WASTE MANAGEMENT PLAN

RE-EPRA-WNA-WMP-005

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WNA Permit Variation

APPROVAL LIST

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1. INTRODUCTION

Rathlin Energy (UK) Limited (Rathlin) is a private company with its head office in Beverley, East Riding of Yorkshire. Rathlin is a petroleum exploration, development and production company with operations in the United Kingdom. Rathlin is the operator of PEDL 183.

Rathlin has prepared an application to the Environment Agency seeking permission to undertake a number of permitted activities in accordance with the Environmental Permitting (England and Wales) Regulations 2016 (EPR2016).

Rathlin is the holder of a number of Environmental Permits issued by the Environment Agency in accordance with EPR2016. The current activities permitted at the West Newton A (WNA) Wellsite permit Rathlin to undertaken the following activities, as presented in Table 1.1.

Permit Number	Reference	Description
EPR/BB3001FT	AR1	The loading, unloading, handling or storage of, or the physical, chemical or thermal treatment of crude oil with a capacity of 500 tonnes
	AR2	The incineration of hazardous waste in a waste incineration plant or waste co-incineration plant with a capacity exceeding 10 tonnes per day.
	AR3	Operate a Medium Combustion Plant.
	AR4	Storage of additional raw materials directly associated with the production of crude oil.
	AR5	The use of up to two oil fired bath heaters with a rated thermal input <1MWth.
	AR6	The use of a diesel generator with a rated thermal input <1MW for onsite power generation
	AR7	Discharge of rainfall dependent surface water runoff.
	AR8	A mining waste operation for the management of extractive waste including gas from prospecting for mineral resources, not involving a waste facility.
EPR/PB3030DJ (SR2014 No4)	1	Accumulation of radioactive waste on the premises.
	2	Disposal of radioactive waste on or from the premises.

Table 1.1: Current Permitted Activities

An analysis of the well test data and further laboratory testing has indicated the need to undertake a small scale reservoir stimulation to create or reinstate natural fractures in the vicinity of the wellbore. The purpose of the reservoir stimulation is to access the natural reservoir beyond any skin damage, which is a zone of reduced permeability due to the effects of drilling or previous wellbore treatments. The reservoir stimulation falls within EPR2016 and, as such, must be authorised.

As such, Rathlin Energy has prepared an application to vary the environmental permits to include a 'reservoir stimulation', which is groundwater activities under Schedule 22, 8(l) of EPR2016, namely the injection of any substance into groundwater to increase the flow of fluids or gas to a well or borehole in connection with the extraction or use of any energy source.

The 'reservoir stimulation' will produce extractive waste, referred to as Mining Waste under Schedule 20, 2(1) of EPR2016, namely the management of extractive waste, whether or not involving a mining waste facility. In addition, the formation within which the stimulation fluid is retained is considered a 'mining waste facility'.

The term 'reservoir stimulation' is defined in Section 3 and described in more detail in Section 6.8.

2. SCOPE

This Waste Management Plan is applicable to WNA Wellsite and all operations permitted therein. It is applicable to Rathlin, its contractors and subcontractors and can be used in support of applications to the Environment Agency under the Environmental Permitting (England and Wales) Regulations 2016 (EPR2016).

3. DEFINITIONS

Active Area:	The area of the wellsite designated for the drilling operation which has a perimeter drainage ditch and is lined with an environmental membrane.
Annulus:	The void between piping, tubing or casing and piping, tubing, casing or formation immediately surrounding it.
BAT:	Best Available Technique
CO_2:	Carbon Dioxide
DFiT:	Diagnostic Fracture Injectivity Test. A pressure transient test carried out in the target formation to obtain reservoir characteristics and inform hydraulic fracture treatment parameters. Also referred to by others as Mini Fall-Off Test or a Pre-Injectivity Test.
EPR2016:	Environmental Permitting (England and Wales) Regulations (2016)
EWT:	Extended Well Test
Hazardous Waste:	As defined by Article 3(2), 7 and Annex III of the Waste Framework Directive
HFP:	Hydraulic Fracture Plan, as required by the North Sea Transition Authority for the reservoir stimulation operation and is expected to be a Pre-Operational Condition under the environmental permit.
HCl:	Hydrochloric Acid (Aqueous Solution)
HDPE:	High-Density Polyethylene
Inert Waste:	Waste which doesn't undergo significant physical, chemical or biological transformations or give rise to environmental pollution or harmful to health.
KCl	Potassium Chloride
Km:	Kilometre
m:	Metre
M^3:	Metres Cubed / Cubic Metre
mm:	Millimetre
MCP:	Medium Combustion Plant
MD KB:	Measured Depth below Kelly Bushing
Non Hazardous Waste:	A waste which is not classified as inert or hazardous waste
NORM:	Naturally Occurring Radioactive Material
PEDL:	Petroleum Exploration and Development Licence
Pollutant:	Any substance liable to cause pollution
Pollution:	A direct or indirect introduction, as a result of human activity, of substances or heat into the air, water land which may; a) Be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems; b) Result in damage to material property; c) Impair or interfere with amenities or other legitimate uses of the environment
Reservoir Stimulation:	A low volume hydraulic fracture stimulation with the primary purpose of overcoming skin damage to the target formation sustained during drilling. Also referred to by others as a proppant squeeze.
SG:	Specified Generators
TVD:	True Vertical Depth
TVD KB:	True Vertical Depth below Kelly Bushing
UK:	United Kingdom
WCU:	Well Clean Up
WNA:	West Newton A

