Viking UK Gas Ltd

Ebberston Moor Early Development Scheme, Ebberston, North Yorkshire

ENVIRONMENTAL STATEMENT ADDENDUM

BARTON WILLMORE
PLANNING/DESIGN/DELIVERY

November 2013

Ebberston Moor Early Development Scheme (EDS), Ebberston, Snainton, North Yorkshire

Environmental Statement Addendum

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A. PREAMBLE

1.1 In July 2013 Viking UK Gas Limited (hereafter referred to as the "Applicant") submitted a planning application (Ref. NYM/2013/0477/EIA) to North York Moors National Park Authority (NYMNPA) seeking full planning permission for the exploitation of conventional hydrocarbon resources only, for an operational period of up to five years, including: gas production from one wellhead at the existing Ebberston Moor 'A' Well Site; piping the produced gas to the adjoining Lockton Compound where the gas would be conditioned; injecting the conditioned gas via an existing Above Ground Installation (AGI) connection to a Northern Gas Network (NGN) pipeline that runs between Pickering and Whitby; and creation of two new access points off Ebberston Common Lane. These activities are collectively referred to hereafter as the "Proposed Development".

1.2 An Environmental Statement (ES) was prepared to accompany the planning application in accordance with the Town and Country Planning (Environmental Impact Assessment) Regulations 2011 (SI 1824) (the "EIA Regulations").

1.3 A number of consultation responses were received following submission of the planning application from various departments within NYMNPA, Yorkshire Water Services, Yorkshire Wildlife Trust, Health and Safety Executive, Allerston and Wilton Parish Council, Ryedale Environmental Health Officer, North Yorkshire Police, Scarborough Fire Station, English Heritage and Moorland Energy Limited.

1.4 In addition at the time of the submission in July 2013, it was made clear in the ES that a separate planning application would be submitted to the NYMNPA at a later date for the injection of produced water into the Sherwood Sandstone. Since that time, the Applicant and its advisors have made considerable progress in agreeing the technical process of water injection with the Environment Agency. Consequently, it is now possible to submit additional information about injection of the produced water into the Sherwood Sandstone within the Planning Application instead of it forming the subject of a separate planning application as discussed originally.

1.5 This document updates the ES to account for the changes to the Proposed Development as a result of the inclusion of the disposal of the produced water.

Methodology

1.6 The ES has been updated, where necessary, with respect to the following issues:

- Description of produced water disposal; and
- Assessment of the likely significant effects of the produced water disposal on the environment.

1.7 The following terminology is used throughout the addendum:

- The planning application submitted in July 2013: the "Original Application";
- The proposals assessed by the ES in 2013: the "Proposed Development";
- The site proposed to be developed: the "Assessment Site";
- The ES submitted alongside the planning application in July 2013: the "ES";
- The updated proposals: the "Proposed Development As Amended"; and
- This document, which updates the ES: the "ES Addendum".

1.8 Text added to chapters is indicated by **bold underlining**. Deleted text is identified by strikethrough text as follows: ~~deleted~~. This chapter is entirely new so normal text is used.

Structure of the ES Addendum

1.9 The structure of the ES Addendum and chapter authors is set out in **Table A.1**. The ES Addendum is designed to be read alongside the ES. Chapter numbers correspond to those used in the ES with a new chapter provided to assess the effects of injection of the produced water into the Sherwood Sandstone. The new chapter is complementary and supplementary to Chapter 12 which provides an assessment of the effects on surface water and groundwater located close to the ground surface.

1.10 Updated chapters and figures from ES Volume 1 and appendices from ES Volume 2 are all contained in the main volume of the ES Addendum. Figures and appendices follow the relevant chapter in the document. Updated references are provided, where required, at the end of the chapters. A Non-Technical Summary Addendum has been submitted as a standalone document and updates Volume 3 Non-Technical Summary of the ES.

Table A.1 Revised ES Structure

ES Chapter	Author	ES Addendum Chapter
N/A	Barton Willmore	Chapter A. Preamble
Chapter 1 Introduction	Barton Willmore	Chapter 1A Introduction
Chapter 2 EIA Methodology	Barton Willmore	Chapter 2A EIA Methodology
Chapter 3 Assessment Site	Barton Willmore	Chapter not updated
Chapter 4 Proposed Development	Barton Willmore	Chapter 4A Proposed Development
Chapter 5 Alternatives and Design Evolution	Barton Willmore	Chapter not updated
Chapter 6 Construction	Barton Willmore	Chapter not updated

ES Chapter	Author	ES Addendum Chapter
Programme		
Chapter 7 Ecology	Barton Willmore	Chapter not updated
Chapter 8 Landscape & Views	Barton Willmore	Chapter not updated
Chapter 9 Air Quality	URS	Chapter not updated
Chapter 10 Noise	ACIA Engineering Acoustics	Chapter not updated
Chapter 11 Transport	R Elliott Associates Ltd	Chapter not updated
Chapter 12 Flood Risk, Hydrology and Drainage	R Elliott Associates Ltd	Chapter not updated
Chapter 13 Archaeology and Cultural Heritage	Archaeological Project Services	Chapter not updated
Chapter 14 Economics	Barton Willmore	Chapter not updated
Chapter 15 Ground Conditions and Contamination	URS	Chapter not updated
Chapter 16 Summary of Mitigation and Monitoring	Barton Willmore	Chapter 16A Summary of Mitigation and Monitoring
Chapter 17 Statement of Significance	Barton Willmore	Chapter 17A Statement of Significance
N/A	Envireau Water	Chapter 18A Produced Water Disposal

Availability of the ES Addendum

1.11 Additional copies of the ES Addendum are available for viewing by the public during normal office hours in the planning department of NYMNPA. Comments on ES Addendum should be sent to the address below:

North York Moors National Park Authority
The Old Vicarage
Bondgate
Helmsley
York
YO62 5BP

Tel: 01439 772700
Email: planning@northyorkmoors.org.uk

1.12 Additional paper copies of the ES Addendum can be purchased at a cost of £75. The Non-Technical Summary can be obtained free of charge. Copies of the ES Addendum and NTS can be obtained on CD for £20. All documents are available from:

Paul Foster
Barton Willmore LLP

St Andrews House
St Andrews Road
Cambridge
CB4 1WB

Tel: 01223 345555

1A.0 INTRODUCTION

1.1 Viking UK Gas Limited (hereafter referred to as the "Applicant") is seeking full planning permission for the exploitation of conventional hydrocarbon resources only, for an operational period of up to five years, including: gas production from one wellhead at the existing Ebberston Moor 'A' Well Site; piping the produced gas to the adjoining Lockton Compound where the gas would be conditioned; injecting the conditioned gas via an existing Above Ground Installation (AGI) connection to a Northern Gas Network (NGN) pipeline that runs between Pickering and Whitby; and creation of two new access points off Ebberston Common Lane. These activities are collectively referred to hereafter as the "Proposed Development". A full description of the Proposed Development is set out in Chapter 4 of the Environmental Statement (ES).

1.2 The area within which the Proposed Development will be located is referred to in this ES as the "Assessment Site". The Assessment Site, as described in detail in Chapter 3, is situated on the edge of the Dalby Forest in the North York Moors within the administrative area of North York Moors National Park Authority (NYMNPA) and is shown on **Figure 1.1** and **1.2**. The minerals planning authority (the decision maker) is also NYMNPA.

Background to the Proposed Development

1.3 The Ebberston Moor gas field (originally called Lockton) was discovered in 1966 and produced gas between May 1971 and 1974. Since the 1970s, further discoveries of gas have been made in the area. The interpretation of seismic data acquired by the Applicant for the fields in 2007 showed that large areas of gas remain un-tapped, while further studies have improved the understanding of the reservoir's behaviour. It is anticipated that new seismic data, acquired by the Applicant in 2012, will confirm the extension of the Ebberston Moor gas field eastwards. Additional information about the history of the Ebberston Moor gas field is contained within the Planning Statement.

1.4 Whilst, inevitably, there is still a degree of uncertainty about the scale of recoverable gas reserves, the Applicant wishes to pursue a phased approach to the development of the Ebberston Moor gas field. This phased approach will help to:

- Ensure a clearer understanding of the production performance and recovery from the gas field;
- Minimise economic risk and mitigate any adverse effects on the local environment;
- Establish early production; and

- Increase the availability of gas to the local supply network.

1.5 The well site was first approved in 2006 and reprofiled in 2008. A further permission was granted to retain the existing well site in 2011. Planning permission was then granted by the NYMNPA on 18 June 2013 to drill a side track from the existing well within Ebberston Moor 'A' Well Site and the drilling of up two additional appraisal boreholes.

1.6 The side track from the existing well will be drilled prior to construction commencing for this Proposed Development. **The second borehole will be used for injecting the produced water into the Triassic Sherwood Sandstone rock layer beneath the well site.** ~~In addition separate planning permission will be sought to use the existing well cellar to drill a borehole for water disposal use, if required at a later date. The use of the borehole through the existing cellar will not be assessed further as part of this ES.~~

1.7 This Proposed Development seeks planning permission to use the existing Lockton gas export pipeline, now part of the Local Transmission Zone (LTZ) pipeline infrastructure, and extend the Lockton Compound adjacent to the Ebberston Moor 'A' Well Site, in order to accommodate the gas conditioning and metering equipment. The Proposed Development will enable medium term production performance of the Ebberston Moor gas reservoir to be assessed, with the aim of proving reservoir volumes sufficient to support investment in future field development.

1.8 If future field development is deemed viable, the second phase of the development of Ebberston Moor gas field would involve the construction of a pipeline between Ebberston Moor 'A' Well Site and Knapton Generating Station (KGS) to allow the sour gas produced on the well site to be transported to KGS. The second phase of field development will form a separate project and the basis of a separate planning application and will not be assessed further within this ES.

Environmental Impact Assessment

1.9 The Proposed Development falls within Schedule 2 (2e) Section of the Town and Country Planning (Environmental Impact Assessment) Regulations 2011 (SI 1824) (the "EIA Regulations") (Ref. 1.1) as it involves a surface industrial installation for the extraction of natural gas where the area of the development exceeds 0.5 hectare. Consequently, it has the potential to have significant environmental effects and is considered to be EIA development and therefore the Applicant has voluntarily submitted an ES alongside the planning application.

1.10 EIA is the process of collection, publication and consideration of environmental information in the determination of a planning application. Consequently information on the likely significant effects of the Proposed Development has been gathered and is presented in this document, the ES. The ES will inform the decision-maker (in this case NYMNPA) of the likely significant environmental effects of the Proposed Development during construction, operation, decommissioning and restoration. It also identifies mitigation measures to prevent, reduce and offset any significant adverse effects on the environment.

Planning Policy

1.11 The EIA Regulations (Ref. 1.1) do not require assessment of planning policy or guidance; however, where appropriate, national and development plan document policies of relevance have been considered within the technical chapters of this ES.

ES Structure

1.12 The EIA Regulations (Reg. 2 (1)) identify a requirement for an applicant to include within an ES:

> ***"...such of the information referred to in Part 1 of Schedule 4 as is reasonably required to assess the environmental effects of the development and which the applicant can, having regard in particular to current knowledge and methods of assessment, reasonably be required to compile."***

1.13 An outline of this information in respect of the Proposed Development and where it can be found in the ES is presented in **Table 1.1**.

Table 1.1: Location of Information within the ES Required by Part 1 and Part 2 of the EIA Regulations

Specified Information		Location within ES
1	Description of the development, including in particular –	
(a)	a description of the physical characteristics of the whole development and the land-use requirements during the construction and operational phases.	Chapter 4 (The Proposed Development), Chapter 6 (Construction Programme)
(b)	a description of the main characteristics of the production processes, for instance, nature and quantity of materials used.	Chapter 4 (The Proposed Development), Chapter 6 (Construction Programme)
(c)	an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting from the operation of the	All technical chapters (7-15)

Specified Information		Location within ES
	proposed development.	
2	An outline of the main alternatives studied by the applicant or appellant and an indication of the main reasons for its choice, taking into account the environmental effects.	Chapter 5 (Alternatives and Design Evolution)
3	A description of the aspects of the environment likely to be significantly affected by the development, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and inter-relationship between the above factors.	All technical chapters (7-15)
4	A description of the likely significant effects of the development on the environment, which should cover the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the development, resulting from:	
(a)	the existence of the development;	All technical chapters (7-15) and summarised in chapter 17 (Statement of Significance)
(b)	the use of natural resources;	Chapter 12 (Flood Risk, Hydrology and Drainage)
(c)	the emission of pollutants, the creation of nuisances and the elimination of waste; and	Chapter 9 (Air Quality), Chapter 10 (Noise and Vibration), Chapter 12 (Flood Risk, Hydrology and Drainage).
(d)	the description by the Applicant of the forecasting methods used to assess the effects on the environment.	Chapter 2 (EIA Methodology) and all technical chapters (7 – 15) where appropriate
5	A description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment.	All technical chapters (7 - 15)
6	A non-technical summary of the information provided under paragraphs 1 to 5 of this Part.	Non Technical Summary (provided as a separate document)
7	An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the applicant in compiling the required information.	Chapter 2 (EIA Methodology) and in technical chapters where appropriate

1.14 The ES comprises three separate volumes, namely:

- The ES Main Text: The full text of the ES which comprises a total of 17 chapters, illustrated throughout by tables and figures;
- The ES Technical Appendices: A complete set of the technical documents undertaken as part of, or in support of, the ES. The technical appendices are provided in a separate

volume to limit the size of the ES main text; and

- The Non-Technical Summary (NTS): The NTS provides a concise and straightforward summary of the Proposed Development, its likely significant environmental effects and the measures proposed to mitigate or to avoid these effects.

EIA Team

1.15 The ES has been coordinated by Barton Willmore LLP and presents the results of technical studies carried out in conjunction with a number of specialist consultants appointed by the Applicant. The EIA team is listed in **Table 1.2** along with their respective disciplines and contributions to the ES.

Table 1.2: EIA Team

Organisation	Expertise/EIA Input
Viking Gas UK Ltd	Description of the Proposed Development; and Description of the Alternatives.
Barton Willmore LLP	Town Planning; EIA Coordination; Landscape and Views; and Socio Economic Assessment.
URS Scott Wilson	Ecology and Nature Conservation; Air Quality; and Ground Conditions and Contamination
Archaeological Project Services	Archaeology and Cultural Heritage
Acia Engineering Acoustics	Noise
R Elliott Associates	Transport; and Flood Risk, Hydrology and Drainage
Envireau Water	Produced Water Disposal

Other Documents

1.16 A number of other documents have been submitted to NYMNPA as part of, or accompanying, the planning application, including:

- Planning and Sustainability Statement;
- Statement of Community Involvement;
- Design and Access Statement;
- Outline Safety Report; and
- Validation Checklist.

ES Availability and Comments

1.17 Paper copies of the ES and the Technical Appendices can be purchased at a cost of £80 and £270 respectively. The Non-Technical Summary can be obtained free of charge. Copies of the

ES, Technical Appendices and NTS can be obtained on CD for £20. All documents are available from:

Paul Foster
Barton Willmore
Elizabeth House
1 High Street
Chesterton
Cambridge, CB4 1WB.

