and pipelines may result in loss of carbon sequestration which may further contribute to climate change. However, the scale of activity is expected to be small and such effects as a consequence, will be minor. It should be noted that unconventional oil and gas sites will generate further emissions of greenhouse gases associated with hydraulic fracturing. The fracturing process is 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). However, given that it is assumed that there will be a small number of unconventional sites under the 13th licensing round, this is not expected to be significant **Overall this option is expected to have a minor negative impact on this objective due to the generation of greenhouse gases and the possible loss of carbon sequestration from loss of soils.**

SEA Objective	Score	Summary
9. To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities.	-	Exploratory drilling is expected to produce waste streams such as construction wastes, drill cuttings and drilling muds as well as some small volumes of hazardous waste. Given the volume of waste expected to be produced from the majority of sites is not expected to have a significant effect on existing waste management systems and the opportunities available to recycle some materials, the 13th licensing round is expected to have a minor negative effect on the waste objective. It should be noted that for sites where unconventional oil and gas takes place there would be significant volumes of flowback returning to the surface. Given that flowback may have elevated concentrations of salinity and minerals it will require treatment. Flowback volumes are estimated to range from 30% to 75% of the volume of water used for hydraulic fracturing, and so could range from 3,000 to 18,750 cubic metres per well. Treatment is likely to be at a regional waste water treatment works. Given that it is assumed that there will be a small number of unconventional sites under the 13th licensing round, this is not expected to be significant. **Overall, the alternative option is expected to have a minor negative impact on this objective due to the generation of waste streams and some small volumes of hazardous waste. Although the generation of flowback water under unconventional oil and gas will increase the waste generated at these sites it is expected that the total number of these sites will be very small and therefore the quantities will not be significant.**
10. To contribute to the sustainable use of natural and material assets.	+/-	Exploratory drilling is expected to result in an increased estimate of hydrocarbon resource in the UK which will have a positive effect on resource availability. However, at the same time activities under this stage will require the use of resources (such as construction aggregate, steel and cement) as well as energy derived from fossil fuels which will have a minor negative impact on this objective. During production development and operation/maintenance stages it is expected that there will be a minor negative effect 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 operation stages, 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. **Overall, it is expected that there will be a mixed minor positive and negative effect on this objective. The positive score is as a result of exploratory drilling leading to an increasing estimate of hydrocarbon resources. The negative score is due to the use of resources and energy derived from fossil fuels.**
11. To protect and where appropriate enhance the historic environment including cultural heritage resources, historic buildings and archaeological features.	0/-	Notwithstanding early survey work to avoid direct impacts on designated sites, there could still be negative effects associated with production development activity or construction of facilities/pipelines associated with unanticipated effects on cultural heritage assets (such as through vibration testing or the impacts of road traffic). The precise effects would depend upon the receiving context such as the location, importance and type of heritage assets. However, the impacts are unlikely to widespread or significant given the scale of operations. 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. **Overall, there may be a negative impact on this objective as a result of loss or damage to cultural heritage features, landscape of sub-surface/buried archaeology. However this is uncertain as it is dependent on local heritage characteristics.**
12. To protect and enhance landscape and townscape quality and visual amenity.	-/?	Minor negative effects are expected during exploration drilling and production development and during construction of facilities and pipelines. The magnitude of effects is uncertain as it is dependent on the actual setting of the site. However, sites where hydraulic fracturing takes place may have additional visual intrusion due to the need for chemical and water storage tanks on site. There is some potential for landscape enhancement during site restoration and reclamation, particularly where the original site is of low value. However, this is uncertain. **Overall, this option may have a minor negative impact on this objective due to visual intrusion of above ground infrastructure; however this is uncertain and highly dependent on the setting of the site. Notwithstanding, it is recognised that landscape and visual impacts would be a key consideration as part of the EIA**

SEA Objective	Score	Summary
		(where appropriate) and planning application processes and it is anticipated that appropriate mitigation would be implemented where possible to minimise adverse effects so that these are not unacceptable in specific locations.

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.

5.6.3 Summary

The draft Licensing Plan and reasonable alternatives to it have been assessed.

An alternative based on an allocation of an unrestricted number of licences (the current draft Licensing Plan) has a number of likely significant effects (when compared to the effects of the existing oil and gas sector), both positive and negative. The magnitude, extent and likely duration of activities also indicate that for certain effects, these could also be locally significant, depending on the nature and quality of the host environment.

An alternative based on limiting the area of land available to be licensed is assumed to lead to a reduction in the level of associated activity. This will in-turn lessen the magnitude of both positive and negative effects, such that it is unlikely that they would be considered significant when compared to existing oil and sector activities. However, there remains the potential for effects from licensing to be clustered in certain areas, where geological conditions are more favourable, meaning that such effects could be locally significant for the communities that host oil and gas activities.

An alternative based on allowing no licensing to proceed under this round will in consequence have no effects on the environment. However, and in common with all options for the draft Licensing Plan, it should be borne in mind that licensed activities will still take place as developers have already been licensed under the previous (13th) onshore licensing round.

5.7 Mitigation and Enhancement

The assessments have identified a range of measures which could be implemented to avoid or minimise any potential negative effects, and to enhance positive effects. These measures are included within each of the topic-based assessments in **Appendix B** and can be broadly categorised as those that are targeted at operators (e.g. measures related to site selection or design at the project level) and those that are to be considered by DECC.

Those measures that are proposed to address the likely to significant negative effects outlined above are summarised in **Table 5.6.**

Table 5.6 Mitigation Measures Proposed to the Address the Likely Significant Negative Effects of the Draft Licensing Plan