Table 3.1: Definitions

4. ENVIRONMENTAL LEGISLATION AND APPLICABILITY

The WNA Wellsite is the subject of several activities which, under current environmental legislation, requires an environmental permit. The Environment Agency regulate all permitted activities under the Environmental Permitting (England and Wales) Regulations 2016, as amended (EPR2016). Under EPR2016, Operators are required to submit environmental permit applications to the Environment Agency to seek approval to undertake such activities.

Onshore oil and gas developments are the subject of the environmental permitting regulations, as such a number of environmental permits have already been obtained. This Waste Management Plan provides an update on the proposed operations to be conducted at the WNA Wellsite and provide an explanation as to which permitted activities will be required/applied for.

4.1 Environmental Permitting (England and Wales) Regulations 2016

The Environment Agency regulate all permitted activities under EPR2016 and require 'Operators' to submit environmental permit applications to seek approval to undertake such activities. Rathlin has assessed the activities associated with the proposed operations and considers certain activities to fall in scope of EPR2016 and therefore require the necessary environmental permits.

4.1.1 Industrial Emissions Activity

Schedule 1, Part 2 of EPR2016 details a number of activities that are classified as an Industrial Emissions Activity including 'Energy Activities' (Chapter 1) and 'Waste Management' (Chapter 5). Energy Activities include the storage of crude oil, whilst Waste Management includes the incineration of waste.

4.1.1.1 Oil Storage

This activity is cited under EPR2016, Schedule 1, Part 2, Chapter 1, Section 1.2, Part A(1) (e)(i).

'The loading, unloading, handling or storage of, or the physical, chemical or thermal treatment of crude oil.'

The proposed operation has the potential to involve the handling and storage of crude oil within the site. Activity A4 of environmental permit EPR/BB3001FT is already in place which permits the loading, unloading, handling or storage of, or the physical, chemical or thermal treatment of crude oil. However, the location of the oil storage facility will be significantly different, as such the permit will be varied to facilitate these changes including the permit boundary.

4.1.1.2 Incineration of Natural Gas

This activity is cited under EPR2016, Schedule 1, Part 2, Chapter 5, Section 5.1, Part A(1) (a).

'The incineration of hazardous waste in a waste incineration plant or waste co-incineration plant with a capacity exceeding 10 tonnes per day.'

The proposed operations involve the incineration of natural gas exceeding 10 tonnes per day. Activity A2 of environmental permit EPR/BB3001FT is being varied to include incineration of natural gas (in excess of 10 Tonnes per day), which may be required for the Well Clean up (WCU) and Extended Well Test (EWT) activities.

4.1.2 A Mining Waste Activity

Schedule 20 of EPR2016 defines a mining waste operation as being the management of extractive waste, whether or not it involves a waste facility. Under EPR2016, an environmental permit is required to authorise a mining waste operation.

The WNA operations will continue to involve the management of extractive waste not including a waste facility. Activity AR8 of environmental permit EPR/BB3001FT is being varied to include a 'reservoir stimulation'.

Further, as a 'reservoir stimulation' will result in extractive waste being retained in the formation being tested, a mining waste facility is being applied for. Refer to Section 5 *Criteria for Determining the Classification of Waste Facilities*.

4.1.3 A Groundwater Activity

Under Schedule 22 of EPR2016, an activity that could involve the discharge of pollutants into groundwater must be notified to the Environment Agency, together with the nature of these pollutants. The Environment Agency will then determine whether the groundwater activity needs to be permitted.

The WNA operations includes a wash and squeeze, should it be deemed necessary to do so and will be based on initial flowrates encountered. These activities fall within the definition of a Groundwater Activity under Schedule 22 of EPR2016.

Schedule 22 3 (3) of EPR2016 provides that the *'The regulator may determine that a discharge, or an activity that might lead to a discharge, is not a groundwater activity if the input of the pollutant…*

(b) is or would be of a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater.

To enable the regulator to deviate from the requirement for a groundwater activity permit for the wash and squeeze, a description of the operations, together with a technical justification to exclude these operations under Schedule 22 paragraph 3 (3) of EPR2016, is included within the Waste Management Plan.

The WNA operations will also include a 'reservoir stimulation, which falls within the definition of a 'groundwater activity' under Schedule 22, 8(l) of EPR2016, namely the injection of any substance into groundwater to increase the flow of fluids or gas to a well or borehole in connection with the extraction or use of any energy source, therefore, a groundwater activity permit is being applied for.