Tel: 01223 345555

1.18 Additional copies of this ES are also available for viewing by the public during normal office hours in the planning departments of NYMNPA. Comments on the planning application should be forwarded to Mark Hill at NYMNPA at the address below:

North York Moors National Park Authority
The Old Vicarage
Bondgate
Helmsley
York, YO62 5BP

Tel: 01439 772700
Email: planning@northyorkmoors.org.uk

2A.0 ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY

Introduction

2.1 This chapter explains the EIA methodology. In particular, it details the process of identifying and assessing the likely significant environmental effects of the Proposed Development.

General Approach

2.2 The ES has been prepared in accordance with the EIA Regulations (Ref. 2.1) which implement European Council Directive 2011/92/EU (codified Directive on EIA) (Ref. 2.2). Reference has also been made to currently available good practice guidance on EIA including:

- Environmental Impact Assessment – A Guide to Procedures, Department of the Environment, Transport and Regions (DETR) 2000 (Ref. 2.3);
- Environmental Impact Assessment, DETR Circular 02/99 (Ref. 2.4);
- Guidelines for Environmental Impact Assessment, Institute of Environmental Management and Assessment (IEMA) 2004 (Ref 2.5);
- Amended Circular on Environmental Impact Assessment – A Consultation Paper, Department for Communities and Local Government (DCLG) (June 2006) (Ref. 2.6);
- Environmental Impact Assessment: A Guide to Good Practice and Procedures, A Consultation Paper, DCLG (June 2006) (Ref. 2.7); and
- Office for the Official Publications of the European Communities (1999) Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions, Luxemburg (Ref. 2.8).

Scoping

2.3 Scoping involves focusing the content of the ES on those issues of greatest potential significance. It is an important tool for identifying the likely significant effects of a proposed development through its design, construction and operation and decommissioning phases and ensures that appropriate mitigation options are considered, where necessary.

2.4 A scoping request specifically for this Proposed Development has not been sought. The Applicant has voluntarily undertaken an EIA. A request for an EIA scoping opinion for a related scheme called the Ebberston to Knapton Pipeline was submitted to North Yorkshire County Council (NYCC) on 6th February 2012 and the NYMNPA on 21st March 2012. The

scoping requests considered that the following environmental issues should be addressed in detail in the ES:

- Ecology;
- Landscape and Views;
- Air Quality;
- Noise and Vibration;
- Transport;
- Flood Risk, Hydrology and Drainage;
- Archaeology and Cultural Heritage;
- Socio Economics; and
- Ground Conditions and Contamination.

2.5 NYCC adopted a scoping opinion on 2nd July 2012 and NYMNPA adopted a scoping opinion on 13th April 2012, both of which generally agreed with the scope set out above for the EIA relating to the Ebberston to Knapton Pipeline (see **Appendix 2.1).** As some of the elements of the Ebberston to Knapton Pipeline scheme are common to the Proposed Development (i.e. gas production from the existing Ebberston Moor 'A' Well Site), coupled with the fact that there is overlap between the Assessment Site boundaries, the Applicant decided to base the scope of this Proposed Development on the adopted scoping opinions from NYCC and NYMNPA.

2.6 A table setting out the issues raised in the scoping opinions and where these have been addressed within the ES is provided in **Appendix 2.2**.

Consultation Process

Consultees

2.7 The following organisations were approached as part of the EIA process to identify baseline information and to enable the Proposed Development to be refined in relation to environmental issues raised, where appropriate:

- NYMNPA (various departments);
- North Yorkshire County Council (NYCC);
- Ryedale District Council (RDC);
- English Heritage;
- Environment Agency;
- Natural England;

- Yorkshire Wildlife Trust; and
- Yorkshire Water

Public Exhibition

2.8 The Applicant carried out a public exhibition on 7th June in Allerston Village Hall. The exhibition described the nature and purpose of the Proposed Development. Leaflets advertising the exhibition were posted prior to the public exhibition to local households and businesses, posters were place on notices boards and other prominent places in the local area and an advertisement was placed in the local media. The issues raised at the public exhibitions and responses, together with the design evolution, are discussed in the Statement of Community Involvement. Involvement with the local community will continue throughout the planning process.

Assessment Methodology

2.9 The EIA Regulations (Ref. 2.1) stipulate that an ES should, where possible, identify, describe and assess the likely significant effects of a development on the environment. Therefore, this ES identifies and assesses the likely significant effects of the Proposed Development in relation to construction, operation, and decommissioning and restoration phases. Environmental effects have been evaluated with reference to definitive standards and legislation where available. Where it has not been possible to quantify effects, qualitative assessments have been carried out, based on available knowledge and professional judgement. Where uncertainty exists, this has been noted in the relevant assessment chapter.

Determining Significance

2.10 Guidance on significance has been mainly of a generic nature (e.g. DETR Circular 02/99 (Ref. 2.4) and DCLG draft Amended EIA Circular (Ref. 2.6)), and practitioners have been obliged to develop definitions for specific topics and projects. It is broadly accepted, however, that significance reflects the relationship between two factors:

- The sensitivity, importance or value of the affected resource or receptor; and
- The magnitude or severity of an effect (i.e. the actual change taking place to the environment).

2.11 The sensitivity, importance or value of the resource or receptor is normally derived from:

- Legislative controls;
- Designated status within the land use planning system;
- The number of individual receptors such as residents;
- An empirical assessment on the basis of characteristics such as rarity or condition; and
- Ability of the receptor to absorb change.

2.12 The magnitude of an effect is often quantifiable in terms of, for example the extent of land take or predicted change in noise levels.

2.13 Determination of significance also includes consideration of:

- Extent and magnitude of the effect;
- Type of effect (beneficial or adverse);
- Duration of effect (whether short, medium or long term; permanent or temporary);
- Nature of effect (whether direct or indirect, reversible or irreversible);
- Whether the effect occurs in isolation, is cumulative or interactive;
- Performance against environmental quality standards or other relevant pollution control thresholds; and
- Compatibility with environmental policies.

2.14 Significant effects occur where valuable or sensitive resources, or numerous receptors, are subject to effects of considerable magnitude. Effects are unlikely to be significant where low value or non-sensitive resources, or a small number of receptors, are subject to minor effects. Allocation of significant effects in intermediate situations will be a matter for professional judgement in each topic area.

2.15 Where an effect is considered to be significant, this significance will generally be classified as major, moderate or minor (with these descriptions again being based on precedent or current guidance). Within this ES, the significance matrix in **Table 2.1** has been used to define the level of significance of effects. In some cases analogous matrices for the various specialist topics are used, and where these use different assessment criteria this is clearly stated within the relevant chapter.

Table 2.1: Significance Matrix

Sensitivity /Value of Receptor	Magnitude of Effect		
	High	**Medium**	**Low**
High (England, UK, International)	Major	Major/Moderate	Moderate
Medium (County, Regional)	Major/Moderate	Moderate	Moderate/Minor
Low (Local, Borough)	Moderate	Moderate/Minor	Minor

2.16 The three levels of significance defined by the generic matrix are:

- Major – an effect which in isolation could have a material influence on the decision making process;
- Moderate – an effect which on its own could have moderate influence on decision making, particularly when combined with other similar effects; or
- Minor – an effect which on its own is likely to have a minor influence only on decision making but when combined with other effects could have a more material influence.

2.17 Effects are also described as:

- Adverse – detrimental or negative effects to an environmental resource or receptor; or
- Beneficial – advantageous or positive effect to an environmental resource or receptor.

2.18 Where an effect is considered to be not significant or have no influence, irrespective of other effects, this is classified as “negligible”.

2.19 Each of the technical chapters or accompanying technical appendices provides the criteria, including sources and justifications, for quantifying the different levels of effect. Where possible, this has been based upon quantitative and accepted criteria, together with the use of value judgements and expert interpretations to establish to what extent an effect is likely to be environmentally significant.

2.20 In the context of the Proposed Development, short to medium term temporary effects are considered to be those associated with construction, and long term or permanent effects are those associated with the operation or decommissioning/restoration of the Proposed Development.

2.21 Local effects are those on receptors in and around the Assessment Site, while effects upon receptors in North York Moors National Park are considered to be at National Park Authority level. Effects on the North East region are considered to be at a Regional level, whilst effects

on England are considered to be at an England level and national effects are considered to be at a UK level. No effects have been identified at an international level.

Cumulative and Interactive Effects

Cumulative Effects

2.22 A requirement of the EIA Regulations is to assess cumulative effects as part of the EIA. Cumulative effects are generally considered to arise from the combination of effects from the Proposed Development and from other proposed or permitted schemes in the vicinity, acting together to generate elevated levels of effects. Circular 02/99 (Ref. 2.4) identifies that:

> ***"in judging whether the effects of a development are likely to be significant, local planning authorities should always have regard to the possible cumulative effects with any existing or approved development..."***

2.23 The scheme that has been covered as part of the cumulative effects assessment is set out in **Table 2.2** and shown on **Figure 2.1**.

Table 2.2: Cumulative Schemes

Scheme	Description
Ryedale Gas Project (NY/2010/0159/ENV)	The Ryedale Gas Project includes five principal elements: • Gas production from the existing Ebberston South Well Site; • The construction of two underground pipelines from the existing Ebberston South Well Site to a new Gas Processing Facility; • A new access road between the A170 and the proposed Gas Processing Facility; • A Gas Processing Facility at Hurrell Lane, Thornton-le-Dale; and • An Above Ground Installation (AGI) connection into the existing National Transmission System (NTS) pipeline to the south of the Gas Processing Facility on land off New Ings Lane.

2.24 Each of the technical assessments take into account the likely significant cumulative effects of the Proposed Development with the Ryedale Gas Project in accordance with the significance matrix set out in **Table 2.2**. The level of detail of assessment has been dependent on the information available for the scheme and has generally been undertaken in a qualitative manner. Where no cumulative effects are predicted, this has also been stated.

Interactive Effects

2.25 Interactive effects are also considered in the ES. Interactive effects arise where effects from one environmental element bring about changes in another environmental element. These effects are also reviewed in each of the technical chapters of this ES. Examples of the main potential types of interactive effects are as follows:

- Effects of traffic on noise;
- Effects of traffic on air quality;
- Effects of water discharges on ecology; and
- Effects of landscaping on ecology.

Structure of Technical Chapters

2.26 Through the EIA process, the likely significant environmental effects of the Proposed Development will be assessed. Each key environmental topic has been assigned a separate chapter (in no particular order) in the ES (Chapters 7 - 15), and within each of these chapters the information that will inform the EIA process has been set out in the following way:

- **Introduction** – a brief summary of what is considered in the chapter;
- **Planning Policy Context** – a review of relevant National and Development Plan Document (DPD) policies related to the technical issues;
- **Assessment Methodology** – an outline of the methods used to undertake the technical studies with reference to legislation, published standards, guidelines, best practice and any relevant significance criteria;
- **Baseline Conditions** – a description of the environmental conditions against which the likely significant environmental effects of the Proposed Development have been assessed;
- **Likely Significant Effects** – identification and assessment of the likely significant environmental effects of the Proposed Development during construction, operation and decommissioning and restoration;
- **Mitigation Measures** – development of measures to avoid, offset or reduce the significant adverse effects of a project. These measures can relate to any of the phases of the project: design, construction, operation, decommissioning and restoration. Where any significant adverse environmental effects have been identified, a commitment is made by the Applicant to implement mitigation measures;
- **Residual Effects** – identification of the remaining effects of the Proposed Development, assuming implementation of available mitigation measures, and includes an assessment

of the significance of those effects in accordance with the criteria set out in paragraphs 2.10 – 2.21; and

- **Summary** – a summary of the key finding of the ES chapter.

Assumptions and Limitations

2.27 The principal assumptions that have been made and any limitations that have been identified, in preparing this ES are set out below. Assumptions relevant to specific topics have been made in the appropriate chapter:

- All of the principal existing land uses adjoining the Assessment Site remain;
- Information received by third parties is complete and up to date;
- The design, construction, operation, decommissioning and restoration phases of the Proposed Development will satisfy minimum environmental standards, consistent with contemporary legislation, practice and knowledge;
- It is anticipated that construction would commence in January 2014 (subject to gaining planning permission) and is scheduled for completion in July 2014;
- Significant environmental effects have been assessed using the design of the Proposed Development;
- Conditions will be attached to the planning permission that will control disturbance during construction works;
- Necessary off-site services infrastructure will be provided by statutory undertakers;
- The planning permission, when granted, will contain conditions that will be sufficient to limit the development to that which has been assessed in the EIA;
- The side track from the existing borehole permitted under NYM/2013/0068/FL will be drilled prior to construction of the Proposed Development~~. Any future drilling other than that included within this existing planning permission will be assessed as part of separate planning applications and therefore is not covered in this ES~~;
- **The second borehole permitted under NYM/2013/0068/FL** ~~borehole~~ will be drilled from the existing well cellar ~~to drill a borehole~~ for water disposal use**; and** ~~, if required at a later date~~;
- Any future **drilling or** development of the Ebberston Moor 'A' Well Site or Lockton Compound after operation of the Proposed Development will be determined through a separate planning application ~~and will not be assessed within this ES~~. **Future proposals would be subject to EIA if required. The ES and ES Addendum assesses all likely significant effects of the Proposed Development on the environment and do not consider any potential future proposals.**

4A.0 THE PROPOSED DEVELOPMENT

Introduction

4.1 The Proposed Development will facilitate an appraisal of the central part of the Ebberston Moor gas field, with the aim of proving reservoir volumes within the gas field sufficient to support investment in future field development as described in Chapter 1 through:

- Gas production from the existing well, Ebberston Moor-1 at the Ebberston Moor 'A' Well Site; and
- Connection to the neighbouring Local Transmission Zone (LTZ) Above Ground Installation (AGI), including the construction of:
  - a gas conditioning facility (the facility where the impurities from the gas are removed to meet the LTZ gas quality specification);
  - metering facilities to deliver gas into the LTZ pipeline; and
  - facilities for the storage and transport of condensate-LPG mix, and gas treatment fluids from the Lockton Compound.

Key Elements of the Proposed Development

4.2 The Proposed Development as shown on **Figure 4.1, Figure 4.2** and **Appendix 4.1** comprises the following elements:

1. Gas production from the existing well (Ebberston Moor-1) which will be side tracked for the purpose of placing a horizontal well bore at the top of the Permian Kirkham Abbey Formation (KAF) reservoir to avoid producing the water underlying the gas reservoir. The side track is proposed to be drilled under planning permission NYM/2013/0068/FL prior to construction commencing on this Proposed Development;
2. Piping the produced gas to the adjacent Lockton Compound, where the gas will be conditioned (i.e. water and hydrogen sulphide content reduced to the required level); ~~and~~
3. Flowing the conditioned gas into the neighbouring LTZ pipeline through the existing above ground pipeline connection within the Northern Gas Network (NGN) AGI, and which is operated by NGN. The gas will then be distributed to meet local demand for gas in the Scarborough and Whitby region of North Yorkshire~~.~~**; and**
4. **Injecting produced and condensed water via a disposal well into the Sherwood Sandstone.**

4.3 The proposed construction sequence and programme of works are outlined in Chapter 6. The

current project schedule anticipates planning and field development approval in 2013, construction commencing in January 2014, once the 'side-track' to Ebberston Moor – 1 well has been drilled under planning permission NYM/2013/0068/FL, and gas production start-up after July 2014. The Proposed Development is expected to be operating for up to five years. If this Proposed Development is successful, a pipeline will be constructed in order to deliver gas and associated liquids from the existing Ebberston Moor 'A' Well Site to the Knapton Generating Station (KGS). The pipeline will be the subject of a separate planning application and is not considered further in this ES.