Measure*	Resource Type	Stage(s)	SEA objective	Responsibility
During the site selection process, careful consideration should be given by the operator to the avoidance of carbon sinks (e.g. peats) in order to minimise loss of carbon sequestration.	Unconventional, VCBM	Stage 2, Stage 3	Climate Change	Operator
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, use of construction materials with low embodied carbon, limiting the volume of construction waste on site.	Unconventional, VCBM	Stage 2, Stage 3, Stage 4	Climate Change	Operator
Operators should adopt the principle of reducing emissions to as low a level as reasonably practicable (ALARP). In particular, "reduced emissions completions" (RECs) or "green completions" should be adopted.	Unconventional, VCBM	Stage 2, Stage 3, Stage 4	Climate Change	Operator DECC
Research should be undertaken with a view to developing more effective extraction techniques for shale gas which would minimise whole-life cycle GHG emissions. Including techniques such as improved REC and self-healing cements, reduced water consumption and vehicle demand.	Unconventional	Stage 2, Stage 3	Climate Change	DECC
The feasibility of measures to reduce GHG emissions through and related to the licensing process should be considered. These measures may include, for example, development of guidance and discussion with regulators on appropriate mandatory requirements.	Unconventional, VCBM	Stage 2, Stage 3, Stage 4	Climate Change	DECC
It is envisaged that the use of Best Available Techniques (BAT) will be adopted as part of Waste Management Plan to transport and treat flowback (generated during hydraulic fracturing) and produced water to minimise negative effects from the significant volumes of wastewater produced following hydraulic fracturing. If treatment is required at a regional waste water treatment centre, early discussion should take place with the relevant water company to ensure there is adequate capacity to accommodate the additional demand.	Unconventional VCBM	Stage 2, Stage 3, Stage 4	Waste	Operator
Best practice construction techniques should be used in order to minimise visual effect. Techniques may include minimising the vertical height of drilling equipment and site screening through existing features or use of planting and landscaping.	Conventional Unconventional, VCBM	Stage 2, Stage 3	Landscape	Operator[#]
Light pollution effects should be mitigated by use of screening, shielding and down lighting and where practical minimising working practices that require lighting.	Conventional, Unconventional, VCBM	Stage 2, Stage 3	Landscape	Operator[#]
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.	Unconventional, VCBM	Stage 2, Stage 3	Land Use	Operator[#]

Measure*	Resource Type	Stage(s)	SEA objective	Responsibility
Locational criteria should be used to avoid sensitive sites such as European designated conservation sites or Groundwater Source Protection Zone 1 locations.				
Options to consider the treatment and re-use of flowback back should be considered as part of an overall Water Management Plan.	Unconventional	Stage 2, Stage 3, Stage 4	Water	Operator#
Given the relatively high consumption of water during hydraulic fracturing, the timing of water consumption should be considered in light of local conditions so as to reduce the risk of abstractions occurring during low flow periods where relevant. . Discussion should take place with the relevant water company regarding the effects on existing mains supply and consideration given to the future demands in the relevant water resource zone in one the site is located.	Unconventional	Stage 2, Stage 3, Stage 4	Water	Operator
Measures should be taken to reduce the emissions from vehicles and machinery. For example; the use of transport plans, shut down engines when not in use, the use of low emissions vehicles and low suphur fuels for electricity generators and and fracturing equipment where possible.	Unconventional, VCBM	Stage 2, Stage 3	Air quality	Operator#
Careful consideration should be given to the effects of vehicle movements arising during well site construction and development on local communities adjacent to sites or on routes to sites. Mitigation could include, for example: the preparation of Transport Plans; the identification of alternative routes; the scheduling and timing of movements; the optimisation of movements to/from the site.	Conventional, Unconventional, VCBM	Stage 2, Stage 3	Population	Operator#

*It should be noted that many of the measures outlined above could also be adopted to address identified minor negative effects that could arise from the exploration and production of conventional oil and gas.

It is envisaged that the operator's approach to these issues will be scrutinised as appropriate through the Town and Country planning process and other regulatory regimes.

Where appropriate, the mitigation measures proposed above should be drawn to the attention of licence applicants, and they should be invited to indicate, in the environmental awareness statements which are already required as part of their applications, to indicate how they intend to incorporate these measures into their planning and operations.

5.8 Secondary, Cumulative and Synergistic Effects

In determining the significance of effects of a plan or programme, the SEA Directive requires that consideration is given to the secondary, cumulative and synergistic nature of the effects. Relevant secondary and synergistic effects are included in the detailed assessment in **Appendix B** whilst the collective implementation of oil and gas exploration and production licensed under the draft Licensing Plan for each resource type has been considered through the assessment of low and high activity scenarios.

This section considers two further categories of cumulative effects, namely:

- the combined effects of all activities that could follow on from the licensing round, across all resource types; and
- the effects of all activities that could follow on from the licensing round in-combination with effects arising from the currently licensed activities under previous licensing rounds.

The effects of the draft Licensing Plan in-combination with other plans, programmes and proposals (e.g. local planning authority land use plans and infrastructure plans and projects) have not been considered in detail as part of this assessment. This reflects the inherent uncertainties with respect to the exact scale and location of future activities which would mean that any such assessment is likely to be of little value. It is, however, expected that cumulative effects in this regard would be considered at the individual project stage as part of the EIA process, once site location has been established.

5.8.1 Cumulative Effects of New Licensed Activities

The detailed assessments contained in **Appendix B** and summarised in **Section 5.2 to 5.5** above have considered the effects of those activities that could follow on from the next licensing round by each resource type. **Table 5.7** considers the combined effects of all activities across all resource types and in combination with the effects of previous licensing rounds. In undertaking this assessment, cumulative effects have been considered under the high activity scenarios for both conventional and unconventional oil and gas exploration and production (as described in Tables 2.6 and 2.7) on the basis that this best supports the identification of likely significant effects (given that effects would be more pronounced, commensurate with the increase scale of activity compared to the low activity scenarios).

Table 5.7 Cumulative Effects of the Draft Licensing Plan

SEA Objective	Score	Summary
1. To protect and enhance biodiversity (habitats, species and ecosystems) working within environmental capacities and limits.	**-/?**	Construction activities associated with well pad preparation and drilling (for conventional and unconventional oil and gas and virgin coalbed methane (VCBM) exploration)) and the construction of gas storage facilities and pipeline works may have a negative effect on biodiversity, principally as a result of the loss or fragmentation of habitat or disturbance from both activities on site and HGV movements, such as noise, light or human presence. The discharge of the produced water from de-watering (from VCBM), and the risk of accidental spillage of flowback arising from hydraulic fracturing (associated with shale gas) and pollutants, could have an adverse impact on aquatic environments, although it is assumed that any discharge would be subject to licence and that risks of spillage would be controlled (through planning requirements, regulatory controls and implementation of good practice in construction and management). Given the combined intensity of onshore oil and gas activities that could follow on from the draft Licensing Plan, there is the potential for negative effects on biodiversity to be significant. Notwithstanding the assumed 5km minimum distance between well pad sites, these effects would be dependent on the sensitivity of the receiving environments and the extent to which activities are undertaken in relative close proximity to one another and/or in close succession, which is currently uncertain. However, the operation of the Habitats Regulations can be assumed to protect the conservation status of European designated nature conservation sites. Effects on biodiversity would also be a key consideration in the determination of applications for planning consent for onshore oil and gas exploration and production and in gaining permits, licences, consents and/or authorisations under environmental regulations implemented in England by the Environment Agency, Wales by Natural Resources Wales and in Scotland by the Scottish Environment Protection Agency (SEPA).

