

Environment Agency Permitting Decisions

Decision document recording our decision making process

The Permit Number is: EPR/BB3800FQ

The Applicant/Operator is: Cuadrilla Elswick Limited

The Site is located at: Roseacre Wood Exploration Site,
Roseacre Road, Fylde,
Lancashire. PR4 3UE

Consultation commenced on: 24th June 2014

Consultation ended on: 19th August 2014

Minded to consultation commenced on: 24th November 2014

Minded to consultation ended on: 6th January 2015

Purpose of this document

This is a decision document, which accompanies an issued permit.

It explains how we have considered the Applicant's application, and why we have included the specific conditions in the permit we have issued to the Applicant. It is our record of our decision-making process, to show how we have taken into account all relevant factors in reaching our position. Unless the document explains otherwise, we have accepted the Applicant's proposals.

We have made our final decision only after carefully taking into account any relevant matter raised in the responses we received.

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 - 1) Consultation responses from Statutory and Non-Statutory Bodies
 - 2) Consultation responses from Members of the Public and Community Organisations
 - 3) Other matters outside the scope of this permit Application that the public have commented on which may be more relevant to Applications for other permissions
- B) Advertising and Consultation on the Draft Decision

Preliminary information

The application we received contained proposals for 3 activities (mining waste/installation/groundwater). We gave the activities the reference number EPR/BB3800FQ/A001. We refer to the Application as “the **Application**” in this document for consistency.

The Applicant also submitted a permit application for a radioactive substances activity, which we have given the application number EPR/KB3795DQ/A001. That application is being treated as an application for a separate permit. The decision with regards to that application is not dealt with in this document. A separate decision document has been produced to explain the position on that application.

The number we have given to the permit is EPR/BB3800FQ. We refer to the permit as “the **Permit**” in this document.

The Application was duly made on 19th June 2014.

The site for the proposed activities is located between Blackpool and Preston in the centre of the Fylde.

The Site is located approximately 500m from Roseacre Road (along a minor road linking the villages of Elswick, Roseacre and Wharles). The national grid reference for the centre of the Site is SD43904, 36438.

The Site is approximately 350m south-east of the village of Roseacre and 700m north-west of the village of Wharles.

Use of terms

The Applicant is Cuadrilla Elswick Limited. We refer to Cuadrilla Elswick Limited as “the **Applicant**” in this document. Where we are talking about what would happen after the Permit is granted, we call Cuadrilla Elswick Limited “the **Operator**”.

Additive

Chemical or chemicals manually added to clean water, or to flowback fluid and clean water, to assist with the hydraulic fracturing process.

Conditioning spacer/spacer fluid

Conditioning spacer/spacer fluid is a fluid used to separate drilling muds and cement and is used to displace drilling muds from the borehole prior to cement being applied.

Drilling muds

Drilling muds are the fluids used to lubricate the drilling bit while drilling.

Drill cuttings

Drill cuttings are broken bits of solid material naturally occurring underground and removed from a borehole as part of the drilling process into underground formations.

Exploration

Activities carried out to provide information about geological structures and the presence or absence of gas reserves together with assessments to determine whether the reservoir development is economically feasible.

Extractive waste

Extractive waste is waste directly resulting from the prospecting, extraction, treatment and storage of mineral resources and the working of quarries.

Flaring

Flaring is a technique used where quantities of flammable waste gas are burnt in a controlled manner. The gas flow is ignited under controlled conditions.

Flowback fluid

A mixture of hydraulic fracturing fluid, which may include mobilised natural gas and formation water which returns to the surface following the hydraulic fracturing process.

Hydraulic fracturing fluid

The fluid injected into the formation under pressure, and which consists predominantly of clean water, or flowback fluid and clean water, together with a proppant (sand) and a friction reducer.

Regulated facility

This is the term used in the Environmental Permitting (England and Wales) Regulations 2010. Those Regulations provide that any regulated facility must be

operated only under and in accordance with an environmental permit. The term is defined in the Regulations so as to include a “mining waste operation, a “groundwater activity” and an “installation”, which in this case includes a facility for the incineration by flaring of hazardous waste in a plant with a capacity exceeding 10 tonnes per day (as an activity listed in Schedule 1 to the Environmental Permitting (England and Wales) Regulations 2010). A “mining waste operation” is further defined so as to include the management of extractive waste, whether or not it involves a waste facility.

Reservoir

The rock formation in which the hydrocarbon being targeted is held. In this case this is the Bowland Shales and Hodder Mudstones.

Surface conductor

The first string of casing run, designed to prevent surface losses and/or washouts below the cellar base, in addition to isolating aquifers. The cellar is the concrete casing surrounding the wellhead and the initial part of the wellbore at the surface.

Target formation

The geological formation specifically being targeted by the exploration activities to assess whether hydrocarbons are present, their extent and the potential future well performance. For the purpose of this Application, the target formations are the Upper and Lower Bowland Shale and Hodder Mudstone formations.

Wellbore

The engineered construction through which the hydrocarbon is to be extracted.

This decision document:

- explains how the application has been determined
- provides a record of the decision-making process
- shows how all relevant factors have been taken into account
- justifies the specific conditions in the permit other than those in our generic permit template.

Unless the decision document specifies otherwise we have accepted the Applicant’s proposals.

Summary of the Application

This Application is for a permit for activities at the Roseacre Wood Exploration Site, Roseacre Road, Fylde, Lancashire, PR4 3UE that relate to the exploration for hydrocarbon resources, namely:

1. A mining waste operation for the management of extractive waste not involving a mining waste facility;
2. In respect of hydraulically fractured wells, a non-hazardous Mining Waste Facility for the accumulation of injected hydraulic fracturing fluid which has not returned back from the underground target formation and has become extractive waste;
3. An above ground hazardous Mining Waste Facility in a designated area (as marked in red on plan HSE-Permit-INS-RW-011) for the temporary deposit and accumulation of hazardous extractive waste in storage containers as the wells are successively drilled. The hazardous waste will include any drill cuttings coated with residual Low Toxicity Oil Based Muds (“LTOBM”);
4. A groundwater activity, being a discharge, namely of hydraulic fracturing fluid, to the target formation, that might lead to the indirect input of pollutants to groundwater; and
5. The incineration by flaring, of hazardous waste, namely natural gas above 10 tonnes per day, as an activity listed in Schedule 1 to the Environmental Permitting (England and Wales) Regulations 2010.

As the flowback fluid arising from the activities has the potential to contain low levels of Naturally Occurring Radioactive Material (NORM) in sufficient quantities to be classed as radioactive waste, the operator has also applied for a separate Radioactive Substances Activity (RSR) permit which will regulate the ways in which the operator manages radioactive waste.

If, following these proposed exploratory activities covered by this permit, the Applicant wishes to carry out different or additional activities and/or full scale commercial production, a variation of the permit will be required.

Any such variation application would be determined on its merits and would be subject to our normal consultation process. Any application to vary will require an amended waste management plan to be submitted.

Except where a permit condition imposes a different requirement, the permit requires the Operator to comply with the techniques in the waste management plan (WMP) and limits the activities to those stated unless otherwise agreed in writing by the Environment Agency. We will only authorise minor amendments to the WMP without the need to vary the permit.

1. Summary of our decision

We have decided to grant the Permit to the Applicant.

This will allow the Operator to operate the mining waste operation for the management of extractive waste arising from the proposed activities as set out in their WMP, subject to conditions in the permit. The permit will also allow flaring of waste gas as set out in the WMP and subject to any conditions in the permit. In addition the permit will also allow a groundwater activity, being a discharge that might lead to an indirect input of pollutants to groundwater.

We consider that, in reaching that decision, we have taken into account all relevant considerations and legal requirements, and are satisfied that the permit will ensure that a high level of protection is provided for the environment and human health.

The Permit includes conditions taken from our standard Environmental Permit template including the relevant Annexes. We developed these conditions in consultation with industry, having regard to the legal requirements of the Environmental Permitting Regulations, Mining Waste Directive, Industrial Emissions Directive, Groundwater Directive, Water Framework Directive and other relevant legislation.

This document does not therefore include an explanation for these standard conditions. Where they are included in the permit, we have considered the Application and accepted that the details are sufficient and satisfactory to make the standard conditions appropriate.

We have tried to explain our decisions as accurately, comprehensively and as plainly as possible, although given the nature of the Application it is inevitable that this document contains a significant amount of technical and specialist language.

2. How we took our decision

The Application was duly made on 19 June 2014. This means that we considered it was in the correct form and contained sufficient information for us to begin our determination.

We carried out consultation on the Application taking into account the Environmental Permitting (England and Wales) Regulations 2010 and our statutory Public Participation Statement. We extended our normal initial consultation period of 4 weeks to provide an 8 week period of time. We advertised the Application by a notice placed on our website, which contained all the information required by the Regulations, including telling people where and when they could see a copy of the Application.

We also placed adverts in the Blackpool Gazette and the Lancashire Evening Post on 24 June 2014 as well as contacting local MPs, local authorities and Parish Councils to

notify them of the consultation.

We placed a paper copy of the Application and all other documents relevant to our determination on our Public Register. We also sent a copy of the Application to Lancashire Council Offices, Flyde Borough Council and Kirkham, Ansdell, Lytham and St Annes Libraries. Please see locations below:

The Environment Agency, Richard Fairclough House, Knutsford Road, Latchford, Warrington WA4 1HT

Kirkham Library, Station Road, Kirkham, Lancashire, PR4 2HD

Ansdell Library, 59 Commonsides, Ansdell, Lytham St Annes, Lancashire, FY8 4DJ

Lytham Library, Clifton Street, Lytham St Annes, Lancashire, FY8 5EP

St Annes Library, 254 Clifton Drive South, Lytham St Annes, Lancashire, FY8 1NR

Lancashire County Council, Development Management Group, Environment Directorate, County Hall, Preston, PR1 0LD

Fylde Borough Council, Public Offices, 292 Clifton Drive South, Lytham St Annes, FY8 1LH

Anyone wishing to see these documents could do so and arrange for copies to be made.

We sent copies of the Application to the following bodies, including those with whom we have "Working Together Agreements":

- Local Planning Authority, Lancashire County Council
- Mineral Planning Authority, Lancashire County Council
- Health and Safety Executive
- Public Health England
- Director of Public Health
- Water Company, United Utilities Water Plc

These are bodies whose expertise, democratic accountability and/or local knowledge make it appropriate for us to seek their views directly.

Although the application contained sufficient information for us to begin our determination we asked the Applicant to provide additional information through two formal requests under Schedule 5 to the Environmental Permitting (England and Wales) Regulations 2010 and through less formal requests.

We have also made publicly available information provided by the Applicant in the form of a response to our Schedule 5 notices for additional information and information received subsequent to those responses. This information was required to determine the application. It was placed on our Public Register and we felt it was appropriate that it was made more widely available for interested parties to view.

As with the initial application the new information was made available at our public register offices, at the libraries and council addresses listed above and on the Environment Agency's E-Consultation website. We contacted local stakeholders and those that contacted us during the consultation to notify them of the additional information.

Further details, along with a summary of consultation comments and our response to the representations we received, can be found in Annex 1 to this Decision Document. We have carefully considered all representations and have taken into account any relevant points in reaching our determination.

We carried out a Minded to consultation on our draft decision taking into account the Environmental Permitting (England and Wales) Regulations 2010 and our statutory Public Participation Statement. We advertised the Application by a notice placed on our website, which contained all the information required by the Regulations, including telling people where and when they could see a copy of the Application.

Amendments made to Permit following the minded to consultation

We have made some changes to the permit conditions listed below. We consider that these changes provide an enhanced level of protection and are not significant enough to require further consultation.

- Condition 3.5.9. has been amended to include reference to the Environmental Management and Monitoring Plan.
- In Table S1.3 Pre-operational measures of the Permit, PO8 has been amended to state that the sampling of groundwater and surface water must be carried out monthly for a minimum period of 3 months.
- In Table S3.7 Ambient air monitoring requirements of the Permit, has been amended to include reference to the approved Environmental Management and Monitoring Plan for the monitoring frequency and parameters,
- In Table S1.3 Pre-operational measures of the Permit, PO2 has been amended to include details of the flare design in the Environmental Management and Monitoring Plan

Amendments made to Decision Document following minded to consultation

This document has been updated to reflect that this is now a final and not a draft decision, to address the consultation comments received and some minor changes have been made for clarity which do not significantly change the nature or sense of what was said previously

Section 7.5 has been amended to explain how we have assessed how drinking water will be protected, specifically in relation to the potential of faults to act as pathways.

Section 7.7 Monitoring has been amended to clarify that the monitoring required by the permit must be carried out until we accept the surrender of the permit and to clarify the requirements to surrender the permit.

Section 8 Pre-operational conditions amended to clarify why we have included design of flare in PO2

We have clarified that in accordance with agreed protocol Natural England were advised of our decision and did not raise any concerns about it although they were not formally asked to agree to it.

The minded to consultation responses and how we have taken these into consideration in the determination and an explanation can be found in Annex 1 section B.

3. Brief outline of proposed process

The planned exploration operations include site construction, drilling, hydraulic fracturing, and initial flow testing, potentially followed by extended flow testing and suspension and/or decommissioning of up to four exploration wells on a single pad.

We regulate the management of the extractive wastes arising from these activities, including the flaring of natural gas. We do not regulate the hydraulic fracturing process itself, although we do regulate any discharge of fracturing fluid that might lead to an indirect input of pollutants to groundwater.

Each of the exploration wells will consist of an initial vertical borehole drilled from surface into the subsurface target formation, followed by deviation to a horizontal wellbore section. The target formation in this case is the Upper and Lower Bowland Shale and Hodder Mudstone formations.

3.1. Drilling

The Applicant proposes to drill a “J-shaped” well, with initially a vertical “pilot hole” of up to 3200m to the lowermost targeted geological horizon for data acquisition, which will then be plugged back to a selected depth and sidetracked to yield a nominally horizontal lateral borehole of up to 2000m in length, which will then be completed for multi-stage hydraulic fracturing. The Applicant will then drill three further J-shaped wells without the initial vertical pilot hole.

3.2. Hydraulic Fracturing

Hydraulic fracturing is a process which is undertaken to improve the flow of liquids and gases through relatively impermeable underground rocks. It is used in situations where, under natural permeability conditions, fluids or gases will not flow freely, for example in shale or in rocks such as granite.

The process entails injecting fluid into the well at a pressure high enough to induce very small fractures in the target formation. At the same time a proppant (sand) is injected into the induced and pre-existing fractures to hold open the fractures once the water pressure is released. The fractures will connect the pore spaces and existing fracture networks in the rock to the well. Natural gas trapped in the target formation can then flow through the fractures and into the well when the flow is reversed.

Polyacrylamide will be added to the fracturing fluid (approximately 0.05% by volume of the fracturing fluid). Polyacrylamide acts as a friction reducer and reduces the loss of water pressure induced by friction within the steel casing in the well.

As a contingency, the Applicant may use dilute hydrochloric acid (<10% concentration) in the event initial injection pressures are too high due to tortuosity, cement invasion or perforation damage/debris in the formation to facilitate entry of the fracturing fluid from

openings in the production casing to the target formation. If it is used, it would also reduce fracturing pressure requirements; however it has not been necessary to use it at other wells drilled in the area to date due to the geophysical characteristics of the local geology, hence it is included for contingency use only. The hydrochloric acid will be stored and used at a strength of no greater than 10% in solution.

Where dilute hydrochloric acid is used, the fracturing stage (consisting of the injection of up to 750 cubic metres of hydraulic fracturing fluid) will be preceded by the injection of 3 cubic metres of dilute hydrochloric acid.

The dilute hydrochloric acid will react with the shale (containing calcium carbonate materials) to produce salty water and carbon dioxide, this will mix with the injected fracturing fluid and return as part of the flowback fluid.

Hydraulic fracturing is carried out in a series of stages along each horizontal well (between 30 and 45 stages per well), with each stage targeting the part of the target formation adjacent to fracturing point on the length of the horizontal wells. Following each fracturing stage or series of stages the well the pressure is released at the surface to reverse the flow of the fracturing fluid, a process referred to as post-hydraulic fracturing flowback, or simply 'flowback'. Some salty water, naturally present within pores in the target formation, will also flow back along with the returning fracturing fluid. The resulting mixture which returns to the surface is referred to as flowback fluid.

Approximately 10-40% of the injected fracturing fluid may return to the surface, depending on geological conditions. The returning flowback fluid will be stored on site and will be reused during future hydraulic fracturing stages if its composition, which may require dilution with mains water, is compatible with the friction reducer which will be added to it. The reuse of the flowback fluid reduces the quantity that will require disposal to offsite permitted treatment facilities at the conclusion of the hydraulic fracturing phase.

A proportion of the injected fluid will remain within the formation and will mix with any water released from the formation by the fracturing process. Some of the fluid remaining underground is expected to be reabsorbed into the rock within the target formation. The retained hydraulic fracturing fluid will become indistinguishable from formation water already present in the formation.

When the fluid remaining underground no longer serves a useful purpose it will be left in situ and will be regarded as extractive waste. This waste will remain in the target formation: for more details see section 7.5 of this document.

3.3. Initial Flow Testing

Following the hydraulic fracturing injection period, each well will be opened at the surface to reverse the flow of fracturing fluid. The purpose of this operation is to remove a portion of the injected fluid from the target formation to enable natural gas to flow into

the well and up to the surface equipment via the constructed wellbore so that its quantity and flow rate can be measured. A separator will be used at the surface to separate the flowback fluid and returning sand from that gas will be placed into storage containers. The separated natural gas will be sent to the flare after being metered.

Once the flowback starts to produce mainly natural gas, and the flowback fluid in the flow stream steadily diminishes, the initial flow test will commence. The initial test of each well is proposed to be for a period of no more than 90 days.

The natural gas cannot be utilised at this stage. Although there may be intermittent flow the aim is to produce a constant gas flow to enable the flow rate to be measured, which would not be compatible with the intermittent energy requirements of the other operations on site. Capturing the gas and generating energy for use on site would disrupt the constant gas flows required for measurement of flow rates and the aims of the exploration activity would not be met. In addition, the quality of the gas may not be compatible with the national grid requirements without further processing.

The gas flowing during the initial flow test no longer serves a useful purpose once it has been metered and therefore becomes extractive waste, which will be disposed of, by way of combustion, in an enclosed flare. Efficient combustion of the gas (at temperatures above 800°C) converts the natural gas, predominantly methane, into carbon dioxide and water vapour. There will be no storage of waste gas prior to combustion.

3.4. Extended Flow Testing

Once the initial flow tests on each well have all been concluded, an extended well test may be conducted. The aim of this is to produce natural gas from the well pad (combining the flow of gas from all 4 wells), in order to gather data on the relationship between flow rates and well pressures, measure decline rates and determine how much fluid will be produced over time with the natural gas. The aim of this test is to enable the Operator to predict the future well performance over its potential working life, should it go into production.

If an extended flow test is conducted, it will last for between 18 and 24 months. Providing that the necessary gas licenses and arrangements are in place, the well pad would be connected by pipeline to the gas grid connection during this extended flow test period. A single flare will be installed for the site during this phase as a safety measure and would only be used in emergency scenarios in order to avoid pressure build up in any pipework or vessels. In addition the flare would be used during maintenance of the surface equipment. If the connection to the gas grid cannot be made, extended flaring may be necessary. Under the permit if the Operator wishes to carry on flaring gas for the purpose of testing beyond the initial flow testing period the Operator will need to obtain our written approval. We would only provide such approval for an extension of flow testing that is in our view insignificant in environmental protection terms. Any significant extension will require an application for a permit variation.

3.5. Well testing

The Applicant proposes to use pressure testing, formation integrity testing (FIT), and wireline logging (such as cement bond logs (“CBL”)), to verify the integrity of the well system during construction and during the exploration activities.

The permit requires the Operator to provide confirmation of the integrity test for written approval prior to the start of hydraulic fracturing and for the approved testing to be implemented.

This approved testing must include verification and pressure monitoring prior to and during hydraulic fracturing and flow testing operations. The process of integrity testing does not create extractive waste: it prevents waste arising and protects groundwater as it provides assurance that the construction of the borehole is sound, preventing pathways to receptors.

Hydraulic tests will be conducted on each section of the well system, once 1-3m of new formation has been drilled, to quality-control the cement job and verify zonal isolation around a casing shoe. This is a pressure test against the exposed new formation below a casing shoe, achieved by pumping drilling fluid into the borehole with a closed blowout preventer (BOP) to obtain the needed pressure at a low pump rate. Simultaneously the pumped volume and/or time are recorded during the injection and fall-off. The process of integrity testing does not create any extractive wastes as all fluids are reused in further processes.

3.6. Well plugging and decommissioning and site reinstatement

Once the exploration activities have been completed, the well and associated surface works will either be suspended, or plugged and decommissioned and the site reinstated to its previous use (agricultural land). The decision to suspend or plug, decommission and reinstate the site will be made once the data from the exploration activities has been appraised.

The Applicant has explained that if a decision is taken to close the site, it shall be suspended, plugged and decommissioned in accordance with established procedures and the following regulatory provisions:

- the Borehole Sites and Operations Regulations 1995 (BSOR);
- the land-based requirements of the Offshore Installations and Wells (Design & Construction etc) Regulations 1996 (DCR);
- Petroleum Exploration and Development Licence (PEDL) 165.

In addition, the guidance set out by the UK Onshore Operators Group (UKOOG) entitled “UK Onshore Shale Gas Well Guidance” will also be observed.

Plugging and decommissioning requires isolating different zones of the borehole (e.g. surface geology, hydrocarbon bearing geology and permeable geology) by permanent barriers. A series of cement plugs will be used to isolate sections of the well, plugs will also be used higher up in the vertical wellbore. During the isolation the cement plug will be tagged, touching the top of the cement plug with a drill pipe, to verify its position and confirm that the cement has set. The sealing capability of the plug / barrier will be verified further by a pressure test, for example the magnitude of which should be a minimum of 500 psi above the injection pressure below the barrier but not exceed the casing strength.

Once the borehole has been properly plugged and decommissioned no further maintenance is required. However, to verify barrier construction, monitoring of the well pressure will be conducted in agreement with the Environment Agency and Health and Safety Executive (HSE) at the time of decommissioning. This process will follow the Oil & Gas UK and UK Onshore Operators Group guidelines, and is reviewed by an independent well examiner and the HSE.

The Applicant will produce a closure plan that covers all the required measures detailed in our prevailing guidance. This current guidance is provided in section 3.4 of our guidance “How to comply with your environmental permit. Additional guidance for: mining waste operations” as part of any application to surrender the environmental permit.

This closure plan will cross-reference the updated Site Condition Report and take into account any changes in site conditions and will include a commitment to post-well decommissioning monitoring in line with the historical operation of the site and in accordance with regulatory/industry guidance at the time of plugging and abandonment of the well. The closure plan will also cover the reinstatement of the site to its previous use (agricultural land) as required by the planning permission.

The Environment Agency has the power to impose further conditions if we think that they are reasonable and necessary to ensure that we are satisfied that the well can be decommissioned and that there will be no risk of pollution and the permit can be safely surrendered. The Permit will remain in force until it is surrendered.

Routine ground-gas and groundwater monitoring will be required to continue post decommissioning as considered appropriate given the site history and site condition report. The frequency of monitoring will be determined based upon the information gathered throughout the operations and the requirements of the site condition report.

The decommissioning stage is sometimes referred to as well abandonment; the use of the term well abandonment at this stage is distinct to any application to surrender the permit. The permit itself cannot simply be abandoned and the obligations under it will remain until we accept that the permit can be surrendered. More details on our criteria for surrendering the permit can be found in Section 7.7 Monitoring.

4. The legal framework

The mining and management of the extractive waste are regulated under different regimes. An Operator will need planning permission from the local Minerals Planning Authority, and a Petroleum Exploration and Development Licence (PEDL) from the Department of Energy and Climate Change (DECC).

The Permit is granted under regulation 13 of the Environmental Permitting (England and Wales) Regulations 2010, which regulates facilities whose activities involve water discharges and groundwater activities, radioactive substances, waste, mining waste, or which involve activities listed in Schedule 1 to the 2010 Regulations. The Environmental Permitting regime is the regulatory framework which requires the Environment Agency to deliver the obligations imposed by national policy and various EU Directives.

We consider that the permit will ensure that the operation complies with all relevant legal requirements and that a high level of protection will be delivered for the environment and human health.

We explain how we have addressed specific statutory requirements more fully in the rest of this document.

5. Description of the operation

The proposed operation authorised by the permit involves three classes of “regulated facility” as defined in the Environmental Permitting (England and Wales) Regulations 2010 (EPR). These are:

A mining waste operation involving:

- The management of extractive waste from exploratory activities not involving a waste facility.
- The management of extractive waste by way of a waste facility for hazardous waste (the management of hazardous drill cuttings, hazardous scale and hazardous spacer fluid).
- The management of extractive waste by way of a waste facility for non hazardous waste (the management of fluid retained underground).

In addition, the proposed activities also include an installation because the proposed activities will involve the incineration of hazardous waste, namely gas with a capacity of more than 10 tonnes a day, which makes this a listed activity under section 5.1 of Chapter 5 of Schedule 1 to the Environmental Permitting Regulations 2010.

The proposed activities also include a groundwater activity because there is a discharge, namely the injection of fracturing fluid that might lead to an indirect input of pollutants to groundwater.

By virtue of the 2010 Regulations, an environmental permit is required for the operation of a regulated facility.

5.1. Description of the site and related issues

5.1.1. Location

The surface site is located South East of Roseacre and North West of Wharles in a predominantly rural area and bordered by fields. The nearest habitations are 190 metres to the North West and 280 metres to the South East.

The surface site is located approximately 2.8 kilometres North East of the Junction 3 of the M55. The national grid reference for the centre of the site is SD 43904 36438

The underground works (i.e. the lateral wells and hydraulically fractured zone) will extend approximately 2 kilometres in a westerly direction and 500 metres in an easterly direction (see figure 2 Directional area for subsurface work in the Waste Management Plan)

The site is not located within a flood zone. The nearest flood zone is located approximately 670 metres to the West. However, Nigget Brook is adjacent to the site and is a designated Main River watercourse and is therefore subject to Land Drainage Byelaws. No trees or shrubs may be planted, nor fences, buildings, pipelines or any other structure erected within 8 metres of the top of any bank or the edge of any retaining wall of a Main River watercourse without our prior written consent. As such, the Operator will need to apply for a Flood Defence Consent prior to starting any works within 8m of the banks of Nigget Brook. The Operator has been informed of this process through the Planning Process, and the relevant Flood and Coastal Risk Management Officer has commented on the planning application.

Flood mapping does not show that the site location is at risk of flooding.

5.1.2 Proposed Waste management activities

The wastes that will or may need to be managed on site are:

Water based Drilling Mud and Drill Cuttings:

- Freshwater drilling muds and wastes (01 05 04) – Non hazardous
- Chloride-containing drilling muds and wastes other than those mentioned in 01 05 05 and 01 05 06 (01 05 08) – Non hazardous

Low Toxicity Oil Based Drilling Mud and Drill Cuttings

- Oil-containing drilling muds and wastes (01 05 05*) - Hazardous

Flowback fluid

- Wastes from mineral non metalliferous excavation (01 01 02) – Non hazardous

Natural Gas

- Wastes from mineral non metalliferous excavation (16 05 04*) - Hazardous

Scale

- Drilling muds and other drilling wastes containing dangerous substances (01 05 06*) - Hazardous

Cement

- Concrete (17 01 01) – Non hazardous

Spacer Fluid

For spacer fluid contaminated with water based muds:

- Freshwater drilling muds and wastes (01 05 04) – Non hazardous
- Chloride-containing drilling muds and wastes other than those mentioned in 01 05 05 and 01 05 06 (01 05 08) – Non hazardous

For spacer fluid contaminated with oil based muds:

- Oil-containing drilling muds and wastes (01 05 05*) - Hazardous

Retained Hydraulic Fracturing Fluid

- Wastes from mineral non metalliferous excavation (01 01 02) – Non Hazardous

We are satisfied that extractive waste has been properly characterised in accordance with Annex II of the Mining Waste Directive.

Storage arrangements and pollution prevention measures are discussed in Sections 6.9 and 6.10.

The following text is a description of how the wastes arise and what will happen to them.

5.1.3. Cementing

Excess cement may arise through the cementing of the wellbore.

Calculations will be made by the Operator and a competent contractor accounting for borehole section and well design in order to estimate the amount of cement required, and the volumes will be measured in order to reduce the amount of cement waste generated. As returned cement cannot be reused on site, the solidified cement will be sent for recycling at an appropriately permitted waste management facility.

5.1.4. Spacer Fluid

Spacer fluid is used to displace drilling muds from the borehole prior to cement being applied.

Calculations will be made by the Operator and a competent contractor accounting for borehole section and well design to estimate the amount of spacer fluid required, and the volumes will be measured to reduce the amount of waste generated by excess. Returned fluid cannot be reused on site for the same purpose. It will be re-used in the water based drilling mud unless it is contaminated with cement slurry. Where it cannot be re-used it will be sent for disposal to an appropriately permitted waste management facility.