Description of the Proposed Development

4.4 The Ebberston Moor 'A' Well Site and the adjacent Lockton Compound lie within the Parish of Allerston at the edge of Dalby Forest approximately 6.5 km to the north of Ebberston.

4.5 The existing well site and compound will be developed to allow for gas production and conditioning to meet the gas quality specification of the neighbouring LTZ. It is anticipated that the volume of gas to be produced will be at an annual average rate of 15 million standard cubic feet per day (mmscf/d), sufficient to supply the gas needs to approximately 75,000 homes. In order to facilitate the construction and development of the Proposed Development, the following facilities listed below will be required as shown in **Figure 4.1**:

- Construction compound;
- Laydown area for pipes, material and associated equipment;
- Fabrication shed;
- Workforce facilities – messing, catering and offices;
- Security cabin;
- Parking spaces;
- Potable water tank; and
- 1000 kw natural gas fuelled electric generator.

4.6 The main equipment to enable the produced gas to be conditioned will include:

- Inlet separator complete with measurement devices for gas and liquids;
- 200kw Gas fired heater;
- Sulphur removal module (Amine);
- Dew point control unit;
- Storage tanks for lean and rich amine and glycol;
- Produced condensate storage;

- Hydrate inhibitor (methanol) storage and injection package;
- Corrosion and/or scale inhibitor storage and injection package;
- Fire water tank;
- Metering skid;
- Flare;
- Pipe track between the well and the flare;
- Utility systems;
- Natural gas fuelled electric generator;
- Interconnecting pressure pipework and valves;
- High Integrity Pressure Protection System (HIPPS) valves and pipelines tie-in arrangement; and
- Site office.

4.7 All storage tanks, loading and unloading areas and all gas conditioning equipment will be sited on an impermeable and curbed surface with suitable drains, catchment and hydrocarbon separation equipment. A specially designed interceptor will be provided to clean rain and surface water within the site drains before leaving the Assessment Site through the soakaway.

4.8 The separation and water handling unit, amine and glycol contactors, produced liquid drum, dew point control unit, and some auxiliary equipment will be enclosed within the Gas Conditioning Building. The building will be 20mx34mx8.5m and has been designed to accord with the guidelines set out in Design Guide 5 (New Agricultural Buildings), published by NYMNPA in February 2013 (Ref. 4.1).

4.9 In addition there will be a new loading bay and impermeable hardstanding. The existing parking area for 18 vehicles at the well site entrance will remain. Within the adjacent NGN AGI, the existing neighbouring LTZ Pipe Manifold operated by NGN, the existing administration building and the existing access into the Lockton Compound will also remain in their current condition as they are located outside of the Assessment Site boundary.

Gas Conditioning/Treatment Facility

4.10 The gas conditioning/treatment process is illustrated in **Figure 4.2**. The gas, associated water and condensate will flow from the well head on the Ebberston Moor – 1 well through a flow line and a line heater into the three phase inlet separator. The inlet separator and gas conditioning modules will operate at the LTZ pipeline pressure. Condensate and water from the inlet separator will be routed to their respective storage tanks prior to removal from site.

4.11 The water saturated gas from the inlet separator will flow through the amine contactor to enable removal of hydrogen sulphide. The rich amine (containing the hydrogen sulphide removed from the gas) will be routed to the rich amine storage tank from where it will be loaded onto road tankers for transport to a remote amine regenerating plant to avoid being released into the atmosphere as sulphur dioxide inside the North York Moors National Park.

4.12 The still water saturated gas from the amine contactor will then flow into the Dew-Point control module for removal of excess water and condensate through contact with lean glycol and refrigeration. Lean glycol will be pumped from the lean glycol storage while the rich glycol (containing the water extracted from the gas) will be routed to the rich glycol storage tank, from where it will be loaded to a road tanker and transported to a remote glycol regeneration plant.

4.13 Once conditioned, the gas will be routed to the metering module where the export gas volume will be measured along with other quality parameters prior to the gas being delivered into the existing neighbouring NGN AGI pipeline connection on the Lockton Compound. At this point, it will flow into the NGN gas distribution system and will be distributed to the local gas market in the Scarborough and Whitby area.

4.14 Methanol will be stored in the well site storage tank and will be injected by pump immediately downstream of the wellhead and upstream of the choke valve and possibly into the gas conditioning/treatment facility to reduce the risk of corrosion and hydrate formation.

4.15 The Proposed Development will be monitored by a System Control and Data Acquisition (SCADA) system and safety systems will be remotely operated via a telephone or satellite link to KGS. The operation of the Proposed Development will be carried out by the KGS management. It will be able to be remotely operated with operators available at KGS to respond to alarms and to carry out routine inspection and maintenance.

Re-generation of Gas Treatment Fluids

4.16 The gas treatment fluids will be transported off site for regeneration.

Produced Water Disposal

4.17 Any water produced during the production of gas will be disposed of via a water disposal well within the well site. Planning permission **(NYM/2013/0068/FL)** has already been granted

for two gas appraisal wells and it is intended that one of the wells will be used for **injecting the produced water into the Triassic Sherwood Sandstone rock layer beneath the well site. The produced water injection will be achieved by low pressure injection from the surface with the hydrostatic pressure of the water column assisting the water injection process. Injection is anticipated to be at a rate of 1600 m^3 of water per day, increasing to 1900 m^3 per day during the final year. This will take place via a well, constructed for the purpose into the Sherwood Sandstone formation. The well will be cased and grouted to the injection zone and injection will take place in either an open hole or through a perforated section, depending on the stability of the borehole wall.** ~~water disposal. Therefore separate planning permission will be sought to use the existing well cellar to drill a borehole for water disposal use, if required at a later date. The use of the borehole through the existing cellar will not be assessed further as part of this ES.~~

Flare

4.18 A flare system will be provided to assist start and stop operations and eliminate fugitive emissions. Flaring will occur when gas needs to be routed to the flare until it is of an acceptable quality before transfer into the NGN facilities.

4.19 The flare knock-out drum will be located inside an open pit with an area of 225 sqm so that all free liquids drain to it. A liquid level control will ensure that any liquid is maintained at a low level. Liquid (hydrocarbons) from the drum will be pumped to the produced liquid separator. Any rain water inside the open pit will be pumped to the drain system by a submersible pump.

Heights

4.20 **Table 4.1** provides the approximate heights of the tallest structures on the Assessment Site during operation.

Table 4.1: Approximate Heights of Structures/Buildings during Operation

Structure/Buildings	Height (m)
Inlet separator	1.8m
Gas fired heater	1.8m
Water storage tank	4.8m
Gas Conditioning Building	8.5m
Flare stack	8.5m

Access

4.21 Access to the Assessment Site is from the A170 via Ebberston Common Lane. No unauthorised vehicles associated within the Proposed Development will use the Dalby Forest Drive. Ebberston Common Lane is an unclassified road with passing places. Approximately 100m north of Givendale Head Farm, the road becomes an unimproved public highway (gravel track) as shown on **Figure 4.1**. There is already an established access using this route to Ebberston Moor 'A' Well Site and the Lockton Compound.

4.22 A new access with a gated entrance will be created from Ebberston Common Lane to enable transport tankers to enter the Lockton Compound. Vehicles will exit the Lockton Compound via a separate gated new access. Two emergency exit gates will be located along the north western fence line of the Lockton Compound. The well site and Lockton Compound will be fenced.

Parking

4.23 Eighteen car parking spaces are already provided at the Ebberston Moor 'A' Well Site and these would be retained and used during all phases of the Proposed Development.

Landscaping

4.24 The landscape strategy for the Proposed Development has been designed with particular consideration to the topography, landscape and ecological constraints and opportunities identified on the Assessment Site. Landscaping works will involve some ground modelling works associated with careful felling of woodland and the creation of new bunds surrounding the flare within the Assessment Site. Elsewhere within the Assessment Site, works will include soil preparation, tree and vegetation planting and seeding. The existing screening along the frontage with the Ebberston Common Lane will be retained and enhanced where possible, with the exception of a small number of trees and a section of hedgerow which will be lost to create the two new entry points into the Assessment Site. A distance of 5m radius from the flare will need to be cleared of vegetation to mitigate fire risk.

Sustainable Drainage Measures

4.25 Sustainable Drainage Systems (SuDS) will be used to reduce flood risk, improve water quality, assist groundwater recharge whilst also providing amenity and wildlife benefits.

4.26 The existing drainage system at Ebberston Moor 'A' Well Site and Lockton Compound will be upgraded to ensure that the Assessment Site is capable of safely containing, separating and disposing of both rainwater and any fluid spills from the tanks and piping. A closed drain system will recover and store any liquids drained from the process equipment, which will be disposed of in an approved manner. Surface water site drains will be sent to a receiving interceptor and then routed to a clean water discharge point. See Chapter 12 for more details.

Utilities

4.27 The Proposed Development will connect into the existing telephone network in close proximity to the Assessment Site, with new infrastructure installed beneath roads, and verges wherever possible. Electric power will be generated on site by a natural gas fuelled engine driven generator. Use of natural gas as fuel instead of diesel for power generation reduces the carbon footprint of the Proposed Development. Natural gas will also be used to fuel a 200kw heater to keep the gas from forming hydrates in the plant inlet.

Lighting

4.28 The facility will not be lit at night except in emergencies or for urgent maintenance. During the winter months, it will be necessary for part of the Assessment Site to be lit during late afternoon and early evening when deliveries and loading takes place for health and safety reasons. A lighting assessment is provided in Chapter 8 and its accompanying **Appendix 8.6**.

Waste Management

4.29 The Proposed Development will provide an appropriate plan and facilities for the efficient collection, storage and transport of waste to an approved and licensed waste company for recycling or disposal. Adequate space for refuse storage and collection will be provided within the Proposed Development as required by NYMNPA.

16A.0 SUMMARY OF MITIGATION AND MONITORING

Introduction

16.1 This chapter of the ES presents a summary of the mitigation and monitoring measures identified by the specialist environmental studies in the ES. Full details can be found in the respective ES chapters.

16.2 Schedule 4, part 1 of the EIA Regulations (Ref. 16.1) require an ES to include:

> ***"...a description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment."***

16.3 The mitigation and enhancement measures included in this ES fall into one of four categories:

1) Measures to be incorporated into the detailed design;
2) Measures to be applied during construction; and
3) Measures to be applied during operation of the Proposed Development; and
4) Measures to be applied during decommissioning and restoration.

16.4 **Table 16.1** outlines a topic by topic summary of the key issues addressed by the ES and the mitigation measures identified. The mitigation measures are separated into the above categories.

Implementation of Mitigation Measures

16.5 The Applicants anticipate that, where appropriate, NYMNPA will attach conditions on the planning permission to ensure commitment to these mitigation measures.

Review Procedure

16.6 The construction programme is expected to take place during 2014, subject to gaining planning permission. It is recognised that environmental standards and legislation that currently apply to the Proposed Development may change during this period. In light of this, the Applicants intend to undertake regular reviews of the Proposed Development, to ensure that best practice is being followed. The review process will be iterative and ongoing, so

that new information is identified at an early stage and incorporated into the Proposed Development.

16.7 Construction techniques will be incorporated into the works which, where practicable, will be updated when new techniques are devised. This will also apply to monitoring of the works, ensuring that effective mitigation measures are used to minimise disturbance to surrounding receptors.

16.8 The Applicants have committed to preparing a Construction Environmental Management Plan (CEMP) which will clearly set out the methods of managing environmental issues during the construction works. The CEMP will be implemented prior to works commencing on the Application Site and will be updated regularly, thus ensuring it reflects and incorporates current legislation as outlined within this ES.

Table 16.1: Summary of Mitigation and Monitoring Measures

Topic	Effect	Measures
1) Measures incorporated into the Detailed Design		
Landscape and Views	Effects on landscape and views	• The separation and water handling unit, amine and glycol contactors, produced liquid drum, dew point control unit and some auxiliary equipment will be enclosed within the Gas Conditioning Building which will be a maximum height of 8.5m. • The height of equipment and structures has been minimized where practicable i.e. tanks positioned horizontally rather than vertically. • Landscape proposals include the enhancement of existing planting along Ebberston Common Lane, adjacent to the proposed location of the flare and further enhancement of planting surrounding the existing well site and compound. • New planting will reinforce and enhance the existing landscape framework and compensate for limited areas of vegetation loss. • Planting to be included within the overall landscape strategy is to include predominately native and locally endemic species with reference to the Supplementary Planning Document Design Guide (Ref. 16.2). • A recessive colour/material pallet for permanent built elements or structures will be established as part of the Proposed Development. Dark colours (dark green, brown, or dark grey) are generally more acceptable as they complement the natural environment throughout the seasons and the different characteristics of daylight during the year. Consideration will also be given to the general colour of the backdrop against which the building will be seen. As a general rule the roof of an agricultural building should be darker than the walls to bring out the building's form. Dark roofs reflect less light and generally make buildings look smaller and less conspicuous. • Lighting will be designed to take account of the environmental classification of the Assessment Site and meets the national guidance and standards for the UK for such an installation. The design has taken due account of any wildlife issues through careful choice of light source and location of lighting luminaries.
Air Quality	Emissions to air from natural gas refining	• The Proposed Development has been designed to minimize emissions to air through the following: - The flow line from the well head to the process piping will not require pigging. - The gas facility will include isolation valves to enable the isolation of relatively small, discrete sections of plant to minimise quantities of gas requiring venting. The relevant isolated section can then be depressurised via the flare. - As the gas inventory is the primary resource it is in the interest of the operator / owner to flare as little gas as possible. The plant will include isolation valves to enable the isolation of relatively small, discrete sections of plant to minimise the quantity of gas to be released. . - The sulphur will be removed from the gas in the upstream processes. The fuel gas

Topic	Effect	Measures
		system will be fed by clean export gas that meets the National Grid NTS specifications (which includes sulphur content).
	Emissions to air from the flare	• The Proposed Development has been designed to minimise emissions to air through the following: - Flaring will be used if depressurisation is required; - A suitable flare control system will be specified. Steam injection is not relevant to the flare; - The flare will be designed to operate without smoke and will be serviced and maintained to ensure reliable operation; - Flaring will be minimised by through the use of: ▪ Integrated control system and instrumentation to avoid emergency scenarios and minimise flaring; ▪ Equipment will be suitably designed and specified to avoid excessive maintenance requirements and minimise the need for (planned) depressurisation; and • Equipment, relief systems and procedures will be designed and specified to minimise flaring. - Relief of gas to flare will be minimised through: ▪ Design and specification of suitable equipment and systems; ▪ Appropriate operating procedures; and ▪ Good housekeeping.
	Effects from odour releases	• The 'sweetening plant'will remove odorous gas from natural gas prior to any combustion on site.
Noise	Effects of noise on sensitive receptors	• At the equipment procurement stage the design team will confirm that all plant operating together can achieve the proposed noise limit of 60dB $L_{Aeq,5min}$ at any point on the Assessment Site boundary.
Flood risk, hydrology and drainage	Effect on flood risk and contamination of ground and surface water	• The areas of the development platform within the Assessment Site (area of the Lockton Compound) which are not currently protected by a bentonite membrane will be leveled and a bentonite membrane with a suitable protective sand layer above and below. Crushed stone or concrete will then be laid on top of the bentonite membrane. • Water falling onto the extended area of the Lockton Compound will drain into a lined perimeter French drain and discharge through the proposed oil interceptor into a soakaway within the well site. • The pipeline between the well site and Lockton Compound will be above ground and will be supported on pipe racks or stands. • The existing perimeter ditch at the well site will be adapted to include an outlet to the oil interceptor and soakaway. • All tanks will be bunded to provide 110% of the capacity of the largest tank.