SEA Objective	Score	Summary
		Overall, cumulative effects have been assessed as minor negative, although the potential for significant negative effects is acknowledged.
2. To promote a strong, diverse and stable economy with opportunities for all; minimise disturbance to local communities and maximise positive social impacts.	**++/-/--**	The activities that could follow the further onshore oil and gas licensing round are likely to generate substantial direct and indirect employment opportunities as well as jobs induced by employed staff. For unconventional oil and gas, at peak there could be between 16,000 and 32,000 jobs (direct, indirect and induced) created under the high activity scenario, and 2,500-5,000 for the low activity scenario. These will be in addition to those jobs created from existing licensed exploration and production activities. The number of jobs likely to be generated would constitute a significant boost to employment in the UK oil and gas sector and there may also be the potential creation of training opportunities (for example, 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). However, the potential for these jobs to directly benefit those local communities in which sites are located 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 required skills and relevant experience. As identified in **Section 2 of Appendix B** of the Environmental Report, under the United Kingdom Onshore Operators' Group (UKOOG) (2013) Community Engagement Charter, benefits for shale gas exploration and production would be provided to host local communities and county/unitary authorities, the total value of which, under the high activity scenario, could be significant. It is expected that significant volumes of domestic oil and gas could be produced following the licensing round. If the volume of gas anticipated by the high activity scenario were realised, this would generate some 0.12 to 0.24 trillion cubic metres (4.32 to 8.64 trillion cubic feet) of gas, more than six times the 0.037 trillion cubic metres (1.31 trillion cubic feet) of gas produced in the UK in 2012 or more than twice the approximate 0.1 trillion cubic metres (3.52 trillion cubic feet) of gas consumed in the UK per annum. 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) and associated vehicle movements, which could range from 16-51 vehicles per day during Stage 3 of the unconventional oil and gas exploration and production lifecycle (under the high activity scenario). There is potential for these activities to have a significant effect on those communities close to development sites and/or living/working directly adjacent to minor roads during the pad preparation and development stages. Whilst these effects would occur at the local level, given the number of pads envisaged under the high activity scenario (120), collectively the magnitude of effect, if concentrated could be significant in a local or sub-regional context, although any such effects can be expected to be mitigated through planning controls. **Overall, in view of the potential significant economic benefits associated with activities that could follow on from the draft Licensing Plan, there are likely to be a sectorally significant positive cumulative effects on this objective. However, it is recognised that there is the potential for construction and operational activities to have a minor negative effect on communities which could be locally significant, though the operation of the planning system can be expected to ensure that these effects remain acceptable.**
3. 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 construction of multiple well pad sites and gas storage facilities and drilling activities (for conventional and unconventional oil and gas and VCBM exploration) could give rise to locally significant negative cumulative effects on health. These could be related to, for example, emissions to air and noise from machinery, associated HGV movements, hydraulic fracturing (for unconventional oil and gas exploration) and flaring. If it occurred, the contamination of groundwater or surface water from exploration and production activities could have a negative effect on human health, if the water were consumed untreated. However, provided that regulatory requirements are followed, the wells are robustly designed and the casing appropriately constructed to ensure integrity, the risk of contamination of groundwater from surface or groundwater release associated with drilling muds, additives and naturally occurring chemicals in well cuttings, fracturing fluids and produced water is considered to be 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 consistent with relevant regulatory controls would help to mitigate this risk. **Taking into account the potential scale of construction activities in particular, there could be minor negative cumulative effects on health, with the potential for effects to be locally significant**. However, this would be dependent on the location of development sites, including the proximity to sensitive receptors, existing background levels of noise/air pollutants and prevailing health issues as well as the extent to which activities are undertaken in relative close proximity to

SEA Objective	Score	Summary
		one another and/or in close succession, which is currently uncertain. Notwithstanding, any such effects can be expected to be mitigated through planning controls including by the imposition of relevant planning conditions (e.g. restrictions to noise levels).
4. To conserve and enhance soil and geology and contribute to the sustainable use of land.	-/--	Pad preparation and provision of associated infrastructure such as pipelines and road connections in particular (for conventional and unconventional oil and gas and VCBM exploration) is likely in the short to medium term to have negative cumulative effects on this objective due to direct landtake, soil loss and compaction over a large area. For conventional oil and gas production, total land take could be around 12-18ha, whilst for unconventional oil and gas production total land take could be between 240-360ha. However, the effects are likely to be minor. Notwithstanding, should development result in the large scale loss of land that is of high agricultural quality or be located in other sensitive areas, the effects could be more significant (although due to national planning policy, this is considered unlikely). The risk of contamination associated with the implementation of the draft Licensing Plan (for example, due to the disturbance of contaminated sites or accidental spillage) is considered to be low. This reflects the expectation that works would be undertaken in accordance with relevant regulations and appropriate mitigation would be implemented at the project stage. The construction and operation of multiple onshore oil and gas sites could have a potentially significant effect on local land use. Effects may be positive where development utilises previously developed land or negative where productive land uses on-site such as agriculture or uses adjacent to sites are adversely affected. However, 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 all sites would be restored such that any adverse effects would be reduced in longer term. 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 would have a minor positive effect on this objective by restoring, and potentially enhancing, soil quality and prospects for beneficial land use. Based on the findings of research published by Green *et al* (2012), AEA (2012) and Davies *et el* (2013) in particular, and taking into account the controls introduced by Government to reduce the risk of undesirable seismic activity, the assessment has concluded that the risk of hydraulic fracturing causing felt seismicity (of magnitude >3) is very small. **Overall, the cumulative effects on this objective have been assessed as a minor negative, although it is recognised that effects could be locally significant depending on the location of sites which would be determined at the project stage.**
5. To maximise water efficiency, protect and enhance water quality and help achieve the objectives of the Water Framework Directive.	-/--	The total volume of water required for all onshore oil and gas activities that could follow on from the draft Licensing Plan would be substantial (as compared to current water requirements of the oil and gas sector). However, this principally reflects the volume of water that would be required under the high activity scenario for unconventional oil and gas exploration and production (up to 9 million cubic metres per annum over the combined terms of Petroleum Exploration and Development Licences (PEDLs), related to hydraulic fracturing)). The demand for water would be in addition to that from existing licensed exploration and production activities. Overall, it is considered that the volume of water that could be required to support onshore oil and gas activities that could follow on from the draft Licensing Plan could be significant at the oil and gas 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. Water would typically be sourced from either a mains water supply with the agreement of the water utility company or an abstraction from groundwater or surface water and would require an abstraction licence that would only be granted where the additional demands are assessed as sustainable by the regulator. Demand 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). The Memorandum of Understanding (MoU) between the water industry and UKOOG will support cooperation throughout the shale gas exploration and extraction process in order minimise adverse effects on water resources and the environment.