4.1.4 Water Discharge Activity

Schedule 21 of EPR2016 relates to water discharge activities. Activity A3 of environmental permit EPR/BB3001FT has previously been obtained by Rathlin, which includes the necessary surface water discharge activities. The site is due to be extended to facilitate the production facility and therefore the permitted activity will need to be updated to include the revised site layout and the surface water management process during production operations and during periods of increased activity i.e. drilling and testing.

4.1.5 A Radioactive Substances Activity

Schedule 23 of EPR2016 provides for the control of Naturally Occurring Radioactive Material (NORM). Schedule 23 defines the production of oil and gas as a NORM industrial activity and therefore any accumulation of radioactive waste, which exceeds concentrations set out in Table 1 of Schedule 23 of EPR2016. Rathlin has previously obtained a SR2014 No. 4 permit (EPR/PB3030DJ) which still remains relevant to the proposed activities.

Due to the nature of the standard rules permit it is anticipated that a new SR2014 No4 permit will need to be applied for due to the expansion of the WNA Wellsite, and therefore the expansion of the permit boundary.

4.1.6 Medium Combustion Plant and Specified Generators

Schedule 25a of EPR2016 considers activities which involve the operation of Medium Combustion Plants (MCP), specifically MCPs with a rated thermal input equal to or greater than 1 megawatt but less than 50 megawatts. Such plants are required to operate within the set Emission Limit Values as cited by EPR2016, as amended.

Schedule 25b of EPR2016 considers activities which involve the operation of combustion plants which is used for the purpose of generating electricity, but does not consider mobile units unless they are connected to an electricity transmission system or distribution system or fulfilling the role of a static generator. These Specified Generators (SG) fall in scope of this Schedule if they have a rated thermal input equal to or greater than 1 megawatt but less than 50 megawatts.

Operators of MCP and SG that are in scope will require an environmental permit under schedule 25A and 25B of EPR2016. A permit to operate both is determined by the capacity, emissions and operating hours of the plant.

Upon commencement of the proposed development it is anticipated that MCP and SG (MCPSG) will be present at the wellsite. However, during construction activities, and the drilling and testing of each well it is considered by Rathlin that the generators associated with these activities fall out of the scope of Schedule 25a and Schedule 25b on account

of being mobile units and being at the wellsite temporarily and intermittently. The Environment Agency will decide whether a mobile generator is operating as a static generator.

As the development progresses into production it is foreseeable that a number of MCPSG units will be used at site to harness waste natural gas and provide electricity to the site with any surplus being exported, either by grid transmission or batteries, subject to planning consent.

As these MCPSG will be fixed and installed at the site it is reasonable to assume that Schedule 25a and Schedule 25b of EPR2016, as amended will be applicable and therefore Rathlin will apply for a permit to perform such activities. The total aggregated thermal input of the proposal is less than 50MW and as such is considered as being a MCP.

4.2 Water Resources Act 1991 (as amended by the Water Act 2003)

Under Section 199 of the Water Resources Act 1991 (as amended by the Water Act 2003), a notice of the intention to construct or extend a boring for the purpose of searching for or extracting minerals must be submitted to the Environment Agency using form WR11.

The WR11 requires that a method statement, including drilling and casing designs, together with storage and use of chemicals and drilling muds, accompanies the WR11 application form. Each additional well drilled from the WNA Wellsite will be the subject of an individual WR11 application as the wells shall be drilled at different stages throughout the lifetime of the development.

5. CRITERIA FOR DETERMINING THE CLASSIFICATION OF WASTE FACILITIES

In addition to the management of extractive waste, the well site requires an environmental permit that covers the deposit or accumulation of extractive waste in a waste facility. The definition of a waste facility is based on the well site having a designated area for the accumulation or deposit of waste subject to certain timescales, depending on the nature and source of the waste.

Article 3 (15) of the Mining Waste Directive defines a waste facility as:

'*any area designated for the accumulation or deposit of extractive waste whether in a solid or liquid state or in solution or suspension, for the following time periods:*

- *No time-period for Category A waste facilities and waste characterised as hazardous in the waste management plan;*
- *A period of more than six months for facilities for hazardous waste generated unexpectedly;*
- *A period of more than one year for facilities for non-hazardous non-inert waste; and*
- *A period of more than three years for facilities for unpolluted soil, non-hazardous prospecting waste, waste, resulting from extraction, treatment and storage of peat and inert waste.'*

With the addition of a 'reservoir stimulation', the WNA operations will now involve the accumulation or deposit of extractive waste exceeding the timescales specified above but is limited to the formation where the 'reservoir stimulation' is to be carried out. As such, the formation will be classified as a waste facility. All other extractive wastes stored at the wellsite will:

a) Be limited to non-hazardous substances; and
b) Be of a short duration, significantly less than 1 year.