Topic	Effect	Measures
Ground Conditions and Contamination	Effects from oil, hydrocarbon and process waste contamination	• The provision of securely bunded areas with interceptors in areas where oil, fuel and process wastes are stored, handled or transferred.
Produced Water Disposal	**Effects from injecting produced water into the Sherwood Sandstone**	• **The borehole to be used for the injection of produced water into the Sherwood Sandstone will be designed in compliance with The Offshore Installations and Well (Design and Construction) to ensure that the borehole is designed and planned to the highest standards.**
2) Measures to be applied during Construction		
Ecology	Effects on habitats resulting from dust emissions	• Dust emissions arising from the topsoil stripping during construction will be controlled through standard dust suppression measures set out in the CEMP to minimise dust deposition.
	Effects on breeding birds	• The following measures will be incorporated into the CEMP: - Vegetation clearance (including tree felling) will be undertaken outside the breeding bird season where possible (typically March to September inclusive). - If vegetation clearance is unable to be undertaken outside the breeding bird season, all areas of vegetation should be checked by an ecologist prior to clearance. In the event that active nest sites are found, an appropriate buffer zone (c. 5m) should be established around the nest and works suspended in this zone until the nest has become unoccupied and any young have fledged. - Liaison will be undertaken with the Forestry Commission during the 2013 goshawk survey season to establish whether any additional goshawk nest sites within 400m of the assessment site have been identified. - In the event that active goshawk nest sites are identified prior to the commencement of construction, the following measures are likely to be required: - Maintenance of a 400m disturbance-free zone between February and July inclusive; and - All tree felling works will be undertaken outside the breeding bird season where practicable (which will be extended to include February due to early nesting habits of goshawk).
	Effects on bats	• Lighting (both permanent and temporary columns) will be directed and focused downwards with appropriate lantern designs to reduce light spillage onto habitats outside construction areas.
	Effects on reptiles	• Areas of deadwood piles and loose heaps of soil/pine needles suitable for reptile hibernation will be cleared outside the winter period to avoid the reptile hibernation season (i.e. between November and February to avoid the bird breeding season) where practicable. • Vegetation will be cleared under the supervision of an ecologist to allow any reptiles to be moved to a place of safety.

Topic	Effect	Measures
		• If site clearance works are to be undertaken in the season during which reptiles are active above ground, phased clearance of the vegetation on the topsoil storage bund will be undertaken to enable any reptiles present to escape from affected areas. • Any reptiles encountered incidentally during the construction works will be immediately moved to a place of safety if they are unable to escape unaided, and the advice of an ecologists sought.
Landscape and Views	Effects on landscape and views	• The following measures will be incorporated into the CEMP: - Retention of existing hedgerows and woodland between the boundary of the Assessment Site and Ebberston Common Lane to keep an established screen between activity within the Assessment Site and adjacent sensitive receptors, all trees to be retained will be protected in accordance with BS5837:2012 - Trees in Relation to Construction (Ref. 16.3); - Establishment of the landscape proposals as an early stage of the construction phase where possible; - Location of contractor's compounds and material stockpiles away from nearby sensitive receptors i.e. south-east corner of the Assessment Site; - Control of the lighting of construction compounds and machinery to minimise upward and outward light pollution. In addition, ensure that the minimum area only is lit, for the minimum period of time; - Limit movements of material between stockpiles so that they do not shift over time thereby adding to the sense of fragmentation and instability of the landscape; - Minimisation of the duration of construction activities which require cranes, scaffolding, and use of designated routes within and around the Assessment Site; and - Agreeing appropriate working hours as proposed (07:00 to 18:00 Monday to Friday and 07:00 to 13:00 on Saturdays) with North York Moors National Park Authority to ensure that adverse visual impacts of construction experienced by the closest residential receptors (Ebberston Common and South Moor Farms) are minimised at times when they could reasonably expect a cessation of construction activity, for example evenings, weekends and bank holidays.
Air Quality	Effects from release of construction dust	• Construction dust will be controlled through the application of a series of measures incorporated into the CEMP including (where appropriate): - Regular inspection and, where necessary, wet suppression of material/soil stockpiles (including wind shielding, storage away from site boundaries, and restricted height of stockpiles); - Appropriate orientation of material stockpiles to minimise wind dispersion; - Provision of wheel washing and wet suppression during loading of wagons/vehicles; - Covering vehicles carrying dry spoil and other wastes; - Shielding of dust-generating construction activities; - Provision of suitable site hoarding;

Topic	Effect	Measures
		- Restricting vehicle speeds on access roads and other unsurfaced areas of the Assessment Site; and - Inspection of unsurfaced haulage routes, and wet suppression as necessary, during prolonged dry periods.
Noise and Vibration	Effects from construction noise	• Good practice as recommended in BS 5228-1:2009 (Ref. 16.4) will be implemented. Measures include maintaining good relations with people living and working in the vicinity of site operations by keeping people informed of progress. • Quiet working methods will be adopted and implemented through the CEMP including: - The use of most suitable plant; - Reasonable hours of working for noisy operations; - Noise will be controlled at source; - On-site noise levels will be monitored regularly; - Avoidance of unnecessary revving of engines; - Switch of equipment when it is not required; - Minimise the drop height of materials; - Starting up plant and vehicles sequentially rather than all together; and - Audible reversing alarms should be of types that have a minimum noise effect on persons outside the site. • The local authority may consider it appropriate to lay down or agree work programmes and periods of use of certain equipment. • Noise from construction will be controlled primarily by the restriction of working hours. In this case, 07.00 to 18.00 Monday to Friday and 07.00 to 13.00 Saturday.
Traffic and Transportation	Effects from traffic along Ebberston Lane and Ebberston Common Lane	• Route cards will be issued to all drivers to ensure that they use the designated access route to the Assessment Site. • All vehicle speeds along Ebberston Lane and Ebberston Common Lane will be restricted to 30 mph. • Large loads being moved up Ebberston Lane and Ebberston Common Lane will be escorted by an escort vehicle to avoid conflict with oncoming traffic.
Flood Risk, Hydrology and Drainage	Effects on surface and groundwater	• The CEMP will include the following measures in compliance with the Environment Agency Prevention Pollution Guidelines especially PPG 6 (Ref. 16.5): - The construction compound and pipe storage area works will be located within the limits of the well site, which has an impermeable membrane passing under the well site and into the perimeter ditches; - The ditch lining that is currently exposed will be protected to ensure that it retains its water retaining qualities; - During the adaptation of the existing perimeter ditch at the well site, the ditches will be temporarily blocked to the side of the working area to prevent accidental discharge of water or contaminants into the partly construction system or the ground;

Topic	Effect	Measures
		- All fuel tanks brought onto site for construction machinery will be kept locked when not being used, and sat within a containment tray in the bunded section of the Assessment Site; - Inspect all storage containers for all materials to ensure that they are fit for purpose regularly inspected and maintained; - No materials will be stored on uncovered ground; - The fuel store will be located where it is not at risk of site vehicles colliding with it; - Machinery shall be re-fuelled in the site compound where the existing site construction will provide protection to the aquifer; - Any maintenance of machinery shall be carried out within the well site to contain spillages of oil, fuel or hydraulic oil; - All cement and grout shall be stored within a contained area and all washing out of cement mixers or concrete delivery lorries must be carried out so that the discharge flows into a lined settlement pond. All tools will also be washed in a suitable area where the discharge cannot flow into the ground; - Avoid storage of large volumes of potential contaminants such as fuel and waste water that will have a much more significant effect than smaller volumes; - All machinery left on site during construction will have drip trays placed under it; - Waste fluids arising from the testing or construction works should be taken off site and disposed of at a suitably licensed facility; and - All static machinery located outside the bunded containment area of the well site during construction shall have drip trays placed under them. • All pipework shall be pressure-tested prior to being commissioned. • All fluids used during testing shall be drained into a prepared sump with a capacity 110% of the pipeline capacity and all waste fluids arising from the testing or construction works will be taken off site by road tanker and disposed of at a suitably licensed facility.
Archaeology and Cultural Heritage	Effects on unknown archaeology beyond the existing made ground	• In the event of the Proposed Development expanding beyond the existing compounds, a programme of archaeological monitoring and recording will be carried in areas outside of the construction work within the footprint of the Proposed Development (such as to the north of Lockton Compound and in the location of the flare) to record any areas of potential archaeological remains.
Ground Conditions and Contamination	Oil and Hydrocarbon contamination	• To mitigate the risk of pollutants entering the controlled waters, handling and storage of fuels and oils will adhere to Environment Agency guidance: PPG1, PPG2, PPG5, PPG6, PPG8, PPG18 and PPG21 (Ref. 16.5). Measures to be implemented through the CEMP will comprise: - Oils and hydrocarbons will be stored in designated locations with specific measures to prevent leakage and release of their contents, including locating the storage area away from the surface water drainage system and watercourses on an impermeable base, with an impermeable bund that has no outflow and is of adequate capacity to contain at least 115% of the contents;

Topic	Effect	Measures
		- Machinery will be refuelled using a transfer hose and valves. Trigger guns will also be protected from vandalism and kept locked when not in use; - When not operational, plant and machinery will have drip trays beneath oil tanks/engines/gearboxes/hydraulics that will be checked and emptied regularly via a licensed waste disposal operator; and - An emergency spillage action plan will be produced, which site staff will have read and understood. On-site provisions will be made to contain a serious spill or leak through the use of spill kits, booms, bunding and absorbent material. Site staff will be trained in the use of emergency spill response equipment.
	Loss of ground support due to dissolution, sliding caused by adverse bedrock structure, collapse and running sands.	• Appropriate geotechnical investigation will be undertaken in key areas of the Proposed Development and construction activities. The ground conditions encountered will need to be logged and geotechnical testing of the soils will need to be undertaken: - Appropriate stability analyses should be undertaken to confirm if there is a risk; and - If required, temporary excavation support and temporary dewatering could be designed to prevent collapse of the excavation while it is open.
Produced Water Disposal	**Effects from injecting produced water into the Sherwood Sandstone**	• **The borehole to be used for the injection of produced water into the Sherwood Sandstone will be constructed in compliance with The Offshore Installations and Well (Design and Construction) to ensure that the borehole is constructed properly.**
3) Measures to be applied during Operation		
Ecology	Effects on bats	• Lighting (both permanent and temporary columns) will be directed and focused downwards with appropriate lantern designs to reduce light spillage onto habitats outside the development footprint.
Landscape and Views	Effects on landscape and views	• A landscape maintenance programme will be adopted to ensure the long-term survival of existing and proposed features in order to enhance their biodiversity and amenity value. The details of the landscape maintenance programme will be agreed with the North York Moors National Park Authority.
Noise and Vibration	Effects of noise on nearby sensitive receptors	• The noise limit to ensure that there is no audible noise above background at the nearest noise-sensitive receptor, Ebberston Common Farm, is 60dB $L_{Aeq,5min}$ at any point on the Assessment Site boundary.
Traffic and Transportation	Effects from traffic along Ebberston Lane and Ebberston Common Lane	• Route cards will be issued to all drivers to ensure that they use the designated access route to the Assessment Site. • All vehicle speeds along Ebberston Lane and Ebberston Common Lane will be restricted to 30 mph. • Large loads being moved up Ebberston Lane and Ebberston Common Lane will be escorted by an escort vehicle to avoid conflict with oncoming traffic.

Topic	Effect	Measures
		• The cargo should be transported by a haulier licensed to carry such products. • The vehicle used to transport the product will have a fully documented maintenance record including a record of examination of hydraulic braking systems. • The vehicle carrying the cargo will be escorted from the A170 up to the Assessment Site. • The vehicle carrying the cargo will avoid taking right hand turns across the flow of traffic unless there is a clearly defined right hand turn lane in a position of good visibility and speed restrictions. • The proposed route to the Assessment Site will come from the west along the A170 and then turn into Ebberston Lane towards the Assessment Site. • The proposed route away from the Assessment Site will turn eastwards on the A170 and then turn southwards on the B1258 to Knapton.
Flood Risk, Hydrology and Drainage	Effects on flood risk	• Rainwater will be gathered in ditches and either used on site or discharged through an oil interceptor into the soakaway.
	Effects on quality of surface and ground water	• The oil interceptor will provide control on all discharge and a monitoring point will permit sampling to check the discharge. • Valves fitted to the outflow pipe from the Assessment Site will enable isolation of the interceptor during drilling operations and the risk of contamination to the aquifer will be negligible. • Rainwater collecting within the new tank bunds and other bunded areas will be taken off site in tankers to be processed at an off-site facility.
Ground Conditions and Contamination	Oil, hydrocarbon and process waste contamination	• To mitigate the risk of pollutants entering the controlled waters, handling and storage of fuels and oils will adhere to Environment Agency guidance: PPG1, PPG2, PPG5, PPG6, PPG8, PPG18 and PPG21 (Ref. 16.5). Measures will comprise: - Oils and hydrocarbons will be stored in designated locations with specific measures to prevent leakage and release of their contents, including locating the storage area away from the surface water drainage system and watercourses on an impermeable base, with an impermeable bund that has no outflow and is of adequate capacity to contain at least 115% of the contents; - Machinery will be refuelled using a transfer hose and valves. Trigger guns will also be protected from vandalism and kept locked when not in use; - When not operational, plant and machinery will have drip trays beneath oil tanks/engines/gearboxes/hydraulics that will be checked and emptied regularly via a licensed waste disposal operator; and - An emergency spillage action plan will be produced, which site staff will have read and understood. On-site provisions will be made to contain a serious spill or leak through the use of spill kits, booms, bunding and absorbent material. Site staff will be trained in the use of emergency spill response equipment.
Produced Water Disposal	**Effects from injecting**	• **The borehole to be used for the injection of produced water into the Sherwood**

Topic	Effect	Measures
	produced water into the Sherwood Sandstone	**Sandstone will be operated in compliance with The Offshore Installations and Well (Design and Construction) to ensure that the borehole is operated properly.** • **Injection pressures will be generally low and will be controlled so that they do not exceed the strength and fracturing pressure of the formation.**
4) Measures to be applied during Demolition and Restoration		
Ecology	Effects on habitats resulting from dust emissions	• Dust emissions arising from the topsoil stripping during decommissioning and restoration regardless of whether future planning permission is secured for the well site will be controlled through standard dust suppression measures set out in the CEMP to minimise dust deposition.
Landscape and Views	Effects on landscape and views	• Reinstatement work if future planning permission is not secured will include removing the existing access, hardcore and fencing associated with the well site and flare and re-grading stored sub-soil and topsoil to replicate the pre-existing levels. This will then be scarified and returned to forestry in accordance with the Forestry Commission Plan within the next planting season. Much of this area is proposed to include regenerating broadleaf forest which will be assisted by the proposed planting of broadleaf species along the Assessment Site's southern boundary. The Lockton Compound will be returned to its existing state. • If future planning permission is secured then the well site will remain as per the operation phase and the Lockton Compound will be returned to its existing state. • A landscape maintenance programme will be adopted to ensure the long-term survival of existing and proposed features in order to enhance their biodiversity and amenity value regardless of securing future planning permission for the well site. The details of the landscape maintenance programme will be agreed with the North York Moors National Park Authority at the appropriate time.
Air Quality	Effects from release of dust	• Dust produced during decommissioning and restoration regardless of whether future planning permission is secured for the well site will be controlled through the application of a series of measures incorporated into the CEMP including (where appropriate): - Regular inspection and, where necessary, wet suppression of material/soil stockpiles (including wind shielding, storage away from site boundaries, and restricted height of stockpiles); - Appropriate orientation of material stockpiles to minimise wind dispersion; - Provision of wheel washing and wet suppression during loading of wagons/vehicles; - Covering vehicles carrying dry spoil and other wastes; - Shielding of dust-generating construction activities; - Provision of suitable site hoarding; - Restricting vehicle speeds on access roads and other unsurfaced areas of the Assessment Site; and - Inspection of unsurfaced haulage routes, and wet suppression as necessary, during prolonged dry periods.