5.1.5. Sand

Sand is used as a proppant in the fracturing fluid to keep the fractures open. Some sand will return with the flowback fluid and will be separated in the separator.

Returned sand cannot, practicably, be reused as a proppant. It would require treatment to remove crushed or broken sand grains, sieving to the correct size and drying before further reuse. That would require additional infrastructure and energy use, which we are satisfied would not provide any environmental benefit. The sand will be sent off site for recycling or disposal at an appropriately permitted facility.

5.1.6. Waste gas

The aim of the proposed flow testing is to determine the quantity and composition of natural gas that can be released from the target formation after hydraulic fracturing has occurred. The gas will be flowed to determine the characteristics of the formation; allowing the Operator to determine whether or not the reservoir is sufficient enough to produce commercial quantities of natural gas. During the initial flow test phase, once the gas has been measured, it becomes waste unless it can be used. This initial flow testing phase is expected to last for a period of between 60 and 90 days per well being tested.

The mixture of flowback fluid, sand and natural gas will pass through a separator to separate the water from the natural gas and to remove any sand from the flowback fluid. The natural gas will be diverted via pipe work to be metered and will then enter one of two enclosed ground flares, located onsite, for incineration.

There is a requirement to prevent or minimise the generation of waste. We are satisfied that it would not be feasible to use the gas on site or by way of connection to the national grid during the initial flow testing phase of the exploratory stage.

The Operator has justified the use of a flare rather than using the gas on site. In order to establish whether there is sufficient flow of gas to move to extended flow testing, there needs to be an uninterrupted flow; using the gas to meet energy requirements on site

would necessitate interrupting the gas flow, preventing the collection of the required data for analysis. In addition, the costs of using the gas would be disproportionate for the 90 day periods. It is also not reasonably practicable to connect the flow of extracted natural gas to the gas grid during the initial flow tests. This is because the flow rates are unknown and the quality of the gas produced may not be compatible with gas grid requirements without further processing.

Should the results of the initial flow test demonstrate that extended flow testing is warranted, subject to obtaining the necessary gas licences and putting in place appropriate arrangements a connection to the gas grid will be made and continuous flaring of gas will cease. Under the permit if the Operator wishes to carry on flaring gas for the purpose of testing beyond 90 days they will need to obtain our written approval. We would only provide such approval for any extension of flow testing that is in our view insignificant in environmental terms. Any significant extension will require a permit variation.

If the Operator proceeds to extended well testing and connects to the grid, a single flare will be installed at the site during this phase as a safety measure and would only be used in emergency scenarios in order to avoid pressure build up in any pipework or vessels. The flare will also be used on occasions when maintenance work is carried out on surface equipment. Venting of gas is not permitted except where necessary for safety reasons.

The flare stacks are fully enclosed combustion chambers constructed of steel with a ceramic insulation to reduce heat loss and provide silencing. A gas inlet pipe connects to the flare with a main burner flame arrester and pilot flame for ignition. There will be 24 hour supervision of operations on site.

Natural gas is considered waste once it is tested and no longer serves a useful purpose. The incineration of gas by flaring is therefore a method of disposing of this extractive waste. An air dispersion modelling assessment has been carried out to determine the likely impact of incinerating gas. We are satisfied that the contribution of emissions from the proposed flaring at locations closest to the well sites is environmentally insignificant. The operator will be required to monitor the emissions to air from the incineration activity.

The permit limits the flaring of gas to a maximum of 130,000 cubic metres per day set out in the Waste Management Plan and on which the Air Quality Modelling was based. See section 7.6 for further information on the air quality assessment.

5.1.7. Scale

It is highly unlikely, due to the short term nature of exploration operations, that any significant scale will build up inside the pipes. Any such scale that is produced cannot be reused on site and will be sent off site for disposal. A radioactive substances activity (RSR) permit has been applied for to manage the accumulation and disposal of waste scale. Hazardous scale, if present, will be managed by using the hazardous mining waste facility.

5.1.8. Flowback fluid

We are satisfied with the Applicant's proposals to minimise the overall quantity of waste arising from this process. The proposals include carrying out a series of small hydraulic fracturing operations that will be performed ahead of the main fracturing stages, in order to assess fracture mechanics within the target formation. This will aid the design of later hydraulic fracturing and flow-testing, enabling the minimum quantity of fresh water and additives to be used in order to achieve optimum gas flow rates.

Approximately 10%-40% of the injected fluid for each fracturing stage is predicted to return as flowback fluid to the surface between hydraulic fracturing stages.

Flowback fluid will be re-used for hydraulic fracturing wherever the level of total dissolved solids are compatible, which may require dilution with mains water, with the friction reducer. This will involve utilising a closed loop system between hydraulic fracturing stages to ensure that all flowback fluid (post separation from any gas and sand) is captured and is available for re-injection into the target formation as part of the hydraulic fracturing process.

Flowback fluid that has been separated from the sand and natural gas will be stored at the surface in enclosed steel containers on top of the well pad membrane within the perimeter fence line. As hydraulic fracturing will be conducted consecutively over a period of days the storage of the separated flowback fluid will be temporary.

Flowback fluid at the surface will be subject to Ultra Violet (UV) disinfection prior to re-use, to control bacterial growth. This is a precautionary approach to help maintain productivity of the fractures and reduce the risk of bacteria causing souring of the natural gas. UV disinfection has been selected to replace the need for the non-hazardous biocide (glutaraldehyde) additive within the early stages of exploration. The process does not create any further waste at the site and increases the number of times that flowback fluid can be reused.

The flowback fluid will contain water, sand, polyacrylamide and mineralised content from the target formation.

No limits are required to be imposed for reuse of the flowback fluid because the mineralised content that is brought to surface with the flowback fluid has come from the

formation to be fractured.

Reuse of the flowback fluid in the hydraulic fracturing fluid will only result in the mineralised content returning to the formation from which it was derived and will therefore have no discernible impact upon the receiving environment.

We have assessed that there is no groundwater in the shale and we do not expect the fractures to propagate into the Millstone Grit. If the retained fluid did unexpectedly migrate into the Millstone Grit, the quality of water in the Millstone Grit and the retained fluid will be so similar that there will be no significant environmental impact.

We have assessed this process and we are satisfied that fracturing fluid that incorporates separated flowback fluid remains non-hazardous. This is addressed in section 7.5.

The permit requires that any fracturing fluid that is injected, whether it is composed of separated flowback fluid or not, must not cause pollution of groundwater and must only contain polyacrylamide unless otherwise approved by us in writing. We would not approve the use of any hazardous additive.

The permit includes a requirement for the Operator to monitor the composition of the hydraulic fracturing fluid (which may include flowback fluid), in particular to demonstrate that no hazardous additives have been used. The monitoring results will be made available to the Environment Agency and will be available on the Public Register.

There is a prohibition on injecting fluids for disposal purposes. Flowback fluid that it is not suitable for reuse will be sent to an appropriately permitted waste facility for treatment or disposal.

5.1.9. Drilling muds and drill cuttings

The well size will be optimised to reduce the amount of drilling mud required and the drill cuttings produced whilst maintaining a sufficiently adequate borehole diameter.

The drilling muds will be reused until spent or spoilt to reduce the continuous addition of fresh muds into the system, subsequent waste creation and continued use of raw materials.

Drilling will be carried out using predominantly water based muds (WBM) with a contingency to use low toxicity oil based muds (LTOBM) if required by the geology being drilled.

Only drilling fluids (water based/salt saturated polymer based muds) non-hazardous to groundwater can be used in the upper section of the borehole when in contact with groundwater receptors including aquifers.

LTOBM has significant operational advantages over water-based mud formulations, including greater lubricity and less interaction with the formations being drilled, resulting in reduced borehole washout and improved hole stability. Where reasonably practicable water based drilling muds will be used, but where the use of LTOBM would be safer, result in better well integrity or less chance of loss of drilling muds to formation, LTOBM may be used instead.

The decision to use LTOBM for one or more of those reasons will be made during drilling operations. Prior to the start of the drilling of the first well, recent results of drilling Bowland Shale with LTOBM by other operators will be reviewed to the extent information is available, and weighed against the alternative water based mud. If actual results from drilling the pilot hole (vertical hole) indicate that a change from water based mud is necessary, the fluid system would be changed for further drilling.

Both WBM and LTOBM containing cuttings returning to the surface are passed through a mechanical separation device, which is used to extract solid drill cuttings. Further centrifugal treatment is used to remove finer drill cuttings from the muds. The drilling muds are then temporarily stored in dedicated steel mud tanks and reused within the further drilling process until no longer required. Water based drilling muds may become spent and no longer reusable; such spent drilling muds will be waste and taken off site for disposal.

Any LTOBM that is recovered at surface will, unless spoiled by being coated on drill cuttings, be returned to the supplier for reuse at the end of the operation. Drilling mud that can be returned to the supplier is not waste. Monitoring and adjustment of LTOBM occurs at the site to measure the oil to water ratio and quantity of low gravity solids to ensure that the LTOBM remains within the supplier's specification and that LTOBM can be returned to the supplier for reuse. LTOBM coated on drill cuttings is spoiled and will be sent for disposal with the contaminated drill cuttings.

Drilling mud lost to any formation would be waste. We are satisfied that measures will be in place to minimise the amount of fluid that is lost to the formation being drilled.

When drilling mud is in contact with the permeable underground rock formation and there is greater hydrostatic pressure in the borehole than in the formation, some mud will be forced into the formation. The solids in the mud will have been "screened out" at the borehole interface, forming a filter cake, so it will be a small amount of fluid (mud filtrate) that will enter the permeable formation. In order to minimise the loss of drilling mud to the formation, the drilling mud is engineered with important filter cake building properties.

When drilling through these permeable underground rock formations using water based muds, fluid loss control agents, generally starch-based, will be added to the drilling fluid if there is an indication of fluid losses. The properties of the mud will be measured onsite using an API Fluid Loss Test (mud filtration). Drilling fluid is designed so that the contained solids quickly form a very thin filter cake that has very low permeability. As filter cake thickens, the filtration rate decreases. During drilling, the filter cake is

constantly eroded and re-deposited, forming a dynamic filter cake of fairly constant thickness.

The filter cake minimises invasion of drilling mud into permeable underground rock formations. Also, the materials which form filter cakes can reduce the uptake of water by clay minerals, thus contributing to borehole stability. Typical filter cake thickness is about 1-3mm

Volumes of fluids pumped and returned will be monitored by two independent systems, the mud engineers and the drilling Pit Volume Totaliser (PVT) system, during the drilling operation. Circulating density is minimised when drilling weak or low-pressure porous formations. If there is indication of fluid losses into the surrounding formation, loss-circulation (solid/ fluid base) material will be deployed as soon as practicable to minimise leak-off. Monitoring will be in place to ensure mud loss is identified as soon as possible allowing measures to mitigate any further loss to be put in place.

Drilling into formations which have very low permeability filtrate loss to the formation is expected to be close to zero. During the process of drilling, steel casing is cemented in the wellbore in a series of stages to protect groundwater receptors and maintain well integrity. This is described in Section 2.2.3 Table 3 of the Waste Management Plan. As each section is being drilled, the geological formations encountered previously are isolated and effectively sealed off by steel casings which will be cemented in place. We are satisfied that there will not be any significant loss of LTOBM within the formations being drilled if LTOBM are used.

Any losses experienced during drilling that are detected by the monitoring systems will be recorded by the Operator on a daily basis.

Drill cuttings will be separated from the drilling mud, as far as reasonably practicable, at the surface so that the maximum amount of drilling mud can be reused on site.

A competent drilling mud engineer will be tasked to monitor and manage the muds to ensure efficiency of use and record the mud management in a daily mud report.

The mud tanks are subject to annual thickness inspections and weekly visual inspections. Any waste drilling muds are removed by vacuum loading road tanker to an authorised waste treatment facility.

We are satisfied that the use of proposed drilling muds will fall within the groundwater activity exclusion under the Environmental Permitting Regulations 2010, paragraph 3.3(b) of Schedule 22 in that any discharge to groundwater that may occur would be of a quantity so small as to obviate any present or future danger of deterioration in the quality of any receiving groundwater and that there is no groundwater activity associated with the use of drilling muds.

Hazardous Mining Waste Facility:

Drill cuttings contaminated with LTOBM are classified as Hazardous Waste, therefore the site includes an above ground hazardous Mining Waste Facility, with the area marked in red on plan HSE-Permit-INS-RW-011 being designated for the temporary deposit and accumulation of hazardous waste in storage containers as the wells are successively drilled. The hazardous Mining Waste Facility also includes the temporary deposit and accumulation of any hazardous conditioning spacer or hazardous scale if these are found to be present. No other hazardous extractive waste is expected to arise.

The whole of the surface site, including the area designated for the temporary deposit and accumulation of the hazardous waste, will be constructed to be impermeable, with sealed drainage as described in section 2.2 of the Waste Management Plan and Section 4 of the Environmental Statement. Section 6.9 below provides more details on the well pad construction.

All hazardous extractive waste must be stored in steel solid containers which are subject to annual non-destructive testing inspection and weekly visual inspection.

Drill cuttings and spent mud wastes will be removed to an offsite permitted waste facility.

As required by the Mining Waste Directive, the Applicant has provided in section 3.9 of the Waste Management Plan a justification of why this hazardous Mining Waste Facility will not be classified as a Category A Mining Waste Facility in accordance with the criteria in Annex III of the Mining Waste Directive.

Annex III provides that a waste facility shall be classified under Category A if:

1. a failure or incorrect operation, e.g. the collapse of a heap or the bursting of a dam, could give rise to a major accident, on the basis of a risk assessment taking into account factors such as the present or future size, the location and the environmental impact of the waste facility; or
2. it contains waste classified as hazardous under Directive 91/689/EEC above a certain threshold; or
3. it contains substances or preparations classified as dangerous under Directives 67/548/EEC or 1999/45/EC above a certain threshold.

In relation to point 1, loss of structural integrity/incorrect operation, the Applicant has assessed the hazardous mining waste facility against the effects resulting from loss of structural integrity or incorrect operation of the storage area for hazardous mining waste streams (comprised in the hazardous Mining Waste Facility).

The Applicant has concluded, and we agree, that there is no risk of a major accident, i.e. involving significant loss of life, serious danger to human health or serious danger to the environment, based on the fact that no one other than the workers operating the

facility is expected to be present for significant periods in the potentially affected area, and the presence of a well pad membrane around the hazardous Mining Waste Facility means that there is no potential source-pathway-receptor relationship between the facility and environmental receptors.

In relation to point 2, hazardous waste above the threshold: before the end of operation of the hazardous waste facility, all of the hazardous waste contents will have been disposed offsite to a permitted waste facility. This is a requirement of the permit. Therefore, the facility cannot be classified as a Category A facility on this basis.

In relation to point 3, dangerous Substances, we are satisfied that extractive hazardous waste which can be deposited in the hazardous Mining Waste Facility will not include any substances or preparations classified as dangerous under Directives 67/548/EEC or 1999/45/EC above the applicable threshold.

We are satisfied that this justification is appropriate and in accordance with the Mining Waste Directive.

5.1.10. Retained fracturing Fluid:

Approximately 10%-40% of the injected fluid for each fracturing stage is predicted to return as flowback fluid to the surface between hydraulic fracturing stages. We consider these predictions to be accurate.

The amount of fracturing fluid used (and therefore the proportion left behind) for each fracturing event will be affected by the geological and physical characteristics of the target formation.

When the injected fluid left behind no longer serves a useful purpose it will be extractive waste. Retained fluid will be made up of a mixture of the injected hydraulic fluid and formation water. The Applicant has provided full details of the components of the hydraulic fluid and we are satisfied that it will be non-hazardous. We are therefore satisfied that the fluid that will be retained underground is properly classified for the purpose of the Mining Waste Directive as non-hazardous and is correctly assigned an absolute non-hazardous List of Waste code. However, given the general level of interest in this activity we have also considered in detail the composition of the fluid.

Formation water will contain dissolved salts and methane. However, both the Applicant and the Environment Agency have carried out assessments, including consideration of samples from Preese Hall exploration site, which has comparable geology, and we are satisfied that retained fluid will not have any of the properties that would render it hazardous under the Waste Framework Directive. Over time, the retained fluid will become indistinguishable from the formation water already in the target formation.

We have reviewed the justification for disposing of this waste by permanent deposit within the target formation (Appendix C of the Waste Management Plan).

The alternative options considered were:

- To access waste fluids by removal of the well casing and cement and excavation downwards to the depth of the vertical well shaft, followed by pumping or lifting waters from the target formation upwards to the surface.

This would involve development of a mineshaft considerably wider than the original wellbore to a depth of approx. 2000 metres below ground, sufficiently large to accommodate structural supports for safety against collapse and of entry of necessary personnel, machinery and supplies. This approach would create additional extractive waste and waste well construction materials, the volume of which would likely far exceed the volume of waste retained fluids that it seeks to retrieve from the target formation, with no perceivable net environmental benefit.

- To postpone the end of the exploration phase and to allow gas to continue to flow from the well, without any further well stimulation/intervention, until the total amount of fluid returned to the surface during operations is equal to or greater than the total volume of hydraulic fracturing fluids injected across the fracturing programme for that exploration well.

This approach would require a much longer period of operation (in excess of 20 years) with additional flaring, increased volumes of flowback fluid and associated traffic and therefore much higher potential environmental impacts.

- To use artificial lift to bring the fluids back to the surface. Artificial lift requires installation of a pump near the bottom of the well bore to lift the water from the formation to the surface.

This technique is designed to extend the life of a producing well (to flow more hydrocarbons) and not to retrieve waste fluid. It is not a technique that has been developed for that purpose. It would also prolong the duration of the activities and require additional flaring, increased volumes of flowback fluid and associated traffic and therefore much higher potential environmental impacts.

We are therefore satisfied that leaving the retained fluid in situ within the target formation is the Best Available Technique. We have carefully considered the protection of groundwater, which is dealt with in section 7.5 below.

As required by the Mining Waste Directive, the Applicant has provided in section 3.9 of the Waste Management Plan, a justification of why this Mining Waste Facility will not be classified as a Category A Mining Waste Facility in accordance with the criteria in Annex III of the Mining Waste Directive.

Annex III provides that a waste facility shall be classified under Category A if:

1. a failure or incorrect operation, e.g. the collapse of a heap or the bursting of a

dam, could give rise to a major accident, on the basis of a risk assessment taking into account factors such as the present or future size, the location and the environmental impact of the waste facility; or

2. it contains waste classified as hazardous under Directive 91/689/EEC above a certain threshold; or
3. it contains substances or preparations classified as dangerous under Directives 67/548/EEC or 1999/45/EC above a certain threshold.

In relation to point 1, loss of structural integrity/incorrect operation, the Applicant has assessed the non-hazardous mining waste facility against the effects resulting from loss of structural integrity or incorrect operation of the non-hazardous mining waste facility (the deposit of retained fluid within the target formation).

The Applicant has concluded, and we agree, that there is no risk of a major accident, i.e. involving significant loss of life, serious danger to human health or serious danger to the environment based on the fact that the Mining Waste Facility is to be located more than a kilometre underground and will not be accessible to people, and there is no relevant source-pathway-receptor chain.

Additionally, well construction will form a barrier to prevent escape of waste retained fluids via the wellbore from the Mining Waste Facility.

Well integrity is assured through compliance with the well examination regime and regulation by the Health and Safety Executive, and further through conformance to Oil & Gas UK and UK Onshore Operators' Group good practice guidelines for well design and construction. Hydraulic fracturing plans and a seismic monitoring programme will be submitted to Department of Energy and Climate Change (DECC) and the Environment Agency for approval prior to hydraulic fracturing operation commencing; operation of the traffic light system for monitoring of induced seismicity is also designed to mitigate the risk from induced seismicity, including any potential for damage to well integrity.

The potential for fractures that are propagated by hydraulic fracturing to extend beyond the target formation has been assessed to be very low and the growth of fractures resulting from each fracturing stage will be assessed with the aid of the seismic monitoring array.

Only substances approved by the Environment Agency as non-hazardous to groundwater will be used as fracturing fluid additives. Polyacrylamide has been approved as non-hazardous to groundwater, if they wish to use any other additive, this will need our prior written approval.

The detailed consideration of the subsurface geology that has been undertaken as part of the Environmental Statement has assessed the potential for retained fluids within the shale rock to migrate upwards into contact with any groundwater bearing formations. This outcome has been assessed as very low and with no plausible pathway (Hydrogeological and Ground Gas chapter Environmental Statement).

In relation to point 2, hazardous waste above the threshold, the waste fluids present in the Mining Waste Facility at closure of the Mining Waste Operation at the site may contain naturally occurring radioactive materials and other dissolved minerals salts. With regard to the threshold referred to in the second indent of Annex III of Directive 2006/21/EC, Commission Decision 2009/337/EC provides that it is calculated as the ratio of the weight on a dry matter basis of:

- (a) all waste classified as hazardous in accordance with Directive 91/689/EEC and expected to be present in the facility at the end of the planned period of operation; and
- (b) waste expected to be present in the facility at the end of the planned period of operation.

We are satisfied that the waste has been properly characterised as non-hazardous waste. In relation to point 3, dangerous substances, a waste facility is required to be classified as Category A if it contains substances or preparations classified as dangerous under Directives 67/548/EEC or 1999/45/EC above a certain threshold. Based on sampling results from Preese Hall well, it has been assessed that no dangerous substances above the thresholds contained in Directives 67/548/EEC or 1999/45/EC are likely to be present.

We are therefore satisfied that this justification is appropriate and in accordance with the Mining Waste Directive.

5.1.12. Description of groundwater activity

The permit includes the authorisation of a groundwater activity, namely the discharge of fracturing fluid into the target formation, which might lead to an indirect input of pollutants to groundwater. In section 7.5 we explain our consideration of groundwater issues.

6. General issues

6.1. Administrative issues

We are satisfied that the Applicant is the person who will have control over the operation of the regulated facility after we grant the permit, in line with our Regulatory Guidance Note RGN 1: *Understanding the meaning of Operator (version 4.0)*; and that the Applicant will be able to operate the regulated facility in compliance with the conditions included in the permit.

6.2. Management

Having considered the information submitted in the application, we are satisfied that appropriate management systems and management structures will be in place.

6.3. Financial competence and relevant convictions

We are satisfied that sufficient financial resources are available to the Operator to ensure compliance with the permit conditions. A financial guarantee will be provided as required by the Mining Waste Directive: see section 7.9.11

The Operator does not have any relevant convictions and it is technically competent.

6.4. External Emergency Plan

The provisions relating to an external emergency plan do not apply as none of the mining waste facilities are Category A facilities (see section 5.1.9 for more details).

6.5. Accident management

Having considered the information submitted in the application, we are satisfied that appropriate measures will be in place to ensure that environmental accidents that may cause pollution are prevented. However, in the unlikely event that an accident should happen, we are satisfied that the consequences will be minimised. This is part of the written management system of the site, required under permit condition 1.1.1 a.

6.6. Surrender of the permit

When the Operator wants to surrender their permit, they will have to satisfy us that the necessary measures have been taken to:

- Avoid any on-going pollution risk resulting from the operation of the facility; and
- To return the site to a satisfactory state, having regard to the state of the site before the activity was put into operation.

We will not grant any application for surrender unless and until we are satisfied that these requirements have been complied with.

6.7. Site security and protection

The surface site will be surrounded with a 4m high perimeter fence line topped with barb wire screened with plants and shrubs. A further smaller inner fence line will surround the well pad. Page 37 of the Environment Statement Chapter 4 provides a drawing of the site perimeter fence line.

Site security will be managed by a security contractor. Man guarding arrangements will be in place to monitor and check the movement of vehicles and personnel accessing site.

In the unlikely event of a security breach, the Site Supervisor will follow the Site Shut Down procedure to prevent unauthorised access to safety critical equipment and operational controls. This procedure will be available for inspection and must be approved by the Environment Agency before the start of operations on site.

We are satisfied that the Operator will work in close co-operation with enforcement agencies to monitor and assess the risk of security to the site.

6.8. Site setting and location

The Applicant proposes to explore for natural gas trapped in the Bowland Shale and Hodder Mudstone formation, at depths between 1900m and 3200m underneath this part of Lancashire. The proposed exploration operations include site construction, drilling, hydraulic fracturing, initial flow testing followed by possible extended flow testing and suspension or decommissioning of up to four exploration wells on a single pad.

The 1.55 hectares well pad is situated at:

Roseacre Wood ("RW") Exploration Site
Roseacre Road
Fylde
Lancashire
PR4 3UE

The national grid reference for the surface Site is SD 43904 36438

The surface site is not located within a flood zone.

The underground works (i.e. the lateral wells and hydraulically fractured zone) extends approximately 2 kilometres in a westerly direction and 500 metres in an easterly direction (see figure 2 Directional area for subsurface work in the Waste Management Plan).

6.9. Planning Permission

Our decision on whether to grant an Environmental Permit is separate from the planning process. An Environmental Permit allows the site to operate and to be regulated by the Environment Agency exercising its pollution control functions. The Planning Authority, in this case the Lancashire County Council, decides whether or not to grant planning permission.

The planning authority determines whether the activity is an acceptable use of the land. It considers matters such as visual impact, traffic and access issues, which do not form part of our Environmental Permit decision making process. The planning authority must also consider and respond to any objections they may receive on a particular planning application.

There is no requirement for planning permission to be in force before an environmental permit is granted.

6.10. Site condition report

The Applicant submitted a site condition report detailing the condition of the site as part of their application. We use the information in a site condition report to establish a baseline for the condition of the site prior to the permitted activity starting. This baseline will be used as a comparison, to establish whether there has been any deterioration of the land as a result of the permitted activities, when the Operator applies to surrender their permit.

The Applicant provided an initial site condition report based on a desktop assessment as they do not have access to the site and cannot start site preparation and investigation prior to planning permission being granted. We are satisfied that this initial site condition report contains appropriate and accurate information.

We have specified a pre-operational condition 2.4.1, which compels the operator to provide the Environment Agency with a report that describes baseline groundwater quality information for the site. The report must be provided at least two weeks prior to the commencement of drilling of the exploration wells at the site and the information will be used to update the initial site condition report.

We have also specified a pre-operational condition, which compels the Operator to take at least 3 samples of groundwater from the groundwater monitoring boreholes and 3 samples of surface water prior to the commencement of any drilling activity on site and following the installation of the groundwater monitoring boreholes and surface water monitoring points. We require a minimum of 3 months baseline monitoring prior to the commencement of any drilling activity on site.

The permit also includes a pre-operational condition that compels the Operator to provide a report that details the 'as built' monitoring borehole designs and describes the baseline groundwater quality sampling for the site, together with the observed geological strata encountered during the construction of the monitoring boreholes to demonstrate that the conceptual model has been confirmed. The agreed baseline groundwater quality sampling programme shall be implemented unless otherwise agreed, in writing, by the Environment Agency.

The results of the groundwater and surface water monitoring shall be submitted to the Environment Agency prior to the drilling of the injection boreholes on site. Prior approval to commence drilling must be obtained from the Environment Agency.

The Operator must keep accurate records throughout the lifetime of their permit to clearly demonstrate that their activity has not adversely affected the site. This record will be used, in conjunction with the baseline data described above and the site condition report, to support any surrender application.

6.11. Pollution prevention measures

We have considered the location of the site, and potential emissions, the sensitivity of receptors and the nature of the activity to decide what appropriate pollution prevention measures need to be in place.

As part of our assessment of the application we have carefully considered the risk assessment and all associated documents provided by the Applicant including the Environmental Statement. We consider that these cover all the potential risks and set out appropriate measures by way of mitigation.

6.12. Well pad construction

The pad construction is consistent across the entire area of the site extending beyond the hazardous waste facility area as described below and in Chapter 4 of the Environmental Statement. The site pad construction will require top soil to be stripped and stored in a mound adjacent to the pad. The top soil will be reinstated at the site restoration phase of the project.

- The pad will comprise an area of approx. 1.55 hectares with a minimum depth of 300mm clean, compacted aggregate laid on a High Density Polyethylene “HDPE” membrane and geotextile layer with protective felt inter-layers. The top of the stone pad will lay at a level 50mm lower than the top of the outer perimeter ditch bund, thus providing 50mm air freeboard (creating a bath tub effect).
- A 1.0m deep, minimum 2.3m wide open trapezoidal drainage ditch will be constructed around part of the well pad perimeter to collect surface water and any spillages and provide surface water run-off attenuation. The ditch will be isolated with double isolation valve, preventing discharge to surface waters, This outlet pipe will be restricted in diameter (using a throttle pipe diameter; an orifice plate stopper or similar) such that storm water runoff from the well pad is reduced to below greenfield rates. Only clean and uncontaminated surface waters will be discharged. During drilling, hydraulic fracturing and initial flow testing stages, the double isolation valve will be kept shut and any surface waters removed from the site to an appropriately permitted facility. Further details are described in the Environment Statement (Chapters 17.4.6, 17.4.7, 17.4.8 and Chapter 19) and we are satisfied with those proposals.

Construction of the well pad incorporating a HDPE membrane is designed to prevent pathways from the surface activities to soil, surface water and groundwater receptors. On completion of the well pad an inspection and integrity test of the membrane will be conducted by a competent contractor. Any identified punctures will be repaired. Once a continuous seal across the pad has been validated by the competent contractor the well pad will be commissioned for operations.