SEA Objective	Score	Summary
		The risk of surface water contamination is considered to be low. Construction activities 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. There is also the potential risk of groundwater contamination from, for example, the loss of well integrity, or the accidental discharge of drilling and hydraulic fracturing fluids or produced water where there are pollutant pathways from the surface to the groundwater body. However, taking into account the requirements for discharge consents/permits and Environment Agency/SEPA policy in respect of groundwater protection, it is considered reasonable to suggest that such risks would be appropriately managed. **In consequence, the draft Licensing Plan has been assessed as having a minor negative effect with the potential to be a sectorally significant cumulative negative effect on this objective.**
6. To minimise the risks of coastal change and flooding to people, property and communities.	?	**Cumulative effects on flood risk and coastal change are considered to be uncertain at this stage.** Conventional and unconventional oil and gas and VCBM exploration activities could increase flood risk, for example, as a result of the removal of vegetation and laying of impermeable surfaces which could increase runoff rates. Sites may also be at risk of flooding particularly if they are located in areas with a high probability of fluvial or coastal flooding. As the location of sites vis-à-vis areas with a high probability of flooding is unknown at this stage, it has not been possible to determine the likelihood or magnitude of effects on this objective. However, it can be assumed that flood risk would be fully considered at the project level and as part of the Town and Country Planning and Environmental Impact Assessment (EIA) processes.
7. 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.	-/--	For conventional and unconventional oil and gas and VCBM exploration, emissions to air from on-site machinery, HGV movements, drilling and hydraulic fracturing could result in cumulative negative effects on sensitive receptors including local residents and biodiversity. Additional cumulative effects could result from the flaring of gases associated with the production process, although this operation is confined to the testing phases only. Although it is assumed that there would be at least 5km between well pad sites and that activities would not be undertaken simultaneously (which could reduce localised impacts), cumulative effects could be locally significant where sites are located within or in close proximity to areas where there are existing air quality issues that could be exacerbated (such as Air Quality Management Areas) and/or sensitive receptors. However, any such effects can be expected to be mitigated through planning and regulatory controls. **Overall, the draft Licensing Plan has been assessed as having a cumulative minor negative effect on this objective, with the potential for effects to be locally significant in certain localities, although it is recognised that effects can be expected to be mitigated through planning and regulatory controls**
8. To minimise greenhouse gas emissions as a contribution to climate change, ensure resilience to any consequences of climate change and establish measures which limit flood risk.	--	For conventional and unconventional oil and gas and VCBM exploration, significant negative effects in respect of greenhouse gas emissions (GHG) at the sectoral level (i.e. as compared to the effects from the existing oil and gas sector) are to be expected during Stage 2 (exploration drilling with coring and hydraulic fracturing) and Stage 3 (production development). However, these effects are unlikely to be significant in terms of emissions at the national level. The effects arise from: emissions associated with pad preparation and drilling (e.g. the direct and indirect combustion of fossil fuels from construction traffic and plant and the embodied carbon within construction materials); emissions of CO_2 and methane associated with disturbance to soils; the potential loss of soil carbon sequestration; and in particular the volume of emissions arising from hydraulic fracturing and well completion. It is estimated that GHG emissions associated with Stage 2 and Stage 3 of the unconventional oil and gas exploration and production lifecycle could be up to 0.96M tCO_2eq per annum (assuming up to a maximum of 360 wells per annum under the high activity scenario). Significant negative cumulative effects are also associated with Stage 4 (production/operation/maintenance) at the sectoral level where there are emissions associated with gas production and arising from power generation, the use of machinery, transportation, fugitive emissions and from flaring and venting. Emissions per annum under the high activity scenario would be between 0.71M and 1.42M tCO_2eq per annum for the peak period when all wells are productive (assuming that GHG emissions during production would be similar to those associated with conventional gas production). This is equivalent to up to 15.3% of the 9.3 M tCO_2eq 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). As compared to the UK inventory of GHG emissions, however, these emissions would be less than 0.3% of the current total. The extent to which domestic production and consumption of shale gas would in practice affect total GHG emissions in the UK is more uncertain, but the principal effect is