Topic	Effect	Measures
Noise and Vibration	Effects from noise	• Good practice as recommended in BS 5228-1:2009 (Ref. 16.4) will be implemented regardless of whether future planning permission is secured for the well site. Measures include: - Maintaining good relations with people living and working in the vicinity of site operations by keeping people informed of progress. • Quiet working methods will be adopted and implemented through the CEMP regardless of whether future planning permission is secured for the well site including: - The use of most suitable plant; - Reasonable hours of working for noisy operations; - Noise will be controlled at source; - On-site noise levels will be monitored regularly; - Avoidance of unnecessary revving of engines; - Switch of equipment when it is not required; - Minimise the drop height of materials; - Starting up plant and vehicles sequentially rather than all together; and - Audible reversing alarms should be of types that have a minimum noise effect on persons outside the site. • The local authority may consider it appropriate to lay down or agree work programmes and periods of use of certain equipment regardless of whether future planning permission is secured for the well site. • Noise from construction will be controlled primarily by the restriction of working hours regardless of whether future planning permission is secured for the well site. In this case, 07.00 to 18.00 Monday to Friday and 07.00 to 13.00 Saturday.
Traffic and Transportation	Effects from traffic along Ebberston Lane and Ebberston Common Lane	• Route cards will be issued to all drivers to ensure that they use the designated access route to the Assessment Site. • All vehicle speeds along Ebberston Lane and Ebberston Common Lane will be restricted to 30 mph. • Large loads being moved up Ebberston Lane and Ebberston Common Lane will be escorted by an escort vehicle to avoid conflict with oncoming traffic.
Flood Risk, Hydrology and Drainage	Effects on surface and groundwater	• The CEMP will include the following measures in compliance with the Environment Agency Prevention Pollution Guidelines especially PPG 6 (Ref. 16.5): - The construction compound and pipe storage area works will be located within the limits of the well site, which has an impermeable membrane passing under the well site and into the perimeter ditches; - The ditch lining that is currently exposed will be protected to ensure that it retains its water retaining qualities; - During the adaptation of the existing perimeter ditch at the well site the ditches will be temporarily blocked with side of the working area to prevent accidental discharge of water or contaminants into the partly construction system or the ground; - All fuel tanks brought onto site for construction machinery will be kept locked when not

Topic	Effect	Measures
		being used, and sat within a containment tray in the bunded section of the Assessment Site; - Inspect all storage containers for all materials to ensure that they are fit for purpose regularly inspected and maintained; - No materials will be stored on uncovered ground; - The fuel store will be located where it is not at risk of site vehicles colliding with it; - Machinery shall be re-fuelled in the site compound where the existing site construction will provide protection to the aquifer; - Any maintenance of machinery shall be carried out within the well site to contain spillages of oil, fuel or hydraulic oil; - All cement and grout shall be stored within a contained area and all washing out of cement mixers or concrete delivery lorries must be carried out so that the discharge flows into a lined settlement pond. All tools will also be washed in a suitable area where the discharge cannot flow into the ground; - Avoid storage of large volumes of potential contaminants such as fuel and waste water that will have a much more significant effect than smaller volumes; - All machinery left on site during construction will have drip trays placed under it; - Waste fluids arising from the testing or construction works should be taken off site and disposed of at a suitably licensed facility; - All static machinery located outside the bunded containment area of the well site during construction shall have drip trays placed under them.
Ground Conditions and Contamination	Oil, hydrocarbon and process waste contamination	• To mitigate the risk of pollutants entering the controlled waters, regardless of whether future planning permission is secured for the well site, handling and storage of fuels and oils will adhere to Environment Agency guidance: PPG1, PPG2, PPG5, PPG6, PPG8, PPG18 and PPG21 (Ref. 16.5). Measures to be implemented through the CEMP will comprise: - Oils and hydrocarbons will be stored in designated locations with specific measures to prevent leakage and release of their contents, including locating the storage area away from the surface water drainage system and watercourses on an impermeable base, with an impermeable bund that has no outflow and is of adequate capacity to contain at least 115% of the contents; - Machinery will be refuelled using a transfer hose and valves. Trigger guns will also be protected from vandalism and kept locked when not in use; - When not operational, plant and machinery will have drip trays beneath oil tanks/engines/gearboxes/hydraulics that will be checked and emptied regularly via a licensed waste disposal operator; and - An emergency spillage action plan will be produced, which site staff will have read and understood. On-site provisions will be made to contain a serious spill or leak through the use of spill kits, booms, bunding and absorbent material. Site staff will be trained in the use of emergency spill response equipment.

17A.0 STATEMENT OF SIGNIFICANCE

Residual Effects

17.1 The residual effects of the Proposed Development following implementation of the measures outlined in the preceding technical chapters and in Chapter 16 have been assessed. Although each technical chapter contains detailed consideration of residual effects, **Table 17.1** summarises the main residual effects of the Proposed Development. The significance criteria are set out in Chapter 2 (EIA Methodology) and within relevant technical chapters where a different approach is followed.

17.2 The preparation of the ES was undertaken in parallel with the design process. Consequently, many measures to mitigate likely significant adverse environmental effects have been incorporated into the Proposed Development design in order to avoid, reduce or offset such effects. With respect to management of the demolition and construction process, the Construction Environmental Management Plan (CEMP) will set out the methods of managing environmental issues for all involved with the construction works to eliminate, reduce or offset adverse environmental effects. These will address relevant environmental issues, such as: noise; air quality and dust; hours of work; site drainage and protection from or minimisation of surface/ground-water pollution and protection of environmental and amenity resources. It is anticipated that the mitigation measures identified will be secured by planning obligations or conditions, to ensure that the scheme proposed by the Applicant is delivered.

17.3 In summary, the Proposed Development comprises the exploitation of conventional hydrocarbon resources only, for an operational period of up to five years, including: gas production from one wellhead at the existing Ebberston Moor 'A' Well Site; piping the produced gas to the adjoining Lockton Compound where the gas would be conditioned; injecting the conditioned gas via an existing Above Ground Installation (AGI) connection to a Northern Gas Network (NGN) pipeline that runs between Pickering and Whitby; and creation of two new access points off Ebberston Common Lane.

17.4 The Proposed Development will result in the following beneficial effects:

- Supplying a significant area of North Yorkshire with locally produced natural gas;
- The creation of up to 30 construction and 10 demolition and restoration jobs, for people with skills that are readily available in the local labour market;
- Introduction of indirect economic vitality to the local area through local procurement of supplies and services during construction;

- Securing the present employment of the Applicant's employees who will be in charge of operating the facility;
- Providing additional and new business to local businesses engaged in transport, engineering, maintenance and supply; and
- Improvement of the UK's ability to manage fluctuations (daily, weekly and seasonally) which occur in gas supply and demand and thus enabling indirect reductions in costs for householders and commercial and industrial companies,

17.5 The ES has also identified a number of adverse effects which will mainly occur during construction and demolition and restoration phases which include the following:

- Loss of breeding bird habitat;
- Changes to a limited number of views associated with construction activities from residential properties, roads and public rights of way;
- Local changes to landscape features, character and the National Park as a result of construction activities;
- Temporary disruption to users of the surrounding road network;
- Potential for mobilisation of contaminants resulting in the deterioration of surface and ground water quality;
- Potential for dust emissions resulting from the clearance of on-site structures and groundworks; and
- Potential for noise and vibration disturbance to the nearby residents.

17.6 However, the implementation of the mitigation measures outlined within the CEMP during construction such as the use of site hoarding, dust and noise suppression measures and temporary drainage will result in many adverse effects being minimised or avoided.

17.7 There would also be adverse residual effects during operation of the Proposed Development resulting from the following:

- Changes to a limited number of views from residential properties, roads and public rights of way;
- Local changes to the National Park;
- Increased traffic along Ebberston Lane and Ebberston Common Lane associated with operational staff access and existing the Proposed Development and the transportation of by products and treatment fluids;
- Visual and landscape effects on Ebberston Low Moor Round Barrow Scheduled Monument and its setting;

- Increased traffic movement affecting the setting of Ebberston Low Moor Round Barrow Scheduled Monument.

17.8 Once decommissioning and restoration has been completed after up to five years of operational activities in scenario 1(future planning permission is secured for the well site) many of the effects on the environment will generally be neutral or slightly beneficial. There will be more beneficial effects in scenario 2 (no future planning permission is secured for the well site) as the whole Assessment Site will be decommissioned and restored to its original state of forestry.

Table 17.1: Significance Table

Topic	Stage of Development	Residual Effects	Duration of Effect	Geographical Importance							Significance of Residual Effect
				I	UK	E	R	C	NP	L	
Ecology	Construction	Displacement/ disturbance to birds in the North York Moors SPA/ SSSI	Temporary	*							Negligible
		Loss of habitat including forestry plantation	Permanent							*	Negligible
		Damage to habitat as a result of dust deposition	Temporary							*	Negligible
		Loss of breeding bird habitat	Permanent							*	Minor Adverse
		Noise/visual disturbance to breeding goshawk	Temporary							*	Negligible
		Noise/visual disturbance to breeding nightjar	Temporary							*	Negligible
		Loss of habitat used by foraging/ commuting bats	Permanent							*	Negligible
		Lighting disturbance to foraging/ commuting bats	Temporary							*	Negligible
		Loss of habitat supporting reptiles	Permanent							*	Negligible
		Loss/ damage to habitat supporting reptiles	Temporary							*	Negligible
	Operation	Changes in air quality resulting in effects on Troutsdale & Rosekirk Dale Fens SSSI	Temporary		*						Negligible
		Changes in water quality resulting in effects on Troutsdale & Rosekirk Dale Fens SSSI	Temporary		*						Negligible
		Noise/visual disturbance to birds in the North York Moors SPA/ SSSI	Temporary	*							Negligible
		Changes in air quality resulting in effects on habitats	Temporary							*	Negligible
		Changes in water quality resulting in effects on habitats	Temporary							*	Negligible
		Noise/visual disturbance to breeding	Temporary							*	Negligible

Topic	Stage of Development	Residual Effects	Duration of Effect	Geographical Importance							Significance of Residual Effect
				I	UK	E	R	C	N P	L	
		goshawk									
		Noise/visual disturbance to breeding nightjar	Temporary							*	Negligible
		Lighting disturbance to foraging/ commuting bats	Temporary							*	Negligible
	Decommissioning and Restoration	Changes in air quality resulting in effects on Troutsdale & Rosekirk Dale Fens SSSI	Temporary		*						Negligible
		Noise/ visual disturbance to birds in the North York Moors SPA/ SSSI	Temporary	*							Negligible
		Noise/ visual disturbance to breeding goshawk	Temporary							*	Negligible
		Noise/ visual disturbance to breeding nightjar	Temporary							*	Negligible
		Increased habitat availability for foraging/ commuting bats	Temporary							*	Minor Beneficial
Landscape and Views	Construction	Landscape Features	Temporary							*	Moderate Adverse
		Landscape Character	Temporary					*	*	*	Moderate Adverse
		National Park	Temporary				*	*	*	*	Moderate Adverse
		Visual Effects – Residential Properties	Temporary							*	Minor Adverse
		Visual Effects – Roads	Temporary							*	Moderate Adverse
		Visual Effects - PRoW	Temporary						*	*	Moderate Adverse
		Visual Effects – Night Sky Character	Temporary								Moderate Adverse
	Operation	Landscape Features	Temporary (up to 5 years)							*	Minor Adverse
		Landscape Character	Temporary (up to 5 years)					*	*	*	Minor Adverse
		National Park	Temporary (up to 5 years)				*	*	*	*	Minor Adverse

Topic	Stage of Development	Residual Effects	Duration of Effect	Geographical Importance							Significance of Residual Effect
				I	UK	E	R	C	NP	L	
		Visual Effects – Residential Properties	Temporary (up to 5 years)							*	Minor Adverse
		Visual Effects - Roads	Temporary (up to 5 years)							*	Moderate Adverse
		Visual Effects – ProW	Temporary (up to 5 years)						*	*	Moderate Adverse
		Visual Effects – Night Sky Character	Temporary (up to 5 years)						*	*	Moderate Adverse
	Decommissioning and Restoration (Scenario 1)	Landscape Features	Permanent							*	Negligible
		Landscape Character	Permanent					*	*	*	Negligible
		National Park	Permanent				*	*	*	*	Negligible
		Visual Effects – Residential Properties	Permanent							*	Negligible
		Visual Effects – Roads	Permanent							*	Negligible
		Visual Effects - PROW	Permanent						*	*	Minor Adverse – Negligible
		Visual Effects – Night Sky Character	Permanent						*	*	Negligible
	Decommissioning and Restoration (Scenario 2)	Landscape Features	Permanent								Minor Beneficial
		Landscape Character	Permanent								Minor Beneficial
		National Park	Permanent								Minor Beneficial
		Visual Effects – Residential Properties	Permanent								Minor Beneficial
		Visual Effects – Roads	Permanent								Minor Beneficial
		Visual Effects - PROW	Permanent								Minor Beneficial
		Visual Effects – Night Sky Character	Permanent								Negligible
Air Quality	Construction	Increase in fugitive dust emissions during construction	Temporary							*	Negligible
		Construction traffic emissions	Temporary							*	Negligible
	Operation	Operational traffic emissions	Temporary							*	Negligible
		Operational plant emissions	Temporary							*	Negligible

Topic	Stage of Development	Residual Effects	Duration of Effect	Geographical Importance							Significance of Residual Effect
				I	UK	E	R	C	NP	L	
	Decommissioning and Restoration	Increase in fugitive dust emissions during decommissioning and restoration	Temporary							*	Negligible
		Decommissioning and restoration traffic emissions	Temporary							*	Negligible
Noise and Vibration	Construction	Noise nuisance at local noise-sensitive properties	Temporary							*	None
		Increased road traffic noise at local noise-sensitive properties	Temporary							*	None
	Operation	Noise nuisance and loss of amenity at local noise-sensitive properties	Temporary							*	Negligible
		Increased road traffic noise at local noise-sensitive properties	Temporary							*	Negligible
		Increased noise for passers-by	Temporary							*	Negligible
	Decommissioning and Restoration	Noise nuisance at local noise-sensitive properties	Temporary							*	None
Transport and Access	Construction	Construction activities	Temporary							*	Minor Adverse / Negligible
	Operation	Operational staff	Temporary							*	Minor Adverse / Negligible
		Transportation of by-products and treatment fluids	Temporary							*	Minor Adverse / Negligible
	Decommissioning and Restoration	Traffic along Ebberston Lane and Ebberston Common Lane	Temporary							*	Minor Adverse / Negligible
Flood Risk, Hydrology and Drainage	Construction	Contamination of Aquifer	Permanent						*	*	Negligible
		Contamination of Aquifer during construction	Permanent						*	*	Negligible
		Construction activities	Temporary							*	Negligible
	Operation	Discharge of surface water from sites	Permanent						*	*	Minor Adverse / Negligible
		Delivery/ collection of fluids by tanker	Permanent						*	*	Minor Adverse / Negligible
	Decommissioning and Restoration	Contaminated discharge	Permanent						*	*	Negligible
		Reinstatement of original environment	Permanent						*	*	Moderate