During the construction process a Construction Quality Assurance (CQA) validation report will be produced to show the well pad is built to a the correct standard and design specification.

A series of groundwater boreholes will be located around the edge of the well pad to establish baseline groundwater quality conditions within the shallow geology and to carry out monitoring during the life of the permit. Drawings of the pad are detailed within HSE-Permit-INS-RW-002a.

6.13. Storage arrangements

Table below shows the storage arrangements for waste types produced on site.

Waste Type	Estimated Volume	Storage Type	Capacity
Drilling Muds / Cuttings	2900m ³ (400m ³ spent drilling muds, 1400m ³ drill cuttings & 1100m ³ water wet and oil wet drill cuttings) per well.	Steel solid containers (approx. 6mm thickness with annual non-destructive testing inspection)	Maximum of 275 tonnes at any one time. Subject to contractor selection multiple steel skips (~50m ³) depending on rig selection and mud circulation system. Drill cuttings and spent mud wastes will be regularly removed to an offsite permitted waste facility.
Flowback Fluid (may not be waste if it is to be re-used)	Up to 22000 m ³ per well during (initial flow test period),	Fully enclosed steel solid tanks (approx. 6mm thickness with annual non-destructive testing inspection)	Up to 3000 m ³ . Regularly removed to an offsite permitted waste facility.
Produced water	10m ³ per well (during extended well test period)		Up to 140m ³ Regularly removed to an offsite permitted waste facility.
Retained fracturing fluid	~16,000m ³ to ~24,000m ³	Geologic shale formation	Variable capacity based on geochemical influences.
Sands	3-7 m ³ per well	Steel solid containers (approx. 6mm thickness with annual non-destructive testing inspection)	Subject to contractor selection ~10-20m ³ steel containers. Regularly removed to an offsite permitted waste facility.
Cement	20-30m ³ per well	Lined steel skips	Subject to contractor selection, lined steel skips (usually 6 m ³ skips) regularly removed to an offsite

Suspension Fluid/ spacer fluid	30m ³ per well	Steel solid tanks approx. 6mm thickness with annual non- destructive testing inspection) (approx. 6mm thickness with annual non- destructive testing inspection)	permitted waste facility. Storage capacity is flexible. 5-25 m ³ . Removed to an offsite permitted waste facility
Surplus Natural Gas	Up to 15,444 tonnes per year	Flared to atmosphere.	Maximum 130,000 m³ per day
Scale	5m ³	Inside the pipe network.	up to 5 m ³ Removed to an offsite permitted facility as equipment decommissioned

6.14. Odour management

We carefully considered potential odour emissions from the activity during our determination.

Odour, from the activities we permit, is not considered likely to be an issue considering the site is in a rural location, which is 190 metres from the nearest sensitive receptor. In addition the regulated activities are not likely to produce any odours due to the processes and chemicals used being inherently non-odorous.

We are satisfied that the environmental risk assessments contain adequate measures to manage any potential odour and that the regulated activities will not cause pollution of the environment or harm to human health from odour.

Under Condition 3.2 of the permit, we can require the Operator to produce and implement an odour management plan in the unlikely event that activities at the site give rise to odour. Should a plan be required in the future, once we have assessed this plan as suitable, it will form part of the permit and the Operator must carry out the activity in accordance with the approved techniques.

6.15. Noise management

We carefully considered emissions from noise and vibration during our determination and concluded that noise and vibration from the regulated activities are not considered to be an issue due to the design of the flare, the rural location of the site, the distance to the nearest receptor (190 metres) and the level of background noise (the site is located 1.4 km from the M55).

The risk of the flares themselves causing noise complaints is low. Based on the sound

pressures presented by the Applicant, it is unlikely to cause a noise level that is greater than 10dB above background at the closest receptor (190m). As these figures assume the flares run at 100% capacity and the distances represent actual distances from the flare, we are satisfied that the environmental risk assessments contain adequate measures to manage noise and that the regulated activities will not cause pollution of the environment or harm to human health from noise.

Under Condition 3.3 of the permit, we can require the Operator to submit a specific noise and vibration management plan, should noise and vibration become a problem from activities we regulate. Should a plan be required in the future, once we have assessed this plan as suitable, it will form part of the permit and the Operator must carry out the activity in accordance with the approved techniques.

Should planning permission be granted, we anticipate that there will also be planning conditions in place relating to the level of noise emitted from the site.

7. Environmental Issues and their control

This section of the document explains how we have approached the critical issue of assessing the likely impact of the permitted activities on human health and the environment. It also contains details of the measures we require to ensure a high level of protection. The principal potential emissions are those to air, water and land.

The key issues arising in relation to human health and the environment during this determination were protection of groundwater; emissions to air; odour; noise; contamination of land; and water quality.

The detail in the sections below relates to how we determined these issues.

7.1. Assessment of environmental impacts

We are satisfied that the Applicant has now properly assessed the risks posed by the proposed activities. To support the Applicant's risk assessments we requested additional information. The risks identified are set out in the Applicant's risk assessment and supporting information, which form part of the application. This covers assessments of risks to surface water, groundwater and air. We have reviewed the Applicant's assessments of the environmental risk from the operations and we are satisfied that, together with the additional information provided, the risks have been adequately identified and that proper mitigation measures will be in place to comply with the requirements of the permit.

7.2. Nature Conservation

7.2.1. Protected Sites

7.2.1.1. Site of Special Scientific Interest (SSSI)

There are no SSSIs within 2 kilometres of the surface site.

Taking into account the potential extent of the underground works (as described in the plan at figure 2 of the Waste Management Plan), there are no SSSIs within 2km of the surface extent of the underground works.

7.2.1.2 Special Areas of Conservation (SAC), Special Protection Areas (SPA), and Ramsar sites

There are no SACs within 10 kilometres of the surface site or underground works. There are 2 SPA and 2 Ramsar designations within 10 kilometres of the surface site and underground works:

Designated site	Distance from operation
SPA: Ribble & Alt Estuaries RAMSAR: Ribble & Alt Estuaries	8.3 km to S / SW
SPA: Morecambe Bay RAMSAR: Morecambe Bay	6.1 km to N / NW

7.2.1.3. National Nature Reserve

There are no National Nature Reserves within 2 kilometres of the surface site or underground works.

7.2.1.4. Local wildlife sites (LWS)

There are 2 Local Wildlife Site within 2 kilometres of the surface site.

LWS	Distance from operation
Medlar Meadows	1.9 km to SW
Medlar Ditch	1.9 km to SW

Taking into account the potential extent of the underground works (as described in the plan at figure 2 of the Waste Management Plan) Medlar Meadows and Medlar Ditch are in the immediate vicinity of the surface extent of the underground works. However, the underground works will be at a depth of over 2 kilometres.

7.2.2. Assessment of potential impacts from surface water and groundwater

A full assessment of the application and its potential to affect the sites and habitats mentioned above showed that the proposed activities are not likely to have a significant effect on these sites or any of their designated interest features.

In relation to the management of extractive wastes (as part of the mining waste operation, the hazardous mining waste facility or the non-hazardous mining waste facility) we are satisfied that there are no pathways for pollutants to reach the designated sites. We are also satisfied that there is no pathway for any extractive waste in the underground fractures to migrate to the surface and the LWS. This is based on the distance of the designated sites both from the surface activities and the extent of the underground works and from the mitigation measures provided by the site construction (see section 6.12. for more details).

Other potential hazards from the management of the waste are failure of containment of the solids and liquids. These will be stored in suitable containers awaiting removal off site.

Should a container or tank fail, the whole site has secondary bunding which will contain any spillages. During operations, any solid spills can be collected and removed off site and liquid spills will be directed to sealed drainage for containment prior to collection.

No spilled material will be able to leave the site and there will be no pathway for these wastes to affect land or water. The site is entirely contained and provides adequate containment for the activities. There will be no discharge to surface water. Well pad construction is detailed in section 6.9 above. We are satisfied with these pollution prevention measures.

7.2.3. Assessment of potential impacts from air quality

There is a potential impact on air quality from the incineration of the waste gas and this impact has been fully assessed and is detailed in section 7.6 of this document. Following our assessment we are satisfied that there will be no likely significant effect on the statutory conservation sites (SPA/Ramsars/SSSI) from air emissions. We presented our assessment and conclusion to Natural England on an Appendix 11 form (Habitats Directive: Form for recording likely significant effect) for information. This conclusion was presented to Natural England so that they were aware of our assessment and they did not raise any concerns.

7.3. Waste Management Plan

Under the Mining Waste Directive (Article 5) an Operator of a mining waste operation must draw up a waste management plan (WMP) for the minimisation, treatment, recovery and disposal of extractive waste. We have assessed the Applicant's WMP and referenced documents.

We have approved the plan as a whole, subject to conditions in the permit. We are satisfied that the permit requirements, including the requirements of the WMP, will protect the environment and that Articles 4 and 5 of the Mining Waste Directive are met.

The WMP provides that the material inputs (e.g. drilling muds, dilute hydrochloric acid and hydraulic fracturing fluid) have been selected to minimise risk and will be restricted to the minimum amount necessary, thereby minimising the amount of waste generated. It provides an estimate of the amount of each waste that will be managed. Wastes arising from the activities will be recovered where possible. It also characterises each waste type. We are satisfied that waste is correctly characterised taking into account the definition in Article 3 of the Waste Framework Directive.

The WMP, including any associated documents, is incorporated into the permit by means of condition 2.3.1 and table S1.2. The WMP needs to be reviewed every 5 years but in the unlikely event that the activities give rise to pollution, condition 2.3.1 enables us to require a revision of the plan to be submitted to us for approval and implemented thereafter. Condition 2.3.2 is a standard condition and refers to an extended time period.

7.4. Setting permit conditions

We have set conditions in the permit in accordance with our Regulatory Guidance Series, No RGN 4 – *Setting standards for environmental protection (version 3.0)*. This guidance note explains how we determine the requirements that should apply to a particular activity. Permit conditions specify certain key measures for that type of activity to protect the environment. Other measures may be required through outcome-based conditions. Outcome based conditions specify what we want the Operator to achieve, but do not tell them how to achieve it.

We have used the relevant generic conditions from our bespoke permit template along with other, activity-specific conditions to ensure that the permit provides the appropriate standards of environmental protection.

Our generic conditions allow us to deal with common regulatory issues in a consistent way and help us to be consistent across the different types of regulated facilities. We have included our generic conditions on fugitive emissions, odour and noise/ vibration to control emissions from the facility.

7.5 Protection of groundwater

We have reviewed the Environmental Risk Assessment and the relevant sections of the Environmental Statement submitted with the planning application submitted to Lancashire County Council, against our information and conceptual understanding of the location. We are satisfied that the potential risks to groundwater have been adequately identified and addressed through mitigation measures in the permit.

Groundwater is defined in the Environmental Permitting Regulations 2010 (EPR 2010) as all water that is below the surface of the ground in the saturation zone and in contact with the ground or subsoil (Regulation 2(1)). There are no restrictions on the quality of the groundwater or the depth of the geological formation that contains that groundwater.

The Environment Agency has determined that the Bowland Shales and the Hodder Mudstones do not contain groundwater because any water that is within the formations will be bound to the rock and will be relatively immobile. The Millstone Grit formation which is directly above the Bowland Shale will contain groundwater, and although the formation will have a relatively low permeability due to the depth of burial the water content is considered to meet the definition of groundwater as defined in the EPR 2010.

Other formations through which the drilling will take place will also contain groundwater, such as the Sherwood Sandstone, albeit of very poor chemical quality.

We have evaluated whether a Groundwater Activity Permit is required for any of the proposed activities.

Drilling

We have reviewed the drilling additives to be used for the construction of the boreholes and are satisfied that they do not present a risk to the groundwater quality in any of the formations. Only those additives that have been identified in the application documents can be used, and any deviation from this list will require prior approval from us. We have evaluated that the use of drilling muds, both water based and also the possible use of low toxicity oil based muds (LTOBM), for the drilling of the boreholes does not require a Groundwater Activity Permit as this complies with the groundwater activity exclusion under paragraph 3.3(b) of Schedule 22 to EPR 2010 in that any discharge to any formations that contain groundwater would be of a quantity so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater.

Where the exclusion applies there is no groundwater activity permit required as there is no groundwater activity. The use of low toxicity oil based muds can only take place once the drilling has advanced through the Sherwood Sandstone unit and the casing has been cemented in place and pressure tested to ensure that the sandstone unit is sealed and that no LTOBM can escape upwards into the sandstone.

Hydraulic Fracturing:

Based on the information presented, we have determined that a Groundwater Activity Permit is required for the hydraulic fracturing of the Bowland Shale formation. We consider that this activity does meet the definition of groundwater activity under paragraph 3(1) of Schedule 22 EPR 2010 in that hydraulic fracturing involves the discharge of pollutants in circumstances which, without control measures, might lead to an indirect input of a pollutant to groundwater. The purpose of the permit is to ensure that control measures are in place that will prevent indirect inputs of pollutants and pollution of groundwater.

The target geological formations into which the hydraulic fracturing will be carried out are expected to be located between 1900m and 3200m below ground level. Above these there are several different geological units, some of which may contain groundwater. Groundwater which is contained in rocks that are isolated from the surface and have no inflow or outflow, are likely to be of very poor quality with a very high mineral content due to the time they have been in contact with the rock, allowing minerals to dissolve into the water.

At this location the rock overlying the Bowland Shale is the Millstone Grit, which is between 1830m and 1900m below ground level.

The Millstone Grit are classed as a secondary (formally known as minor) aquifer. In the areas where they outcrop at the ground surface they can provide important drinking water resources to isolated rural communities, as well as being the headwater springs for streams.

Where these rocks occur at Roseacre Wood site they are located approximately 1830m below ground level and have several layers of other rocks above them. The Millstone Grit at this depth do have fluid in them, however, it has been trapped within the rocks for many millions of years and it is isolated from the fresh hydrological cycle at the surface. As there is no inflow and no discharge area from these rocks the fluids do not circulate, this means that the fluids will be very saline having had so long to dissolve the minerals from the rock matrix. It is likely that the chemical signature of water in the Millstone Grit will be similar to the chemistry of any formation water in the shales. If fracture fluid did diffuse from the shale into the Millstone Grit the impact would be insignificant due to the similarity in chemistry of the fluids.

The Groundwater Activity Permit conditions are designed to ensure that activities are controlled and monitored to reduce the possibility of a discharge to Millstone Grit.

The permit contains conditions such that the hydraulic fracturing can only be carried out within the target formations.

- The Applicant will be required to submit a hydraulic fracturing plan, which will need to be approved by DECC and the Environment Agency. This plan will detail the mitigation measures that are outlined in The Environmental Statement section 12, and appendix L – Induced Seismicity.
- The Applicant will be required to monitor the propagation of the fractures to ensure that the fractures remain within the target formation.
- We have stipulated that the Operator report the results of all testing undertaken to ensure we know this condition is being complied with. This will include reviewing data and the interpretations made of the microseismic monitoring of fracture propagation.

The Applicant is required to carry out the hydraulic fracturing process in a controlled manner by applying a stepped approach that will allow the geomechanical properties of the reservoir to be understood and the hydraulic fracturing programme to be tailored accordingly. The process will begin with small volumes of fracture fluid, building up to a maximum of 765m³. Fracture development will be monitored using the buried seismic equipment. This will allow the operator to assess the location, orientation and extent of the induced hydraulic fractures, which will allow identification of the areas where the fracture fluid is likely to be retained. It will also ensure that the operator knows which formations the fracture fluid has been injected into and allow confirmation of the extent and direction of the fractures.

Should any fractures propagate into the Millstone Grit above the target Bowland Shale this can be identified and the hydraulic fracture plan can be modified, for example by reducing the volume of fracture fluid being used, reducing the pressure applied or moving the injection location to ensure this is avoided in subsequent fracturing phases. The permit takes account of the possibility of fracture fluid indirectly discharging into the Millstone Grit so this would not constitute a breach of the permit but it is expected that this will be controlled and mitigated against as outlined above, should it occur. As

described above, the impact of any indirect discharge to the Millstone Grit would be insignificant due to the chemical similarity of the fluids.

The injection boreholes within the site boundary (marked in Schedule 7 of the permit) shall comply with the details submitted and agreed under section 199 of the Water Resources Act 1991 and each injection borehole will be integrity tested prior to the hydraulic fracturing commencing on site. This will minimise any risk from leakage during the operations.

The hydraulic fracturing fluid will only contain additives which have been verified in writing by us as non-hazardous, the hydraulic fracturing fluid will include a friction reducing agent (polyacrylamide) which is present in the hydraulic fracturing fluid at no more than 0.05% of the total volume and we have determined that polyacrylamide is non-hazardous. If for commercial or engineering reasons, the Operator needs to use a different friction reducer or a different percentage of polyacrylamide, in the hydraulic fluid they will have to fully disclose the proposed friction reducer and its components for assessment, or percentage change, and obtain approval by the Environment Agency prior to the activity occurring on site.

As a conservative approach, we have imposed a pre-operational condition 2.4.1, which requires the operator to establish baseline groundwater quality and surface water quality. We have also imposed condition 3.5.1(b), which requires the Operator to monitor groundwater and surface water during and after the operations on site, at specific points as listed in Table S3.5 in the permit.

In addition, we have included a condition in the permit that provides that the hydraulic fracturing process must be designed and implemented to ensure any fracture remains in the target formation, namely the Upper and Lower Bowland Shale and Hodder formations. Details of the methodology to achieve this are to be produced in the Hydraulic Fracture Plan to be submitted to DECC and which needs to be approved by the Environment Agency as a condition of the permit, prior to the commencement of any hydraulic fracturing operations.

In the event of fractures leaving the target formation the fracturing fluid could discharge into the overlying Millstone Grit. The groundwater within the Millstone Grit is likely to be highly saline in a similar range to the quality of the flowback fluid, and because of this the impact on this groundwater would be negligible. Once the hydraulic fracturing pressure has been released there would be no driver to move this fluid any further and as there is no significant flow within the Millstone Grit due to the confined nature of the formation, any fracturing fluid reaching the Millstone Grit will not move far from the point of entry.

The operator is also required to monitor the quality of hydraulic fracturing fluid entering each of the injection boreholes. The results of the hydraulic fracture fluid quality, groundwater and surface water monitoring are to be reported to us on a quarterly basis so that we can assess any impact on the surrounding groundwater and surface water quality. Results will also be held on site for inspection at any time.

Other considerations are:

The boreholes will be constructed in accordance with the requirements of the HSE and the Petroleum Exploration and Development Licence. They are designed in accordance with industry best practice and in compliance with the Installation and Wells (Design and Construction) Regulations 1996 (DCR). DCR requires the design of the well to be such that no unplanned escape of fluids can occur.

The Environment Agency has assessed the risk of drilling a borehole at this location and we consider that the design of the proposed boreholes meets the requirement to prevent any release of liquids into the water environment. The boreholes will be constructed in accordance with the agreed notification submitted under section 199 Water Resources Act 1991.

In areas where the Sherwood Sandstone outcrops at, or is present close to, the surface, it has been classified as a principal aquifer and is an important source for public water supply.

At the Roseacre Wood site, the boreholes will penetrate the Sherwood Sandstone, but the groundwater present in the sandstone unit is not considered to be usable for drinking water supply.

At this location the sandstone is buried beneath approximately 330m of impermeable Mercia Mudstone. It is isolated from the surface and has no inflows or outflows. The groundwater is effectively static in the rock and has been confined over many thousands of years. Over this time the groundwater will have dissolved minerals from the rock and become highly mineralized, making it unfit to be treated for drinking water supply.

The Woodsfold Fault lies approximately 2.5 kilometres east of the site and acts as a barrier to groundwater flow preventing the poor quality water from the sandstone on the west of the fault from interacting with the good quality water that is used for public water supply on the east of the fault. This understanding has been tested and demonstrated by groundwater modelling work carried out by the Environment Agency in conjunction with United Utilities during water resource assessment work in the 1990s and 2000s, it is also backed up by observations in the differences in groundwater levels and chemical quality of the water on either side of the fault.

The sandstone unit to the East of the site can reach as much as 1000m deep in places and although it will contain water throughout this depth, it is only the upper section that will contribute water to the public supply abstractions and to water features at the surface. The public supply boreholes are mainly less than 120m deep.

As is typical of any aquifer unit, the groundwater circulation becomes slower and longer as the depth of the unit increases. This means that the quality of the water decreases with depth as it dissolves minerals from the rock.

The work undertaken for the groundwater model also showed that marl bands present at depth within the sandstone unit impede the vertical movement of groundwater at depth. Should the sandstones be connected at depth across the Woodsfold fault, the above evidence shows that there will be effectively no flow between the two sides and that the water quality at this depth between the two sides of the fault is likely to be similar due to long residence times.

Work carried out on the Mercia Mudstone group in Cheshire has also shown that where faults cross this formation, the mudstone has been recrystallised along the fault line and has become less permeable than the surrounding undisturbed formation. This would also prevent the migration of fluids or gas upwards along the fault.

In order for fluids or gas to be able to migrate a continuous permeable pathway together with a pressure gradient will need to be present. The faults shown on the published geological maps pass through impermeable formations such as the Mercia Mudstone and the Manchester Marl, as well as other thinner mudstone bands.

Where these formations have been disturbed by the fault, there is likely to be a sealing effect where the fine grained material forms a blinding against other formations. This will produce areas along the faults which effectively seal the fault to the migration of gas and fluid. If this were not the case then the hydrocarbons below the Manchester Marl would have been able to migrate upwards and be present in the sandstone above, which they are not.

The other factor that is required to cause the migration of fluids or gases is a pressure gradient to drive a flow. A pressure gradient will be created during the injection phases of the hydraulic fracturing operations, however these will have a short time period and the gradient will reverse immediately as the pressure is released at the well head.

Monitoring during the hydraulic fracturing process in line with an agreed programme in the Hydraulic Fracture Plan will minimise the potential for fracture fluid to be injected into areas where preferential pathways exist and ensure that the fractures are retained in the target formation.

We are therefore satisfied that the permitted activities will not cause pollution of drinking water supplies.

We have assessed the method of construction of the boreholes and the proposed drilling additives including the use of low toxicity oil based muds (LTOBM) and we are satisfied that the methods used are appropriate and will ensure that the groundwater is protected. The Operator can only use additives that have been assessed and approved by the Environment Agency or equivalent alternatives subsequently approved. Assessment and approval is also required prior to the use of any other additive during the activities if the Operator needs to use different additives for operational reasons.

The Operator's own monitoring will include the monitoring of any loss or gain of fluids within the mud system throughout drilling, and appropriate actions to be taken.

We have also considered the risk from induced seismicity on well integrity.

The permit requires the Operator to submit for approval the Hydraulic Fracture Plan. That plan will include:

- A map showing faults near the well and along the well path, with a summary assessment of faulting and formation stresses in the area and the risk that the operations could reactivate existing faults;
- Information on the local background seismicity and assessment of the risk of induced seismicity;
- Summary of the planned operations, including stages, pumping pressures and volumes;
- A comparison of proposed activity to any previous operations and relationship to historical seismicity;
- Proposed measures to mitigate the risk of inducing an earthquake and monitoring of local seismicity during the operations; and
- A description of proposed real-time traffic light scheme for seismicity, and proposed methods for fracture height monitoring.

In the event of suspension of activities caused by a seismic event greater than the threshold agreed in the hydraulic fracturing plan and proposed real-time traffic light scheme, the permit requires the Operator to carry out well integrity testing of each injection borehole to confirm that the wells are not damaged and that groundwater remains protected, before resuming operations.

7.6 Emissions to air

During initial flow testing operations, there is a likelihood of natural gas being produced from the target formations and flowed at different rates to determine the characteristics of the formation. The initial flow tests will allow the Operator to determine whether or not to carry out extended well testing. If an extended well test is carried out, this will enable the operator to determine the future well performance over its potential working life, should it go into production.

The ability to prevent or minimise the production of natural gas is extremely limited

during the initial and extended well tests as it is necessary to allow the operator to determine the condition or state of the reservoir. Given that the operation is exploratory, the infrastructure required and the temporary nature of the operations, it is not practicable during the initial flow test to capture the gas for sale and transportation for use as a fuel or other means of generating energy.

Natural gas is separated from flowback fluids at the surface and diverted via temporary pipe work for the flow rate to be tested. It will then enter one of two enclosed ground flares located onsite for incineration.

When in operation, the flares will be supervised 24 hours a day (either on site or remotely) to ensure their effectiveness to incinerate the natural gas.

We have included monitoring conditions in the permit requiring the Operator to monitor for temperature, volume of gas going into the flare from which the emissions of oxides of nitrogen, carbon monoxide, total Volatile Organic Compounds (VOCs) and methane can be calculated, and to provide monthly reports of the results.

7.6.1 Fugitive Emissions:

During drilling of the exploratory boreholes, fugitive emissions of natural gas are to be prevented by increasing the hydrostatic pressure of fluids so as to prevent gas release. The well will also be equipped with physical control equipment which enables the borehole to be shut at the surface to prevent escape of gas emissions. Gas monitoring equipment will be in constant use at the surface. The permit does not allow the venting of natural gas unless it is necessary for safety reasons.

Fugitive emissions of methane could potentially arise from the wellbore and mud circulation system. The Operator has provided a specific risk assessment for this scenario, which includes monitoring and proposes emergency control measures. The Operator will carry out testing of all surface pipework to check for leaks prior to starting the operations and will be carrying out monitoring using Flame Ionization Detection monitoring equipment during the operations as part of the Environmental Management and Monitoring Plan required by the permit. The operations will be benchmarked against baseline levels and should elevated levels of methane be detected, the well will be shut and the cause for the changes investigated and remedied. Operation will only resume once we are satisfied that the issue has been resolved. We are satisfied that these measures minimise the risk of fugitive emissions and, together with condition 3.1, provide acceptable controls.

7.6.2 Point source emissions from the incineration of waste gas:

During the determination of this application, we carefully considered emissions to air that will arise from the flow testing operations and the potential impact of these emissions on human health and ecological receptors.

Natural gas is considered waste once it has served its useful purpose, namely having been tested and metered. It will therefore be extractive waste at the point of incineration. An air dispersion modelling assessment has been carried out to assess the potential impact on human health and ecological receptors.

The expected composition of any natural gas that may arise from the activities is approximately 96% methane, with the remainder a mixture of other hydrocarbons.

Regulated activities can present different types of risk to the environment, these include odour, noise and vibration; accidents, fugitive emissions to air and water; as well as point source releases to air, discharges to ground or groundwater, global warming potential and generation of waste. We have also considered the effect of emissions being subsequently deposited onto land (where there are ecological receptors). All these factors are discussed in this and other sections of this document.

The next sections of this document explain how we have approached the critical issue of assessing the likely impact of the emissions to air from the flaring of natural gas on human health and the environment and what measures we are requiring to ensure a high level of protection.

7.6.2.1. Assessment Methodology

7.6.2.1.a) Application of Environment Agency H1 Guidance

A methodology for risk assessment of point source emissions to air, which we use to assess the risk of applications we receive for permits, is set out in our Horizontal Guidance Note H1 and has the following steps:

- Describe emissions and receptors
- Calculate process contributions
- Screen out insignificant emissions that do not warrant further investigation
- Decide if detailed air modelling is needed
- Assess emissions against relevant standards
- Summarise the effects of emissions

The H1 methodology uses a concept of “process contribution (PC)”, which is the estimated concentration of emitted substances after dispersion into the receiving environmental media at the point where the magnitude of the concentration is greatest. The guidance provides a simple method of calculating PC primarily for screening purposes and for estimating process contributions where environmental consequences are relatively low. It is based on using dispersion factors. These factors assume worst case dispersion conditions with no allowance made for thermal or momentum plume rise and so the process contributions calculated are likely to be an overestimate of the actual maximum concentrations. More accurate calculation of process contributions can be achieved by mathematical dispersion models, which take into account relevant

parameters of the release and surrounding conditions, including local meteorology – these techniques are expensive but normally lead to a lower prediction of PC.

7.6.2.1.b) Use of Air Dispersion Modelling

The Applicant has submitted full air dispersion modelling as part of their application. Air dispersion modelling enables the process contribution to be predicted at any environmental receptor that might be impacted by the operation of the flare.

Once short-term and long-term PCs have been calculated in this way, they are compared with Environmental Quality Standards (EQS) referred to as “benchmarks” in the H1 Guidance.

Where an EU EQS exists, the relevant standard is the EU EQS. Where an EU EQS does not exist, our guidance sets out a National EQS (also referred to as Environmental Assessment Level - EAL) which has been derived to provide a similar level of protection to Human Health and the Environment as the EU EQS levels.

National EQSs do not have the same legal status as EU EQSs, and there is no explicit requirement to impose stricter conditions than BAT in order to comply with a national EQS. However, national EQSs are a standard for harm and any significant contribution to a breach is likely to be unacceptable.

PCs are considered Insignificant if:

- the long-term process contribution is less than 1% of the relevant EQS; and
- the short-term process contribution is less than 10% of the relevant EQS.

The long term 1% process contribution insignificance threshold is based on the judgements that:

- It is unlikely that an emission at this level will make a significant contribution to air quality;
- The threshold provides a substantial safety margin to protect health and the environment.