SEA Objective	Score	Summary
		expected to be a displacement of imported LNG, or possibly pipeline gas, and the net effect on total UK GHG emissions is likely to be small. If LNG or other fossil fuel displaced from the UK is used elsewhere, that could lead to an increase in global GHG emissions (although this is dependent on global energy policy and market demand). Whilst under the low activity scenario the number of wells would be lower (between 180 and 360 wells), GHG emissions would be up to 0.18M tCO_2eq per annum. This is equivalent to up to 2% of the 9.3 M tCO2eq of sectoral emissions from the exploration, production and transport of oil and gas in the UK in 2011 or 0.04% of UK GHG inventory. In total, over the assumed lifetime of the wells, a total of up to 3.56M tCO_2eq could be generated from the low activity scenario and a total of up to 28.49M tCO_2eq could be generated from the high activity scenario. GHG emissions would be in addition those from existing licensed exploration and production activities. 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. However, there is considered to be sufficient regulations in place in the UK that leakage of gas into aquifers is unlikely to occur. **Overall, the cumulative effects on this objective have been assessed as a significant negative at the sectoral level (i.e. when compared to the existing oil and gas sector), although it is recognised that effects would need to be set against the substitution of the extracted hydrocarbons for existing fuels.**
9. To minimise waste arisings, promote reuse, recovery and recycling and minimise the impact of wastes on the environment and communities.	--	A range of wastes are associated with all stages of production, including construction and demolition wastes, drill cuttings and drilling muds. The total volume of drill cuttings per pad for conventional oil and gas production is assumed to be around 1,500 cubic metres whilst for unconventional oil and gas, this could range from 3,240 to 6,480 cubic metres per pad. The largest and most significant waste stream would be likely to be flowback. Volumes of flowback are assumed to be between 3,000 cubic metres to 18,750 cubic metres per well (each well requiring 10,000 to 25,000 cubic metres of water, and the percentage of flowback assumed to be 30-75 %). Under the high activity scenario, there would be the potential production of 108 million cubic metres of wastewater that would require treatment during Stages 2, 3 and 4. Flowback has the potential to have increased salinity and mineral content including NORM (naturally occurring radioactive material). Whilst there is the potential to recycle a proportion of the flowback fluid, the remaining volume and nature of the fluid is considered to be of sufficient scale to place a substantial burden on existing wastewater treatment infrastructure capacity, particularly where this would occur at treatment works already receiving wastewater from existing licensed exploration and production activities and therefore all three stages have been assessed as having a significant negative effect on waste. **Consequently, there are likely to be significant negative cumulative effects at the local level associated with this objective, indicating that additional water treatment capacity would need to be considered in particular localities in light of the likely volumes of wastewater, implying that new or further investment might be required.**
10. To contribute to the sustainable use of natural and material assets.	++/-/--	Exploratory drilling is generally undertaken to estimate the amount of oil and gas that can be technically and economically produced from a geological formation. This quantity is known as 'reserves'. DECC has stated that while shale gas clearly has potential in the UK, limited drilling or testing has taken place and therefore it is not yet possible to make meaningful estimates of how much shale gas may be practically and commercially recoverable. If the level of activity anticipated by the high scenario were realised, this might be expected to generate in total some 0.12 to 0.24 trillion cubic metres (4.32 to 8.64 trillion cubic feet) of gas in total, more than six times the 0.037 trillion cubic metres (1.31 trillion cubic feet) of gas produced in the UK in 2012 or more than twice the approximate 0.1 trillion cubic metres (3.52 trillion cubic feet) of gas consumed in the UK per annum. During Stage 2, estimates of reserves would be expected to develop and improve in-line with increased exploratory drilling which has been assessed as having a significant positive effect on the resource use objective, if the scale of activity within the high scenario was realised. However, during Stage 4, the extraction and use of hydrocarbon reserves would result in the direct loss of a primary natural resource that is non-renewable. Significant effects would be more likely under the high activity scenario as it could be reasonably assumed that more reserves would be extracted. However, the determination as to whether it would be significant cannot be made currently as: the determination of total UK shale gas resource is still at an early stage; the precise geology of host formations is unknown; and the likely yield per well is not yet possible to ascertain.

SEA Objective	Score	Summary
		Overall, reflecting the differing effects of the differing Stages of the draft Licensing Plan, it has been assessed as having a cumulative significant positive effect and potentially significant negative effect on this objective.
11. To protect and where appropriate enhance the historic environment including cultural heritage resources, historic buildings and archaeological features.	**-/?**	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 assumed construction density of a minimum of 5km between well pad sites would help to reduce likely visual effects on the setting of cultural 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 activities 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; and that these issues are duly addressed through the planning process. **Overall, the draft Licensing Plan has been assessed as having a cumulative minor negative effect on this objective with uncertainties over localised effects.**
12. To protect and enhance landscape and townscape quality and visual amenity.	**-/--**	Pad preparation during Stage 2 and Stage 3 of the unconventional oil and gas exploration and production lifecycle has been assessed as having a minor negative effect on landscape but with the potential for adverse effects to be significant, dependent on the location and setting of well pad sites. Construction activity associated with pad preparation, road access, well construction and (during Stage 3) pipeline works would have temporary, short-term effects on visual amenity and landscapes. Further temporary visual impacts could result from the presence of drilling rigs (over a period of approximately four weeks per well), as well as chemical storage tanks and plant associated with hydraulic fracturing. The height of the drilling rig could be approximately 26m and could result in locally significant effects depending on the setting, screening and extent to which a site would be overlooked. Flaring associated with testing may also result in visual impacts. The effect would be dependent on location, height, duration and timing of the flare. However, regulations require that flaring must be kept to the minimum that is technically and economically justified. Furthermore, it is assumed that effects would be minimised through the use of best available technology (BAT), which would include the use of a stack design which minimises visual intrusion effects. The assumed construction density of a minimum of 5km between well pad sites would help to reduce likely visual effects. Whilst it is generally anticipated that landscape and visual effects would be minor, should well pad sites be located in sensitive areas including, for example, Areas of Outstanding Natural Beauty (AONBs) or National Parks, or in close proximity to a number of sensitive receptors then effects have the potential to be significant. The probability of significant landscape effects would be greater under the high activity scenario, commensurate with the area of land take required to accommodate up to 2,880 wells (for unconventional oil and gas exploration and production) and the density/duration of activity (for the high activity scenario it is anticipated that up to 24 wells could be drilled per pad which could require a drilling rig to be on site for more than two years, assuming that it takes four weeks to drill each well). **Overall, the draft Licensing Plan has been assessed as having a cumulative minor negative effect on this objective with potential to have significant negative effects in certain localities, although it is recognised that landscape and visual impacts would be a key consideration as part of the EIA (where appropriate) and planning application processes and it is anticipated that appropriate mitigation would be implemented where possible to minimise adverse effects so that these are not unacceptable in specific locations.**

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

SEA Objective	Score	Summary
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.		

6. Conclusions and Monitoring

6.1 What are the Environmental Effects of the draft Licensing Plan?

The likely significant environmental effects of activities following further onshore oil and gas licensing have been identified, described and evaluated in order to comply with the requirements of the Strategic Environmental Assessment Directive (2001/42/EC). These activities could cover: conventional oil and gas exploration and production; unconventional oil and gas exploration and production (shale oil and gas, virgin coalbed methane); and natural gas storage in hydrocarbon reservoirs. Consideration was given to all the stages in the oil and gas production and development lifecycle under high and low activity scenarios for both conventional and unconventional oil and gas.