Topic	Stage of Development	Residual Effects	Duration of Effect	Geographical Importance							Significance of Residual Effect
				I	UK	E	R	C	N P	L	
											Beneficial
Archaeology and Cultural Heritage	Construction	Damage / destruction buried archaeological remains or deposits within Assessment Site	Permanent						*		Moderate Beneficial
		Visual and landscape effects on Scheduled Monument: Ebberston Low Moor Round Barrow (Map code 9)	Temporary		*						Minor Adverse
		Increased traffic movement affecting setting of Scheduled Monument: Ebberston Low Moor Round Barrow (Map code 9)	Temporary		*						Minor Adverse
		Landscape effect on setting of Scheduled Monument: Ebberston Low Moor earthworks (Map code 8)	Temporary		*						Negligible Adverse
		Damage post-medieval quarry site (Map code 18)	Permanent							*	Negligible Adverse
	Operation	Visual and landscape effects on Scheduled Monument: Ebberston Low Moor Round Barrow (Map code 9)	Temporary		*						Minor Adverse
		Increased traffic movement affecting setting of Scheduled Monument: Ebberston Low Moor Round Barrow (Map code 9)	Temporary		*						Minor Adverse
		Landscape effects on setting of Scheduled Monument: Ebberston Low Moor earthworks (Map code 8)	Temporary		*						Negligible Adverse
	Decommissioning and Restoration	Visual and landscape effects on Scheduled Monument: Ebberston Low Moor Round Barrow (Map code 9)	Temporary		*						Moderate Beneficial
		Increased traffic movement of Scheduled Monument: Ebberston Low Moor Round Barrow (Map code 9)	Temporary		*						Moderate Beneficial
		Landscape effects on setting of Scheduled Monument: Ebberston Low Moor earthworks (Map code 8)	Temporary		*						Moderate Beneficial
Socio Economics	Construction	Effects on	Short Term					*	*	*	Minor Beneficial

Topic	Stage of Development	Residual Effects	Duration of Effect	Geographical Importance							Significance of Residual Effect
				I	UK	E	R	C	NP	L	
		Employment									
	Operation	Effects on Employment	Medium Term					*	*	*	Minor Beneficial
		Effects on Gas Supply	Medium Term		*						Moderate Beneficial
	Demolition and Restoration	Effects on Employment	Short Term					*	*	*	Minor Beneficial
Ground Conditions and Contamination	Construction	Hydrocarbon contamination	Temporary							*	Negligible
		Ground collapse during construction	Temporary							*	Negligible
	Operation	Hydrocarbon contamination	Temporary							*	Negligible
		Process waste contamination	Temporary							*	Negligible
	Decommissioning and Restoration	Hydrocarbon contamination	Temporary							*	Negligible
		Process waste contamination	Temporary							*	Negligible
Produced Water Disposal	**Construction**	**Contamination of aquifer**	**Permanent/ Long Term**						*	*	**Negligible**
	Operation	**Contamination of aquifer**	**Permanent/ Long Term**						*	*	**Negligible**
	Decommissioning	**None**									**N/A**
	Restoration	**Reinstatement of original environment**	**Permanent**						*	*	**Negligible Beneficial**

*** Geographical Level of Importance**

I = International; UK = United Kingdom; E = England; R = Regional; C = County; NP = National Park; L = Local

18A.0 PRODUCED WATER DISPOSAL

Introduction

18.1 This chapter of the ES assesses the likely significant effects of the Proposed Development in terms of the disposal of produced water and should be read in conjunction with Chapter 12 Flood Risk, Hydrology and Drainage of the Original ES which assesses the effects on the surface water environment. The description of the process of injecting water into the Sherwood Sandstone formation is provided in Chapter 4A Proposed Development.

18.2 This chapter describes: the approach to disposal; the technical assessment; the baseline conditions relating to the disposal; the likely significant environmental effects; the mitigation measures required to prevent, reduce or offset any significant adverse effects; and the likely residual effects after these measures have been employed. This chapter has been prepared by Envireau Water.

Planning Policy Context

Relevant Legislation and UK Regulation

18.3 The European Water Framework Directive (2000/60/EC) (WFD) (Ref. 18.1) came into force in December 2000 and became part of UK law in December 2003. Groundwater issues are addressed by the Groundwater Daughter Directive (2006/118/EC) (GWDD) (Ref. 18.2) and the preceding Groundwater Directive (80/68/EEC) (GWD) (Ref. 18.3).

18.4 Disposal of water into the natural environment is controlled by the Environment Agency under the Environmental Permitting Regulations 2010 (Ref. 18.4). In order to be able to discharge water to groundwater a permit is required ("a groundwater permit") under these regulations.

18.5 The Environment Agency's groundwater protection strategy of prevention and limitation is informed by the publication, Groundwater Protection: Principles and Practice (Nov 2012, Version 1) (GP3) (Ref. 18.5).

18.6 The Applicant and its advisers have had a number of constructive discussions with the Environment Agency at both local (area) and national levels about the proposed disposal of produced water to the Sherwood Sandstone formation. The proposal to discharge water will be the subject of a formal application to the Environment Agency under the Environmental Permitting Regulations 2010 (Ref. 18.4).

18.7 A detailed review of the regulatory context of this application has been undertaken by the Applicant. The review demonstrates that under European and English law and regulation that the proposed discharge can be permitted if:

- The receiving water is permanently unsuitable and has no resource value;
- That the discharge lies within the policy described by the Environment Agency in GP3 (Ref. 18.5);
- That the discharge represents best available technology (BAT) and best practicable environmental option (BPEO);
- That the discharge meets the requirements of the Water Framework Directive (Ref. 18.1) and Groundwater Daughter Directive (Ref. 18.2).

National Planning Policy

18.8 The NPPF (Ref. 18.6) was published in March 2012 and sets out the new approach to streamlining the Planning System and encouraging growth. All previous Planning Policy Guidance (PPGs) and Planning Policy Statements (PPSs) listed in Annex 3 of the NPPF are replaced by the NPPF.

18.9 Fundamental principles underpinning the NPPF are the need to deliver sustainable development and build a strong, competitive economy nationwide. In terms of produced water disposal the following sections of the NPPF are considered of relevance to this assessment.

18.10 11. Conserving and enhancing the natural environment states in paragraph 109 that:

> ***"The planning system should contribute to and enhance the natural and local environment by:***
>
> - ***protecting and enhancing valued landscapes, geological conservation interests and soils;***
> - ***recognising the wider benefits of ecosystem services;***
> - ***minimising impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including by establishing coherent ecological***

networks that are more resilient to current and future pressures;

- ***preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability; and***
- ***remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate."***

18.11 In addition paragraph 143 states that:

"In preparing Local Plans, local planning authorities should:

- ***set out environmental criteria, in line with the policies in this Framework, against which planning applications will be assessed so as to ensure that permitted operations do not have unacceptable adverse impacts on the natural and historic environment or human health, including from noise, dust, visual intrusion, traffic, tip- and quarry-slope stability, differential settlement of quarry backfill, mining subsidence, increased flood risk, impacts on the flow and quantity of surface and groundwater and migration of contamination from the site; and take into account the cumulative effects of multiple impacts from individual sites and/or a number of sites in a locality;"***

Local Planning Policy

NYMNPA Local Development Framework

18.12 Mineral planning within the National Park comes under the jurisdiction of the North York Moors National Park Authority (NYMNPA). The Local Development Framework consists of a number of different documents to guide future development whilst ensuring that the National Park's special qualities are conserved and enhanced. The Core Strategy and Development Policies document, adopted in November 2008 (Ref. 18.7), is key to the NYMNPA Local Development Framework. It sets out a spatial vision for the future of the National Park and provides Core Policies guiding a strategic framework for the scale and location of all types of new development and detailed development policies against which individual proposals such as waste and minerals will be assessed.

18.13 Development Policy 1 Environmental Protection states that

"To conserve and enhance the special qualities of the North York Moors National Park, development will only be permitted where:

1. ***It will not have unacceptable adverse impact on surface and ground water, soil, air quality and agricultural land.***
2. ***It will not generate unacceptable levels of noise, vibration, activity or light pollution.***
3. ***There will be no adverse effects arising from sources of pollution which would impact on the health, safety and amenity of the public users of the development.***
4. ***Land stability can be achieved without causing unacceptable environmental or landscape impact. "***

Assessment Methodology

Desk Top Study

18.14 This assessment of the risk associated with the disposal of produced waters takes the form of a desk top study supported by water sampling and analysis undertaken in the summer of 2013. The assessment has covered the following key areas:

- A detailed overview of the relevant legislation and UK regulation governing disposal of produced water from onshore oil and gas production, within the context of the proposal to dispose of produced water from gas production at Ebberston Moor 'A' Well Site to the Sherwood Sandstone formation;
- A detailed, technical appraisal of the geology beneath the Ebberston Moor gas field and the quality of the relevant water bearing formations;
- A comprehensive risk assessment for the proposed method of disposal, conducted in accordance with the approach set out in DEFRA's Green Leaves III (Ref. 18.8). Green Leaves III is the latest edition of the Government's Guidelines for Environmental Risk Assessment and Management, providing generic guidelines for the assessment and management of environmental risks. The guidelines supersede earlier versions published in 1995 by the Department of the Environment, and in 2000 by the Department of the Environment, Transport and the Regions and the Environment Agency. Revision III brings the guidelines in England and Wales in line with current thinking in the field of environmental risk management;
- A robust justification for the proposed method of disposal, based on the principles of Best Practicable Environmental Option (BPEO) and Best Available Technology (BAT).

Technical Assessment

18.15 The desk top study reviewed the information provided by:

- Environment Agency;
- British Geological Survey;
- Geological Society;
- The Applicant's geological and geophysics (G&G) team; and
- Peer reviewed journals and other publications.

18.16 A full Bibliography of all reference materials used to inform the baseline study is presented in **Appendix 18A.1**. A dull description of the produced water injection proposals is contained within Chapter 4A Proposed Development.

18.17 The detailed technical assessment examined the following:

- The geographical, hydrological, geological and hydrogeological setting;
- Examination of water dependent features and protected water rights within a 70 km radius of the proposed injection site (Ebberston Moor 'A' Well Site);
- Examination of the quality of the formation water within the Permian Kirkham Abbey Formation (KAF) reservoir and the Sherwood Sandstone formation, both by analysis of samples and with reference to published information;
- Examination of proposed additives;
- Comparison of injection and formation waters with sea water; and
- Review of the injection method, rates and volumes.

18.18 The technical assessment has been drawn together into a conceptual model which is illustrated in **Figure 18.1**. In summary the conceptual model comprises:

- Four hydrogeological units – namely:
  - The geology above the Oxford Clay (Layer 1);
  - The geology from the base of the Mercia Mudstone to the Oxford Clay (Layer 2);
  - The Triassic Sherwood Sandstone formation (Layer 3); and
  - The Zechstein (Permian) / Carboniferous (Layer 4);
- The lateral variation in geology, is controlled by dip and east west faulting;
- Natural recharge to the Sherwood Sandstone formation is limited to the outcrop and subcrop areas in Vale of York / Mowbray. Recharge to the geology above the Oxford Clay is limited to the outcrop on the North York Moors;

- Hydraulic properties of the layers have been defined by literature search, but broadly:
  - Layer 1 can be taken as having useful hydraulic conductivity and storage;
  - Layer 2 is poorly permeable (very low hydraulic conductivity) and has limited useful storage;
  - Layer 3 has useful hydraulic conductivity and storage; and
  - Layer 4 has limited hydraulic conductivity and storage, and poorly permeable clay and mudstone horizons effectively hydraulically separate the Permian (Layer 4) from the overlying Triassic water bearing formation;
- Differences in water quality between the water bearing formations has been defined by literature search and confirmed in the case of Layer 3 & 4, from water sampling and analysis.
- The change in salinity of the formation water in the Sherwood Sandstone is illustrated by an arbitrary line on **Figure 18.2**. This line denotes a change from what can be described as groundwater to formation water. This line has been located based on the literature search and can be conceptualised as an isochlor (a line of equal salinity [or more accurately chloride concentration]); and
- To the west of the above line the Sherwood Sandstone can be considered to form an aquifer, where the groundwater has a resource value. The Ebberston Moor 'A' Well Site is some 40 km to the east of this aquifer, where the formation water has no resource value.

18.19 When combined, the various aspects of the conceptual model produce a system with no transfer of water vertically between the permeable Layers 1 and 3, either upward or downward. This is achieved by the low permeability and thickness of Layer 2 and low vertical hydraulic conductivity of Layer 4. The effectiveness of the hydraulic separation is demonstrated by the marked difference in water quality between Layers 1 and 3, where the sandstone is located at great depth; in excess of 1km below ground level.

18.20 The quality of the sandstone water at depth demonstrates that circulation of recharge into the Sherwood Sandstone formation is limited to near the outcrop/subcrop areas, with very little deep circulation occurring. Evidence published in the literature (Bottrell 2006) indicates that the sodium chloride (NaCl) in the sandstone formation water is mineral rather than sea water based. This demonstrates that the salinity is due to the long residence time of the water in the rock and the dissolution of salt based minerals. This further demonstrates that the significant down dip distance of the Ebberston Moor 'A' Well Site (~40 km) effectively separates it from the aquifer zone.

18.21 This assessment has adopted the following descriptions of groundwater, aquifers and formation water, in order to differentiate between the relatively shallow, potable water supplies and the deep system with no resource value:

- **Groundwater:** That water which occurs in the strata above the Triassic Mercia Mudstone and can be reasonably attributed to relatively geologically recent recharge and which would reasonably be considered to be wholesome (potable) unless it has been contaminated (altered) by anthropogenic activity;
- **Aquifer:** The strata that contains groundwater as described above;
- **Produced Water:** The water (brine) produced from the gas production formation in association with the extraction and separation of gas or the development of the well;
- **Formation Water:** The water (brine) within the deep geological horizons which can be considered as connate, or sourced from geologically old recharge and has no resource value; and
- **Water Bearing Formation:** A geological unit (or formation) which contains formation water.

18.22 The meaning of groundwater and aquifer are the same as that intended in the Water Framework Directive (Ref. 18.1) and Groundwater Daughter Directive (Ref. 18.2), whilst the other terms are commonly used in the oil and gas industry.

Assessment of Effects

18.23 The assessment of effects will use the criteria stated in Chapter 2, including the matrix detailed in **Table 2.1**, reproduced below as **Table 18.1**, which defines the level of significance of effects. Where an effect is considered to be significant, this significance will generally be classified as major, moderate or minor (with these descriptions again being based on precedent or current guidance).