Details of the extractive waste streams are provided within Section 7.3 of this Waste Management Plan.

5.1 Criteria for Determining a Category A Waste Facility

Where the proposed activities include a waste facility, the Operator is required to include an assessment as to whether the proposed facility will be classified as Category A or not.

Where a mining waste facility is to be considered, a review of the mining waste facility against criteria specified within Annex III of the Mining Waste Directive must be undertaken to determine whether or not the mining waste facility should be classified as a Category A Mining Waste Facility. The criteria for the determination of which is as follows:

a) A failure or incorrect operation e.g. the collapse of a heap or the busting 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 water facility;
b) It contains waste classified as hazardous under Directive 91/689/EEC above a certain threshold: or
c) It contains substances or preparations classified as dangerous under Directives 67/548/EEC or 1999/45/EC above a certain threshold.

Whilst the proposed fluid to be used to undertake a 'reservoir stimulation' may contain substances that fall within the classification of hazardous waste, the volume of fluid retained within the target reservoir (referred to as the West Newton reservoir), within the Kirkham Abbey formation, is extremely small (60m^3) and will be 1,700m below ground level. The formation beyond the target reservoir, in the basinal and lagoonal depositional environment, reduces in permeability to such an extent that the target reservoir is hydraulically isolated from the surrounding Kirkham Abbey formation. The risk of reservoir stimulation fluid migrating has been assessed using the British Geological Survey / Environment Agency 3DGWV tool, which considers potential pathways through a thick sequence of strata, the findings of which are presented as a Technical Addendum to the Hydrogeological Risk Assessment *Envireau Water, 2021* (HRA). The HRA and Technical Addendum collectively conclude that faulting is not expected to provide a plausible pathway between the target reservoir and the overlying strata containing useful groundwater. In this context, Article 4 (4) of the Commission Decision, *April 2009* states:

'Where there is no pathway between the source and the receptor, the facility concerned shall not be classified as a Category A on the basis of failure due to loss of structural integrity or incorrect operation.'

On completion of the reservoir stimulation activity, 60m^3 of hazardous waste is expected to be present in mining waste facility. The design of the stimulation activity is 30m in height and 32.8m in diameter, resulting in the mining waste facility being 25,349m^3 total volume. Article 7 of the Commission Decision, April 2009 sets out basis for determining a Category A facility on a percentage ratio of waste expected to be present in the mining waste facility at the end of the planned period of operation. The ratio is based on the weight of the waste on a dry matter basis.

The classification of a Category A mining waste facility within the Commission Decision does not align itself easily with the type of mining waste operation being proposed at WNA-2. The classification is more aligned with waste tips, above ground or below ground, for purpose of disposing of liquid and/or solid waste. It is, therefore, difficult to apply the threshold ratio directly to the WNA-2 operation. Further, the classification of a Category A mining waste facility considers the waste expected to be present in the facility at the end of the planned period of operation. At the time of submitting this permit variation application, the waste expected to be present at the end of the planned period of operation is unknown, as the planned period of operation includes hydrocarbon production, followed by well abandonment. On a volume basis, the percentage of waste present in the mining waste facility immediately following the reservoir stimulation activity is 0.24%. Over the life of the production period until the abandoned of the WNA-2 well (the end of the planned period of operation), the mining waste facility is expected to be subject to other production activities (produced water reinjection) and workovers, resulting in the reservoir stimulation fluid commingling with other fluids and extractive wastes within the reservoir and either be returned to surface with produced hydrocarbons, separated and removed from site or diluted within the mining waste facility. Article 4(3)(a) of the Commission Decision provides some relevance here, in that *inter alia*:

'The potential danger of the environment shall be considered to be not serious if:

(a) The intensity of the potential containment source strength is decreasing significantly within a short time.

Whilst Article 4 relates to failure due to loss of structural integrity or incorrect operations of a waste facility, it does acknowledge that the intensity of a hazardous waste can decrease over time, which is relevant to the reservoir stimulation fluid described above and its interaction with other fluids within the mining waste facility during the planned period of operation.

In summary, the HRA and Technical Addendum conclude that faulting is not expected to provide a plausible pathway between the target reservoir formation and the overlying strata containing useful groundwater. The overall percentage of hazardous waste with the spatial volume of mining waste facility will be 0.24% immediately following the reservoir stimulation activity, reducing during the production of hydrocarbons and/or comingling with other extractive wastes. As such, the reservoir stimulation fluid will not lead to a serious danger to the environment and, therefore, should not be classified as a Category A Waste Facility.