The assessment did not identify any likely significant environmental effects for conventional oil and gas exploration and production, virgin coalbed methane or underground gas storage. The assessment did, however, identify likely significant effects for shale oil and gas exploration and production when compared to the existing oil and gas sector or at the local community level, although no negative effects were identified for any objective which would be significant at the national level:

- Employment - the high activity scenario during the peak development phase could create 16,000-32,000 full time equivalent positions (including direct, indirect and induced jobs), an increase of up to 7% in employment in the oil and gas industry sector. The potential for these jobs to directly benefit local communities would depend on the availability of skills and experience in the local labour market;

- Hydrocarbon reserves - the high activity scenario could generate in total some 0.12 to 0.24 trillion cubic metres (4.32 to 8.64 trillion cubic feet) of gas over 20 years. This is more than six times the 0.037 trillion cubic metres (1.31 trillion cubic feet) of gas produced in the UK in 2012 or more than twice the approximate 0.1 trillion cubic metres (3.52 trillion cubic feet) of gas consumed in the UK per annum;

- Water use – total water consumption associated with hydraulic fracturing over a 20 year period could be between 7 million – 18 million cubic metres under the low activity scenario and 57.6 million –144 million cubic metres under the high activity scenario. For the high activity scenario, annual water use could reach 9 million cubic metres, 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, but substantially less than 1% of total UK annual non domestic mains water usage. The potential impacts that this could have on, for example, water resource availability, water based habitats and water quality is, however, more uncertain. Water would typically be sourced from a mains water supply which would need agreement from the relevant water company or could be abstracted from groundwater or surface water which would need an abstraction licence that would only be granted where acceptable to the regulator. Demand could 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). The Memorandum

of Understanding (MoU) between the water industry and UKOOG will support cooperation throughout the shale gas exploration and extraction process in order minimise adverse effects on water resources and the environment;

- Climate change – greenhouse gas emissions during exploration could be up to 0.96 million tonnes of carbon dioxide equivalent (M tCO_2eq) per annum under the high activity scenario. Greenhouse gas emissions during production are estimated as between 0.71M and 1.42M tCO_2eq per annum for the peak period when all wells are productive. This is equivalent to up to 15.3% of the 9.3 M tCO_2eq 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). Domestic shale gas production and consumption could help to reduce net greenhouse gas emissions associated with reduced imports of liquefied natural gas (LNG) in particular; however, the substitution of LNG in the UK with shale gas could increase the carbon intensity of electricity production in other countries;

- Wastewater - flowback could range from 3,000 cubic metres to 18,750 cubic metres of water per well which under the high activity scenario. This could mean that up to 108 million cubic metres of wastewater could require treatment. Current wastewater volumes from the oil and gas sector are not available but are estimated to be trivial in comparison. Depending on where the wastewater is treated, the additional volume could place a substantial burden on existing wastewater treatment capacity. However, on-site treatment and reuse could reduce the volumes of wastewater generated and lessen any effects on offsite treatment infrastructure capacity. In addition, scrutiny through the planning system and cooperation between operators and the water industry under the Water UK and UKOOG MoU can be assumed to ensure that these effects will not be unacceptable in the local context. It is also noteworthy that the industry is not expected to be at substantial scale before the 2020s and this will allow time for further investment and development in treatment infrastructure.

The assessment also identified likely significant effects for shale oil and gas exploration and production for local communities:

- Community economic contributions - Under the United Kingdom Onshore Operators' Group (UKOOG) (2013) Community Engagement Charter, benefits for 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. Total UK contributions could be between £3 and £12 million. Further, it is estimated that community benefits to the value of 1% of revenue from production could amount to a total of £2.4 million to £4.8 million per site (equivalent to between £0.3 billion and £0.6 billion across all sites) under the high activity scenario, assuming each well is productive for 20 years;

- Community effects - it is estimated that there will be approximately 14-51 vehicle movements each day during site preparation, exploration and pre-production over a 32-145 week period, depending on the activity scenario. This could have an adverse impact on traffic congestion, noise or air quality depending on existing roads, traffic and air quality. It could have a sustained and locally significant effect on communities adjacent to the development sites and to the routes to the sites during exploration and site preparation. However, although any such effects can be expected to be mitigated through planning controls.

An alternative based on limiting the area of land available to be licensed is assumed to lead to a reduction of the level of associated activity which will lessen the magnitude of both positive and negative effects, such that it is unlikely that they would be considered significant when compared to the existing oil and sector activities; however, there remains the potential for effects from licensing to be clustered in certain areas, where geological conditions are more favourable, meaning that such effects could be locally significant for the communities that host the sites.

An alternative based on allowing no licensing to proceed under this round will have no environmental effects. However, it does not preclude licensed activities taking place as developers have already been licensed under the previous (13th) onshore licensing round. Given the low level of current and anticipated activity, any effects that arise will not be significant at the sector level. However, depending on where the effects occur and for individually affected communities, the effects may still be considered locally significant.

When reviewing the effects of each alternative considered, the alternative that seeks to restrict licensing area, provided that it does affect the scale of activity, could lead to a reduction in the magnitude of the environmental effects identified. As such, it does present advantages when considering the objectives of the draft Licensing Plan that seek to avoid compromising the biodiversity, ecosystem functioning and the interests of nature and heritage conservation, and other material assets and users. However, given the importance of achieving the other objectives of the plan, and that the activities that follow licensing will need to meet a range of regulatory requirements (which, when applied and enforced, will ensure that effects at the project level will be identified, assessed and mitigated to an acceptable level), the unrestricted alternative (i.e. the draft Licensing Plan as proposed) may prove to be the preferable alternative.

For whichever alternative that is adopted, the activities that follow licensing will need to meet a range of regulatory requirements. Existing regulatory requirements, provided they are followed, will ensure that effects at the project level will be identified, assessed and mitigated to an acceptable level. These will include:

- gaining planning permission from the relevant minerals planning authority. This will include addressing the effects of siting, landtake, community disturbance, flood risk, contamination of land and traffic. Effects on European designated conservation sites will be assessed as part of the Habitat Regulations Assessment process and will also be considered by Natural England and/or Natural Resources Wales or Scottish Natural Heritage;

- gaining permits, licences, consents and/or authorisations under environmental regulations implemented in England by the Environment Agency, Wales by the Natural Resources Wales and in Scotland by the Scottish Environment Protection Agency. These processes will, inter-alia, ensure that ay new or incremental demand on water resources will remain within sustainable limits;

- implementing the health and safety legislation of the Health and Safety Executive, including assurance of well integrity; and

- implementing DECC controls on flaring, venting and mitigation of seismic risks.