Table 18.1: Significance Matrix

Sensitivity /Value of Receptor	Magnitude of Effect		
	High	**Medium**	**Low**
High (England, UK, International)	Major	Major/Moderate	Moderate
Medium (County, Regional)	Major/Moderate	Moderate	Moderate/Minor
Low (Local, Borough)	Moderate	Moderate/Minor	Minor

18.24 The three levels of significance defined by the generic matrix are:

- Major – an effect which in isolation could have a material influence on the decision making process;
- Moderate – an effect which on its own could have moderate influence on decision making, particularly when combined with other similar effects; or
- Minor – an effect which on its own is likely to have a minor influence only on decision making but when combined with other effects could have a more material influence.

18.25 Effects are also described as:

- Adverse – detrimental or negative effects to an environmental resource or receptor; or
- Beneficial – advantageous or positive effect to an environmental resource or receptor.

18.26 Where an effect is considered to be not significant or have no influence, irrespective of other effects, this is classified as "negligible".

18.27 Where an effect is not relevant for any reason then "NA" (not applicable) is used.

Limitations and Assumptions

18.28 This assessment is based on a desk study, supported by analysis of data on water quality in the KAF at Knapton and the Sherwood Sandstone formation at Ebberston Moor.

18.29 Appropriate geological and hydrogeological techniques have been used to extrapolate data to the Ebberston Moor 'A' Well Site and where necessary the extrapolations have been checked against published data for reasonableness.

18.30 The underlying assumptions therefore, are that the water quality identified from the samples which have been analysed are representative of the water quality at the Ebberston Moor 'A' Well Site and that the hydrogeological properties of the underlying geology is consistent with published information on those properties elsewhere in the region.

Baseline Conditions

Produced water quality

18.31 The Applicant is currently producing gas from wells targeting the KAF in the Vale of Pickering. The water produced from the wells is considered by Envireau Water to be representative of the produced water that would be obtained from producing wells targeting the KAF at Ebberston Moor gas field. This is based on the fact that the geological setting and

the depth of the geological units is similar in both cases.

18.32 A sample of injection water has been collected from the Vale of Pickering and was analysed in the RPS Mountainheath laboratory for a basic chemistry suite and EU defined hazardous and non-hazardous substances. The results are provided in **Appendix 18A.2**, whilst **Table 18.2** presents the principal components of the water.

Table 18.2: Major Cations, Anions and General Chemistry of Produced Water

Component	Result	Units
pH	5.6	pH units
ammonia	46.9	mg/l NH_3
chloride	170000	mg/l
fluoride	< 100.0	mg/l
nitrite	< 1000.0	mg/l
nitrate	< 1000.0	mg/l
phosphate	< 100.0	mg/l
sulphate	1050	mg/l
aluminium	63.0	µg/l
copper	< 2.0	µg/l
zinc	11.0	µg/l
potassium	5300	mg/l
magnesium	620	mg/l
calcium	6700	mg/l
iron	0.32	mg/l
manganese	220	µg/l
mercury	< 0.10	µg/l
sodium	84000	mg/l
conductivity	208000	µS/cm
total dissolved solids	Not Determined	mg/l
density	1212	g/l

18.33 The sodium, chloride and conductivity results are indicative of deep formation water and confirm that the production water is highly saline. Salt (sodium chloride) concentrations are greater than would be found in seawater (Hem 1985) (Ref. 18.8).

18.34 **Table 12.3** gives a summary of the main hydrocarbon analyses and shows that the production water contains in the region of 7.4mg/l of hydrocarbons, which is consistent with the fact that the production water is from a hydrocarbon (gas) reservoir.

Table 12.3: Diesel & Petrol Range Organics plus Mineral Oils

Component	Result	Units
aliphatic C5-C6:	280	µg/l
aliphatic C6-C8:	1200	µg/l

Component	Result	Units
aliphatic C8-C10:	610	µg/l
aliphatic C10-C12:	820	µg/l
aliphatic C12-C16:	550	µg/l
aliphatic C16-C21:	75	µg/l
aliphatic C21-C35:	73	µg/l
aromatic C5-C7:	1600	µg/l
aromatic C7-C8:	1100	µg/l
aromatic C8-C10:	940	µg/l
aromatic C10-C12:	120	µg/l
aromatic C12-C16:	72	µg/l
aromatic C16-C21:	5.9	µg/l
aromatic C21-C35:	< 1.0	µg/l
aliphatic C5-C35:	3600	µg/l
aromatic C5-C35:	3800	µg/l
TPH ali/aro:	7400	µg/l

Sherwood Sandstone formation water quality

18.35 Samples were collected from the Ebberston Moor EMB well site on 21 August 2013 at depths of 1131m and 1141m below ground level. Full results are provided in **Appendix 18A.3** and **Table 18.4** provides a summary of the key components. These results are consistent with a detailed literature review of Sherwood Sandstone formation water chemistry and on that basis are considered representative.

Table 12.4: Major Cations, Anions and General Chemistry of Sherwood Sandstone Formation Water

Component	Result		Units
	232206 1131mbgl	232207 1141mbgl	
pH	6.7	6.3	pH units
ammonia	13	13	mg/l NH3
chloride	108000	101000	mg/l
fluoride	<100	<100	mg/l
nitrite	<3000	<3000	mg/l
nitrate	<100	<100	mg/l
phosphate	<100	<100	mg/l
sulphate	12600	11600	mg/l
aluminium	79	200	µg/l
copper	220	390	µg/l
zinc	340	350	µg/l
potassium	5700	6900	mg/l
magnesium	440	310	mg/l
calcium	2100	2100	mg/l
iron	8.9	17.0	mg/l

Component	Result		Units
	232206 1131mbgl	232207 1141mbgl	
manganese	620	600	µg/l
mercury	1.99	.25	µg/l
sodium	65000	61000	mg/l
conductivity	260000	250000	µS/cm
total dissolved solids	190000	180000	mg/l
density	1100	1100	g/l

18.36 **Table 18.5** gives a summary of the main hydrocarbon analyses and shows that the formation water in the Sherwood Sandstone formation contains in the region of 0.5 – 1.2mg/l of naturally occurring hydrocarbons, which is consistent with the fact that the Sherwood Sandstone formation is a hydrocarbon reservoir on a regional scale.

Table 18.5: Diesel & Petrol Range Organics plus Mineral Oils in the Sherwood Sandstone

Component	Result		Units
	232206 1131mbgl	232207 1141mbgl	
aliphatic C8-C10:	<0.1	<0.1	µg/l
aliphatic C10-C12:	72.0	29.0	µg/l
aliphatic C12-C16:	550	160	µg/l
aliphatic C16-C21:	200	110	µg/l
aliphatic C21-C35:	200	110	µg/l
aromatic C8-C10:	<0.1	<0.1	µg/l
aromatic C10-C12:	7.4	1.3	µg/l
aromatic C12-C16:	77.0	14.0	µg/l
aromatic C16-C21:	35.0	8.3	µg/l
aromatic C21-C35:	79.0	30.0	µg/l
aliphatic C8-C35:	1022	409	µg/l
aromatic C8-C35:	198.4	53.6	µg/l
TPH ali/aro:	1220.4	462.6	µg/l

Sea Water Quality

18.37 In order to provide a context of the salinity of the produced water from the Sherwood Sandstone formation, a comparison has been made to the salinity of the North Sea.

18.38 The Royal Belgian Institute of Natural Sciences provides monitoring data on the salinity of the North Sea. Data collected from their website (www.naturalsciences.be) (Ref. 18.9) shows that the salinity (total dissolved solids) is in the order of 34,000 to 35,000 mg/l.

Comparison of Water Types

18.39 **Table 18.6** gives a summary of the main constituents of the two different waters with a comparison of the North Sea salinity. The results show that the KAF water is approximately two times more saline than the Sherwood Sandstone formation water, owing to a higher concentration of sodium chloride. However, this is within the context of both waters having total dissolved solids concentration (TDS) in excess of 180,000mg/l. Both waters show significant amounts of naturally occurring hydrocarbons, with the produced water showing more, as would be expected. The produced water and Sherwood Sandstone formation water are 10 and 5 times more saline than the North Sea, respectively.

Table 18.6: Comparison of Produced, Formation and Sea Waters

Component	Result			Units
	KAF Produced Water	Sherwood Sandstone Formation Water	North Sea	
Conductivity	208000	255000		µS/cm
TDS	349	180	34 - 35	g/l
Density	1212	1100		g/l
Chloride	170	104.5		g/l
Sulphate	1.05	12.1		g/l
Sodium	84	63		g/l
Calcium	6.7	2.1		g/l
Potassium	5.3	6.3		g/l
aliphatic C8-C35:	3600	715		µg/l
aromatic C8-C35:	3800	126		µg/l
TPH ali/aro:	7400	841		µg/l

Likely Significant Effects

18.40 The proposed disposal route for produced water is injection into the Sherwood Sandstone formation, below the Ebberston Moor 'A' Well Site. This section provides an assessment of the effects resulting from the injection activities without the inclusion of mitigation measures beyond those incorporated directly into the design of the Proposed Development.

Construction

18.41 Construction of the injection well is controlled by The Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996 (Ref. 18.11) and the environmental impacts via a notice to the Environment Agency under section 199 of the Water Resources Act 1991 (Ref 18.12).

18.42 While the construction of any well or borehole poses a theoretical risk to shallow aquifers, the construction method and final completion is designed and operated to minimise any significant effects. Standard practice and regulatory requirements mean that shallow aquifers are cased, grouted and sealed before a well is progressed into underlying geological units which may contain poor or saline water. Therefore the only plausible risk of contamination of water supplies will relate to inadequate construction of the injection well.

18.43 The effect of any issues arising during construction would be limited to the immediate environs of the well and of a low magnitude. Thus the overall effect would be minor adverse.

Operation

18.44 Injection of produced water will be via a borehole, constructed for the purpose into the Sherwood Sandstone formation. Planning permission was granted by NYMNPA in 2013 for two appraisal boreholes and one of these will be used for injection purposes. The borehole will be cased and grouted to the injection zone and injection will take place in either an open hole or through a perforated section, depending on the stability of the borehole wall.

18.45 Injection will be achieved by low pressure injection from surface; the hydrostatic pressure of the water column will assist the water injection with only limited additional pressure added from pumping.

18.46 The moderate hydraulic conductivity of the Sherwood Sandstone formation means that no high pressure injection is anticipated, since the "injectivity" of the well should be sufficient to provide the required injection flow rates. During the life of the injection well, accumulation of fines may lead to a higher pressure being required to maintain injection flow rates although the injection pressure will always be below the material strength of the Sherwood Sandstone formation and therefore far below the pressure required to fracture the rock.

18.47 The proposed rates and volumes of injection for the Proposed Development are presented in **Table 18.7** below.

Table 18.7: Proposed Injection Rates & Volumes for the Proposed Development

Duration (years)	Total Injection Volume (m^3)	Average Daily Injection (m^3/day)
4.25	2.41 million	1600 increasing to 1900 during the final year

18.48 A calculation has been undertaken to assess the volume and size of the "bubble" of injected produced water. Assuming that the Sherwood Sandstone formation has a porosity of 10%; and that the injected produced water forms a spherical bubble; the radius of the bubble for

the total volume given in **Table 18.7** would be in the order of 180m (360m diameter). If it is assumed that the porosity is 1%, then the radius increases to 390m (780m diameter).

18.49 The act of injection will result in displacement of the formation water within the Sherwood Sandstone formation, with a theoretical zone of influence of less than 800m diameter (see para 18.44). The effects of the displacement will be controlled by the elastic storage of the formation. Assuming this to be 1 x 10^{-5} m^3/m^3 then head effects would be expected to propagate up to 3900m from the injection point. Given the fact that the Assessment Site is 40 km from the outcrop then no effect will be seen in the outcrop area. It is the outcrop area where the Sherwood Sandstone contains useful groundwater.

18.50 The conceptual model has been used as the basis of a risk assessment for the proposed disposal of produced waters to the Sherwood Sandstone at Ebberston Moor in accordance with the DEFRA Green Leaves III (GL III) (Ref. 18.8) methodology. The risk assessment has covered:

- Hazard Identification;
- Source – Pathway – Receptor linkage analysis;
- Consequence – Likelihood – Risk analysis; and
- Mitigation analysis.

18.51 The analysis shows that while the consequence of contamination would be high, the likelihood and therefore the risk of occurrence is very low. The likelihood of occurrence is low because:

- Approximately 750m of low permeability formations provide a vertical separation between the point of injection and the nearest groundwater supplies; and
- The lateral distance between the point of injection and the Sherwood Sandstone outcrop area is in excess of 40 km and injection displacement of formation water is less than 400m, with pressure effects limited to less than 3.9 km.

18.52 Owing to the natural geology at Ebberston Moor, disposal of produced water will not present any discernible impact on the quality of groundwater, the Sherwood Sandstone formation water, any potential receptors; or beneficial users which may be abstractors for domestic or industrial / agricultural uses; or the natural environment where groundwater feeds springs, wetlands and base flow to rivers.

18.53 During operation of the injection system, there will be no change from the baseline situation in the overall risk to the groundwater system. The only plausible risk of contamination of

water supplies would therefore relate to inadequate construction of the injection well. As such, the effect of any issues arising during operation would be limited to the immediate environs of the well and of a low magnitude. Thus the overall effect would be minor adverse.

Decommissioning

18.54 The decommissioning of the injection system will involve shutting down the injection well and removal of the equipment. All pipelines and ancillary equipment will be drained and then dismantled down to their original components in order for them to be transported away from the well site. Any residual water in the pipelines will be collected and stored, for safe disposal at a suitable facility.

18.55 The injection well will be decommissioned before the impermeable base to the well site is removed. Therefore any saline water that is spilt will be captured and recovered by the water management system on the well site.

Contaminant Risk during Decommissioning of the System

18.56 During decommissioning of the injection system, there will be no change from the baseline situation in the overall risk to the groundwater system. As such, there is no significant effect.

Restoration

18.57 Restoration will result in cutting the well casing at 2m below ground level; sealing the top of the well with a steel plate and placement of a 1.5m x 1.5m x 300mm concrete block over the plate. The land will be reinstated to its original level, using the soil stored in the stockpiles and bunds around the well site.

Contaminant Risk during Restoration

18.58 During restoration of the injection system, there will be no change from the baseline situation in the overall risk to the groundwater system.

18.59 Completion of the restoration phase will result in the appropriate sealing of the injection well and removal of potential contaminants from the Assessment Site so that there will be a long term negligible beneficial significance.

Mitigation Measures

18.60 This section provides a description of the mitigation measures to be incorporated into the Proposed Development to minimise the possible minor adverse effects, identified above.

18.61 The Significance Analysis above has identified that the only plausible risks of contamination of water supplies is during the construction and operational phases which would relate to inadequate construction of the injection well.

18.62 In accordance with best practice, a number of mitigation measures will be taken to minimise the risks associated with the disposal of produced waters to the Sherwood Sandstone formation. These will be based on The Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996 (Ref. 18.11) to ensure that the well is designed, modified, constructed, commissioned, operated and abandoned, such that there is no unplanned escape of fluids from the well and that the risks to the health and safety of person from it or anything in it, or in strata to which it is connected, are as low as is reasonably practicable. This will be confirmed in writing by an independent competent person before the design of the well is commenced, to ensure that the well is designed and constructed properly and is maintained adequately. These regulations ensure that the well is designed and planned to the highest standards. In addition, injection pressures will be generally low and will always be controlled to ensure they do not exceed the strength and fracturing pressure of the formation.