The short term 10% process contribution insignificance threshold is based on the judgements that:

- spatial and temporal conditions mean that short term process contributions are transient and limited in comparison with long term process contributions;
- the threshold provides a substantial safety margin to protect health and the environment.

Where an emission is screened out in this way, we would normally consider the Applicant’s proposals for the prevention and control of the emission to be BAT. That is because if the impact of the emission is already insignificant, it follows that any further reduction in this emission will also be insignificant.

However, where an emission cannot be screened out as insignificant, it does not mean

it will necessarily be significant.

For those pollutants which do not screen out as insignificant, we determine whether exceedences of the relevant EQS are likely. This is done through detailed audit and review of the Applicant's air dispersion modelling taking background concentrations and modelling uncertainties into account. Where an exceedence of an EU EQS is identified, we may require the Applicant to go beyond what would normally be considered BAT for the Installation or refuse the application. Whether or not exceedences are considered likely, the application is subject to the requirement to operate in accordance with BAT. This is not the end of the risk assessment, because we also take into account local factors (for example, particularly sensitive receptors nearby such as a SSSIs, SACs or SPAs). These additional factors may also lead us to include more stringent conditions than BAT.

If, as a result of reviewing of the risk assessment and taking account of any additional techniques that could be applied to limit emissions, we consider that emissions would cause significant pollution, we would refuse the Application.

7.6.2.1.c) Assessment of Impact on Air Quality

The Applicant's assessment of the impact of air quality is set out in Chapter 6 of the EIA and in the response to the Schedule 5 notice; request for further information. The assessment comprises:

- An H1 screening assessment of emissions to air from the operation of the flare.
- Dispersion modelling of emissions to air from the operation of the flares.
- A study of the impact of emissions on nearby sensitive habitat / conservation sites.
- A qualitative assessment of amenity impacts during construction.
- Dispersion modelling of the impact of additional road traffic arising from the operation of the flare.

Of these the amenity impacts during construction and air quality impacts arising from additional road traffic have not been considered as these are essentially matters for the local planning authority when considering the parallel application for planning permission, and outside the scope of our determination under the Environmental Permitting Regulations.

The Applicant has assessed the potential emissions to air from the flaring activity against the relevant air quality standards, and the potential impact upon local conservation and habitat sites and human health. These assessments predict the potential effects on local air quality from the flare using the ADMS 5.0 dispersion model, which is a commonly used computer model for regulatory dispersion modelling. The model used 5 years of meteorological data collected from the weather station at Blackpool Airport between 2008 and 2012, being 12 kilometres from the site. The applicant did not model the impact of complex terrain on dispersion. Our checks confirm that this modelling was not necessary.

The air impact assessments, and the dispersion modelling upon which they were based, employed the following assumptions:

- they assumed that the flares would operate at a capacity for a whole year;
- they assumed the locations of the sensitive receptors would be representative.

We are in agreement with this approach. The assumptions underpinning the model have been checked and are reasonably conservative.

The Applicant has included background air quality pollution data extracted from the Defra background maps. The Defra maps are a reliable data source and are comparable with values for the same location obtained from Fylde District Council, and from APIS (Air Pollution Information System).

The Applicant has modelled the concentration of key pollutants at a number of specified locations within the surrounding area, and also on a grid covering the surrounding area.

The way in which the Applicant used dispersion models, its selection of input data, use of background data and the assumptions it made have been reviewed by the Environment Agency's modelling specialists to establish the robustness of the Applicant's air impact assessment. The output from the model has then been used to inform further assessment of health impacts and impact on habitats and conservation sites.

Our review of the Applicant's assessment leads us to agree with the Applicant's conclusions.

The Applicant's modelling predictions are summarised in the following sections.

7.6.2.1.d) Assessment of Air Dispersion Modelling Outputs

The Applicant's modelling predictions are summarised in the tables below. The figures shown indicate the predicted peak impacts at receptors. Whilst we have used the Applicant's modelling predictions in the table below, we have made our own simple verification calculation of the percentage process contribution and predicted environmental concentration. These are the numbers shown in the tables below and so may be very slightly different to those shown in the Application. Any such minor discrepancies do not materially impact on our conclusions.

7.6.2.2. Emissions modelled

The air dispersion modelling considered the potential impacts of the main pollutants that could be emitted from the combustion of natural gas based on its expected composition:

- Oxides of nitrogen / nitrogen dioxide (NO_x / NO₂),
- Benzene (a volatile organic compound, VOC).
- PAH emissions (with reference to Benzo-a-pyrene)

We are satisfied with the extent of the emissions modelled by the operator.

Particulates have been covered by a qualitative assessment as we would not expect PM10 to result from gaseous emissions. It formed part of the air quality assessment submitted by the Applicant and is included in the habitats section for completeness.

Carbon monoxide (CO) emissions are not likely to exceed the relevant EAL, and would only be modelled for the purposes of process controls rather than environmental controls. The global warming impact of carbon dioxide is addressed in section 7.6.3.8 below.

Persistent Organic Pollutants (POPs) which can result in dioxins / furans are unlikely to be produced due to the composition of the natural gas, i.e. the lack of chloride ions in it .

Sulphur dioxide (SO₂) has not been included in the assessment; the Applicant provided information based on other gas extractions locally that no hydrogen sulphide (H₂S) has been identified during monitoring of the drilling muds or the gas. A sulphurous gas, carbonyl sulphide, has been found to be present in gas extracted from Preese Hall exploration site, prior to combustion.

Using the data for carbonyl sulphide (9ppb), we have calculated a sulphur dioxide, (SO₂) emission rate, assuming 96% destruction during combustion (expected efficiency about 98%).

On this basis we predicted the sulphur deposition at all ecological receptors and its contribution to acid deposition and have concluded that the contribution from SO₂ is likely to be insignificant (as suggested by the Applicant's data). Therefore we did not consider it necessary to require the Applicant to calculate sulphur deposition in their acid deposition predictions at statutory sites.

7.6.2.3. Assessment of Emissions to Air

Pollutant	EQS / EAL	Background		Process Contribution (PC)		Predicted Environmental Concentration (PEC)	
	µg/m ³	1	2	µg/m ³	% of EAL	µg/m ³	% of EAL
NO ₂	40	1	9.4	3.5	8.8	12.9	32
	200	2	18.8	31.1	15.6	49.9	25
Benzene	5	1	0.21	0.017	0.3	NA	NA
BaP*	0.00025	1	0.00008	0.000012	4.8	0.000102	36.8

* PAH as benzo[a]pyrene BaP

1 Annual Mean (long-term)

2 99.79th %ile of 1-hour means (short-term)

* For BaP, the applicant did not present any background data. We can note, however that we have established a value of 0.08ng/m³ from the nearest rural station and taking other similar rural stations into account in the UK indicate that an exceedence is highly unlikely. The conclusion is also based on the conservative nature of the impact assessment as a whole.

i) Screening out emissions which are insignificant (with reference to the criteria detailed above in section 7.6.2.1.b)

From the tables above the following emissions can be screened out as insignificant in that the process contribution is < 1% of the long term EQS/EAL and <10% of the short term EAQ/EAL. These are:

- Benzene

Therefore, generally, we consider the Applicant's proposals for preventing and minimising the emissions of these substances to be BAT for the Installation subject to the detailed audit referred to below.

(ii) Emissions unlikely to give rise to significant pollution

Also from the tables above the following emissions (which were not screened out as insignificant) have been assessed as being unlikely to give rise to significant pollution in that the predicted environmental concentration is less than 100% (taking expected modelling uncertainties into account) of both the long term and short term EQS/EAL

- Nitrogen Dioxide (NO₂)
- BaP

For these emissions, we have carefully scrutinised the Applicant's proposals to ensure that they are applying the Best Available Techniques to prevent and minimise emissions of these substances. As described in section 7.6.3 we consider the design of the

proposed flares will achieve efficient combustion.

(iii) Emissions requiring further assessment

All emissions either screen out as insignificant or where they do not screen out as insignificant are considered unlikely to give rise to significant pollution.

7.6.3. Conclusions

We are satisfied that the contribution of emissions from the proposed flaring at locations closest to the well sites is insignificant.

We are satisfied that the combustion of this natural gas will not result in pollution or harm to human health and that it is not necessary to set emission limits, as the operating controls will ensure effective and efficient combustion, maximising the conversion of the methane to carbon dioxide and water vapour and minimising other emissions.

The ability to prevent or minimise the production of natural gas is extremely limited during this operation as the purpose is to enable the Operator to determine the condition and state of the gas reservoir and make a determination of whether or not the reservoir is viable for commercial production.

Should the results of the initial flow test demonstrate that extended flow testing is warranted, subject to obtaining the necessary gas licenses and other arrangements being put in place a connection to the gas grid will be made and continuous flaring of gas will cease.

A single flare will be installed for the site during this phase as a safety measure and would only be used in emergency scenarios in order to avoid pressure build up in any pipework or vessels. The flare will also be used on occasion when maintenance to surface equipment is required.

In the event that a connection to the gas grid connection is not available and further flaring is required (except as a safety measure or for surface equipment maintenance work as described above) we have put a restriction in the permit requiring the Operator to obtain written approval from the Environment Agency before this takes place. We would only provide such approval for any extension of flow testing that is in our view insignificant in environmental terms. Any significant extension will require a permit variation.

We are satisfied that the operating procedures will minimise the emissions as far as practicable and that there is still a high level of protection for the environment as a whole.

We have reviewed the information submitted and we are satisfied that the design of the flare is appropriate to achieve efficient combustion of the gas at various rates. The

Applicant proposes to use two enclosed ground flares, which we consider to be BAT for the disposal of waste gas. An enclosed flare provides abatement for noise and for visual impact and this technology is preferred over the use of an open flare or venting directly to air.

The permit limits the flaring of gas to a maximum of 130,000 cubic metres per day as set out in the Waste Management Plan and on which the Air Quality Modelling was based.

7.6.3.1. Human Health

The Applicant's report predicted no exceedences of any relevant Air Quality Environmental Quality Standards (EQS) established for human protection as a result of the proposed flare operations. This includes the combined impacts of the nearby proposed Preston New Road site.

Our audit, checks modelling and sensitivity analysis confirms this. We are satisfied that the use of the flares, for a period of no more than 90 days for each well, will not breach EQS as detailed in the tables above.

The modelling was based on the conservative assumption that the flares would be operating for 24 hours, 365 days a year. The actual proposal is for the flares to operate for no more than 90 days for each well; the modelled predictions are therefore higher than are expected.

7.6.3.2. Ecological Receptors

We are satisfied that the flare operations will not have a significant impact on ecological receptors.

We assess the process contribution (PC) of each pollutant and compare it to the critical level and critical load for that pollutant; if the long-term PC is below 1% of the critical level or critical load, or the short-term PC is below 10% of the critical level or critical load then we can conclude that the emission will have no likely significant effect on the interest features of these receptors (in accordance with our H1 guidance, Annex F).

The Applicant has predicted concentrations of NO₂ up to 2 kilometres around the site as a contour plot, and then at specific residential receptors around the site and at ecological receptors within 10 kilometres.

7.6.3.3. Hazard Assessments

The flare activity does not generate dust or particulates; however the general site operations may release some dust during construction. This is not covered by this permit, however as it has been included in the air quality model and has been assessed, we have included it for completeness.

Smothering – by dust (PM₁₀), the potential for dust or particulate matter emitted from the flaring activity would only arise should there be incomplete combustion of the gas. However the Operator has measures in place to monitor and control the flare to achieve efficient combustion. The permit requires compliance with these agreed operating techniques.

We are satisfied that there will be no likely significant effect on Morecambe Bay SPA / Ramsar or Ribble & Alt Estuaries SPA / Ramsar by smothering habitat from dust. No further assessment of PM₁₀ is required.

Acidification and Toxic Contamination could occur from the gaseous products SO₂ and NO_x. As discussed above, based on our assessment of the Applicant's assessment and supplied data of sulphurous emissions, we are satisfied that there would be no likely significant effect on Morecambe Bay SPA / Ramsar or Ribble & Alt Estuaries SPA / Ramsar from acidification or toxic contamination. No further assessment of these hazards is required.

See the full assessment below for the impacts of NO₂.

Nutrient enrichment – an assessment for nutrient nitrogen deposition is shown below in Table 5. Based on the low level of process contribution compared to the minimum critical load we can conclude that there will be no likely significant effect from nitrogen deposition at Morecambe Bay SPA / Ramsar or Ribble & Alt Estuaries SPA / Ramsar. No further assessment is required.

7.6.3.4. Background pollutant levels of nitrogen at the European sites

The Applicant obtained the relevant background pollutant levels within the European Sites from the Defra Background maps which are as follows:

Morecambe Bay: N deposition = 34.44kg N/ha/yr

Ribble & Alt Estuaries: N deposition = 33.74kg N/ha/yr

Estimated annual mean background concentrations in 2013 (Defra maps) – NO₂ µg/m³ = 10.1

The APIS figures for these sites differ slightly and have been used in the tables below for consistency.

Morecambe Bay: N deposition = 35.42kg N/ha/yr

Ribble & Alt Estuaries: N deposition = 34.08kg N/ha/yr

Estimated annual mean background concentrations from APIS – NO₂ µg/m³:

Morecambe Bay = 14.38

Ribble & Alt Estuaries = 12.86

7.6.3.5. Environmental benchmarks

The critical levels/loads used as environmental benchmarks in the assessment are given in Tables 1 and 2. They were obtained from APIS and Environment Agency H1 guidance, Annex F.

Critical levels are defined as gaseous concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge.

Critical loads relate to the quantity of pollutant deposited from air to the ground; defined as a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on sensitive elements of the environment do not occur according to present knowledge

Table 1 Critical levels for pollutant concentrations (applicable to the European sites).

Pollutant	Objective	Time period
NOx	75 µg/m ³	Short-term (24 hour mean)
NOx	30 µg/m ³	Annual mean (long term)

Table 2 Critical loads for pollutant concentrations (applicable to the European sites).

European site	Pollutant	Objective
Morecambe Bay	NOx	8 -10 kgN/ha/yr
Ribble & Alt Estuaries	NOx	8-10 kgN/ha/yr

7.6.3.6. Calculation of the process contribution

Tables 3 to 5 show the predicted process contributions (PC) at the closest part of the SPA / Ramsar to the Roseacre Wood site.

The PC is the modelled contribution from the flares at Roseacre Wood.

The following thresholds have been applied in accordance with the Environment Agency's Operational Instruction: Assessing the impact of aerial emissions from new and varying IPPC Regulated Industry for impacts on nature conservation (in preparation) and AQTAG 21:

- a) 1 % threshold for long-term PC;

b) 10 % threshold for short-term PC;

c) 70 % threshold for PEC.

If either threshold a) or b) and c) are exceeded the next level of appropriate assessment is required in consultation with Natural England.

Table 3. Assessment results – NOx long-term

Receptor	Max PC µg/m ³	Background µg/m ³	Critical level µg/m ³	PC as % of critical level	Likely signifi cant effect?
Morecambe Bay	0.13	14.38	30	0.43	No
Ribble & Alt Estuaries	0.07	12.86	30	0.23	No

Table 4. Assessment results – NOx short-term

Receptor	Max PC µg/m ³	Background µg/m ³	Critical level µg/m ³	PC as % of critical level	Likely significant effect?
Morecambe Bay	4.46	14.38	75	5.94	No
Ribble & Alt Estuaries	2.74	12.86	75	3.65	No

Table 5. Assessment results – Nitrogen deposition

Receptor	Max PC kgN/ha/yr	Background kgN/ha/yr	Critical load kgN/ha/yr	PC as % of lower critical load	Likely significant effect?
Morecambe Bay	0.02	35.42	8-10	0.25	No
Ribble & Alt Estuaries	0.01	34.08	8-10	0.13	No

Table 6. Assessment results – Acid Deposition

Pollutant	Max PC keq/ha/yr	Background keq/ha/yr	Critical load range keq/ha/yr	PC as % of min critical load range*	Likely significant effect?
Nitrogen deposition					
Morecambe Bay SPA / Ramsar	0.0028	2.53	0.223 – 0.643	based on max load value 0.43	No
Ribble & Estuaries	0.0014	2.43	0.223 – 0.848	based on min load value 0.62	No

* this value has been calculated using the lowest value of the critical load range

7.6.3.7. In-combination assessment with other plans and projects

Where the maximum process contribution (PC) at the European sites is less than the screening threshold of the relevant critical level or load, the PC is considered to be inconsequential and there is no potential for an alone or in-combination effects with other plans and projects.

However, due to the high level of public interest in this type of activity we have also considered the potential in-combination effect of another hydraulic fracturing operation proposed for a site at Preston New Road which is located at SD 37407 32737 about 7km away from this Roseacre Wood site. The two operations will be identical in scope.

The Applicant has included this scenario in the air quality assessment report, which we have audited. Following our assessment, we are satisfied that the Applicant has demonstrated that the operation of these flares simultaneously will not increase the likelihood of significant effect on the European sites.

We have also checked the combined effect of the Preston New Road flare on human health. We agree with the Applicant's conclusion that including this other site does not change the conclusions of the air quality assessment.

7.6.3.8. BAT and global warming potential

This section summarises the assessment of greenhouse gas impacts which has been made in the determination of this Permit. Emissions of carbon dioxide (CO₂) and other greenhouse gases differ from those of other pollutants in that, except at gross levels, they have no localised environmental impact. Their impact is at a global level and in terms of climate change. Nonetheless, CO₂ is clearly a pollutant for Industrial Emissions Directive (IED) purposes.

The principal greenhouse gas emitted is CO₂, but the plant could also emit small amounts of methane (CH₄) arising from the combustion process. We expect combustion efficiency of at least 98%, therefore there is potential for a small amount of unburnt CH₄ to be emitted from the flare. [Fully efficient combustion converts CH₄ to CO₂ and water vapour]. CH₄ has a global warming potential 21 times that of CO₂.

The major source of greenhouse gas emissions from the installation is however CO₂ from the combustion of natural gas. BAT for greenhouse gas emissions is to maximise energy recovery and efficiency. We are satisfied that flaring the gas is the best available option.

The Operator has justified the use of a flare rather than using the gas on site by demonstrating that the costs of using the gas would be disproportionate for the 90 day periods. It is also not reasonably practicable to connect the flow of extracted natural gas to the gas grid during the initial flow tests. This is because the flow rates are unknown and the quality of the gas produced may not be compatible with gas grid requirements

without further processing.

In addition, in order to establish whether there is sufficient flow of gas to move to extended flow testing, there needs to be an uninterrupted flow; using the gas to meet energy requirements on site would necessitate interrupting the gas flow, preventing the collection of the required data for analysis.

The incineration of hazardous waste is not subject to the Greenhouse Gas Emissions Trading Scheme Regulations 2012; therefore it is a requirement of IED to investigate how emissions of greenhouse gases emitted from this activity might be prevented or minimised.

The only factor influencing the GWP of the installation is the efficient operation of the combustion unit.

The operator will ensure the combustion of natural gas is carried out to the maximum efficiency; by monitoring the combustion temperature and air flow. Requirements to this effect are in the permit.

7.6.3.9. Conclusions:

SO₂ concentrations: SO₂ has not been modelled based on the justification provided by the Applicant, as described above.

NO_x: Tables 3 and 4 show that both the long-term and short-term process contributions of NO_x are not considered significant as they are not above 1% or 10% of the environmental benchmark.

Nutrient N deposition: Table 5 shows that the process contribution is less than 1 % of the minimum relevant critical load for both European sites.

Acid deposition: Table 6 shows the PCs to be very low for both sites; for Ribble & Alt Estuaries the PC is less than 1% of the minimum critical load.

At Morecambe Bay, the PC is above the 1% threshold for the minimum critical load value. However there are no species that are sensitive to acidity at this location, nor are the broad habitats of the species sensitive to acid deposition. Therefore the PC has been assessed against the maximum critical load and is less than 1% of this value.

The operator will be required to monitor emissions from incineration activities which will be released into the air as detailed in section 7.7.

7.7. Monitoring

Condition 3.5 of the permit will require the operator to monitor the input to the flare and assess by calculation the emissions to air. The condition contains separate requirements for groundwater and surface water monitoring.

The permit ensures that the Operator will be required to provide an Environmental Management and Monitoring Plan (EMMP) for approval as part of pre-operational conditions prior to the start of any gas flaring. This EMMP will be incorporated into the permit once approved.

Direct monitoring of emissions from a flare stack is not possible because the length of the flare stack is insufficient for the stack gases to cool sufficiently so as not to damage the sampling equipment. For this reason the Operator will use surrogate parameters to calculate the emissions. The stack emissions can be calculated from the combustion chemistry using the feed gas composition, feed gas flow rate and combustion efficiency.

The permit requires the Operator to submit their proposed method for calculating the emissions for written approval by the Environment Agency prior to flaring any gas.

Monitoring of the point source emissions involves continuous measurement of the gas flow through the flare, the combustion temperature, and the gas composition. From this data the emissions from the flare can be derived, i.e. oxides of nitrogen (NO_x), carbon monoxide (CO), volatile organic compounds (VOCs).

The Operator is required to continuously monitor the feed gas flow rate and analyse periodic samples of the feed gas to determine its composition. The flare efficiency is known from technical specification provided by the flare supplier. It is not possible to directly monitor combustion efficiency, but combustion temperature will be used as a surrogate indicator and also as a control parameter to ensure that the efficiency is maintained at its design value.

Using the parameters above, the operator is required to assess point source emissions which will be released into the air from incineration of gas, and will also undertake ambient air monitoring for comparison against a baseline.

The Operator will keep records of the data collected, which must be submitted to the Environment Agency on a regular basis.

The Applicant / operator will undertake a baseline study of ambient air quality around the proposed site prior to operations commencing. Once operational the Operator will continue to monitor air quality in the same locations that the baseline measurements were taken. The results of the monitoring will be made available by the Operator.

We are satisfied that assessing the emissions from the flare using the feed gas flow rate, the feed gas composition and the flare efficiency is appropriate considering that

direct monitoring of the flare is not technically possible. This level of assessment will demonstrate whether the combustion is working at the correct level of efficiency to minimise harmful emissions.

Monitoring standards will be confirmed with the Applicant prior to commencement of operations and will form part of their Environmental Management and Monitoring Plan (EMMP).

Annex II of the Industrial Emissions Directive (IED) lists a number of air pollutants that emission limits could be set for. We have considered the relevant pollutants listed in the IED Annex II that would result from this activity and are satisfied that it is not necessary to set emission limits, as the operating controls will ensure effective and efficient combustion.

We will be reviewing the assessment of point source emissions as part of our compliance work and if we have reasons to believe that emissions limits are required, we have the power to vary the permit to impose such limits. If appropriate monitoring methods/techniques are developed for monitoring point source emission from flares, we will review the activities and may vary the permit to change the monitoring requirements.

When in operation, the flare will be supervised 24 hours a day to ensure its effectiveness to incinerate the natural gas. Should a problem arise the flare can be shut off, on site or remotely.

The operator's EMMP will have to be approved prior to gas flaring operations commencing as required by the pre operational condition in the permit. This document is intended to set out the appropriate measures and processes for the management of the environmental aspects of the activity.

The permit contains requirement for monitoring of groundwater and surface water. This monitoring will be carried out monthly prior to the activities commencing over a minimum period of 3 months, weekly during active operations (drilling/fracturing) and then monthly thereafter. This monitoring requirement is for an indefinite period of time and will continue unless the condition is varied or the permit is surrendered. We would not accept an application to vary the monitoring condition unless we considered that the proposed variation provided adequate environmental protection. We would not accept an application to surrender the permit unless we are satisfied that the statutory test is met. The operator would need to demonstrate that the necessary measures have been taken to avoid a pollution risk from the operation of the regulated facility and to return the site to a satisfactory condition, having regard to the state of the site before the facility was put into operation.

The Operator will keep records of the data collected, which must be submitted to the Environment Agency on a regular basis.

The Applicant / Operator will undertake a baseline study of groundwater and surface water quality around the proposed site prior to operations commencing. This is required by the pre-operational condition in the permit. We will require a minimum of 3 months baseline monitoring of groundwater and surface water before we allow the operations to begin. Once operational the Operator will continue to monitor groundwater and surface water quality in the same locations that the baseline measurements were taken. The results of the monitoring will be submitted to the Environment Agency by the Operator.

7.8. Site stability

The management of waste is limited to waste generated from exploration. Although hydraulic fracturing does involve the injection under pressure of large volumes of fluid to create fractures in the reservoir, this process happens at depths of between 1,900 and 3,200 metres below ground. In addition, the fractures created by this process are tiny and will not affect the stability of the site.

The Operator is also required by DECC to monitor seismic activity during and after fracturing and follow a “traffic light” system that controls whether injection can proceed or not, based on these checks. Any hydraulic fracturing must stop when tremors higher than the threshold agreed in the approved hydraulic fracturing plan are detected. Current indications are that DECC, who also have to approve the plans, will require this to be a magnitude of 0.5ML (Richter Scale).

This level is well below what could be felt at the surface and within the range of normal background noise. This monitoring ensures that seismic events that may have an effect of the integrity and stability of the site are prevented.

The details of the monitoring of seismic activity are part of the hydraulic fracturing plan that the Operator is required to provide for Environment Agency approval as part of the pre-operational conditions in the permit prior to any hydraulic fracturing starting. The approved plan must be implemented unless otherwise agreed in writing.

7.9. Other legal requirements

7.9.1. Mining Waste Directive 2006/21/EC

In this section we explain how we have addressed other relevant legal requirements under the Mining Waste Directive, to the extent that we have not addressed them elsewhere in this document.

7.9.2. Article 4 – General requirements

Article 4 sets out requirements for the protection of the environment and human health which apply to the management of extractive waste. Under the Environmental Permitting (England and Wales) Regulations 2010 an environmental permit is required for a mining waste operation, which is defined as the management of waste whether or not it involves a waste facility. It is through the permit and the conditions imposed that we are satisfied that the provisions of Article 4 will be met.

7.9.3. Article 5 - Waste management plan

This includes the requirement for the Operator to provide a waste management plan and the information required within this. The waste management plan, including associated documents, has been assessed in accordance with these requirements and is approved subject to conditions. Condition 2.3.1 ensures that the operations are limited to those described in the WMP and in table S1.2. It also ensures that the Operator follows the techniques set out and that any deviation will require our written approval. Any significant changes will require a formal variation of the permit. Where a condition imposes a specific requirement that will take precedence over anything in the plan.

7.9.4. Article 6 – Major accident prevention

We are satisfied that the proposed activities do not involve a Mining Waste Facility which should be classified as a Category A facility.

7.9.5. Article 7 – Application for a permit

The permit covers the management of extractive waste and includes a Mining Waste Facility as defined in the MWD. The Application contained all necessary elements in Article 7(2) relevant to this site. We are satisfied that the requirements in Article 7(3) are met.

7.9.6. Article 8 – Public participation

Through our consultation procedure we are satisfied that the public have been informed as required by Article 8 and that we have made available the information set out in Article 8(2). We have provided the public with the ability to express comments and opinions to us before a decision has been taken and the results of the consultation will be taken into account in deciding whether to grant this permit.

7.9.7. Article 9 – Classification system for waste facilities

We are satisfied that there is no waste facility that should be classified as a Category A facility. Although the waste facility in respect of the on-site storage of waste will contain hazardous waste during the operational phase, no waste is expected to be present at the end of the planned period of operation.

7.9.8. Article 10 - Excavation voids

There is a requirement under this Article for the Operator to take appropriate measures in order to secure the stability of the extractive waste, prevent the pollution of soil, surface water and groundwater and ensure the monitoring of the extractive waste and the excavation void when placing extractive waste into excavation voids.

We are satisfied that the Operator will comply with the relevant requirements based on the information provided and the conditions in the permit.

7.9.9. Article 11- Construction and management of facilities

This outlines a requirement for the facility to be suitably constructed, managed and maintained to ensure its physical stability and to prevent pollution and contamination of soil, air, surface water and groundwater. Under this article there is a requirement for suitable plans and arrangements for regular monitoring and inspection of the facility by competent persons.

We are satisfied that the operator will comply with these requirements, based on the information provided and the conditions in the permit.

7.9.10. Article 13 - Prevention of water status deterioration, air and soil pollution

We are required, as the competent authority, to be satisfied that the Operator has taken the necessary measures in order to meet environmental standards, particularly to prevent deterioration of current water status.

We are satisfied that the Operator will comply with these requirements based on the information provided and the conditions in the permit.

7.9.11. Article 14 - Financial Guarantee

Article 14 requires the provision of a financial guarantee, in respect of a waste facility, to ensure funds are available to meet the obligations of the permit and to rehabilitate the site when operations finish. We will require a financial guarantee to be provided in respect of the area designated for the accumulation or deposit of hazardous waste stored at the surface before any permit is issued to satisfy this requirement.

In respect of the waste facility relating to waste fluid left in the formation, we are satisfied that this waste is properly characterised as non hazardous waste. By virtue of paragraph 9(3) of Schedule 20 to the Environmental Permitting (England and Wales) Regulations 2010 the requirements mentioned in Article 2(3) of the MWD are waived. These waived requirements include the need for a financial guarantee for non hazardous waste, unless deposited in a Category A facility. So no financial guarantee

can be required in respect of the fluid left in the target formation.