Permits and consents will require operators to provide information on chemicals used, gas produced, emissions, discharges, and the results of any well integrity testing during exploration and operation.

It is considered likely that, through the use of construction and operation best practice, environmental effects resulting from licensing of onshore exploration and production activities could be minimised and managed to be acceptable to regulators, decision makers and communities. Mitigation measures include: careful site selection to avoid adverse impacts on sensitive land uses, important soil types, biodiversity and water courses; the use of best practice in construction and plant specification to minimise releases to air through fugitive emissions; phasing water demand to avoid periods of low flow or water stress; ensuring waste management plans include the transport and treatment of the flowback and produced water generated; and ensuring transport plans include measures to address the effects on local communities including vehicle frequency, scheduling, speed restrictions and routing.

6.2 Proposals for Monitoring

It is a requirement of the SEA Directive to establish how the significant effects of implementing the Licensing Plan will be monitored. As set out in ODPM Guidance, *"it is not necessary to monitor everything or monitor an effect indefinitely. Instead, monitoring needs to be focused on significant sustainability effects."*

Monitoring should therefore be focused on:

- the significant effects identified in the appraisal that may give rise to irreversible damage, with a view to identifying trends and where appropriate to implement relevant mitigating measures before such damage is caused; and
- uncertain effects where monitoring would enable preventative or mitigating measures to be undertaken.

Article 10(2) of the SEA Directive specifically states that, where appropriate, existing monitoring arrangements may be used to assess the success of the appropriate plan in achieving its objectives. It does not require that targets be developed for the SEA itself.

Of the 10 topics considered in this SEA, it is proposed that monitoring should focus on the following indicators and sources of information, as set out in **Table 6.1**.

Table 6.1 Potential Environmental Monitoring Indicators

SEA Topics	Proposed Monitoring Indicators	Possible Source(s) of Information
Biodiversity	Annual (where information allows) trends in; Condition of designated sites Threatened habitats and species	Joint Nature Conservancy Committee (JNCC) Department for Environment, Food and Rural Affairs (Defra) Operator Independent Expert

SEA Topics	Proposed Monitoring Indicators	Possible Source(s) of Information
Population	Employment Information (number of jobs, sector, e.g. – construction/oil and gas) Number of apprenticeships offered Value of payments made to local communities under the (UKOOG) community engagement charter Traffic activity levels around sites (annual average daily traffic flows)	Operator Office of National Statistics (ONS) UK Onshore Operators' Group (UKOOG)
Human Health	Monitoring of noise levels during hydraulic fracturing, drilling, construction and decommissioning Number of nuisance complaints received Traffic activity levels around sites (annual average daily traffic flows) National statistics – respiratory illness etc	Operator Relevant local authority's environmental health department/Annual Monitoring Report Department for Transport, Local Authority
Land Use, Soil and Geology	Seismic monitoring, before, during and after hydraulic fracturing Area of vegetation and soil layers cleared	Operator
Water & Flood Risk	Volumes of water consumption during hydraulic fracturing Consented/permitted aqueous discharges Groundwater quality monitoring	Operator Environment Agency (EA), Scottish Environment Protection Agency (SEPA), Natural Resources Wales (NRW)
Air	Air Quality monitoring (including NOx, hydrocarbons, CO, PM and methane) Traffic activity levels around sites (annual average daily traffic flows)	Operator Local Authority
Climate Change	Energy consumption Emissions of greenhouse gases	Operator
Waste & Resource Use	Volume of construction waste and proportions recycled Volume of hazardous waste Volume of controlled wastes and proportions recycled Volumes of wastewater (including from flowback) Quantity of materials ordered by sites	Operator, EA, NRW and/or SEPA
Cultural heritage	Condition of historic assets	Operator English Heritage, Historic Scotland, Cadw
Landscape	Annual (where information allows) trends in; Change in AONB (area, threats and quality) Changes in conservation areas	National Association of AONB English Heritage

6.3 Next Steps

This Environmental Report is presented for consultation until **28th March 2014**. Feedback received from consultees will be documented and considered in reviewing the proposals for the Licensing Plan. A Post Adoption Statement will summarise how the SEA and the consultation responses have been taken into

account and how environmental considerations have been integrated into the final decisions regarding the Licensing Plan.

Glossary and Abbreviations

Term	Definition
ALARP	As Low As Reasonably Possible. This involves weighing a risk against the trouble, time and money needed to control it. Thus, ALARP describes the level to which see workplace risks should be controlled.
AONB	Area of Outstanding Natural Beauty; an area of countryside considered to have significant landscape value.
AQMA	Air Quality Management Area. These are areas which have been identified by local authorities as unlikely to reach national air quality objectives.
BAT	Best Available Technique. BATs are required to be considered (under EC Directive 96/61) in order to avoid or reduce emissions resulting from certain installations and to reduce the impact on the environment as a whole
CEMP	Construction Environment Management Plan. A Plan which details management measures to adopt and implement during construction activities to avoid and manage construction effects on the environment and surrounding communities.
CO	Carbon monoxide (a colourless, odourless and toxic gas)
CO_2	Carbon dioxide. A naturally occurring gas, also a by-product of burning fossil fuels and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance.
Conventional Oil and Gas	Refers to hydrocarbons which have been previously sought in sandstone or limestone.
Cumulative effects	Effects that occur where several individual activities which each may have an insignificant effect, combine to have a significant effect.
DCLG	Department for Communities and Local Government.
DECC	Department of Energy and Climate Change.
Drilling fluids / drilling mud	Fluid or lubricant added to the wellbore to facilitate the drilling process by suspending cuttings or controlling pressure for example.
EA	Environment Agency. The non-departmental public body of the Department for Environment, Food and Rural Affairs within England.
Flowback water	Water and excess proppant that flow back up to the surface after the hydraulic fracturing procedure is complete.
FTE	Full Time Equivalent. This is a unit to measure employed persons in a way that makes them comparable although they may work a different number of hours per week. It is obtained by comparing an employee's average number of hours worked to the average number of hours of a full-time worker.
Gas Storage	There are three types of large-scale underground natural gas storage facilities: salt caverns; depleted/depleting gas or oil fields; and aquifers. However, this SEA only covers licensing for gas storage in depleted gas or oil fields since the other options are subject to different regulatory regimes.