6. WASTE GENERATING ACTIVITIES

A waste is defined in Article 3(1) of the Mining Waste Directive by reference to Article 3(1) of the Waste Framework Directive 2008/98/EC. The definition is; 'waste' shall mean any substance or object in the categories set out in Annex I which the holder discards or intends or is required to discard. The wastes are defined in Article 3 of the Directive as inert, non-hazardous or hazardous and are as follows:

Hazardous Waste: The Waste Framework Directive (2008/98/EC) (WFD) sets out what waste is and how it should be managed. The WFD defines some wastes to be hazardous waste. A hazardous waste is defined as a waste that has one or more of the fifteen specified hazardous properties listed in Annex III to the WFD. The application of this is determined by the List of Wastes Decision (2000/532/EC).

Non-hazardous Waste: A waste which is neither classed as inert or hazardous.

Inert Waste: Inert Waste is waste which does not undergo any significant physical, chemical or biological transformations. Inert waste will not dissolve burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm human health. The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant and in particular not endanger the quality of surface water and/or groundwater.

Whilst the UK has withdrawn from the European Union, the Waste (Circular Economy) (Amendment) Regulations 2020 which transposes (transfers requirements into UK law) six amending EU Directives in the field of waste including Directive 2008/98/EC ("the Waste Framework Directive"). The definition provided above are still considered applicable.

A summary of the proposed WNA operations is detailed below with a more detailed description of each activity provided within each subsection. Each development will consist of nine (9) principal phases which, for ease of the reader is set out in a linear format. However, several phases will be carried out simultaneously, particularly the drilling and appraisal testing of additional wells, which is likely to be carried out during early production from the existing wells.

- Wellsite Extension including the Production Facility;
- Drilling of up to six (6) Hydrocarbon Boreholes;
- Well Clean Up (WCU);
- Extended Well Testing (EWT);
- Well Treatments;
- Production;
- Well Workovers, Routine Maintenance and Repairs;
- Site Decommissioning; and
- Site Restoration and Aftercare.

This Waste Management Plan sets out the classification of waste streams associated with the WNA Wellsite and associated site activities. Waste management arrangements for each waste stream are detailed within Section 7.3 of this Waste Management Plan.

For clarity, wastes generated during wellsite construction works and subsequent wellsite restoration works are not considered extractive wastes and are therefore not detailed within this Waste Management Plan.

6.1 Wellsite Construction Activities

Construction works undertaken in relation to the WNA Wellsite are not considered to fall under the remit the Environmental Permit with regards to the management of extractive waste, and therefore will not be considered further within this Waste Management Plan.

Details of the proposed wellsite construction have been provided within the WNA Site Condition Report as a means to illustrate and describe the proposed construction design and how Rathlin will ensure that it is built so as to ensure so far as reasonably practicable the quality assurances of the build are sufficient and have been designed so as to be suitable to the proposal and mitigates against the potential for pollution offsite. For clarity the wellsite construction activities include the production facilities that will be in place for the treatment and storage of crude oil.

6.2 Drilling Operations

Rathlin is proposing to drill up to six new boreholes from the WNA Wellsite and potentially re-enter the two existing boreholes (WNA-1 and WNA-2). The purpose of splitting the drilling phase into multiple campaigns allows further evaluation of the target formations, learning from previous campaigns to increase efficiency of drilling and maintaining production flow.

Each wellbore shall be drilled in sections with an appropriate drilling rig. The exact well design shall be agreed with the Environment Agency by way of WR11 application prior to drilling of the wells. An indicative well design has been provided within the Chemical Inventory which shows the structure of the well, the formations being drilled, the drilling mud being proposed and the cement log.

The formation tops presented within the Chemical Inventory Schematic are based on the actual formation tops from the well logs and samples collected during the construction of the wells drilled on the WNA and WNB sites. The specific casing depth will not rely on the estimate provided within this application but will be determined by the actual formation tops, as determined by sample and log evaluation whilst drilling.

Drilling fluid additives shall be the subject of approval by the Environment Agency prior to the undertaking of any drilling activities. Rathlin is proposing to use a number of drilling additives which have been the subject of approval within previous applications to the Environment Agency as well as including the use of oil-based mud in the lower section of the well. Details of the drilling additives have been provided within the Chemical Inventory together with the location on where these additives shall be used within the well. Any oil based mud system will be comparable with the requirements of SR2015 No.1 permit, i.e. will be low toxicity. For clarity, an SR2015 No.1 permit is not being applied for.

The anticipated extractive wastes during this phase includes:

- Water Based Rock Cuttings;
- Water Based Drilling Fluid;
- Oil Based Rock Cuttings; and
- Oil Based Drilling Fluid.

6.2.1 Indicative Well Design

A conductor casing shall be set from surface, this section is typically constructed by using a smaller drilling rig to drill a 26” hole and setting 20” casing. The conductor hole shall be drilled using water-based mud and / or air and the annulus shall be cemented back to surface. The main reason for a conductor section is usually to create a stable start to the well whilst allowing the main rig to start drilling from a deeper depth.

The surface casing shall be drilled through the Cretaceous chalk using water-based mud. This section shall be drilled in a smaller hole size than the conductor casing – typically 17.5”, and steel casing (typically 13-3/8”) shall be run and cemented back to surface. This casing shall isolate the cretaceous chalk from any deeper porous formations.