7.9.12. Further legislation

7.9.12.a) Industrial Emissions Directive (IED)

We have addressed the requirements of the IED in the body of this document above. The specific requirements of Chapter IV only apply to waste incineration plant burning solid or liquid waste and so do not apply here where the waste is gaseous.

There is one requirement not addressed above, which is that contained in Article 5(3) IED. Article 5(3) requires that “In the case of a new installation or a substantial change where Article 4 of Directive 85/337/EC (the EIA Directive) applies, any relevant information obtained or conclusion arrived at pursuant to articles 5, 6 and 7 of that Directive shall be examined and used for the purposes of granting the permit.”

- Article 5 of EIA Directive relates to the obligation on developers to supply the information set out in Annex IV of the Directive when making an application for development consent.
- Article 6(1) requires Member States to ensure that the authorities likely to be concerned by a development by reason of their specific environmental responsibilities are consulted on the Environmental Statement and the request for development consent.
- Article 6(2)-6(6) makes provision for public consultation on applications for development consent.
- Article 7 relates to projects with transboundary effects and consequential obligations to consult with affected Member States.

The grant or refusal of development consent is a matter for the relevant local planning authority. The Environment Agency’s obligation is therefore to examine and use any relevant information obtained or conclusion arrived at by the local planning authorities pursuant to those EIA Directive articles.

In determining the Application we have considered the following documents: -

- The Environmental Statement submitted with the planning application (which also formed part of the Environmental Permit Application).
- The response of the Environment Agency to the local planning authority in its role as consultee to the planning process.
- The Roseacre Committee Report and associated appendices (Jan 2015) written by the planning officer of Lancashire County Council.

We have complied with our obligation under Article 9(2) so far as we are able in that no conclusion has yet been arrived at. From consideration of the Environmental Statement and our response as consultee to the planning process we are satisfied that no additional or different permit conditions are necessary.

The Environment Agency has also carried out its own consultation on the Environmental

Permitting Application which includes the Environmental Statement submitted to the local planning authority. The results of our consultation are described elsewhere in this decision document.

7.9.12.b) Schedule 22 to the EPR 2010 – Water Framework and Groundwater Daughter Directives

To the extent that it might lead to a discharge of pollutants to groundwater (a “groundwater activity” under the EPR 2010), the Permit is subject to the requirements of Schedule 22, which delivers the requirements of EU Directives relating to pollution of groundwater. The Permit will require the taking of all necessary measures to prevent the input of any hazardous substances to groundwater, and to limit the input of non-hazardous pollutants into groundwater so as to ensure such pollutants do not cause pollution, and satisfy the requirements of paragraph 6 of Schedule 22 and Article 6(1) Groundwater Daughter Directive.

7.9.12.c) Directive 2003/35/EC – The Public Participation Directive

Regulation 59 of the EPR 2010 requires the Environment Agency to prepare and publish a statement of its policies for complying with its public participation duties. We have published our public participation statement.

This Application has been consulted upon, in line with that statement, as well as with our guidance RGS6 on Sites of High Public Interest, which addresses specifically extended consultation arrangements for determinations where public interest is particularly high. This satisfies the requirements of the Public Participation Directive.

Our decision in this case has been reached following a programme of extended public consultation, both on the original application and later, separately, on this permit and a decision document. The way in which this has been done is set out in Section 2. A summary of the responses received to our consultations and our consideration of them is set out in Annex 1.

7.9.12.d) Section 4 Environment Act 1995 (pursuit of sustainable development)

We are required to contribute towards achieving sustainable development, as considered appropriate by Ministers and set out in guidance issued to us. The Secretary of State for Environment, Food and Rural Affairs has issued *The Environment Agency’s Objectives and Contribution to Sustainable Development: Statutory Guidance (December 2002)*. That document:

“provides guidance to the Environment Agency on such matters as the formulation of approaches that the Environment Agency should take to its work, decisions about priorities for the Environment Agency and the allocation of our resources. It is not directly applicable to individual regulatory decisions of the Environment Agency.”

The guidance contains objectives in relation to the Environment Agency's operational functions and corporate strategy. Some of these objectives relate to the Environment Agency's wider role in waste management and strategy. In respect of the management of extractive waste, the guidance notes state that the Environment Agency should pursue the following objective:

“to prevent or reduce as far as possible any adverse effects on the environment as well as any resultant risk to human health from the management of waste from the quarrying and mineral extraction industries.”

In respect of water quality, the Environment Agency is required to: *‘protect, enhance and restore the environmental quality of inland and coastal surface water and groundwater, and in particular:*

- *To address both point source and diffuse pollution;*
- *To implement the EC Water Framework Directive; and to ensure that all relevant quality standards are met.’*

In respect of regulation of industrial pollution through the EPR, the Guidance refers in particular to the objective of setting permit conditions *“in a consistent and proportionate fashion based on Best Available Techniques and taking into account all relevant matters...”*.

The Environment Agency considers that it has pursued the objectives set out in the Government's guidance, where relevant, and that there are no additional conditions that should be included in this Permit to take account of the Section 4 duty

7.9.12.e) Section 5 Environment Act 1995 (preventing or minimising effects of pollution to the environment)

We are satisfied that our pollution control powers have been exercised for the purpose of preventing or minimising, or remedying or mitigating the effects of pollution of the environment in accordance with section 5 of the Environment Act 1995.

7.9.12.f) Section 6 Environment Act 1995 (conservation duties with regard to water)

Consideration has been given to our duty to promote the conservation and enhancement of the natural beauty and amenity of inland waters and the land associated with such waters, and the conservation of flora and fauna which are dependent on an aquatic environment.

We do not consider that any conditions additional to those in the permit are required.

The Applicant has stated that mains water, obtained from United Utilities, will be used

during the activities.

7.9.12.g) Section 7 Environment Act 1995 (pursuit of conservation interests)

Section 7(1)(c) of the Environment Act 1995 places a duty on us, when considering any proposal relating to our functions, to have regard amongst others to any effect which the proposals would have on the beauty and amenity of any urban or rural area.

We do not consider that any conditions additional to those in the permit are required to meet this duty. The structures that could affect visual amenity will be the drilling rig and the flares. These structures are temporary in nature and any visual impact will be limited. In addition, this issue will be addressed through the planning process, for which we are statutory consultees.

7.9.12.h) Section 81 Environment Act 1995

The site is not within a designated Air Quality Management Area.

We consider that we have taken our decision in compliance with the National Air Quality Strategy and that there are no additional or different conditions that should be included in this permit.

7.9.12.i) Section 40 Natural Environment and Rural Communities Act 2006

Section 40 places a duty on us to have regard, so far as it is consistent with the proper exercise of our functions, to conserving biodiversity. 'Conserving biodiversity' includes, in relation to a living organism or type of habitat, restoring or enhancing a population or habitat. We have done so and consider that no conditions additional or different to those in the permit are required.

7.9.12.j) Section 23 of the Local Democracy, Economic Development and Construction Act 2009

Section 23 requires us, where we consider it appropriate, to take such steps as we consider appropriate to secure the involvement of interested persons in the exercise of our functions by providing them with information, consulting them or involving them in any other way. Section 24 requires us to have regard to any Secretary of State guidance as to how we should do that.

The way in which the Environment Agency has consulted with the public and other interested parties is set out in this document. The way in which we have taken account of the representations we have received is set out in annex 1. Our public consultation duties are also set out in the Environmental Permitting (England and Wales) Regulations 2010, and our statutory Public Participation Statement, which implement the requirements of the Public Participation Directive. In addition to meeting our consultation responsibilities, we have also taken account of our guidance in

Environment Agency Guidance Note RGS6 and the Environment Agency's Building Trust with Communities toolkit.

7.9.12.k) Water Environment (Water Framework Directive) (England and Wales) Regulations 2003

Consideration has been given to whether any additional requirements should be imposed in terms of the Environment Agency's duty under regulation 3 to secure compliance with the requirements of the Water Framework Directive through (inter alia) environmental permits, but we consider that existing conditions are sufficient in this regard, and no other appropriate requirements have been identified.

7.9.12.l) Human Rights Act 1998

We have considered any potential interference with rights under the European Convention on Human Rights in reaching our decision and consider that our decision is compatible with our duties under the Human Rights Act 1998. In particular, we have considered the right to life (Article 2), the right to a fair trial (Article 6), the right to respect for private and family life (Article 8) and the right to protection of property (Article 1, First Protocol). We do not believe that Convention rights are engaged in relation to this determination and to the extent that they may be, any interference with those rights is justified.

7.9.12.m) Countryside and Rights of Way Act 2000 (CROW 2000)

Section 85 of this Act imposes a duty on Environment Agency to have regard to the purpose of conserving and enhancing the natural beauty of the area of outstanding natural beauty (AONB). There is no AONB which could be affected by the mining waste operation, groundwater activity or gas incineration activity.

7.9.12.n) Wildlife and Countryside Act 1981

Under section 28G of the Wildlife and Countryside Act 1981 the Environment Agency has a duty to take reasonable steps to further the conservation and enhancement of the flora, fauna or geological or physiographical features by reason of which a site is of special scientific interest. Under section 28I the Environment Agency has a duty to consult Natural England in relation to any permit that is likely to damage SSSIs.

We have assessed the application and concluded that there will be no likely damage to any SSSIs - see section 7.2 and 7.6 of this document.

7.9.12.o) The Conservation of Habitats and Species Regulations 2010

We have assessed the Application in accordance with guidance agreed jointly with Natural England and concluded that there will be no likely significant effect on any European Site.

We acknowledged that there was a potential for impact on air quality from the incineration of the waste gas and this has been fully assessed and is detailed in section 7.6 of this document. Following our assessment we are satisfied that there will be no likely significant effect either alone or in combination on the statutory conservation sites (SPA/Ramsars/SSSI) from any emissions. We presented our assessment and conclusion to Natural England on an Appendix 11 form (Habitats Directive: Form for recording likely significant effect) for information. In accordance with the procedure agreed with them this conclusion was presented to Natural England so that they were aware of our assessment and they did not raise any concerns.

8. Pre-operational conditions:

The permit contains a number of pre-operational conditions that require the Operator to carry out works, gather data and provide reports prior to certain activities starting. The Operator must have written approval from the Environment Agency prior to the specified activities starting and must implement the approved measures/procedures once they have been agreed.

The following table lists all of the pre-operational conditions and explains why we have imposed them:

Pre-operational measures		
Reference	Pre-operational measures	Reason
PO1	The Operator shall submit to the Environment Agency for approval a written Site Shut Down procedure to prevent unauthorised access to safety critical equipment and operational controls in case of a security breach and obtain the Environment Agency's written approval to it.	To ensure that the appropriate measures are in place to protect the environment in the event of unauthorised access to the site.
PO 2	At least 4 weeks prior to commencement of the gas flaring activity the operator shall submit to the Environment Agency for approval a written Environmental Management and Monitoring Plan (EMMP) which will include, but is not limited to: <ul style="list-style-type: none"> details of the baseline air quality study undertaken prior to activities commencing; details of the ambient air monitoring programme proposed for during and after the period of gas flaring; details of the flare design; <p>the monitoring programme should be written with reference to the Environment Agency Technical Guidance Note (Monitoring) M8 Version 2 May 2011, and the 'Performance Standards for Continuous Ambient Air Quality Monitoring Systems' (MCERTS).</p> <p>and shall obtain the Environment Agency's written approval to the EMMP.</p>	To ensure that an appropriate monitoring plan is agreed and in place and to gather baseline data for air quality prior to the flaring starting. We have included design of flare as this is likely to become a standard pre-operational condition to ensure we are satisfied the type of flare to be used is the type referred to in their application and on which the modelling was based
PO 3	The Operator shall submit to the Environment Agency for approval a written Hydraulic Fracturing Plan (as referred to in Waste Management Plan (WMP) section 2.3) and obtained the Environment Agency's written approval to it.	To ensure that the hydraulic fracturing programme has been appropriately designed and will not cause harm to the environment.
PO 4	The operator shall submit for approval a written groundwater monitoring plan to include: Details of the proposed location; depth; construction and construction method of the monitoring boreholes with provision for the number of boreholes provided to increase as activities progress. The plan shall also address the requisite surveillance requirements to monitor groundwater both pre-operation and over the	To ensure that an appropriate groundwater monitoring plan is place prior to activities starting and to approve the design, construction and installation methods for the groundwater boreholes.

	lifetime of the activities authorised by this permit. The operator shall obtain the Environment Agency's written approval to the groundwater monitoring plan.			
PO 5	The injection boreholes shall be installed in accordance with condition 2.3.3 and following installation the Operator shall conduct a well integrity test on each borehole in accordance with section 2.4.4 of the Waste Management Plan.	To verify the integrity of the injection boreholes prior to hydraulic fracturing.		
PO 6	The Operator shall submit a written report to the Environment Agency for approval including the results of the integrity test carried out in accordance with PO5 and the as built construction and design details of the injection boreholes including the distance (in metres) below ground level of the laterals and the national grid references for each borehole and the end of each lateral for each borehole, and obtain the Environment Agency's written approval to the report.	To verify the results of the well integrity tests and verify the construction and final location of the injection boreholes.		
PO7	<p>The operator shall provide a written report that provides the following information for each groundwater monitoring borehole installed:</p> <ul style="list-style-type: none"> (a) casings/linings (length, diameter, material, type of grout or filter media and whether slotted or plain); (b) depths and diameters of unlined sections; (c) records of groundwater ingress during construction and standing groundwater levels on completion; (d) details of strata encountered during drilling; (e) reference levels in metres above ordnance datum; (f) a location plan at a suitable scale showing the boreholes in relation to the point of discharge; (g) national grid references of the borehole(s) in the form AB 12345 67890; (h) any other information obtained from the borehole(s) relevant to the interpretation of water sample analysis. 	To verify that the boreholes have been constructed to the correct standard.		
PO 8	<p>The Operator shall undertake at least 3 samples of groundwater from each monitoring borehole and 3 samples of surface water. Sampling, as a minimum, must include the parameters listed below and shall be carried out monthly over a minimum period of 3 months prior to the commencement of the drilling of the injection wells. The results of the groundwater and surface water monitoring shall be submitted to the Environment Agency.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; text-align: center;">Parameter</td> <td style="width: 50%; text-align: center;">Parameter</td> </tr> </table>	Parameter	Parameter	To gather data on groundwater and surface water baseline data prior to the start of drilling operations on site. A minimum of 3 months baseline monitoring will be required.
Parameter	Parameter			

	Acrylamide	Dissolved Ethane	
	Alkalinity (Total) as CaCO3	Dissolved Methane	
	Ammoniacal Nitrogen as N	Fluoride	
	Arsenic	Iron (Total)	
	Aluminium	Lead	
	Antimony	Lithium	
	Barium	Magnesium	
	Beryllium	Mercury	
	BOD (settled)	Nickel	
	Boron	Nitrate as NO3	
	Bromide	Nitrite as NO2	
	δ13C-CH4	pH	
	δ13C-CO2	Potassium	
	Cadmium	Salinity	
	Calcium	Selenium	
	Carbon Dioxide	Silver	
	Chloride	Sodium	
	Chromium (Total)	Strontium	
	Cobalt	TPH including Benzene, DRO (nC10 to nC24, GRO (nC5 to nC10), m/p Xylenes, o Xylene, MTBE, Toluene, Xylene, Ethyl Benzene.	
	COD (settled)	Total dissolved solids	
	Copper	Total suspended solids	
	Dissolved Butane	Vanadium	
	Dissolved Propane	Zinc	
PO9	The Operator shall provide for approval a method for calculating the emissions from the flare as required by condition 3.5.8. and obtain the Environment Agency's written approval to the method.		To agree the method of calculation for the emissions from the flares prior to the start of flaring.

Annex 1: Consultation and web publicising

Summary of responses to consultation and web publication and the way in which we have taken these into account in the determination process.

A) Advertising and Consultation on the Application

The Application has been advertised and consulted upon in accordance with the Environment Agency's Public Participation Statement. The way in which this has been carried out along with the results of our consultation and how we have taken consultation responses into account in reaching our decision is summarised in this Annex. Copies of all consultation responses have been placed on the Environment Agency public registers.

The Application was advertised on the .GOV.UK website from 24th June 2014 to 19th August 2014. Copies of the Application were placed in the Environment Agency Public Register at Richard Fairclough House, Knutsford Road, Latchford, Warrington WA4 1HT.

The following statutory and non-statutory bodies were consulted:

- Local Planning Authority – Lancashire County Council
- Public Health England
- Director of Public Health – Lancashire County Council
- Health and Safety Executive
- Mineral Planning Authority – Lancashire County Council
- Water Company – United Utilities

1) Consultation Responses from Statutory and Non-Statutory Bodies

Response Received from Public Health England	
Brief summary of issues raised:	Summary of action taken / how this has been covered
<p>Although onshore oil and gas extraction and related activities have the potential to cause pollution to air, land and water, the currently available evidence indicates that the potential risks to public health from exposure to the emissions associated with such extraction will be low if the operations are properly run and regulated.</p> <p>We recommend that any Environmental Permit issued for this site should contain conditions to ensure that potential emissions do not impact upon public health.</p> <p>Based solely on the information contained within the application provided, PHE has no significant concerns in relation to the potential emissions from the site adversely impacting the health of the local population from this proposed activity providing that the Regulator ensures the applicant takes all appropriate measures to prevent or control pollution, in accordance with the relevant sector technical guidance or industry best practice.</p> <p>However, PHE has highlighted areas where the planning authority may wish to request additional information to support the conclusions presented by the applicant.</p>	<p>We have assessed the potential emissions from the proposed site. We are satisfied that the combustion of the natural gas will not result in pollution or harm to human health and that it is not necessary to set emission limits as the operating controls will ensure effective combustion. See Section 7.6 for more details. We are satisfied that the appropriate controls are in place and that activities will be properly regulated and not cause pollution or harm to human health.</p> <p>We have reviewed the Environmental Risk Assessment and the relevant sections of the Environmental Statement submitted with the planning application submitted to Lancashire County Council, against our information and conceptual understanding of the location. We are satisfied that the potential risks to groundwater have been adequately identified and addressed through mitigation measures in the permit. See Section 7.5 for more details.</p> <p>The permit includes pre-operational requirements to provide reports detailing the baseline monitoring of groundwater, air quality and surface water for written approval prior to operations starting. The permit also includes a requirement to provide for</p>

<p>PHE agrees that it is important to undertake baseline monitoring of ground waters, surface waters and local air quality to better assess the impact on the environment from any development. However, the Regulator should validate the suitability of the applicant's proposals for baseline monitoring for the purpose of comparisons with future monitoring for assessing the impact of operations. It is important for monitoring to be fit for purpose, and results presented to be comparable to relevant health based standards, where applicable.</p>	<p>approval of an Environmental Management and Monitoring Plan (EMMP) at least 4 weeks prior to any gas flaring.</p>
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PHE follow up response received 17 September 2014 based on further information provided by the Applicant

<p>The applicant states that operations will be halted if there are continued and significant variation to the baseline data, in terms of emission's to air and water. Health based standards have been provided for nitrogen dioxide, PM10 and benzene emissions to air. We suggest the regulator confirms they are satisfied with the proposed definition of significant variation for other determinands (relevant health based standards for substances to be assessed during operations for emissions to air eg hydrogen sulphide, sulphur dioxide, ozone, and BTEX; and surface water and ground water eg VOCs and potential contaminants associated with drilling operations such as constituents of drilling fluids).</p>	<p>Under pre operational condition PO2, the Operator is required to submit for approval an Environmental Management and Monitoring Plan. This plan will cover all the substances to be assessed during operations for emissions to air, surface water and groundwater. Under condition PO2, the Operator will be required to implement the approved EMMP.</p> <p>We will require any deviation from a baseline to be investigated and appropriate control measures to be put in place to minimize such emissions; this would include halting operations.</p>
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<p>Details of emissions from the generator have not been provided within the application due to their size and duration of operation. We suggest the regulator confirms that the contribution of these emissions has been considered during the</p>	<p>The operation of the generators is not part of the activities controlled by the permit. However any emissions from the generators when operational, would contribute to overall background levels which could be identified during ambient air monitoring. The flares will operate for no more than 90</p>
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<p>assessment of impact on air quality of operations at site.</p>	<p>days at a time for each well, and there may be short periods where the flares and the generators would be operating concurrently. Flaring is limited to 130,000 cubic metres per day.</p> <p>The existing background levels that we use for comparison are relatively low and we are satisfied that the short term operation of the generators will not contribute to the background levels in a way that any air quality Health Based Standards will be breached by the emissions from the flares.</p> <p>Ambient air monitoring will be included in the EMMP which must be approved by the EA prior to flaring operations commencing and be implemented by the Operator, as described above. Should the generators be in use at this time, the results will demonstrate the level of impact they have on air quality.</p>
<p>Section 8.7 considers potential fugitive emissions in terms of greenhouse gas emissions. PHE suggests the regulator confirms the applicant confirms they are satisfied with proposals for monitoring higher chain hydrocarbon monitoring. Section 5.6 provides details for monitoring methane emissions by FID and proposals for operations following identification of a significant change to baseline levels of fugitive methane emissions. The applicant states that uncontrolled fugitive emissions may give rise to VOCs and odours, with releases assessed qualitatively taking into account the planned activities, their duration and distance to sensitive receptors. We suggest the regulator confirms they are satisfied with this qualitative assessment.</p>	<p>As mentioned above, the EMMP will cover the monitoring requirements for both point source and fugitive emissions.</p> <p>The EMMP will outline the full monitoring proposals and will be approved by the Environment Agency prior to being implemented. We will not approve the EMMP until we are satisfied with all of the proposals.</p>

Response Received from Health and Safety Executive	
Brief summary of issues raised:	Summary of action taken / how this has been covered
<p>We have reviewed the consultation documents associated with this EA permit application EPR/AB3101MW/A001 for the Cuadrilla Bowland Limited Preston New Road Site and the EA permit application EPR/BB3800FQ/A001 for the Cuadrilla Elswick Limited Roseacre Wood Exploration Site and have no issues from a well operations perspective with the proposals.</p> <p>The Operator has included details of the generic well design, in compliance with the wells aspects of the Offshore Installations and Wells (Design and Construction, etc) Regulations 1996 [DCR], The Borehole Sites and Operations Regulations 1995 [BSOR] and acknowledges there will be directional control management at a well site with multiple (4) boreholes.</p> <p>The Operator is also required to submit a well notification to the Executive for each borehole which will be inspected by a specialist well operations inspector</p>	<p>None required</p>

Response Received from Local Planning Authority – Lancashire County Council	
Brief summary of issues raised:	Summary of action taken / how this has been covered
<p>The County council believes the Agency must satisfy itself that all environmental risks can be controlled to an acceptable level.</p>	<p>As explained in the main body of this document we are satisfied there will be no significant pollution or harm to human health from the proposed activities</p>
<p>The Environment Agency should be</p>	<p>The Waste Management plan conforms with</p>

<p>convinced that the operator has taken every effort to reduce the amount of waste to be treated and disposed off-site in line with the Waste Hierarchy.</p> <p>The County Council would also recommend that appropriate baseline and operational monitoring of groundwater and air quality should be a requirement of any permit, and the Agency should randomly verify the applicant's monitoring results.</p> <p>The County Council is keen to ensure that long term environmental monitoring of the site and its environs is undertaken after operation have ceased, and the results of such monitoring are published regularly.</p>	<p>the requirements of the Mining Waste Directive, including the requirements to minimise the quantities of waste generated by the activity. The proposals are in line with the Waste Hierarchy. In particular, there is a requirement to re-use the flowback fluid, once gas has been separated, in the fracturing fluid, wherever possible. These measures will reduce the amount of waste which needs to be disposed of at an off site treatment facility.</p> <p>The permit includes pre-operational requirements to provide baseline monitoring of groundwater, air quality and surface water for approval before the start of operations. The permit also includes a requirement to provide, for approval, an Environmental Management and Monitoring Plan at least 4 weeks prior to any gas flaring.</p> <p>We have specified monitoring of groundwater and surface water in the permit and this will be carried out until we accept the surrender of the permit. We have also required that the Operator assesses emissions from the flares based on a calculation method using the gas flow rate, flare efficiency and gas composition as surrogate parameters, rather than carrying out monitoring of emissions directly from the flare, due to technical limitations.</p> <p>The duration of the monitoring required post cessation of the activity will be assessed as part of site compliance activities and of any eventual application to surrender the permit. All monitoring results will be made available on the Public Register and shared with other regulatory bodies.</p>
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Response Received from Environmental Health – Lancashire County Council	
Brief summary of issues raised:	Summary of action taken / how this has been covered
<p>The main issues for residents are that the area is rural and has low background noise level and negligible air quality issues however the location is close to noise sources such as the M55 and A583 and background levels are more prevalent. That the installation of the site will increase “pollution” levels albeit to below relevant guidelines but will produce a high percentage in the level difference.</p> <p>We would ask that the following is considered:</p> <ol style="list-style-type: none"> 1) Continuous monitoring be in place for noise at the boundary of the site nearest to residential property. Noise levels shall be set to current WHO Guidance or applying BS4142 2) The continuous noise from the generator shall not be audible off site. Suitable and sufficient acoustic mitigation shall be installed. 3) Continuous monitoring for air pollutants rather than set sampling periods. 4) Consideration for light luminescence from the flare. 	<p>We carefully considered emissions from noise and vibration from the activities we regulate, during our determination and concluded that noise and vibration from the regulated activities are not likely to be an issue due the design of the flare, the rural location of the site, the distance to the nearest receptor (metres) and the level of background noise.</p> <p>We are satisfied that the environmental risk assessments contain adequate measures to manage noise and vibration from the regulated activities.</p> <p>Condition 3.4 in the permit requires that all appropriate measures are taken to ensure that emissions from the activities likely to cause pollution from noise or vibration outside the site are prevented or where that is not possible, minimised.</p> <p>We have included condition 3.4.2 in the permit. This condition enables us to require the Operator to submit a specific noise and vibration management plan, should noise and vibration become a problem. Should a plan be required in the future, once we have assessed this plan as suitable, it will form part of the permit and the Operator must carry out the activity in accordance with the approved techniques.</p> <p>We have specified that the Operator assesses and reports monthly on the emission from the flare using a calculation method using the gas flow rate, flare efficiency and gas composition as surrogate parameters, rather than carrying out monitoring of emissions directly from the flare, due to technical limitations. However,</p>

	<p>we are specifying continuous monitoring of the flare temperature and gas flow rate, which considering the design of the flare and the expected composition of the gas, will be the best indicator that the flare is performing at the stated efficiency and that emissions from the flare, as predicted, will not result in pollution or harm to human health.</p> <p>The flare is of an enclosed design and will minimise light emissions; we are satisfied that the use of the flare will not result in light pollution.</p>
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Response Received from Director of Public Health – Lancashire County Council	
Brief summary of issues raised:	Summary of action taken / how this has been covered
<p>An initial Health Impact Assessment (HIA) is under way and the findings will be reported within the time period for planning determination by Lancashire County Council. We will be sharing the output from the HIA to correspond with Environment Agency in due course.</p>	<p>We have considered Lancashire County Council's Director of Public Health's Report for the cabinet meeting on 6th November 2014. We have also considered the appendices to that report. A detailed response can be found in section 2) of this Annex</p>

2) Consultation Responses from Members of the Public and Community Organisations

A total of 55 responses were received. The respondents included Sefton Green Party, Medlar with Wesham Town Council, Elswick Parish Council and Treales, Roseacre & Wharles Parish Council.

Although the consultation ended on 19/08/2014, any comments that have been received after the close of the consultation and prior to issue of our minded to position were taken into consideration as part of our determination process.

We can only consider comments which are relevant to the management of the extractive waste arising from the exploration for oil and gas and well testing, including hydraulic fracturing, groundwater protection as part of a Groundwater Activity Permit and flaring of gas regulated under the Industrial Emission Directive which is what the Application relates to. For consultation comments that relate to matters beyond our regulatory control see section 3 below.

Summaries of the consultation responses and how we have addressed them are as follows:

Inappropriate applications applied for

Concerns were raised that the proposed drilling of wells which could result in gas being fed into the national grid after 3 months of testing were effectively production wells that will be operated without relevant production permits. It was argued that if the operator were to earn an income from the produced gas, then the proposed activities for 18 to 24 months constitute full scale gas production rather than gas exploration and would require a different permit than that applied for.

We have taken the view that the proposed activities, due to the nature of the extended well testing, do go beyond the definition of prospecting in Article 3(21) of the Mining Waste Directive.

However, whilst the permit authorises extended well testing which may involve a connection to the national grid, we do not consider that this stage is full scale gas production, The reason for the tests are set out in section 2.4 of the waste management plan and make it clear that these are to determine future well performance should it go into production. In addition, the permit, at condition 2.3.1, requires the operator to comply with the approved waste management plan. That plan describes one well pad from which four wells will be developed and will ensure that the activities are limited to the proposed testing. We do not consider that this amounts to full scale commercial development. Furthermore, we have limited the activities to exploration as defined in the permit.

Should the operator decide to proceed to additional wells or well pads or extend its

activities beyond the described testing they will need to apply for a variation of the permit.