Residual Effects

18.63 Based on the application of these mitigation methods, the residual risk associated with the proposed injection of produced water to the Sherwood Sandstone formation through all phases of the Proposed Development is negligible.

Cumulative Effects

18.64 The injection system into the Sherwood Sandstone formation is a self-contained activity. There are no other similar schemes in the region and therefore there are no cumulative effects to consider.

Summary

18.65 The water to be produced during the production of gas is from the gas reservoir within the Permian Kirkham Abby Formation (KAF). The produced water is highly saline with salt

concentrations greater than would be found in seawater. The produced water will be injected into the Sherwood Sandstone formation which is located above the KAF. The produced water originating from the KAF will typically have twice the salinity than the Sherwood Sandstone formation water. In addition both waters show significant amounts of naturally occurring hydrocarbons related to the presence of natural gas. The water found in the KAF and Sherwood Sandstone beneath the well site is not used for drinking water or any other uses and is separated from drinking water and other usable water supplies vertically by impermeable rock and horizontally by a considerable distance.

18.66 The injection system into the Sherwood Sandstone formation involves the movement of water from one very saline water bearing formation to another. In both cases the formation water has no resource value. The geological units involved are at great depth; are distant from any groundwater with resource value; and lie below a great thickness of clay rich, low permeability geological units.

18.67 Based on the nature of the natural geology and the application of appropriate mitigation methods, the residual risk associated with the proposed injection of produced water through all phases of the Proposed Development is negligible.

18.68 The injection system into the Sherwood Sandstone formation is a self-contained activity. There are no other similar schemes in the region and therefore there are no cumulative effects to consider

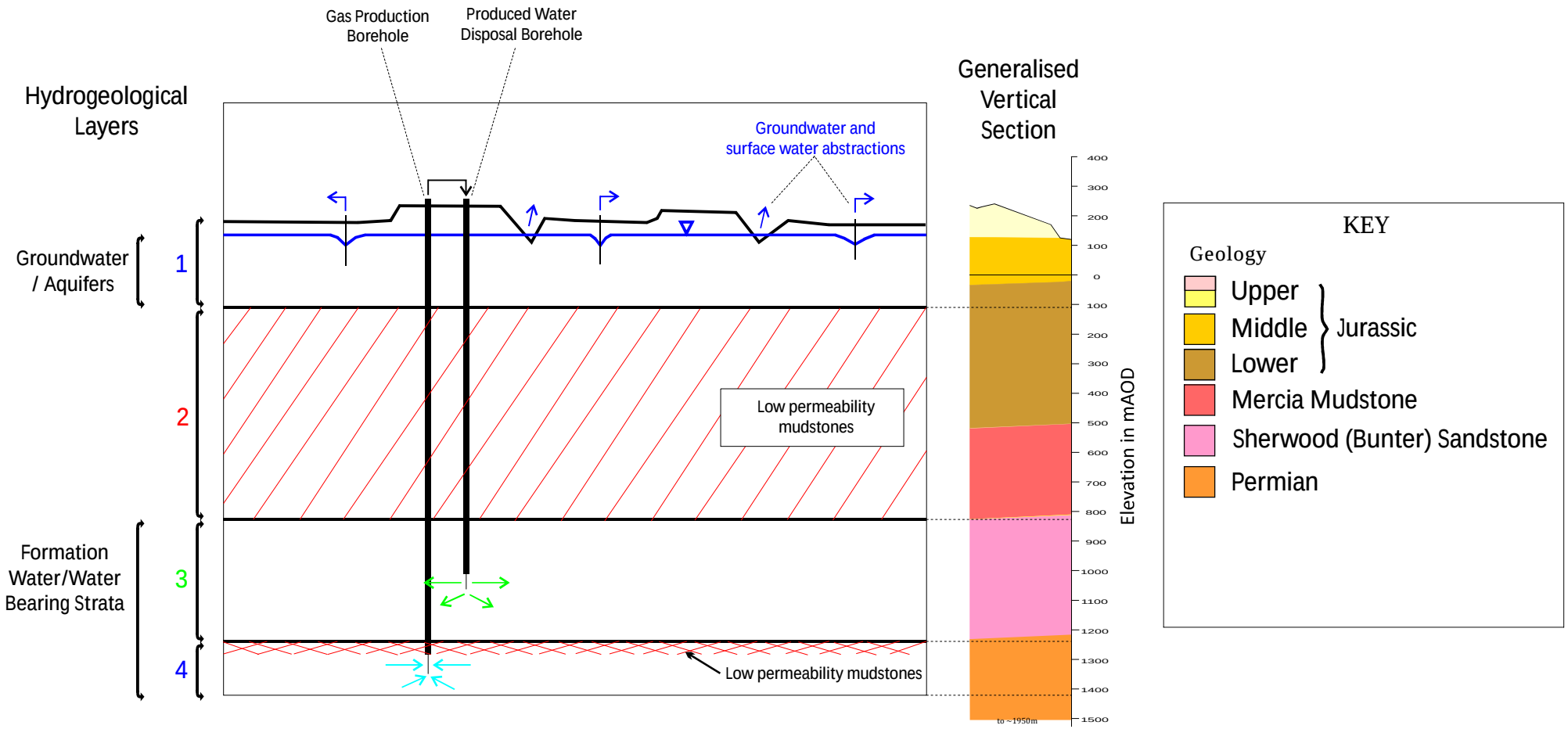
18.69 The injection system has been discussed at length with the Environment Agency at both local and national levels. The permit application and determination process will run in parallel with the planning process.

18.70 **Table 18.7** contains a summary of the likely significant effects of the injection system.

Table 18.7: Table of Significance – Produced Water Disposal

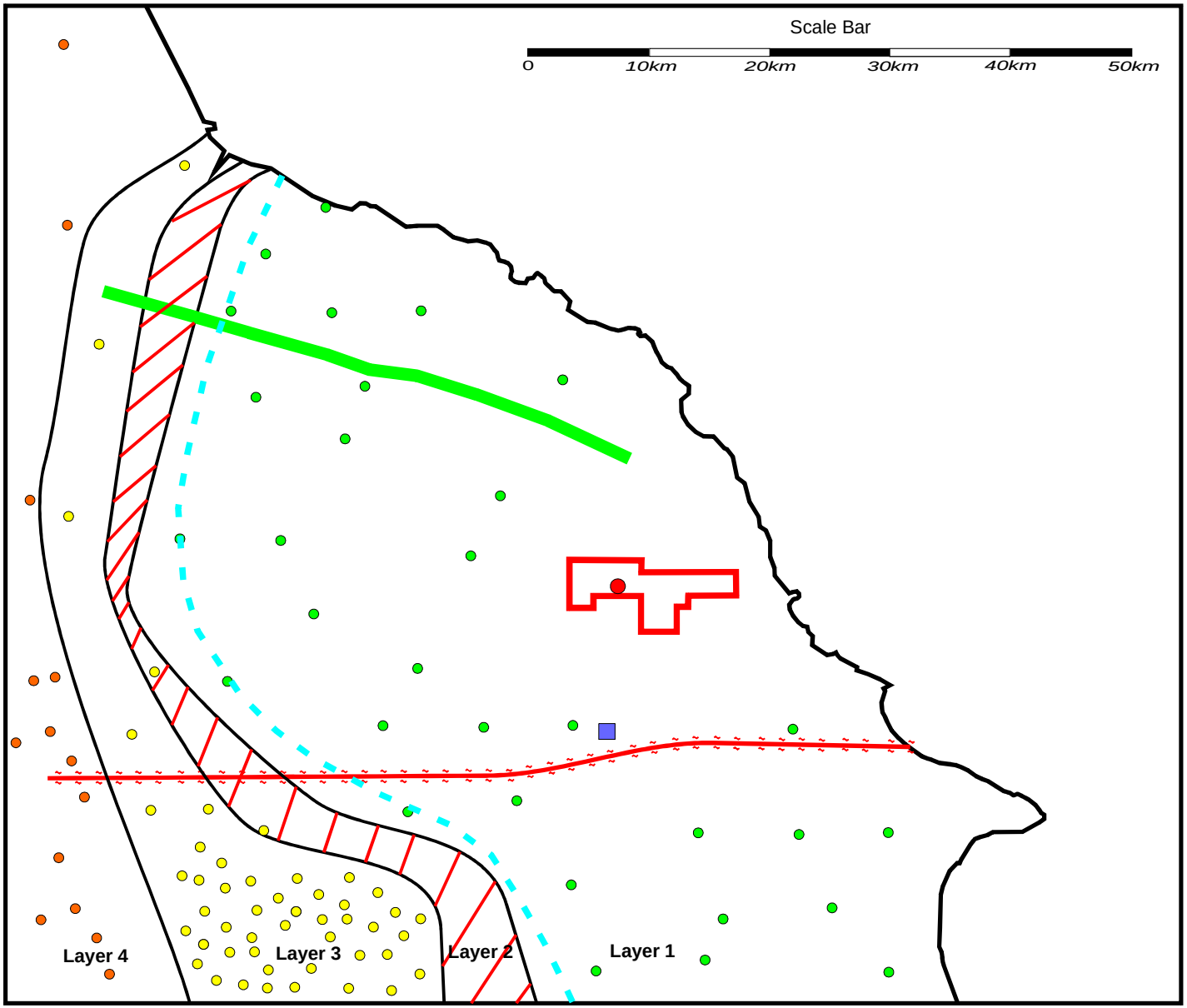
Potential Effects	Nature of Effects (Permanent/ Temporary)	Significance (Major/Moderate/Minor) (Beneficial/Adverse/ Negligible)	Mitigation / Enhancement Measures	Geographical Importance*							Residual Effects (Major/Moderate/Minor) (Beneficial/Adverse/Negligible)
				I	UK	E	R	C	NP	L	
Construction											
Contamination of Aquifer	Permanent/Long Term	Major/Moderate Adverse	Well cased into injection horizon						*	*	Negligible
Contamination of Aquifer during construction	Permanent/long term	Major/Moderate Adverse	Implement rigorous site management of the construction process using The Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996						*	*	Negligible
Operation											
Contamination of Aquifer	Permanent/Long Term	Major/Moderate Adverse	Geology of site naturally controls risk						*	*	Negligible
Decommissioning											
None	N/A	N/A	N/A								N/A
Restoration											
Reinstatement of original environment	Permanent	Moderate Beneficial	None						*	*	Negligible Beneficial
Cumulative Effects											
None	N/A	N/A	N/A								N/A

***Geographical Level of Importance**
I = International; UK = United Kingdom; E = England; R = Regional; C = County; NP = National Park; L = Local



envireau WATER

Ref: P:\Viking Planning Support (1631) \Figure A Date: 17/11/13	
Figure 18.1	Conceptual Model - Cross Section



KEY

Ebberston Moor A well site (NGR SE 89901 89679)

Petroleum Licence Pl077 (Ebberston Moor Field)

Knapton Generating Station

Fault Zone

Cleveland Dyke

Schematic Groundwater Abstractions
Density denotes concentrations of abstractors
Colour denotes source layer

Layer 1 Layer 3 Layer 4

Schematic Isochlor
Line denotes a conjectured line of equal salinity separating groundwater from formation water in Layer 3

envireau WATER

Ref: P:\Viking Planning Support (1631) \Figure B Date: 17/11/13	
Figure 18.2	Conceptual Model - Plan

REFERENCES

The additional references are set out below; the remainder of the references are as previously set out within the ES.

CHAPTER 18: PRODUCED WATER DISPOSAL

18.1 European Water Framework Directive - DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal of the European Communities.

18.2 Groundwater Daughter Directive - DIRECTIVE 2006/118/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 December 2006 on the protection of groundwater against pollution and deterioration. Official Journal of the European Union.

18.3 Groundwater Directive - Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances. Official Journal of the European Communities.

18.4 Environmental Permitting (England and Wales) Regulations2010

18.5 Environment Agency (November 2012) Groundwater Protection: Principles and Practice (GP3), Version 1,

18.6 Department of Communities and Local Government (March 2012) National Planning Policy Framework

18.7 North York Moors National Park Authority Development Framework (2008). Core Strategy and Development Policies (Adopted Nov 2008)

18.8 Defra and the Collaborative Centre of Excellence in Understanding and Managing Natural and Environmental Risks, Cranfield University (November 2011) Green Leaves III - Guidelines for Environmental Risk Assessment and Management: Green Leaves III. Revised Departmental Guidance Prepared by Defra and the Collaborative Centre of Excellence in Understanding and Managing Natural and Environmental Risks, Cranfield University

18.9 Hem (1985) Study and Interpretation of the Chemical Characteristics of Natural Water. USGS Water Supply Paper 2254

18.10 Royal Belgium Institute of Natural Sciences website: www.naturalsciences.be

18.11 The Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996

18.12 Water Resources Act 1991

APPENDIX 18A.1

REFERENCE DOCUMENTS FOR DESCRIBING BASELINE CONDITIONS

APPENDIX 18A.1: REFERENCE DOCUMENTS FOR DESCRIBING BASELINE CONDITIONS

1980 Groundwater Directive - Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances. Official Journal of the European Communities.

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Bricker, S. H., et al (2012) Effects of CO_2 injection on shallow groundwater resources: A hypothetical case study in the Sherwood Sandstone aquifer, UK. International Journal of Greenhouse Gas Control 11, pp337-348

British Geological Survey (BGS) 1:50 000 scale sheets:

E027 - Durham

E032 - Barnard Castle

E033 - Stockton

E034 - Guisborough

E035 - Whitby & Scalby (includes part of E044)

E041 - Richmond

E042 - Northallerton

E043 - Egton

E051 - Masham

E052 - Thirsk

E053 - Pickering

E054 - Scarborough

E055 - Flamborough and Bridlington (includes part of E065)

E062 - Harrogate

E063 - York

E064 - Great Driffield

E070 - Leeds

E071 - Selby

E072 - Beverley

E073 - Hornsea

E078 - Wakefield

E079 - Goole

E080 - Kingston upon Hull

Downing, R.A., et al (1985) Cleethorpes No. 1 Geothermal Well – a preliminary assessment of the resource, Investigation into the Geothermal Potential of the UK, British Geological Survey

Environment Agency, The Refining of the Scarborough Source Protection Zone Delineation in the Corallian Limestone Aquifer, Environment Agency Report, 2012

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APPENDIX 18A.2

KAF WATER QUALITY

APPENDIX 18A.3

SHERWOOD SANDSTONE WATER QUALITY

APPENDIX 18A.4

GLOSSARY OF TERMS

Glossary of Technical Terms

Hydrogeological unit	A geological unit or group of units that behave in a similar hydrogeological manner
Dip	Slope of geological units
Outcrop	Where geological units occur at the surface (or at shallow depths)
Sub-crop	Where geological units occur below other materials, often superficial deposits
Hydraulic conductivity	The ability of a geological unit to transmit water
Storage	The volume of water that can be released from a unit volume of rock under a unit fall in head (water level)
Elastic storage	Storage due to the elastic nature of a rock mass
Salinity	Synonymous with Total Dissolved Solids (TDS), within the context of this report
Isochlor	A line of equal salinity, within the context of this report
Injectivity	The ability of a geological unit to accept a fluid via well injection
Porosity	Proportion by volume of the pore space volume of a volume of rock or soil
Zone of influence	Area around a well or borehole where the water head or pressure is materially affected by the act of abstraction or injection


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