The intermediate section shall drill through the Sherwood Sandstone and steel casing be run and cemented into place. The section shall be a smaller diameter than the surface section – typically 12.25” hole with 9-5/8” casing.

Production casing shall be run across the Permian section. This hole section would typically be 8.5” with 7” steel casing set and cemented into place. The section over the producing formation may be left uncased or uncemented.

A contingency liner section of 6” hole and 4.5” liner may be run in the event of a sidetrack or needing and extra section of casing in the well.

An indicative well schematic depicting a number of well designs together with the location each drilling mud may be used is provided within the chemical inventory.

6.2.1.1 Logging

Geological logging is undertaken during well construction to determine whether formations encountered during drilling may contain petroleum. The borehole logs assist Rathlin in determining specific zones, which justify subsequent testing. Coring may also be undertaken.

6.2.1.2 Perforation

In order to establish communication between the formation(s) being tested and the wellbore the casing must be perforated.

The perforating operation, in particular the use of explosive charges, is regulated by the Police Authority and the Health and Safety Executive. Perforating may be undertaken several times as deemed necessary by Rathlin.

Once the casing has been perforated, the fired perforating guns will be recovered at a time determined within the operation. The perforation process may be repeated a number of times.

The anticipated extractive wastes during this phase includes:

- Circulation Fluid / Suspension Brine; and
- Metal Debris.

6.2.2 Contingency Side-tracks

As a contingency, each well may require a side track in the unlikely event of a sub-surface well constraint or the requirement of a new subsurface location target. As this is a contingency option it is impossible to predict the size or depth of a side track, however it is standard oilfield practice to allow for engineering contingency to conduct this if required. Rathlin will confirm the estimated quantity of waste in writing to the Environment Agency if a contingency side track is required. The same drilling and cementing procedures shall be followed but a smaller hole size will be drilled and small casing ran for the remainder of the well. An indicative well schematic of what the sidetrack may look like has been provided as part of the application.

6.2.3 Lateral Wells

Each of the wells will consist of an initial vertical borehole or deviated borehole drilled from surface into the subsurface target formation. A decision will be made to kick off and side track followed by a deviation to a horizontal wellbore. It is also possible, for the second well, to drill a horizontal wellbore without an initial vertical wellbore. Details of wells will be written within the WR11 submission.

For the purposes of the waste estimation a lateral well of 2km has been assessed. Estimated waste quantities for the drilling of the 2km lateral well have been provided within Table 7.5 and Table 7.7 included within Section 7.3 of this Waste Management Plan.

6.2.4 Well Integrity

Regulation 13 of The Offshore installations and Wells (Design and Construction, etc) Regulations 1996 requires that well-operators ensure that a well is designed, constructed and controlled (throughout its lifecycle) so there can be no escape of fluids from the well and that the risks to strata to which it is connected are as low as reasonably practicable. This is done by (Regulation 14) taking into account the geological strata and formations, and fluids within them and any hazard which such strata and formations may contain at pre-design stage and (Regulation 16) ensuring that every part of a well is composed of material suitable to achieving these purposes.

The design and well activities must be independently reviewed (Regulation 18) and submitted to the HSE prior to constructing the well.

As per the OGUK Well Life Cycle Integrity Guidelines, integrity tests shall be undertaken during the construction of the well. These shall include pressure testing of the casing once cemented and the BOP installed, prior to drilling out the cement shot, to a higher pressure than the maximum potential pressure the casing will be subjected, and then the cement seal around the shoe will be tested by a LOT of FIT.

By following these regulations and guidelines to ensure integrity of the well, this should limit the risk of contamination to the environment.

6.3 Well Testing

Upon completion, the well(s) will be the subject to subsequent, clean up and testing. The purpose of the well test is to evaluate the commercial viability of the hydrocarbon reservoir, if encountered. The test will be conducted in 2 (two) parts consisting of a Well Clean Up (WCU) and an Extended Well Test (EWT). During the well test hydrocarbons will be

produced. A Waste Gas Management Plan has been developed for the purpose of demonstrating Best Available Technique (BAT) for the management of waste gas as a result of each well testing phase and the production phase.

For clarity, the WCU and EWT may be undertaken several times throughout the development after each well is drilled. The proposal is to target several isolated zones within the Permian section, each zone has the potential to contain oil, gas or a combination of the two. The reason for multiple well tests is due to the zones within the Permian section being distinct and isolated. Information obtained from a specific zone is highly unlikely to inform the behaviour of the other zones within the target formation due its natural variability.

The anticipated extractive wastes during this phase includes:

- Natural Gas;
- Circulation Fluid / Suspension Brine; and
- Formation Water.

6.3.1 Well Clean-up Phase

A WCU is conducted when trying to bring the reservoir fluids to surface for the first time, either after drilling, after a period of in-operation or after any maintenance has been conducted in the well. The aim of the WCU is to get the reservoir fluids to surface and flowing at a consistent rate for testing or production.