Potential impact of activity on surface water and groundwater

Concerns were raised that surface water and groundwater may be contaminated by the proposed hydraulic fracturing activities.

Some respondents noted that the Applicant intends to recycle flowback fluid wherever possible. Concerns raised were that the recycling without treatment only enhances the potential for toxic build-up below ground.

We have reviewed the Environmental Risk Assessment and the Hydrogeological Risk Assessment provided by the applicant against our information and conceptual understanding of the location. We are satisfied that the method of well construction, including drilling additives and hydraulic fracturing activities, which are controlled by this permit, will not pose a risk to groundwater or surface water given the mitigation measures required. Drinking water supplies are not at risk.

The Waste Management Plan (WMP) and the Environmental Risk Assessment specify the pollution prevention measures that will ensure that surface water and groundwater will be protected. The Waste Management Plan sets out the nature of the fluids to be used in each process of the proposal, their expected volumes and their treatment or disposal, where applicable. These measures are required through conditions in the permit.

Each injection borehole will discharge hydraulic fracturing fluid (which may include reused flowback fluids) only into geological formations as described in section 7.5, which are being targeted for the exploration or extraction of hydrocarbons. The target strata are the upper and lower Bowland Shale and Hodder Mudstone Formation. The permit also requires the Operator to monitor the location, orientation and extent of induced fractures and provide this information to the Environment Agency.

The fluid used for hydraulic fracturing will contain only additives that have been assessed as non-hazardous to groundwater as defined in the Groundwater Directive, this limitation applies at all times and is enforced through a condition in the permit, including where the fracturing fluids' composition includes re-used flowback fluid, which will have been separated from the gas and sand. The operator will be required to reuse flowback fluid from the fracturing process in subsequent fracturing phases, wherever possible, to reduce the generation of waste requiring disposal. Flowback fluid will be monitored to ensure that it remains fit for reuse; the fluid that can be injected must remain non-hazardous. This is addressed in section 2.3 of the Waste Management Plan.

Flowback fluid is fluid which returns from hydraulic fracturing operations where fresh water and additives have been injected into the formation to create fractures, together

with formation water. It is not a naturally occurring fluid, however the minerals that are returned are naturally occurring within the target formation.

We are satisfied that measures can be taken to ensure that the fracturing fluids do not migrate from the target formation. We have included a pre-operational condition that provides that hydraulic fracturing shall not commence until we have approved, in writing, the hydraulic fracturing plan, which is referred to in section 2.3.1 of the waste management plan. A stepped approach will allow the geomechanical properties of the reservoir to be understood and the hydraulic fracturing programme to be tailored accordingly.

We have included a condition in the permit that provides that the hydraulic fracturing process must be designed and implemented to ensure that any fracturing fluid remains in the target formation, namely the Upper and Lower Bowland Shale and Hodder formations. The information gained from the hydraulic fracturing of the Preese Hall well will be used, together with the geological information gained during the well drilling, to inform the Hydraulic Fracture Plan (HFP) and determine the location of fracture injections. This will include expected fracture distances modelled using the geomechanical properties from the well site. The HFP will set out the methodology of a phased approach starting with low volumes of fracturing fluids building to a maximum of 765m³.

The operations will be continually monitored, reviewed and modified to ensure that the programme is carried out in the safest and most effective way. This will include ensuring that the fractures stay within the target formation, as any fractures leaving the target represent a waste of energy and reduce the efficiency of the operation.

It is not anticipated that the fracturing fluids, which remain in the ground after the operations are complete, could migrate any distance from the fractures created by the hydraulic fracturing process within the target formation. In order for fluids to move in the rock a driving head would be required to produce a gradient to cause fluid movement. Once the hydraulic fracturing stage is complete the pressure is released to allow the fluid and gas to return to the extraction well and the pressure gradient will be from the rock towards the well. It is expected that 10-40 % of the injected fracturing fluid will return to the surface as part of the flowback fluid. Fracturing fluid left behind will have nothing to 'push' it further into the formation. There would be limited potential for fluids to migrate further into the rocks. The shales are capable of absorbing some of the fracturing fluid, allowing it to migrate away from the fractures, however the distance over which that migration could occur is small due to the inherent low permeability of the shales.

When the wells come to the end of their useful life they will be either suspended or plugged and decommissioned; this process ensures that there is no pressure gradient remaining that could continue to push fluid away from the well locations.

We have assessed the proposed hydraulic fracturing activities and we have concluded that the Applicant requires a groundwater activity permit, see section 7.5 of the decision

document above. An assessment of the impacts on groundwater has been reviewed as part of the decision on whether or not a groundwater activity permit should be issued. The decision document outlines how we have made our decision: see section 7.5 Protection of Groundwater.

Protection of surface water is addressed in details in section 6.12 of the decision document.

The operator will be carrying out groundwater monitoring to confirm that there is no pollution of groundwater, as well as monitoring the propagation of the hydraulic fractures they induce to ensure that they remain within the target formation. We are satisfied that both the Waste Management Plan and Environmental Risk Assessment submitted for this application adequately define the risks to groundwater in this location from both the drilling and hydraulic fracturing and that the appropriate mitigation measures to protect the groundwater have been imposed through the permit. See Potential impact of activity on surface water and groundwater section above for more details.

Concerns have also been raised that there is an insufficient natural barrier to upward migration of gas or contaminants to protect the groundwater and surface waters from being impacted by the proposed activity.

The formations between the Bowland Shale and the Manchester Marl have all been demonstrated to contain gas, and the formations above the Manchester Marl have been shown not to contain gas.

This Manchester Marl is acting as a regional seal to the upward migration of hydrocarbon. This was demonstrated most recently by Cuadrilla at the Preese Hall site where gas logs show conclusively that the Manchester Marl is in fact acting as a very good seal. Geological logs taken from the Preese Hall borehole and published in the Geomechanical Study of the Bowland Shale Seismicity, Synthesis Report November 2011, show that there is a thick anhydrite (with associated halites), near the base of the Manchester Marl, equivalent to the Zechstein of the southern North Sea.

This evaporite sequence forms a significant regional seal between the underlying Carboniferous Section and formations closer to the surface. The Mercia Mudstone present below the superficial deposits at the surface which themselves may contain water and support surface water features such as ponds and streams, is also known to be a good seal to the migration of gas or fluid.

Work published by Seedhouse and Racey in 2007 (Sealing Capacity of the Mercia Mudstone group in the east Irish Sea Basin : Implications for Petroleum exploration) show that the Mercia Mudstone is a good regional seal from threshold pressure tests carried out on samples obtained from this area at Kirkham and Weeton Camp. The Mercia Mudstone also has multiple bands of halites which have been proved in the Kirkham borehole, which add to the impermeable nature of the formation.

We are satisfied that we have fully assessed the risk to surface water and groundwater and that there will be no unacceptable impact or risk of pollution.

Reinjection of flow back fluid

Concerns were raised that some of the flowback fluid would be disposed of by reinjecting it back into the underground strata, which may eventually cause pollution.

The operator is restricted to activities described in the waste management plan, which do not include the input of waste hydraulic fracturing fluid or flowback fluid to land for disposal.

We have also included a permit condition that prohibits injection of any component of flow back fluid for the purpose of disposal.

Drinking water protection

Concerns were raised that the proposed activities will pose a risk to drinking water supplies. Drinking water supplies for this area come from a combination of reservoir water from the Lake District and Wales and from boreholes in the Sherwood Sandstone to the east of the site. These boreholes run in an approximate line between Preston and Garstang. The Sherwood Sandstone is classified as a principal aquifer in this area and is an important drinking water resource.

At the Roseacre Wood site the Sherwood Sandstone unit is buried beneath approximately 330m of impermeable Mercia Mudstone. This is due to the presence of the Woodsfold Fault, which has caused the geological formations to be split and moved by around 300m vertically.

To the east of the Woodsfold fault the sandstone outcrops at surface, being on the upthrown side of the fault. Rainfall flows into the aquifer and water discharges to the local rivers allowing a circulation of fresh water in the top 150m to 200m which means it is good quality and easily treatable for drinking water supply.

To the west of the Woodsfold fault where the rocks are downthrown, as at the Roseacre Wood Site, the sandstone is isolated from the surface and has no inflows or outflows; the groundwater it contains is effectively static in the rock. Over the many thousands of years it has been confined the water has become highly mineralised and is unfit to be considered treatable for drinking water supply.

The Woodsfold Fault acts as a barrier to flow preventing the movement of water in the Sherwood Sandstone on the east from interacting with that on the west, This understanding has been tested and demonstrated by groundwater modelling work carried out by the Environment Agency in conjunction with United Utilities during water resource assessment work in the 1990s and 2000s, it is also backed up by observations in the differences in groundwater levels and chemical quality of the water on either side.

Work carried out on the Mercia Mudstone group in Cheshire has also shown that where faults cross this formation the mudstone has been recrystallised along the fault line and has become less permeable than the surrounding undisturbed formation. This would also prevent the migration of fluids or gas upwards along the fault.

We are therefore satisfied that the permitted activities will not cause pollution of drinking water supplies.

Additionally, the permit conditions require mitigation measures to protect groundwater and ensure no pollution.

Overuse of groundwater

Concerns have been raised that the permitted activity will use large quantities of local groundwater and that this is not a sustainable approach.

The application states that they will be using mains water from United Utilities. United Utilities have abstraction licences and any supply they provide will have to be within the limits they are licensed to abstract. If the applicant wishes to abstract groundwater they will need to apply to the Environment Agency for an abstraction licence and this will be assessed to ensure that any abstraction would not have a detrimental impact on the water environment before a licence could be granted.

Monitoring (surface water/groundwater/air)

Concerns were raised as to how the activities will be monitored and what mechanisms will be put in place to ensure that hydraulic fracturing fluids will remain in the target formation and not migrate to other formations.

The Waste Management Plan details the monitoring that the Operator will be carrying out before, during and after the permitted activities are taking place and the permit will limit hydraulic fracturing activities to specific geological formations (upper and lower Bowland Shale and Hodder Mudstone formation).

We have also specified monitoring requirements in the permit.

Currently there is no water quality data for Nigget Brook available within the

Environment Agency, so we will carry out water quality sampling for Nigget Brook. This will allow us to check the monitoring of the Operator's water quality data. Upstream and downstream sites have been selected, and testing will be done on at least a monthly basis until a good baseline of data has been gathered. The Environment Agency testing will test for the same determinands as the Operator has identified in section 8.9 of the Waste Management Plan.

As part of site inspections, water quality samples will be taken of Nigget Brook, and of other surface waters in the vicinity.

The other surface waters are:

An unnamed watercourse that originates to the south-west of the Roseacre Wood drill site, at approximately NGR SD 43888 36270. Two closed surface water ponds close to this grid reference will also be checked. This will ensure that the site is being effectively contained, and no additional pathways (discharge pipes, faults in liner etc) are present on site.

Nigget Brook itself flows into Inskip Brook at NGR SD 43888 36270 which originates to the north-west of the site, some distance away. Checking of this watercourse will be done to assess the impacts, if any, the site is having on the aquatic environment.

Nigget Brook will be checked as part of site inspections to ensure that the surface water discharge is of clean, uncontaminated water only (e.g. rainfall that has landed on the site). The un-named watercourse and Inskip Brook will be checked if we have concerns regarding any decrease in water quality.

The results of this monitoring will be made available on our public register.

The mechanisms to ensure that hydraulic fracturing fluid remain in the target formation are discussed in detail in section 7.5 of the decision document.

Human health impacts

We are satisfied that the activities we are permitting will not give rise to significant pollution or harm to human health.

Visual impact

Comments were received stating that the proposed shale gas extraction would have a high visual impact on the beauty of the area with long lasting impacts. There were concerns that the proposed activities would result in the overall change of use from a grazing pasture to a highly industrialised site.

The structures with the most impact on visual amenity will be the drilling rig and the flares. These structures are temporary in nature and any visual impact will be limited. In

addition, this issue will be addressed through the planning process, for which we are statutory consultees.

Spillages

Concerns were raised that the risk from potential spillages had not been adequately addressed by the Applicant in their risk assessment. Concerns were also raised about potential spillages off-site during transport of the waste waters.

The proposals include the lining of the site with an impermeable membrane to protect the underlying soils and groundwater. The permit will require groundwater monitoring boreholes to be constructed to monitor the quality of the groundwater beneath the site. The on-going monitoring data will be compared to the baseline data. In the unlikely event that changes in quality are detected that can be attributed to any activities on the site, then action will be required to remediate any impact.

The risk assessment includes details of how spillages will be reduced or avoided and how the risks from potential spillages are going to be minimised. The extractive waste transfer and storage activities will take place on an impermeable surface with sealed drainage and containment. Spillages to surface water will be prevented by the site drainage arrangements (see section 6.12 for details).

Spillages during transport outside the permitted site boundary are outside the scope of the permit, but are, for waste, subject to other regulatory controls (Duty of Care).

Emergency planning

A number of comments were made regarding the lack of emergency planning in case of a severe accident on site or health impacts on the local community.

This facility does not meet the criteria for a Category A mining waste facility as detailed in the Mining Waste Directive; as such an emergency plan is not required. However the permit requires the Operator to have an appropriate management system, and we will be checking that they comply with their permit conditions as part of our compliance work. This management plan will include avoidance of accidents, the management of potential accidents and the minimisation of their consequences.

The Health and Safety Executive and Public Health England have been consulted and have not raised any concerns relating to emergency planning.

Light pollution

Concerns have been raised that the flare will create light pollution which may impact on both local residents and wildlife.

The flare is of an enclosed design and will minimise light emissions; we are satisfied

that the use of the flare will not result in light pollution. The use of artificial lights on site is controlled by the planning permission and falls outside of the remit of this permit.

Suitability of the Risk Assessment

Concerns have been raised about the adequacy and impartiality of the Applicant's Risk Assessment and whether it identified all the risks and categorised them correctly.

We have reviewed the assessment, and we are satisfied that it complies with our relevant guidance and that it identifies and covers all appropriate risks and that measures are in place to address them.

We have placed the risk assessment on our website for people to view and comment on it.

Inadequate consultation

A number of comments have raised concerns that the consultation has been inadequate due to lack of public awareness and that the absence of an Environment Agency website made it difficult for stakeholders to locate and review the application documents. Concerns were also raised that the hydraulic fracturing plan was not included amongst the documents which the Environment Agency was consulting on.

We carried out an extended consultation on the Application taking into account the Environmental Permitting Regulations and our statutory Public Participation Statement and the requirements of Article 8 of the Mining Waste Directive (MWD). The website for the Environment Agency has been incorporated into the GOV.UK website as part of the UK Government's decision to have a single website for all statutory organisations.

We advertised the Application by a notice placed on the .GOV.UK website, which contained all the information required by the regulations, including telling people where and when they could see a copy of the Application.

We placed a paper copy of the Application and all other documents relevant to our determination on our Public Register. Anyone wishing to see these documents could do so and arrange for copies to be made. In addition copies of the relevant documents were made available at a number of libraries and council offices in the local area. The Applicant also made all the Application documents available on their website.

We have included a pre-operational condition that provides that hydraulic fracturing shall not commence until we have approved, in writing, the hydraulic fracturing plan which is referred to in section 2.3.1 of the waste management plan. The hydraulic fracturing plan has not been included in the documents submitted with the application and consulted upon as it is not yet available. The hydraulic fracturing plan will not be available at this stage since it can only be developed after drilling and well evaluation.

Inadequacy of the Waste Management Plan and inadequate controls for flow back fluid

Concerns have been raised that the Waste Management Plan does not contain an adequate level of information addressing the potential risks associated with chemicals generated from the proposed activities and that there is not enough treatment capacity available to deal with flowback fluid that will be produced from the proposed activities.

We have assessed the Waste Management Plan and we are satisfied that the generation of waste will be minimised. Our approval of the Waste Management Plan is subject to conditions, the requirements of any conditions in the permit will override any conflicting details in the Waste Management Plan.

We have assessed the Application and we are satisfied that the waste can be safely dealt with. Capacity is primarily an issue for the Applicant and if an appropriately permitted outlet for the waste cannot be found, the operations will have to stop.

Impact of property value

A number of comments have been made that the proposed activities will have a negative impact on property values in the local area. Concerns were raised that no consideration had been made of residences that were in close proximity to the site.

Any negative impact of property values in the local area is not relevant to the determination for environmental permit applications.

Operator competence and lack of trust in the Operator

A number of concerns have been raised about the Operator and their competence to run the operations on site. Concerns were also raised that the operator was not transparent in their dealings with the public.

The Permit conditions require the Operator to have an appropriate management system in place that includes details of staff capability, roles and responsibilities, experience and training records to demonstrate technical competence. We will assess the Operator's activities and we will be checking they comply with their permit conditions as part of our compliance work.

We have carefully considered Operator competence and we have no reason to think that they would not comply with Permit requirements and conditions.

We have considered all relevant factors and have determined that there is no reason to consider that the Applicant will not operate in accordance with the permit.

It is quite common for Operators to conduct their own outreach programmes. Although

we offer guidance to Operators, we are not involved in directing how the Operators conduct their public relations exercises. However, we have noted that the Operator published on their website detailed meeting notes produced from each of the community liaison meetings that they held with the local community.

Stress

A number of comments have raised concerns that the activities will cause stress to the local community.

See above in relation to Public Health England comments. Public Health England have raised no objection and we are satisfied that the activities we are permitting will not give rise to any significant pollution or any emissions that will cause harm to human health.

In the context of Environmental Law, pollution is defined as any emission as a result of human activity which may be harmful to human health or the quality of the environment, cause offence to a human sense, result in damage to material property, or impair or interfere with amenities or other legitimate uses of the environment. This definition does not extend to fear, anxiety or stress.

Noise pollution

Concerns have been raised that the activities will cause noise pollution.

We are satisfied that the activities, if carried out in accordance with the Permit, will not cause noise pollution.

See above for our response to the consultation response from Environmental Health on noise pollution for more details.

Condition 3.4 of the Permit controls Noise and Vibration and requires that such emissions are minimised and, in the unlikely event that the activities give rise to pollution due to noise or vibration outside the site, a noise and vibration management plan can be requested and will have to be submitted to the Environment Agency for approval prior to being implemented.

Odour pollution

Concerns have been raised that the activities will cause odour pollution.

We have carefully considered all the permitted activities and are satisfied that they are unlikely to give rise to any significant odour. In particular, the flaring of the gas is unlikely to give rise to odour due to the origin of the gas and its predicted composition.

Condition 3.3 of the Permit controls Odour and requires that emissions are minimised and, in the unlikely event the activities give rise to pollution due to odour outside the

site, an odour management plan can be requested and will have to be submitted to the Environment Agency for approval and, once approved, be implemented.

Nature of chemicals used

Concerns were raised that the proposals mention the use of chemicals within the hydraulic fracturing fluid, but no details of these chemicals have been provided. Further, that in order to assess the impact that these chemicals will have, it is necessary for the regulator to know what chemicals are included in the hydraulic fracturing fluid.

The Applicant has provided a full list of all the additives and fluids that will be used for drilling and hydraulic fracturing. We have assessed the additives to be used and we do not consider that they will cause environmental harm at the rates and levels of use proposed. The fluids will be non-hazardous to groundwater and the Permit will limit the composition of the fluids to those disclosed in the Waste Management Plan and approved by the Environment Agency.

Underground waste facility and fate of fluid left underground

Concerns were raised on the accumulation of waste fracturing fluid underground which the applicant had referred to as best available practice. Most respondents cited a paper published by Professor Davies which expressed concerns that hydraulic fracturing wastes, including NORM (Naturally Occurring Radioactive Materials), may migrate to other formations and eventually cause contamination.

Professor Davies has published a follow up to his paper on fracture propagation which states that the paper was based on purely statistical probabilities and that his findings are therefore blind to factors such as local geology and the operational factors such as the volumes of fracture fluid to be used and that these do need to be considered on a site specific basis to produce meaningful data.

We have taken a conservative approach and this is why appropriate mitigation measures have been proposed and included throughout the Permit. These will limit the potential of fracture propagation beyond the target formation and this will in turn reduce the chances of fracture fluid being lost to other formations. These mitigation measures include the stepped approach to the hydraulic fracturing process, using small volumes of fluid initially and monitoring the propagation of the fractures using the seismic arrays, then increasing the volumes used up to a maximum volume which has been proposed at a much reduced volume than previously used at Preese Hall, and is limited in the Permit.

The Hydraulic Fracture Plan to be approved by DECC will also need approval by the Environment Agency prior to hydraulic fracturing commencing and this will be a condition of the Permit. The plan will be designed to ensure that the propagation of fractures is carefully monitored. It should also be noted that it is not in the Operator's

interest to create fractures that extend into the Millstone Grit as it is a waste of energy and may result in additional water having to be pumped for no extra gas production.

See section 7.5 of the Decision Document and the potential impact of activity on surface water and groundwater section above for more details.

Adequacy of the Waste Management Plan and management of spent drilling muds

Concerns have been raised that the options outlined in Waste Management Plan for the disposal of spent drilling muds and radioactive waste through a composting facility could result in contamination of land beyond the permitted site.

Exploratory drilling activities are not a NORM industrial activity. Only the activities relating to well testing would fall under NORM industrial activity. NORM will be managed in accordance with conditions of the radioactive substances activity permit which is separate to this permit.

Air emissions gas/fugitive emissions:

Concerns have been raised about how fugitive methane emissions and point source emissions from a flare would be controlled.

Condition 3.2 of the Permit applies controls on fugitive emissions. Flowback fluid will be transferred through the separator and to the storage tanks via enclosed pipe work. As described in section 9.9 of the WMP, pipework and connections will be tested for integrity prior to use and will be monitored during operations.

Most methane will have been stripped out in the separator. The Operator will regularly monitor the flowback fluid post separator to determine the levels of dissolved methane and other hydrocarbons. If levels of dissolved methane and other hydrocarbons are found to require further controls as indicated in section 9.5.5 and 9.9 of the WMP abatement measures will be implemented. The flow of gas from the separator will be isolated and will be temporarily shut-in to prevent the flow of further flowback fluid and appropriate long-term abatement measures will be designed, presented to the Environment Agency for approval and implemented. Unabated releases of methane to the atmosphere will be prevented, however it may be necessary to vent for safety reasons.

We recognise that the flaring of gas needs to be controlled and we have required that the Operator assesses and reports the emissions from the flare using a calculation method using the gas flow rate, flare efficiency and gas composition as surrogate parameters, rather than carrying monitoring of emissions directly from the flare, due to technical limitations.

Using this method the Operator can determine the emissions of oxides of nitrogen, carbon monoxide and volatile organic compounds. These results will be submitted to the Environment Agency on a monthly basis.

The Application includes a request to flare more than 10 tonnes of gas per day. The flaring will be done as part of the initial flow tests to determine the rate at which the gas flows from the wells. The purpose of the flare is to incinerate natural gas which, if encountered during the well testing phase, is flowed to surface under controlled conditions.

A smaller flare may also be used during Extended Well Testing following connection to the gas grid as a safety measure and would only be used in emergency scenarios in order to avoid pressure build up in any pipework or vessels and on occasions when maintenance work is carried out on surface equipment.

As the natural gas flows to surface, the Operator will monitor and record flow rate and pressure, giving them a greater understanding of the likely volume of natural gas in place within the formation.

The key to a well test is not only the formation pressure and flow rate per day but the total volume of natural gas produced during the test. If the quantity and flow rate of natural gas from the initial flow test is sufficient, and necessary licences and arrangements are in place, the well pad is suitable for connection to the national grid.

In support of the permit application, an air dispersion modelling assessment was carried out and these assessed the maximum concentrations of pollutants generated for nitrogen dioxide and carbon monoxide. The predicted concentrations were compared against relevant air quality standards and their contribution to the ambient concentrations at locations of human habitation closest to the well site.

The flares will be of an enclosed design, which will provide noise abatement, and there will be no visible flame. The point source emissions to air from the operation of the flares have been modelled by the Applicant and the conclusions are that there will be no significant impact on human health or ecological receptors from the operation of these flares for a period of no longer than 90 days for each well. Flaring is also limited to a maximum of 130,000 cubic metres per day.

We have audited the Applicant's findings and agree with these conclusions.

We have also included a condition that provides that flaring of gas shall be limited to a period not exceeding 90 days for each well and that thereafter gas can only be flared where it is necessary to do so either as a safety measure or due to maintenance of surface equipment, unless otherwise approved by us, in writing.

Therefore, in the event that a connection to the gas grid is not available and further flaring is required (except as a safety measure or due to maintenance work on surface

equipment) the Operator will need to obtain our written approval before this takes place.

We are satisfied that the contribution of emissions from the proposed flaring operation at locations of human habitation closest to the well site is insignificant.

Full details of the air quality assessment can be found in section 7.6 of this document. The Applicant has justified the use of the flare rather than using the waste gas to meet energy requirements on site, and we consider this to be satisfactory and in line with BAT requirements for this type of operation.

Flaring is not a best available technique

Concerns were also raised on the proposed flaring of gas. It was argued that flaring was not the Best Available Practice; a better practice was to capture waste methane from wells, compressors and processing operations for use.

The applicant has justified the use of the flare rather than using the gas to meet energy requirements on site, and we consider this to be satisfactory and in line with BAT requirements for this type of operation. See section 5.1.6. We asked for further information during the determination of the application in order to satisfy ourselves that all options for dealing with the waste gas had been considered.

The aim of the well testing activity is to establish the quantity and composition of the gas, and its flow rates to forecast potential future production flows from the well. The data will be gathered over a period not exceeding 90 days for each well, during which the aim is to achieve a constant flow.

We are satisfied that flaring is necessary to achieve this objective. At the end of this initial testing period a decision will be made based on the data as to whether there is enough gas to justify a grid connection for the extended well testing, or where there is not enough gas the well will be closed.

During initial testing the costs of linking to the grid would be prohibitive for what could be a short-term situation and the quality of the gas may not be compatible with the gas grid requirement without further processing (and associated infrastructure); Based on the intermittent energy requirements of the site, capturing the gas and generating energy for use on site would not produce the constant gas flows required for analysis, and the aims of the exploration activity would not be met.

Radioactive waste

Several comments raised concerns on how the radioactive substances generated from the activity will be managed. To plan for such potential, the Applicant has applied for a radioactive substances activity (RSR) permit that will deal with the management of naturally occurring radioactive materials arising from the proposed activities. Issues

relating to the management of radioactive materials raised as part of the consultation have been shared with the relevant officers and will be considered under the RSR permit.

Assessment of financial provision

Comments were made which raised concerns on the absence of monetary provision that could be set aside and which could be used for any remedial work required in the event of a pollution incident.

The requirement in the MWD for financial guarantee does not apply to all activities. It only applies to the waste facility for hazardous waste see section 7.9.11 for further details.

In respect of the appropriate amount to be provided by way of a financial guarantee, we considered the obligations of the Permit in respect of the management of the hazardous waste on the surface. Matters considered included: transportation and disposal of drill cuttings and drill waste; inspection and replacement of tank; sampling costs; waste handling and cleaning equipment hire; and security of the site.

The Operator is to provide a financial guarantee by means of an agreed mechanism which will remain in place until management of the hazardous waste on the surface is no longer necessary

Earth tremors/Seismic activity

Concerns were raised that hydraulic fracturing could cause earthquakes. Some of the respondents pointed to previous earth tremors that were experienced on the Fylde coast in the Blackpool area as a result of hydraulic fracturing. Concerns were also raised that the Operator was planning to drill straight through a fault and hydraulically fracture close to it.

We have considered the risk of seismicity in relation to the potential impact on the permitted activities, including the integrity of the wells, and we are satisfied that appropriate measures will be in place to ensure that seismicity will not result in pollution or harm to human health from the permitted activities.

Precautions against seismic activity are addressed by conditions on permissions for hydraulic fracturing that are granted by the Department of Energy and Climate Change (DECC). DECC oversee the implementation of precautions to prevent the occurrence of earth tremors as a result of hydraulic fracturing.

The Applicant will only drill away from 'regional faults' which they have defined as those that have been defined by the British Geological Survey and presented on the 1:50,000 scale geological maps. They have carried out 3D seismic mapping that has shown where the faults are in the Bowland shale area. The proposed mitigation measures are

built into the hydraulic fracturing plan which the Operator is required to provide for approval to the Environment Agency prior to undertaking any hydraulic fracturing. This will allow the process to be carried out in a controlled and monitored manner that will mean that full account can be taken of the geomechanical properties of the shale and the programme can be adjusted to suit the findings.

The Royal Society and the Royal Academy of Engineering conducted an independent review of the scientific and engineering evidence on the risks associated with hydraulic fracturing for shale gas. Its report, published in June 2012, concluded that the environmental (and health and safety) risks can be managed effectively in the UK, provided that “operational best practices are implemented and enforced through regulation”. The Government has accepted all of the recommendations from the report. The industry is not new to the UK, it is the process of high volume hydraulic fracturing that is new and is being closely monitored through this exploratory period.