Term	Definition
GHG	Greenhouse gases. These gases absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect.
Green Completions	Green Completions are techniques used to complete wells to reduce the emissions of gases to air (also known as Reduced Emissions Completions; REC).
GWD	The Groundwater Directive. Directive 2006/118/EC on the protection of groundwater against pollution and deterioration.
H2S	Hydrogen sulphide (a colourless, toxic, highly flammable gas).
Ha	Hectare; a metric unit of area defined as 10,000m2
HGV	Heavy Goods Vehicle. Typically these vehicles are designed or adapted to have a maximum weight of 3,500 kg when in normal use.
HRA	Habitats Regulation Assessment. A HRA is required under the Habitat Regulations to be carried out on any proposed plan or project that has the potential to cause impacts on a Natura 2000 site (e.g. – SAC, SPA).
HSE	Health & Safety Executive; the independent regulator for work-related health, safety and illness.
Hydraulic Fracturing	Hydraulic fracturing or "fracking" is a technique that uses fluid, usually water, pumped at high pressure into the rock to create narrow fractures to create paths for the gas to flow into the well bore and to surface. The water normally contains small quantities of other substances to improve the efficiency of the process, e.g. to reduce friction. Once the fractures have been created, small particles, usually of sand, are pumped into them to keep the fractures open.
Induced seismicity	Earthquake and tremor activity caused by human activity.
IED	Industrial Emissions Directive. Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control)
IPPCD	Integrated Pollution Prevention and Control Directive. Directive 2008/1/EC concerning integrated pollution prevention and control
LNG	Liquefied Natural Gas. Natural Gas compressed at moderate pressure but cooled to -258oF to remain liquid to reduce its volume (the volume of natural gas as liquid is 1/600th its volume as gas).
ML	Megalitre; a unit of volume defined as a million litres.
M_L	M_L (local magnitude) from the Richter magnitude scale (often shortened to Richter scale) developed to quantify the energy released during an earthquake. The scale is a base-10 logarithmic scale. An earthquake that measures 5.0 on the Richter scale has a shaking amplitude 10 times larger than one that measures 4.0, and corresponds to a 31.6 times larger release of energy.
MWD	Mining Waste Directive. Directive 2006/21/EC on the management of waste from extractive industries and amending Directive 2004/35/EC
Mt CO_2 eq	Millions of tonnes of carbon dioxide equivalent. This is a metric measure used to compare the emissions from various greenhouse gases on the basis of their global warming potential by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential.

Term	Definition
NRW	Natural Resources Wales; sponsored by Welsh Government to be responsible for the management of the natural resources of Wales.
NTS	Non-Technical Summary.
NORM	Natural Occurring Radioactive Material. Material that contains radioactive elements of natural origin. NORM primarily contains uranium and thorium (elements that also release radium and radon gas once they begin to decay) and potassium.
NOx	NOx is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts
NVC	National Vegetation Classification is a common standard developed for nature conservation agencies which provides classification and description of the plant communities of Britain.
PEDL	Petroleum Exploration and Development Licences; the name of onshore oil and gas production licences which are generally offered within Licensing Rounds.
Produced water	Water that returns from the well along with the natural gas after fracturing has taken place. The water may be naturally occurring and may contain residual fracturing fluid.
Proppant	Solid material, typically treated sand or man-made ceramic materials, designed to keep an induced hydraulic fracture open.
Ramsar	Ramsar sites are wetlands of international importance, designated under the Ramsar Convention.
REC	Reduced Emissions Completions are techniques used to complete wells to reduce the emissions of gases to air (also known as green completions).
SEA	Strategic Environmental Assessment
SEAD	Strategic Environmental Impact Assessment Directive. Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment
SEPA	Scottish Environmental Protection Agency; Scotland's environmental regulator
SO_2	Sulphur Dioxide (a toxic and odorous gas).
SAC	Special Areas of Conservation are strictly protected sites designated under the EC Habitats Directive
Secondary effects	Effects that do not occur as a direct result of the draft Licensing Plan's implementation, but occur at distance from the direct impacts or as a result of a complex pathway.
SPA	Special Protected Areas are strictly protected sites classified in accordance with Article 4 of the EC Birds Directive.
SPZ1	Groundwater Source Protection Zone 1. SPZs are areas defined by the Environment Agency as areas that highlight the risk of groundwater contamination from any activities that might cause pollution in the area. SPZ1 is the inner protection zone; it 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.
SSSI	Site of Special Scientific Interest, is an area notified by nature conservation agencies as an area of land which is 'of special interest by reason of any of its flora, fauna, or geological or physiographical features'
Synergistic effects	Effects that interact to produce a total effect that is greater than the sum of the individual effects.

Term	Definition
TDS	Total dissolved solids.
UKCP09	UK Climate Projections 09 provide projections on climate change based on methodology designed by the Met Office. The projections are designed to help plan how to adapt to a changing climate.
UKOOG	United Kingdom Onshore Operators' Group, the representative body for the UK onshore oil and gas industry.
Unconventional oil and gas	Refers to hydrocarbons which are located in tight sands, shale or coal which are now the focus of unconventional exploration. However, the techniques used to extract hydrocarbons are essentially the same. What has changed are advancements in technology over the last decade (e.g. – hydraulic fracturing) which have made shale gas development economically viable.
VCBM	Virgin Coal Bed Methane; a coalbed methane derived from coal seams which have otherwise been untouched (i.e. they have not been previously mined), and is generally worked from surface boreholes.
WRZ	Water Resource Zone; describes an area within which the management of supply and demand of water is largely self-contained (apart from agreed bulk transfers of water).
WFD	Water Framework Directive. Directive 2000/60/EC establishing a framework for Community action in the field of water policy

Appendix A
Summary of Consultation Responses Received to the Scoping Report

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Appendix B
Topic Contextual Information and Assessments

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Appendix C
Species Used to Calculate Population Indicators

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Appendix D
Natural Areas in England Relevant to SEA Areas 2, 3 and 5

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Appendix E
International Designations in SEA Areas

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Appendix F
Quality Assurance Checklist

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