A WCU will involve the use of a well testing spread, typically consisting of at least a choke manifold, surface safety valve, three-phase separator, fluid storage tanks, vent line(s) and a combustion unit(s). Waste gas produced as a result of the well clean-up operations shall be managed in accordance with the approved BAT as demonstrated by the Waste Gas Management Plan.

Ordinarily, natural gas flows to surface however, during a WCU the rate of natural gas produced is likely to fluctuate unpredictably. Any natural gas composition data acquired during WCU may not be accurate due to being comingled with wellbore fluids. Once at surface, natural gas and produced fluids will be diverted by temporary pipework to a three-phase separator, which will separate out oil and condensate, water and natural gas. Oil and condensate, which for clarity is not a waste, will be diverted via temporary pipework to dedicated storage tanks onsite for subsequent offsite removal by a licenced haulier to a permitted refinery for sale. Produced water, which is considered a waste, will be diverted via temporary pipework to dedicated storage tanks onsite for subsequent offsite removal by a licenced haulier to an Environment Agency permitted water treatment facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility.

Any natural gas separated during the three-phase separation will be managed in accordance with the identified BAT as identified within the Waste Gas Management Plan.

If the well does not flow on its own after perforation then a number of processes, which are described below, may be conducted in order to bring the reservoir fluids to surface.

6.3.2 Extended Well Test

Should the WCU phase indicate that hydrocarbons are present then testing operations will continue with the EWT stage. An EWT is a longer duration test, which is carried out to assess the commercial viability of the well and establish detailed gas and oil composition.

Once at surface, produced fluids and hydrocarbons will be diverted by temporary pipework to a three (3) phase separator, which will separate out oil and condensate, formation water and associated natural gas. Oil and condensate, which for clarity is not a waste, will be diverted via temporary pipework to dedicated storage tanks onsite for subsequent offsite removal by a licenced haulier to a permitted refinery for sale. Formation water, which is considered a waste, will be diverted via temporary pipework to dedicated storage tanks onsite for subsequent offsite removal by a licenced haulier to an Environment Agency permitted water treatment facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility.

Formation water produced during the EWT has the potential to contain low levels of Naturally Occurring Radioactive Material (NORM). Samples of formation water will be sent to a laboratory holding the appropriate accreditations for radionuclide analysis by gamma spectrum. Depending on the outcome of radionuclides analysis, formation water will be transported via a licenced haulier to either an Environment Agency permitted waste water treatment works facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment

facility, or to a bespoke RSR permitted waste treatment facility for treatment and disposal in accordance with the Best Available Technique (BAT).

Again, any natural gas separated during the three-phase separation will be managed in accordance with the identified BAT as identified within the Waste Gas Management Plan.

The purpose of an extended well test is to analyse the flow characteristics of a formation, which may contain petroleum, over an extended period. The duration of the extended well test will differ, whether oil or gas is being flow tested.

6.4 Well Completion

Once the well has been drilled (in accordance with details included in the WR11) a completion assembly shall be run into the well to allow the production of reservoir fluids. The completion may consist of production tubing, packers, sliding sleeves, down hole pumps or other equipment to allow the reservoir fluids to move to surface. The completion is semi-permanent and will be retrieved at the end of the life of the well or during well maintenance.

On completion of the drilling phase, or prior to testing, circulation runs will be conducted to remove residual muds or debris from the drilling using a clean fluid, as shown in the chemical inventory. The waste from the circulation run will be managed at surface using the same techniques as the drilling phase.

The anticipated extractive wastes during this phase includes:

- Circulation Fluid / Suspension Brine;
- Water Based Rock Cuttings;
- Water Based Drilling Fluid;
- Oil Based Rock Cuttings; and
- Oil Based Drilling Fluid.

6.5 Borehole Clean Up

A clean up assembly will be run into the well and will scrape and remove any debris from the perforations. A clean fluid will be circulated down the work string during the wellbore cleaning operation and will circulate out to surface any debris. The debris, consisting of small steel scrapings, will be separated from the fluid at surface using conventional shakers and circulating tanks. The steel scrapings are anticipated to be very small in volume, due to the design of the perforation guns, insofar as they have been designed to minimise debris by reducing external burrs (steel edges) which form as the jet exists the casing.

The anticipated extractive wastes during this phase includes:

- Circulation Fluid / Suspension Brine; and
- Metal Scrapings.