In 2011 there were small tremors at Preese Hall near Blackpool, where hydraulic fracturing operations were taking place. DECC suspended all hydraulic fracturing operations while investigating the cause. Following these investigations DECC introduced new controls and checks for operators using hydraulic fracturing. Amongst other things, the operators are required to monitor seismic activity during and after fracturing and adopt a “traffic light” system that controls whether injection can proceed or not, based on the these checks. Any hydraulic fracturing must stop when tremors higher than the threshold agreed in the approved hydraulic fracturing plan are detected. Current indications are that DECC, who also have to approve the plans, will require this to be a magnitude of 0.5.

This level is well below what could be felt at the surface and is within the range of normal background noise and vibration caused by vehicles, trains and farming activities. DECC have since produced a report that address concerns that have arisen from activities at Preese Hall and which outlines measures taken to reduce the risk of hydraulic fracturing related tremors.

We are satisfied that measures can be taken to ensure that the fracturing fluids remain in the target formation. We have included a pre-operational condition that provides that hydraulic fracturing shall not commence until we have approved, in writing, the hydraulic fracturing plan which is referred to in section 2.3.1 of the waste management plan. A stepped approach will allow the geomechanical properties of the reservoir to be understood and the hydraulic fracturing programme to be tailored accordingly.

The fracturing plan will include

- A map showing faults near the well and along the well path, with a summary assessment of faulting and formation stresses in the area and the risk that the operations could reactivate existing faults;
- Information on the local background seismicity and assessment of the risk of induced seismicity;

- Summary of the planned operations, including stages, pumping pressures and volumes;
- A comparison of proposed activity to any previous operations and relationship to historical seismicity;
- Proposed measures to mitigate the risk of inducing an earthquake and monitoring of local seismicity during the operations; and
- A description of proposed real-time traffic light scheme for seismicity, and proposed method for fracture height monitoring.

In addition, we have included a condition in the Permit that provides that the hydraulic fracturing process must be designed and implemented to ensure any fracturing fluid remains in the target formation, namely the Upper and Lower Bowland Shale and Hodder formations.

Well integrity

Concerns were raised that there was no certainty that the exploratory boreholes to be drilled were safe and structurally adequate to prevent leakages that could cause pollution. Concerns were also raised that the Environment Agency is dependent on the designs approved by HSE, but that the HSE did not enforce their designs nor were they involved in carrying out checks at the permitted sites. As there were no regulations that enforced long term monitoring, leaks of abandoned wells could result in irreversible environmental damage.

The boreholes will be constructed in accordance with the requirements of the HSE and the Petroleum Exploration and Development Licence. They are also designed in accordance with industry best practice and in compliance with the Installation and Wells (Design and Construction) Regulations 1996 (DCR). The DCR requires the well design to be such that no unplanned escape of fluids can occur. The Environment Agency has assessed the risk of drilling boreholes at this location and considers that the design of the proposed boreholes meets the requirement to prevent any release of liquids in to the water environment. The boreholes will be constructed in accordance with notifications under Section 199 of the Water Resources Act 1991 and confirmation of completed drilling construction and integrity testing will be required.

At the point when the wells are no longer productive and the Operator wishes to decommission them they will have to carry out any necessary works to make the well safe and prevent any leakage that could cause environmental damage. The Health and Safety Executive have detailed legal requirements relating to this stage of the well life, which the Operator will have to comply with. The Environment Agency will be involved in this process to ensure that any groundwater is protected during the abandonment process and for the future. The Operator will have to provide sufficient evidence to satisfy the Environment Agency that the decommissioned well will not cause any on-going or future impact on the environment before surrender of the permit would be accepted.

Monitoring at the site will continue into the post decommissioning period and will have to demonstrate that no impact has occurred and that there are no on-going environmental issues.

Additional Correspondence

In addition, we have received certain correspondence and representations submitted to the Local Planning Authority in response to the planning application. Although this has not been directly submitted to us as part of our consultation, we have carefully considered any issues raised in those representations that are relevant to determination of this permit application, and taken them into account for the purposes of our decision. These issues have been addressed in this Annex.

Health Impact Assessment

We have considered Lancashire County Council's Director of Public Health's Report for the cabinet meeting on 6th November 2014. We have also considered the appendices to that report. The report was prepared in relation to the determination of the planning application and so covers matters that are outside the scope of the applications the Environment Agency is currently determining.

We are satisfied that we have had regard to all matters relevant to our determination and that there will be no significant impact on human health from the activities we regulate.

In particular we have looked at the main recommendations in the Director of Public Health's Report and are satisfied that those relevant to our determination have been addressed:

In relation to community understanding, we have explained our approach to public engagement during the consultation. The detailed recommendations go beyond our remit in determining the current applications. As part of our ongoing regulation (if any permits are issued) we will continue to work together with other regulators to understand how we can improve communications and engagement with the local communities.

For air quality we explain elsewhere in this document how we have assessed and addressed emissions to air from the activities we regulate.

The Permit requires that greenhouse gas emissions are prevented and where that is not possible minimised. As explained in section 7.6.1) the Applicant will monitor for fugitive emissions of methane. It is not possible to apply a limit on fugitive emissions as by definition they are unplanned and from a variety of sources so it is not possible to measure all emissions of them.

The current application already covers extended well testing.

For recommendations on emergency preparedness, as explained elsewhere this is not

a Category A mining waste facility and so an emergency plan is not required. We address accident prevention and the minimisation of the consequences of any accident through the site's management plan.

Noise is addressed in section 6.15

The recommendations relating to induced seismicity are not directed towards the Environment Agency and are outside our remit. For our part, we will need to approve the hydraulic fracturing plan and seismic monitoring programme. This should ensure that fracking fluid remains in the target formation and will minimise any risk to well integrity.

For waste, we explain elsewhere in this document that hydraulic fracturing fluid left underground will become waste once it no longer serves a useful purpose. We also explain our approach to monitoring. Any permit can only be surrendered when we no longer consider ongoing monitoring is required.

The Environment Agency regulates how waste will be dealt with. Issues relating to the provision and capacity of facilities are matters for the waste planning authority and market forces. In the event that sufficient storage and treatment capacity is not available for a particular waste stream operations generating that waste will need to cease. On site storage capacity and containment measures are covered by the Permit.

Lighting and transport are matters for Lancashire County Council. Nor is occupational health within the Environment Agency's remit.

Monitoring requirements are addressed in the permit and explained elsewhere in this document in section 7.7. In the event there was a breach of any Permit the Environment Agency would take such action as it considered appropriate at that time which could include informing other regulators and the Director of Public Health.

The recommendations relating to local policy and practice are matters for Lancashire County Council. Those relating to national policy and research are outside the scope of our determination but will be considered.

3 Other matters outside the scope of this permit Application that the public have commented on which may be more relevant to Applications for other permissions.

Hydraulic fracturing (“hydraulic fracturing”):

Concerns were raised that hydraulic fracturing is an extremely dangerous process. The permitted activities include the management of waste from hydraulic fracturing. DECC issues permission that authorises hydraulic fracturing.

However, we do regulate activities associated with hydraulic fracturing as outlined in the body of this document. We have addressed the risks of those activities and how we have dealt with them.

Location of the site and industrialization of the countryside:

Decisions over land use are matters for the planning system. Lancashire County Council is responsible for determining whether or not the proposed development is appropriate in this location, having regard to relevant policies within the adopted local plan and the National Planning Policy Framework. The location of the site is a relevant consideration for Environmental Permitting, but only in so far as affects the potential for the site to have an adverse environmental impact on communities or sensitive environmental receptors. The environmental impact is assessed as part of the determination process and has been reported upon in the decision document.

Vehicle access to the site and traffic movements:

These are relevant considerations for the grant of planning permission, but do not form part of the Environmental Permit decision making process except where there are established high background concentrations of pollutants contributing to poor air quality and the increased level of traffic might be significant in these limited circumstances. This is not the case for this location.

Climate change policy:

Policy is made by the Government and the policy on exploitation of Shale Gas is no different to that of any other fossil fuel. The policy states “We aim to maximise the economic recovery of oil and gas from the UK’s oil and gas reserves, taking full account of environmental, social and economic objectives”.

Industry Self Regulation:

Where an environmental permit is issued, we have a responsibility and a duty to ensure that it is complied with. Concerns about industry self-regulation are not relevant to our Permit determination or the subsequent regulation of any permit.

The industry is not new and has been in the UK producing oil and gas for many decades; as regulators of the refineries and combustion plants using this resource, we have extensive relevant experience.

We recognise that Hydraulic Fracturing is a relatively new activity, however the

proposed activities are well regulated by legislation enforced by the Environment Agency, the Health and Safety Executive, the Local Planning Authority and DECC.

The waste management activities proposed for this site in terms of storage and processes for recovery and disposal, are well established and the risk management measures in place are commonly used across a variety of industries

The regulatory system that manages this industry and others has also been developed over many decades through global experience. Many of the regulations controlling this sector have been introduced in the last decade and are continually under review both in the UK and EU. What is new is the technique of high volume hydraulic fracturing, about which we have gathered regulatory information from around the world and particularly the US. This is the nature of industry as it develops new methods and techniques. To date there has only been one hydraulic fracturing event in the UK that has helped inform the requirement for permits to carry out all such exploratory activities.

We have stated from the outset that we will take a conservative approach and will require operators to fully risk assess their activities and demonstrate how risks will be managed and mitigated when applying for any permits. We have taken the same position in considering the Permit conditions to include in this Permit.

B) Advertising and Consultation on the Draft Decision

This section reports on consultation on our draft decision carried out between 24/11/2014 and 06/01/2015

A total of 20 responses were received from individual members of the public.

In some cases the issues raised in the consultation were the same as those raised previously and already reported in section A of this Annex. Where this is the case, the Environment Agency response provided in section A of this Annex has not necessarily been repeated and reference should therefore be made to section A in addition to any response below. The exception to this relates to air quality concerns from members of the public. We have sought to amend the original text to provide greater clarity and this is incorporated into the response below.

Also some of the consultation responses received were on matters which are outside the scope of the Environment Agency's powers under the Environmental Permitting Regulations. Our position on these matters is as described previously.

Response Received from Public Health England	
Brief summary of issues raised:	Summary of action taken / how this has been covered
Apparent omission of a requirement to monitor surface water within the scope of the groundwater monitoring plan required by PO4 and condition 3.5.9.	Surface water monitoring requirements are included in the Permit under condition 3.5.1. and Table S3.5 of Schedule 3.
Clarification sought on the rationale regarding the defined quantity of hazardous extractive waste (limited to a maximum of 275 tonnes at any one time) and on the lack of a maximum time period for the storage of hazardous waste.	<p>The area designated for the deposit or accumulation of hazardous extractive waste from the drilling of the wells constitutes a hazardous mining waste facility. We have specified a maximum limit for hazardous waste in the permit to allow us to calculate accurately the financial provision.</p> <p>This is described in the approved waste management plan and also forms part of the requirement for financial provision. The permit reflects the figure quoted in the approved Waste Management Plan.</p> <p>The approved Waste Management Plan specifies that all hazardous wastes will be regularly transported off site to a suitably permitted facility. We are satisfied that in combination with the limit on the total quantity of hazardous waste stored at any one time, a</p>

	<p>maximum time period for the storage of this hazardous waste is not required. This will be monitored as part of our compliance work.</p>
<p>Clarification sought on the lack of a maximum storage quantity and maximum storage time for activity A4.</p>	<p>Activity A4 is for the long term accumulation of extractive waste within the formation being hydraulically fractured. It would therefore be impossible to state a maximum storage time as the accumulation will be permanent. The quantity of extractive waste accumulated within the facility will depend on the physical characteristics of the rocks being fractured and will be monitored as part of the requirements of condition 3.5.1. and table S3.6 of schedule 3.</p>
<p>Content of the Environment Management and Monitoring Plan (EMMP).</p>	<p>The content of the EMMP will be assessed as part of the requirement of the preoperational condition PO2 and will include a review of relevant available health-based standards. Ambient air monitoring will also form part of the approved EMMP as detailed in table S3.7 of schedule 3 of the permit.</p>
<p>Use of Environmental Assessment Level (EAL) which are derived from occupational exposure standards and maximum exposure levels and may not consider variability in susceptibility of the general population.</p>	<p>Statutory Air Quality Values are used where they exist, otherwise EALs apply. The full discussion of how EAL are derived is set out in the H1 Annex F Air Emissions (https://www.gov.uk/government/publications/h1-environmental-risk-assessment-for-permits-overview) Where we use EAL, we are satisfied that they are appropriate and they provide the appropriate level of protection.</p>

Response Received from Campaign to Protect Rural England	
Brief summary of issues raised:	Summary of action taken / how this has been covered
Concerns about the monitoring of seismicity, including the use of microseismic data, resolution and real time monitoring.	The hydraulic fracturing activity cannot start until the Operator has produced a hydraulic fracturing plan and we have reviewed and approved this plan. A summary of what the plan contains is detailed in section 7.5 of this document. The hydraulic fracturing plan will include details of the local seismicity and also contains details of the proposed real time monitoring of seismicity and fracture growth. We will not approve the fracturing plan unless we are satisfied that the monitoring is appropriate and effective.
Concerns about the reuse of flowback fluid and its retention within the fracture formation.	<p>Flowback fluid will be reused as part of subsequent fracturing stages in order to minimise the waste generated. The permit requires that any fracturing fluid that is injected, whether it is composed of separated flowback fluid or not, must not cause pollution of groundwater and must only contain polyacrylamide as an additive unless otherwise approved by us in writing. We would not approve the use of any additive hazardous to groundwater.</p> <p>The Permit includes a requirement for the Operator to monitor the composition of the hydraulic fracturing fluid (which may include flowback fluid), in particular to demonstrate that no hazardous additives have been used and that the fluid injected remains non-hazardous. The monitoring results will be made available to the Environment Agency and will be available on the Public Register.</p> <p>Section 7.5 of this document details our approach on groundwater protection.</p>
Concerns about the design, management and monitoring of the flare and its emissions and concerns about the potential for methane to form 13% of fugitive emissions and the monitoring of fugitive emissions,	<p>The Applicant has provided the technical specifications of the flare and the prediction of emissions were modelled based on best estimate of gas composition under a variety of flow rates. We are satisfied that this is appropriate.</p> <p>Methane will not form 13% of fugitive</p>

	<p>emissions. This figure of 13% is a “tonne of carbon dioxide equivalent” used to demonstrate the potential source and scale of greenhouse gas emissions from the whole operation, not just the permitted activity. This does not mean that incomplete combustion of methane equates to 13% of fugitive emissions. The combustion process results in a point source emission and the permit requires the Operator to maintain efficient combustion to convert at least 98% of methane into carbon dioxide and water. Without measures being taken, fugitive emissions may arise from other parts of the process (e.g. in the event of a leak from any pipes). The Permit requires the Operator to take necessary measures to prevent and/or minimise these emissions.</p> <p>The Environment Management and Monitoring Plan required by the pre-operational condition PO 2 will include details of the Ambient Air monitoring that is required to be carried out by the Operator. This is also detailed in the Approved Waste Management Plan in section 9.6.1.</p>
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Response Received from Sefton Green Group	
Brief summary of issues raised:	Summary of action taken / how this has been covered
Concerns about the lack of limits specified in tables in the permit's schedules	<p>Regarding air emissions, we have assessed the potential emissions from the proposed site. We are satisfied that the combustion of the natural gas will not result in pollution or harm to human health and that it is not necessary to set emission limits as the operating controls will ensure effective combustion. See Section 7.6 for more details.</p> <p>There are no emissions from the activities to surface water apart from the potential discharge of clean, uncontaminated water, While the site is operational, all surface water collected from the site will be contained and taken off site to a suitably</p>

	permitted site for treatment and/or disposal.
Concerns that the impermeable membrane cannot be guaranteed to not to leak	Site construction is detailed in section 2.2.1 of the approved Waste Management Plan. We are satisfied that the design of the site containment is appropriate. As part of the site construction, the impermeable membrane will be tested for integrity. During operations, the membrane will be protected via the aggregate work surface and will be visually inspected. Any spillage will be identified and remediated. In addition, groundwater monitoring boreholes will be installed on the periphery of the surface site to monitor the local groundwater.
Concerns about the determination of residual gas release after flaring which is to be based on the input flow analysis and the efficiency of the flare and questions about what real analysis will be done on residual gas releases to air.	The efficiency of the flare is based on the measurement of the flare temperature (>800°C) which is monitored as part of the Permit requirement and the retention time which is dependent on the design of the flare. We have assessed the technical specification of the flare and we are satisfied that, if operated within these specifications, the emissions from the flare will not be significant. Direct monitoring of emissions from the flare is not currently possible due to practical difficulties of performing representative measurements inside the combustion chamber of a flare, and the hazards associated with such measurement procedures.
Concerns about why Lytham Coastal Changes and Wyre Estuary are listed as not sensitive to nitrogen.	Lytham Coastal Changes is a Site of Special Scientific Interest (SSSI) located over 5 km away from the site and lies outside of the statutory 2km screening distance. Wyre Estuary SSSI also lies outside the 2 km screening distance; However the Morecambe Bay SPA covers the same area and has been assessed in terms of nitrogen deposition. The result of the air quality modelling and our audit is that there will be no significant effect on the SPA from the flare activity.
Concerns about whether flaring of the produced gas is considered Best Available Technique (BAT).	Whether flaring is BAT is discussed in detail in the Decision Document, section 7.6.3.8. We are satisfied that flaring is appropriate for the initial flow test.

Concerns about how the Agency will ensure compliance with the permit.	Compliance with the permit will be assessed using site and desk based assessments, including site inspections and assessments of data gathered by the Operator and by the Environment Agency.
Concerns about the investigation of samples causing concerns.	The Permit includes a preoperational condition (PO2) that requires the Operator to submit for approval an Environmental Management and Monitoring Plan (EMMP). The EMMP will include the procedure for investigating samples. . Condition 4.3.1 of the permit requires the Operator to immediately inform us and to initiate a site based investigation to identify and correct any potential cause of concern.
Concerns about potential spillages of diesel or lubricants into Carr Bridge Brook.	A spill of fuels and oils on site without adequate containment would be a significant risk, and would have an impact on the local surface waters. However, the site does have adequate measures to minimise the risk of such a spillage and its consequences to an acceptable level. In summary, spill kits will be present on site to allow for the clean up of fuels and oils, stone/aggregate working surface and the impermeable membrane will allow for the containment of spilt materials. In addition, the surface water drain on site can be isolated on site to prevent the escape of pollutants. Only clean and uncontaminated surface waters will be discharged. During drilling, hydraulic fracturing and initial flow testing stages, the double isolation valve will be kept shut and any surface waters removed from the site to an appropriately permitted facility.

Response Received from Lancashire County Council	
Brief summary of issues raised:	Summary of action taken / how this has been covered
The Agency should be satisfied prior to the granting of any permits for the site that adequate disposal capacity is available off site and will remain available into the future to treat and dispose of the waste streams set	We are satisfied that there is currently adequate capacity to treat and/or dispose of the waste generated by the permitted activity. In the event that the operator could not find somewhere to take their waste, the operator would have to take the necessary

<p>out in the permit.</p>	<p>measures to ensure that no further waste of this type is generated until alternative treatment/disposal routes were in place.</p>
<p>Independent monitoring should be undertaken for the long term, well after site restoration, to demonstrate there is no risk of impacts occurring in the long term.</p>	<p>Sample analysis from monitoring will be carried out by suitable certified, qualified and independent laboratories. This can be compared to the Environment Agency's data collected by local officers and analysis by the National Laboratory Service. The monitoring requirements in the Permit are for an indefinite period of time and will continue unless we accept an application to vary to appropriate conditions or an application to surrender. See further details in section 7.7 of this document</p>
<p>The Environment Agency should consider a public consultation period before the surrender of permits happens.</p>	<p>We will consider any application to surrender the permit in accordance with the prevailing guidance and legislation at the time of any eventual surrender.</p>
<p>As far as its powers allow, the agency should seek to regulate the pollution from the entire site during its operation. This will mean that emissions from the whole site will be managed and not just from the flare.</p>	<p>In addition to air emissions, the permit includes requirements to monitor groundwater and surface water. We will be regulating the whole of the permitted activities as defined in the permit. We do not have the power to go beyond this but will work closely with other regulators.</p>
<p>The Environment Agency should use international best practice standards to measure fugitive emissions and establish a pre-operating condition of an explicit threshold for fugitive emissions beyond which the Environment Agency will ask the operations to cease.</p>	<p>We use our standard condition and will be assessing and approving the Operator's Environment Management and Monitoring Plan (EMMP) prior to operations commencing. The Operator will be measuring any methane emissions as described in the approved EMMP. The EMMP will also include measures to take in the event of significant levels of methane being detected (e.g. operations to be suspended). On site health and safety measures will also be in place to protect the workforce.</p> <p>Fugitive emissions are by definition unplanned and therefore imposing a limit is not appropriate. The permit requires the Operator to prevent or, where that is not possible, to minimise fugitive emissions.</p>
<p>With regards to point source</p>	<p>As stated in the body of this document (see</p>

<p>emissions it is noted that that there are no limit values for oxides of nitrogen carbon monoxide, total volatile organic compounds in the draft permit. The EA should require limit values by monitoring close by for the above pollutants and consider measuring a comprehensive list of hazardous air pollutants.</p>	<p>section 7.7), direct monitoring of emissions from the flare is not currently possible due to practical difficulties of performing representative measurements inside the combustion chamber of a flare, and the hazards associated with such measurement procedures. Monitoring air pollutants close to the permitted facility would not provide data sufficient to show that any limit is met.</p> <p>We are satisfied that, if operated within the technical specifications we have assessed as part of the application, the emissions from the flare will not be significant. In addition, the condition in the permit states that such emissions shall not cause pollution.</p>
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Response Received from Friends of the Earth	
Brief summary of issues raised:	Summary of action taken / how this has been covered
<p>Concerns that the Environment Agency has failed to adopt a precautionary approach in relation to the proposal to issue a permit in this case.</p>	<p>The United Kingdom Interdepartmental Liaison Group on Risk Assessment (UK-ILGRA) state in their paper "The Precautionary Principle: Policy and Application" that the precautionary principle should be invoked when there is good reason to believe that harmful effects may occur and that the level of scientific uncertainty about the consequences or likelihood of the risk is such that the best available scientific advice cannot assess the risk with sufficient confidence to inform decision making. Public Health England (<i>"review of the potential public health impacts of exposures to chemical and radioactive pollutants as a result of the shale gas extraction process"</i> June 2014) say that <i>"PHE has reviewed the literature on the potential public health impacts of exposures to chemical and radioactive pollutants as a result of shale gas extraction. We conclude that the currently available evidence indicates that the potential risks to public health in the vicinity of shale gas extraction sites will be low if shale gas extraction is</i></p>

	<p><i>properly run and regulated.”</i></p> <p>In view of this and of our assessment of the proposals, we do not consider that the precautionary principle applies in this case, although, as set out above, we have taken a conservative approach to assessment of the application and have required full risk assessment of the relevant activities.</p>
<p>Concerns that the disposal of large volumes of fluid in the rock following hydraulic fracturing is contrary to Article 4 of the Mining Waste Directive due to the risk of well failure and potential pathways to sensitive receptors.</p>	<p>We are satisfied that the wells design is appropriate and that there are no pathways to shallow receptors during operations. Once the operations have ceased and the well is decommissioned, the method of decommissioning used will close off pathways from the formation that has been fractured to overlying groundwater bearing formations and also from the surface into the well.</p> <p>We discuss in detail the protection of groundwater in section 7.5 above. We are satisfied that the appropriate measures are in place to ensure that there are no pathways from the fractured formation into the overlying groundwater bearing formations. The permit includes a requirement for the Operator to monitor the extent and direction of the fractures to demonstrate that the fractures (and therefore the accumulated waste fluid) remain within the target formation.</p>
<p>Concerns about the use of additive and their accumulation in the fracture formation and that the Industrial Emissions Directive applies to this disposal.</p>	<p>Flowback fluid will be reused as part of subsequent fracturing stages. The permit requires that any fracturing fluid that is injected, whether it is composed of separated flowback fluid or not, must not cause pollution of groundwater and must only contain polyacrylamide unless otherwise approved by us in writing. We would not approve the use of any hazardous additive.</p> <p>The Permit includes a requirement for the Operator to monitor the composition of the hydraulic fracturing fluid (which may include flowback fluid), in particular to demonstrate</p>

	<p>that no hazardous additives have been used and that the fluid injected remains non-hazardous. The monitoring results will be made available to the Environment Agency and will be available on the Public Register.</p> <p>The Industrial Emissions Directive applies to the underground storage of hazardous waste with a total capacity exceeding 50 tonnes. We are satisfied that the waste fluid left in the formation will be non-hazardous waste and therefore that the Directive is not applicable to this activity.</p>
<p>Concerns about the approach to post-closure monitoring and the lack of a minimum period of required monitoring prior to surrender of the permit.</p>	<p>The Permit conditions are not time limited and will remain in place unless we grant an application to vary the permit requirements or accept a surrender application. See further details set out in section 7.7 in the body of this document.</p>
<p>Concerns about self-regulation and that there does not appear to be controls of pollutants listed in Annex II of the Industrial Emissions Directive.</p>	<p>Self-regulation is government policy and we will regulate the permitted activities in accordance with prevailing guidance, which at present is set out in our Enforcement and Sanctions Guidance.</p> <p>In addition to the requirements under the Permit and the requirements under of the planning permission, the Operator must get consent from Department of Energy and Climate Change (DECC) prior to drilling. DECC will only give consent once the Mineral Planning Authority has granted permission to drill and the relevant planning conditions have been discharged and The Health and Safety Executive (HSE) has had notice of and is satisfied with the well design and the British Geological Survey (BGS) has been notified of the intent to drill.</p> <p>In addition to our compliance work at the site, the HSE will monitor progress on the wells. The HSE will be notified of any unplanned events and will undertake inspections of specific well operations on site.</p>

	<p>Article 14 (2) of the Industrial Emissions Directive allows for emission limit values to be replaced by technical measures or other parameters to achieve an equivalent level of environmental protection.</p> <p>We have considered the relevant pollutants listed in the IED Annex II that would result from this activity and are satisfied that it is not necessary to set emission limits, as the operating controls will ensure effective and efficient combustion.</p>
<p>Concerns that the requirements for liability and financial cover are not adequate and potentially at odds with the polluter pay principle.</p>	<p>The requirement in the MWD for financial guarantee does not apply to all activities. It only applies to the waste facility for hazardous waste see section 7.9.11 for further details. We are only able to require financial provision where we have the power to do so.</p> <p>In respect of the appropriate amount to be provided by way of a financial guarantee, we considered the obligations of the Permit in respect of the management of the hazardous waste on the surface. Matters considered included: transportation and disposal of drill cuttings and drill waste; inspection and replacement of tank; sampling costs; waste handling and cleaning equipment hire; and security of the site.</p> <p>The Operator is to provide a financial guarantee which will be in place before the Permit is issued by means of an agreed mechanism which will remain in place until management of the hazardous waste on the surface is no longer necessary.</p>
<p>Concerns about the disposal of large volumes of waste off site and the potential lack of capacity</p>	<p>We are satisfied that there is currently adequate capacity to treat and/or dispose of the waste generated by the permitted activity. In the event that the operator could not find somewhere suitable to take the waste, it would have to take the necessary measures to ensure that no further waste of this type is generated until alternative treatment/disposal routes were in place.</p>

<p>Concerns that the requirements of Article 5 of the Mining Waste Directive, which require the management of extractive waste to prevent impacts on human health and the environment, have not been met adequately.</p>	<p>The waste management plan, including associated documents, has been assessed in accordance with the requirements of the Mining Waste Directive and has been approved subject to conditions. We are satisfied that extractive wastes generated by the permitted activities will be minimised. We are satisfied that the retention of fluid that will become waste when it no longer serves a useful purpose in the target formation is the Best Available Technique.</p> <p>The management of this waste once it has left the site is not covered by the waste management plan, and we are satisfied that it does not need to be. The recitals to the MWD make it clear that duplication of regulation should be avoided and that the scope of the MWD should be limited to the particular operations that are considered a priority for meeting its objectives. Wastes generated at a prospecting, extraction or treatment site and transported to a location that is not a waste facility are stated as being subject to the Waste Framework Directive and the Landfill Directive.</p>
<p>Concerns that the whole of the proposed activity has not been classified as a Category A Mining Waste Facility and that the facility has been split and will be regulated as separate surface and sub-surface facilities.</p>	<p>We are satisfied that the Mining Waste facilities are classified correctly. Details of this assessment can be found in sections 5.1.9. and 5.1.10.</p> <p>The Mining Waste Directive defines the term “waste facility” and sets the criteria by which a waste facility should be classified. We consider the classification of the waste facilities at the site to be correct and in accordance with the Directive, for the reasons set out in the body of this document.</p>
<p>Concerns that the deposit of large quantities of fluid in the rock amounts to “uncontrolled depositing” of extractive waste within the meaning of Article 4(1) of the Mining Waste Directive.</p>	<p>The requirement in Art 4(1) of the MWD to take the necessary measures to prevent the uncontrolled depositing of extractive waste, read in context, requires Member States to take action to ensure that there is appropriate regulation of the recovery or disposal of extractive waste.</p>

	<p>The accumulation of this fluid, which will become waste once it no longer serves a useful purpose is controlled, the permit only authorises the waste facility to be within a specified area and within the target formation. Furthermore there are controls in the permit to ensure that that is the case.</p>
<p>Concerns that the Environment Agency does not propose to monitor actual emissions from the flaring.</p>	<p>We recognise that the flaring of gas needs to be controlled and we have required that the Operator assesses and reports the emissions from the flare using a calculation method based on the gas flow rate, combustion efficiency and gas composition, rather than monitoring emissions directly from the flare, due to the practical difficulties of performing representative measurements inside the combustion chamber of a flare, and the hazards associated with such measurement procedures.</p>
<p>Concerns that flaring is considered BAT when there is no BAT reference document directly applicable to underground mining waste facilities and when storage of gas as an alternative to flaring has not been considered.</p>	<p>Article 14(6) of the Industrial Emission Directive makes provision for activities carried out in an installation, which are not covered by a BAT conclusion. It states that “the competent authority shall, after prior consultations with the operator, set the permit conditions on the basis of the best available techniques that it has determined for the activities or processes concerned, by giving special consideration to the criteria listed in Annex III.”</p> <p>We do not consider waste gas storage on site is an available option for exploratory or appraisal sites for a number of reasons. We have concerns about the uncertainty and potential variability of the pressure and flow rate of gas from the well, the size of gas balloons that would be required, the increased accident risk associated with storage above ground of a large volume of highly flammable gas the cost of equipment and additional regulatory burden associated with gas storage, and the uncertainty about a market for a short term supply of captured gas.</p>

	<p>This is not a technique that has been applied at existing oil and gas facilities in this country. However, we will be mindful of developments. If there is significant evidence of this technology being successfully implemented elsewhere at exploratory and appraisal sites, then we will consider this as an emerging technique, worthy of further investigation, for future transfer to the UK.</p>
<p>Concerns that financial provision has not been provided as per the requirements of Article 14 of the Mining Waste Directive.</p>	<p>Financial provision does have to be agreed and in place before the permit can be issued and it is. We have assessed the applicant's proposals with regards to financial provision for the hazardous mining waste facility and they have provided this using an agreed mechanism as stated in condition 1.1.5. of the permit.</p>
<p>Concerns that the amount of the financial provision has not been disclosed in response to an earlier request.</p>	<p>We are currently reviewing the request made under access to environmental information legislation.</p>
<p>Concerns that the Environment Agency has erred in law in not classifying the site as a Category A site which is considered to be inconsistent with requiring financial provision in respect of the hazardous waste facility.</p>	<p>It appears that the responder has misunderstood the text in the decision document. We have explained that by virtue of paragraph 9(3) of Schedule 20 to the Environmental Permitting (England and Wales) Regulations 2010 the requirements mentioned in Article 2(3) of the MWD are waived. These requirements include the need for a financial guarantee for non hazardous waste, unless deposited in a Category A facility. The requirement for financial provision applies to a waste facility for hazardous waste whether or not it is classified as a Category A waste facility. There is therefore no inconsistency and we have slightly amended the text in the body of this document to make the situation clearer.</p>
<p>Concerns that flaring of gas has not been classified as a Hazardous Waste Facility (and potentially Category A)</p>	<p>The flaring of gas is correctly not considered to be a waste facility. The gas will not become waste until after it has been tested. Once tested it will be immediately sent to the flare for combustion. There will be no deposit or accumulation of waste gas and therefore no relevant waste facility.</p>

<p>Concerns that the decision fails to take due account of the health impacts</p>	<p>We have addressed Lancashire County Council's Health Impact Assessment (see section A) and we remain satisfied about any potential impact on health from the proposals.</p>
<p>Concerns that the Environment Agency may not have had due regards to climate change impacts in reaching the decision, particularly with regards to the impact of the combustion of gas being extracted when burnt to generate electricity, the displacement effects of unconventional oil and gas, the absence of an effective global climate change treaty to prevent these impacts and the uncertainty about the availability of carbon capture and storage technology at the industrial stage within the foreseeable future.</p>	<p>We are required to assess the impacts of the proposed activity and those that can be reasonably related to the activity, in accordance with national and EU law and policy. The Environmental Permitting regime is the regulatory framework under which the Environment Agency must operate, so as to deliver the obligations imposed by national policy and various EU Directives. Matters such as the climate change impacts of using gas to produce electricity, or the absence of an effective global climate change treaty, are not matters that fall to be considered as part of this regulatory process.</p>
<p>Concerns that the scope of the permit is inadequate on the basis that the company's activities are likely to exceed any natural or ordinary meaning of exploration.</p>	<p>The Permit is limited to activities relating to exploration as defined in the Permit and the body of this document.</p> <p>We consider that the proposed activities go beyond the definition of "prospecting" in the Mining Waste Directive and for that reason have not applied the derogation in Article 2(2) second sub-paragraph to the non-hazardous fluid left in the formation.</p> <p>However, it is also clear that the proposed activities do not relate to full scale commercial development. The use of the term exploration, as defined in the Permit, ensures that it is very clear that the Permit does not extend to full scale commercial development, which was a concern raised during the consultation process.</p>

Response Received from Roseacre & Wharles Parish Council	
Brief summary of issues raised:	Summary of action taken / how this has been covered
Concerns about the percentage of flowback fluid to be returned to the surface and concerns about the inconsistencies in the estimation of the flowback and the impacts it has on assessments made by applicant	<p>The Mining Waste Directive requires the Applicant to provide an estimate of the quantities of extractive waste the activities will produce. We have reviewed their prediction, as well as compared it with data available from the Oil and Gas industry in the UK and abroad and we are satisfied that it is appropriate.</p> <p>It is important to note that not all of the flowback fluid is injected fluid which returns to the surface. Flowback fluid also contains formation water released by the fracturing process and we are satisfied that the applicant's predictions and risk assessments are appropriate.</p> <p>We have specified a limit on the total quantity of waste flowback fluid stored at the surface at any one time and in the event that this storage capacity limit is reached the operator will need to suspend operations that generate any further such waste until capacity is available.</p>
Concerns about the storage arrangements on site for the returned flowback fluid.	<p>Up to 3000m³ capacity will be available for onsite temporary storage of waste flowback fluid prior to offsite disposal at a permitted waste facility or re-use. The permit allows onsite temporary storage for 3000m³ prior to offsite disposal at a permitted waste facility.</p> <p>We are satisfied that there is sufficient capacity in the storages tanks for the flowback fluid.</p> <p>The tanks will be located on the well pad membrane providing secondary containment. The integrity of tanks and vessels will be visually checked weekly and subject to annual thickness tests.</p> <p>The well design incorporates a shut-off valve that can be isolated immediately to stop the flow of waste flowback fluid.</p>

	<p>The Operator will visually monitor the level of fluid within the tanks and will shut off the flow when they reach their predetermined shut-off capacity. The tanks are fitted with a diffuser to prevent internal damage during high velocity inflows.</p> <p>Hoses and hose fittings will be regularly inspected to avoid detachment of hose assemblies during filling due to mechanical failure. Standard hose clamp fittings will be used for hose fittings to ensure secure liquid-sealed connection. Equipment will be hydro tested, or integrity tested, using clean water before initial operation to identify any leaks.</p> <p>This is incorporated into the approved Waste Management Plan and forms part of the operating techniques in the permit.</p>
<p>The impact of volumes of flowback fluid on management systems, storage, distribution, transport movements and waste processing capacity</p>	<p>As part of their management activities the Operator has stated that they will activate the shut off valve at the well head if necessary, to avoid breaching from the pre-determined maximum waste flowback fluid storage limit.</p> <p>This has been set at 3000m³ for flowback fluid in the permit.</p> <p>The Operator must comply with the conditions of this permit and will not be permitted to store any additional capacity of waste flowback fluid.</p> <p>The distribution and transport movements do not fall under the activities regulated by the Environment Agency but the Operator will have to comply with any planning permission requirements imposed by the local planning authority.</p> <p>The permitted waste facility/facilities that the waste flowback fluid is sent to will have to comply with the conditions in their own permit and will only be permitted to treat the type and quantity stated in that permit.</p>

	<p>Capacity is primarily an issue for the Applicant and if an appropriately permitted outlet for the waste which cannot be re-used, is not available, the operations which generate flowback fluid will have to stop.</p> <p>If necessary, the Operator would have to suspend activities to ensure that the waste storage limits are not exceeded</p> <p>The Operator is required to minimize waste production through incorporation of the WMP what is generated must be disposed of appropriately and its transport and subsequent treatment will be subject to normal waste management controls including the 'Duty of Care' for transportation</p>
<p>Concerns why a risk assessment & consequential management plan specific to flowback fluid was not submitted as part of the environmental permit application.</p>	<p>We have assessed the risk assessment and the outline management plan submitted with the application and we are satisfied that they are appropriate.</p> <p>The risk assessment submitted with the application covers all the phases of the development and associated risks. The outline management plan covers the necessary sections. The permit also requires the activities to be managed in accordance with a written management system and also requires the Operator to produce an Environmental Monitoring and Management Plan prior to activities taking place. These documents will be assessed throughout the life of the permit as part of our compliance work and will form part of the extended management plan for the permitted activities.</p> <p>A consequential management plan for flowback fluid has not been requested as we are satisfied that there are sufficient control measures (specified in the risk assessment and in place in the permit to address an increased return of flowback fluid from the wellbore. This is</p>

	discussed in the 'Concerns about the storage arrangements on site for the returned flowback fluid' section above)
Concerns about the volume of fracking fluid to be used	<p>The Applicant has provided details of the volumes to be used for each fracturing stage in the approved waste management plan</p> <p>The permit allows the Operator to inject a maximum of 765 m³/day. This permits the Operator to inject a maximum of 68,850 m³ over the 90 day period.</p> <p>In order to minimise the overall quantity of fluid injected into the target reservoir to flow-test the well the Operator will conduct a series of small hydraulic fracturing operations ahead of the main fracturing stages in order to assess fracture mechanics within the target formation. This will aid the design of later hydraulic fracturing and flow-testing, enabling the minimum quantity of fresh water and additives to be used in order to achieve optimum gas flow rates.</p> <p>If the Operator wants to use larger volumes, they will have to apply for a variation to the permit.</p>
Question raised about the flaring of methane gas being the Best Available Technique (BAT)	<p>Gas can only be used to generate electricity when it is produced, i.e. during the flow testing phase and if they proceed to an extended well testing stage. There is no gas produced during the drilling of the wells.</p> <p>We are satisfied that it would not be feasible to use the gas on site to generate electricity during the initial flow testing phase of the exploratory stage.</p> <p>It is not reasonably practicable to connect the flow of extracted natural gas to the gas grid during the initial flow tests. This is because the flow rates are unknown and the quality of the gas produced may not be compatible with gas grid requirements without further processing.</p> <p>The costs of using the gas on site would be</p>

	<p>disproportionate for the 90 day periods</p> <p>In order to establish whether there is sufficient flow of gas to move to extended flow testing, there needs to be an uninterrupted flow; feeding it into a generator on site would necessitate interrupting the gas flow as the amount of electricity generated would be far greater than the site requires at that stage, preventing the collection of the required data for analysis.</p>
<p>Concerns about the installation activity not being classed as Category A Mining Waste Facility</p>	<p>We are satisfied that the Mining Waste facilities are classified correctly.</p> <p>The flaring of gas is correctly not considered to be a waste facility. The gas will not become waste until after it has been tested. Once tested it will be immediately sent to the flare for combustion. There will be no deposit or accumulation of waste gas and therefore no relevant waste facility.</p> <p>The Mining Waste Directive defines the term “waste facility” and sets the criteria by which a waste facility should be classified. We consider the classification of the waste facilities at the site to be correct and in accordance with the Directive, for the reasons set out in the body of this document.</p>
<p>Concerns over well integrity</p>	<p>As part of the approved Waste Management Plan and Pre-operational condition number 5 the Operator must conduct pressure testing, formation integrity testing (FIT) as stated in Section 2.2.4 of the Waste Management Plan. More details on Well Integrity can be found in the “Response to points raised by members of the public in the minded to consultation that were also raised in the initial consultation as set out in Section A” section further in this document.</p>
<p>Concerns about the competency of the applicant</p>	<p>We are satisfied that sufficient financial resources are available to the Operator to ensure compliance with the permit conditions. A Financial guarantee will be provided as required by the Mining Waste Directive: see section 7.9.11</p> <p>The Operator does not have any relevant</p>

	<p>convictions and it is technically competent.</p> <p>We assess technical competence in accordance with our guidance RGN 5 “Operator Competence” (https://www.gov.uk/government/publications/rgn-5-operator-competence)</p> <p>For mining waste activities, this involves a high level assessment of the Applicant’s management system. The Applicant supplied a summary of their management system and we are satisfied that it is appropriate. The permit requires the activities to be managed in accordance with a written management system and also require the Operator to produce an Environmental Monitoring and Management Plan prior to activities taking place. These documents will be assessed throughout the life of the permit as part of our compliance work.</p>
<p>Concerns about future tense of the management system</p>	<p>We have assessed the management arrangements for the operations as part of our determination. The management system will be finalised once the Operator is granted access to the site and before the permitted activities begin.</p> <p>The permit requires the operator to operate the site in accordance with a written site specific management system. and we will be reviewing this as part of our compliance activities.</p> <p>There are also pre-operational measures in the permit that require the Operator to submit specified reports and plans to be approved by the Environment Agency before carrying out activities on site</p>
<p>Concerns about off-site surface water drainage</p>	<p>We are satisfied the drainage infrastructure will protect the environment</p> <p>An unnamed watercourse that originates to the south-west of the Roseacre Wood drill site, at approximately NGR SD 43888 36270 and two closed surface water ponds close to this grid reference will also be checked and water quality samples taken. This will ensure that the site is being effectively contained, and no additional</p>

	<p>pathways (discharge pipes, faults in liner etc) are present on site.</p> <p>Nigget Brook itself flows into Inskip Brook at NGR SD 43888 36270 which originates to the north-west of the site, some distance away. Checking of this watercourse will be done to assess the impacts, if any, the site is having on the aquatic environment.</p> <p>Nigget Brook will be checked as part of site inspections to ensure that the surface water discharge is of clean, uncontaminated water only (e.g. rainfall that has landed on the site). The unnamed watercourse and Inskip Brook will be checked and water quality samples taken if we have concerns regarding any decrease in water quality.</p> <p>The results of this monitoring will be made available on our public register.</p>
<p>Concerns about the requirement for baseline monitoring</p>	<p>The permit requires as a pre-operational condition to gather data on groundwater and surface water baseline data prior to the start of drilling operations on site. A minimum of 3 months baseline monitoring will be required.</p> <p>The results of the groundwater and surface water monitoring shall be submitted to the Environment Agency and placed on the public register.</p>
<p>Concerns about self regulation</p>	<p>Self-regulation is government policy and we will regulate the permitted activities in accordance with prevailing guidance, which at present is set out in our Enforcement and Sanctions Guidance.</p> <p>In addition to the requirements under the permit and the requirements under any planning permission, the Operator must get consent from Department of Energy and Climate Change (DECC) prior to drilling. DECC will only give consent once the Mineral Planning Authority has granted permission to drill and the relevant planning conditions have been discharged and The Health and Safety Executive (HSE) has had notice of and is satisfied with the well design and the British Geological Survey (BGS) has been</p>

	<p>notified of the intent to drill.</p> <p>In addition to our compliance work at the site, the HSE will monitor progress on the wells. The HSE will be notified of any unplanned events and will undertake inspections of specific well operations on site.</p>
Concerns about the mitigation of polyacrylamide and its decomposition to acrylamide	<p>There will be no direct discharge of acrylamide into groundwater and our assessments show that any risks that may arise because of the decomposition of polyacrylamide into very small amounts of acrylamide are themselves insignificant. Neither directly nor as it decomposes will the polyacrylamide cause pollution of groundwater.</p>
Concerns about the measurement and mitigation of PM2.5	<p>PM_{2.5} have not been assessed specifically in our determination however we have looked at the issue of particulates as a whole which included PM2.5.</p> <p>Significant emissions of dust (or particulates) are not likely from the required fully enclosed flares. For a well designed unit with a mainly methane feed in a well-mixed combustion chamber there would only be a small amount of soot generated from minor amounts of incomplete combustion . We expect the operator to maintain combustion efficiency of at least 98%, and based on the expected exhaust flows from these flares, the impacts would be insignificant; including at human and environmental receptors .</p> <p>The conditions in the permit will ensure the fully enclosed flares are well designed and operated efficiently</p>
Question raised to why extended flow testing is not considered as production	<p>We have taken the view that the proposed activities, due to the nature of the extended well testing, do go beyond the definition of prospecting in Article 3(21) of the Mining Waste Directive.</p> <p>However, whilst the permit authorises extended</p>

	<p>well testing which may involve a connection to the national grid, we do not consider that this stage is full scale gas production, The reason for the tests are set out in section 2.4 of the waste management plan and make it clear that these are to determine future well performance should it go into production. In addition, the permit, at condition 2.3.1, requires the operator to comply with the approved waste management plan. That plan describes one well pad from which four wells will be developed and will ensure that the activities are limited to the proposed testing. We do not consider that this amounts to full scale commercial development. Furthermore, we have limited the activities to exploration as defined in the permit.</p> <p>Should the operator decide to proceed to additional wells or well pads or extend its activities beyond the described testing they will need to apply for a variation of the permit.</p>
<p>Question raised as to why four wells are required rather than one for exploration</p>	<p>The applicant is seeking to determine the production potential from a multi-well site targeting different horizons within the area defined in the Waste Management Plan.</p>
<p>Concerns about long term monitoring</p>	<p>The permit contains requirement for monitoring of groundwater and surface water. The conditions of the permit require monitoring to be carried out monthly prior to the activities commencing over a minimum period of 3 months, weekly during active operations (drilling/fracturing) and then monthly thereafter. This monitoring requirement is for an indefinite period of time and will continue unless the condition is varied or the permit is surrendered. We would not accept an application to vary the monitoring condition unless we considered that the proposed variation provided adequate environmental protection. We would not accept an application to surrender the permit unless we are satisfied that the statutory test is met. The operator would need to demonstrate that the necessary measures have been taken to avoid a pollution risk from the operation of the regulated facility and to return the site to a satisfactory</p>

	condition, having regard to the state of the site before the facility was put into operation.
Concerns about lack of reference to risk assessments conducted for the 160 boreholes for the proposed field array infrastructure and the need for the scale of the proposed monitoring infrastructure	The proposed field array infrastructure falls outside the remit of the Agency and cannot be considered as part of the permit determination. This is a matter for the planning authority,

Response to points raised in by members of the public in the minded to consultation that were also raised in the initial consultation as set out in Section A

Further comments on air emissions were received during the minded to consultation and so we have revised our original response to that set out below to make it clearer. For the other issues in this section the responses below are in addition to those in Section A

Air emissions gas/fugitive emissions:

Condition 3.2 of the permit applies controls on fugitive emissions. Flowback fluid will be transferred through the separator and to the storage tanks via enclosed pipe work. As described in section 9.9 of the WMP, pipework and connections will be tested for integrity prior to use and will be monitored during operations for evidence of any leaks.

Most methane will have been stripped out in the separator and directed to the combustion unit. The Operator will regularly monitor the flowback fluid post separator to determine the levels of dissolved methane and other hydrocarbons. If levels of dissolved methane and other hydrocarbons are found to require further controls as stated in section 9.5.5 and 9.9 of the WMP abatement measures will be implemented. The flow of gas from the separator will be isolated and will be temporarily shut-in to prevent the flow of further flowback fluid and appropriate long-term abatement measures will be designed, presented to the Agency for approval and implemented. Unabated releases of methane to the atmosphere will be prevented, however it may be necessary to vent for safety reasons under controlled conditions. This emergency venting would not release large volumes of gas and would only occur, if at all, for short periods of time while the Operator shut off the well and any impacts are not predicted to be significant.

We recognise that the flaring of gas needs to be controlled and we have required that the Operator assesses and reports the emissions from the flare using a calculation method based on the gas flow rate, combustion efficiency and gas composition, rather than monitoring emissions directly from the flare, due to the practical difficulties of performing representative measurements inside the combustion chamber of a flare, and the hazards associated with such measurement procedures.

Combustion efficiency is determined primarily by maintaining the temperature above 800 °C; this parameter will be continually monitored.

Using this method the Operator can determine the emissions of oxides of nitrogen, carbon monoxide and volatile organic compounds. These results will be submitted to the Environment Agency at least on a monthly basis and will be published by the Operator and will be available on the public register.

The Application includes a request to flare more than 10 tonnes of gas per day. The flaring will be done as part of the initial flow tests to determine the rate at which the gas flows from the wells. The purpose of the flare is to incinerate natural gas which, if encountered during the well testing phase, is flowed to surface under controlled conditions.

A smaller flare may also be used during Extended Well Testing following connection to the gas grid as a safety measure and would only be used in emergency scenarios in order to avoid pressure build up in any pipework or vessels and on occasions when maintenance work is carried out on surface equipment.

As the natural gas flows to surface, the Operator will monitor and record flow rate and pressure, giving them a greater understanding of the likely volume of natural gas in place within the formation.

The key to a well test is not only the formation pressure and flow rate per day but the total volume of natural gas produced during the test. If the quantity and flow rate of natural gas from the initial flow test is sufficient, and necessary licences and arrangements are in place, the well pad is suitable for connection to the national grid.

The flares will be of a fully enclosed steel design, which will provide noise abatement, and there will be no visible flame. The point source emissions to air from the operation of the flares have been modelled by the applicant and the conclusions are that there will be no significant impact on human health or ecological receptors from the operation of these flares for a period of no longer than 90 days for each well. Flaring is also limited to a maximum of 130,000 cubic metres per day.

In support of the permit application, an air dispersion modelling assessment was carried out which modelled the maximum concentrations of pollutants generated for nitrogen dioxide, benzene and B[a]P. The predicted concentrations were compared against relevant air quality standards and their contribution to the ambient concentrations at locations of human habitation closest to the well site.

Benzene has been raised as particular concern in the consultation. The annual EQS for benzene is $5 \mu\text{g}/\text{m}^3$, the predicted contribution assessed in a worst case scenario from this activity is $0.017 \mu\text{g}/\text{m}^3$.

We have audited the applicant's findings and agree with the conclusions.

We have included a condition that limits flaring of gas to a period not exceeding 90 days for each well and that thereafter gas can only be flared where it is necessary to do so either as a safety measure or due to maintenance of surface equipment, unless otherwise approved by us, in writing

Monitoring (surface water/groundwater/air)

Additional concerns were raised during the minded to consultation about the long term monitoring of the site prior to the surrender of the permit.

We have specified monitoring requirements in the permit. These monitoring requirements, both those specified in the permit and conditioned through incorporation of the waste management plan, are for an indefinite period of time and will continue unless the condition is varied or the permit is surrendered. We would not accept an application to vary the monitoring unless we considered that the proposed variation provided adequate environmental protection. We would not accept an application to surrender the permit unless we are satisfied that the relevant statutory test is met. The operator would need to demonstrate that the necessary measures have been taken to avoid a pollution risk from the operation of the regulated facility and to return the site to a satisfactory condition, having regard to the state of the site before the facility was put into operation.

Risk associated with well failure

Concerns have been raised during the minded to consultation about the risk of well failure and the associated risks to groundwater.

Well integrity is assured through compliance with the well examination regime and regulation by the Health and Safety Executive, and further through conformance to Oil & Gas UK and UK Onshore Operators' Group good practice guidelines for well design and construction. Hydraulic fracturing plans and a seismic monitoring programme will be submitted to Department of Energy and Climate Change (DECC) and the Environment Agency for approval prior to hydraulic fracturing operation commencing; operation of the traffic light system for monitoring of induced seismicity is also designed to mitigate the risk from induced seismicity, including any potential for damage to well integrity.

The wells will be designed and constructed such that well integrity is appropriate to ensure that the environment is protected from fluid or gas releases, through both our requirements and those of the HSE. These standards of construction are detailed in section 2.2 of the approved Waste Management Plan. More details of our assessment have been set out in this document in section 7.5 on Groundwater Protection and in the Appendix above on page 102 on Well Integrity.

Individual barrier failures (where an individual casing fails) are rare but possible. All boreholes (whether offshore or onshore) used for hydrocarbon extraction are subject to The Offshore Installations and Wells (Design and Construction) Regulations 1996 (DCR). These regulations, enforced by HSE, are primarily concerned with well integrity and require the Operator to carry out regular monitoring and reporting of the well integrity. This is usually done by monitoring well casing pressure, which would indicate possible failures of casings. The Agency and HSE will work together to carry out inspections and assess well integrity during the lifetime of the well.

If casing failure is detected, condition 4.3.1. of the permit, requires the Operator to inform the Agency and carry out remediation work to repair the casing.

The applicant is required to report any unplanned releases of fluids or gases to the environment under the conditions in the permit and will be required to investigate and remediate any loss of well integrity that had lead to such a release, as well as remediating any environmental impact that might occur

Full loss of well integrity, which could lead to pollution, is very rare (King and King SPE Paper 2013) as it would involve the simultaneous failure of multiple casings. This could lead to the release of flowback fluid, including gas, into the immediate vicinity of the well casing, however this would be detected by the monitoring of the well integrity under DCR and the Operator would have to stop the activity and take immediate action to repair the well and remediate or mitigate any loss.

In addition, the permit requires the Operator to monitor groundwater and surface water at a number of locations around the surface site We require this monitoring to demonstrate that the well integrity has not been compromised and that, in the unlikely case of casing failure and subsequent remedial work, that well integrity has been successfully restored.

In the event that a seismic event above the threshold specified in the approved hydraulic fracturing plan (which is required by pre-operational condition 3 of the permit), the Operator is required to test the integrity of each well prior to restarting the activities.

At the point of decommissioning the wells the operator will need to test the wells to verify well integrity and submit plans to the Environment Agency and the HSE for approval to show that the well is plugged to ensure that should the well structure corrode in the future, no fluid or gas would be able to migrate into formations where they could cause environmental impact. For instance, there will need to be a seal across the well at the depth of the Manchester Marl which acts as the regional seal to the upward migration of gas from the underlying gas bearing formations, this will prevent the borehole becoming a conduit for flow in the future.

Protection of drinking water and the potential of faults to act as pathways for pollutants

Concerns have been raised during the mined to consultation that the potential of faults within the geology acting as pathways for pollutants between the hydraulically fractured zone and groundwater bearing zones have not been adequately assessed and that faults have not been defined properly by the applicant.

The applicant will only drill away from 'regional faults' which they have defined as those that have been defined by the British Geological Survey and presented on the 1:50,000 scale geological maps. We are satisfied that this classification is appropriate.

The Woodfold Fault lies approximately 8 kilometres east of the site and acts as a barrier to groundwater flow preventing the poor quality water from the sandstone on the west of the fault from interacting with the good quality water that is used for public water supply on the east of the fault. This understanding has been tested and demonstrated by groundwater modelling work carried out by the Environment Agency in conjunction with United Utilities during water resource assessment work in the 1990s and 2000s, it is also backed up by observations in the differences in groundwater levels and chemical quality of the water on either side of the fault.

The sandstone unit to the East of the site can reach as much as 1000m deep in places and although it will contain water throughout this depth, it is only the upper section that will contribute water to the public supply abstractions and to water features at the surface. The public supply boreholes are mainly less than 120m deep.

As is typical of any aquifer unit, the groundwater circulation becomes slower and longer as the depth of the unit increases. This means that the quality of the water decreases with depth as it dissolves minerals from the rock.

The work undertaken for the groundwater model also showed that marl bands present at depth within the sandstone unit impede the vertical movement of groundwater at depth. In the unlikely, the sandstones are connected at depth across the Woodfold fault, the above evidence shows that there will be effectively no flow between the two sides and that the water quality at this depth between the two sides of the fault is likely to be similar due to long residence times.

Work carried out on the Mercia Mudstone group in Cheshire has also shown that where faults cross this formation, the mudstone has been recrystallised along the fault line and has become less permeable than the surrounding undisturbed formation. This would also prevent the migration of fluids or gas upwards along the fault.

In order for fluids or gas to be able to migrate a continuous permeable pathway together with a pressure gradient will need to be present. The faults shown on the published geological maps pass through impermeable formations such as the Mercia Mudstone

and the Manchester Marl, as well as other thinner mudstone bands.

Where these formations have been disturbed by the fault, there is likely to be a sealing effect where the fine grained material forms a blinding against other formations. This will produce areas along the faults which effectively seal the fault to the migration of gas and fluid. If this were not the case then the hydrocarbons below the Manchester Marl would have been able to migrate upwards and be present in the sandstone above, which they are not.

The other factor that is required to cause the migration of fluids or gases is a pressure gradient to drive a flow. A pressure gradient will be created during the injection phases of the hydraulic fracturing operations, however these will have a short time period and the gradient will reverse immediately as the pressure is released at the well head.

Monitoring during the hydraulic fracturing process in line with an agreed programme in the Hydraulic Fracture Plan will minimise the potential for fracture fluid to be injected into areas where preferential pathways exist and ensure that the fractures are retained in the target formation.

We are therefore satisfied that the permitted activities will not cause pollution of drinking water supplies. More details of our assessment of the risks to groundwater can be found in section 7.5 of this document.