6.6 Solvent Treatment

Due to the nature of the oil bearing formation and its mineralogy, a solvent treatment preflush may be required in advance of any wash and squeeze activity taking place. The solvent pre-flush is a process of removing the build-up of hydrocarbons on the rock within the near wellbore area. It consists of circa 0.3m^3 ethylene glycol monobutyle ether (EGMBE), Xylene or Methanol which is pumped down the well in a carrier fluid, generally, 5% KCL brine (14.7m^3). The solvent strips the hydrocarbon coating from the near wellbore formation allowing any subsequent acid/alkali wash and squeeze treatment to make efficient and uninterrupted contact with the near wellbore formation. For clarity, no solvent remains within the formation as it is brought back to surface, comingled with produced oil, or displaced with brine or spent acid/alkali.

No solvent will remain within the formation as it will be produced back to surface either comingled with the produced oil if conducted as part of production operations, displaced with spent acid/alkali in the event it is used as a pre-cursor to an acid wash or displaced with brine if undertaken in isolation.

The order in which the fluids are retrieved to surface will be in the reverse order in which they were applied. A solvent treatment solution would therefore be retrieved to surface following the retrieval of either the spent acid/alkali. For clarity, the solvent will either be produced to surface under production mode or displaced with brine used to circulate the solvent and acid.

The use of ethylene glycol monobutyle ether (EGMBE), Xylene, Butanol or Methanol may be used as a solvent pre-flush. Protekt 318 (or similar approved) will be added to the solvent for corrosion and iron control (inhibitors) at 1-2% concentration.

The extractive wastes anticipated during this phase is as follows:

- Circulation Fluid / Suspension Brine (entrained with solvent).

6.7 Acid / Alkali Wash and Squeeze

A wash is designed to reduce near wellbore formation damage from drilling to help restore the natural permeability of the formation or to remove scale or similar deposits from perforations and well-completion components during production.

A wash is applying the acid to the formation under pressure not exceeding the fracture pressure of the formation.

For clarity, the term 'squeeze' used within this Waste Management Plan has been defined within the Environment Agency's January 2018 publication, 'Use of acid at oil and gas exploration and production sites' as:

An "acid squeeze" is an oil industry term that is generally used when the intention is for the acid to not travel far from the well in to the geological formation. It is most frequently used when the permeability of the geological formation is very low. An acid squeeze results in the acid being squeezed in to the rock formation and dissolving the rock. It may also result in opening up new fractures, although very small and close to the well. This may enhance or create new flow paths to enable the well to be more productive. Exactly the same processes are at work as in acid washing, matrix acidisation and fracture acidisation, but just at a very local scale to the well due to the poor permeability of the geological formation. The Environment Agency assesses each proposed type of acidisation activity on a site specific basis prior to deciding whether the activity is acceptable or not, and whether an environmental permit can be granted or whether an exclusion applies.

Rathlin does not consider the use of an alkali as opposed to an acid to materially change the definition of a squeeze.

6.7.1 Acid Treatment

To improve the flow of petroleum from the Permian formation to surface, an acid, most commonly hydrochloric Acid (HCl) at 15% concentration with water (i.e. 150kg of HCl with 850kg of water), is applied to the formation through the wellbore. It may be necessary to apply HCl at a concentration up to 28% to achieve the desired results depending on the condition of the near wellbore formation. The operation is very much akin to acidisation of boreholes in the water well industry and results in high permeability channels through which water or petroleum can flow.

Should Rathlin determine that the formation may benefit from alternative acidic products as part of an acid wash and squeeze activity then they will be used as an alternative or in addition to the HCl treatment.

An acid wash is applying the acid to the formation under pressure not exceeding the fracture pressure of the formation.

The proposed dilution of acid will be made up of one or more of the following:

- HCl (≤ 28% Concentration);
- Acetic Acid (≤ 10% Concentration);
- Formic Acid (≤ 10% Concentration); and
- Citric Acid (≤ 10% Concentration).

Corrosion and iron inhibitors will be added to the acid solution, the same chemicals previously approved for use under the trade name Protekt 15 Plus as part of the previously approved chemical inventory, namely:

- Tallowalkylamine ethoxylates (1-3% Concentration);
- Formaldehyde reaction productions, oleylamine (1-3% Concentration);
- Proprietary antifoam (0.5-1% Concentration); and
- Proprietary dispersants (Protekt 318 (1-2% Concentration)).

EGMBE may be added to the acid solution at a concentration of circa 10%.

The acid solution (comprising of acid, inhibitors, EGMBE and water) will be mixed at surface prior to being applied to the formation.

The proposed acid solution is circulated across the perforations using $1m^3$ of solution per meter of perforation plus an initial $1m^3$ of solution as a pre-wash. The process of washing the perforations is repeated until there is adequate clean-up of the perforation.

Following the washing of the perforations, the acid is then squeezed into the near formation, again at $1m^3$ of acid per metre of perforation. The process may be repeated several times as necessary to ensure a reaction within the target formation has restored natural pathways.

The acid is squeezed into the natural formation below the facture gradient and will remain within the near wellbore target formation. The acids' primary and only objective is to reinstate natural permeability within the near wellbore formation.

If more than one interval within the Permian interval is to be tested, the operation will be repeated.

The HCl reacts with the calcite through dissolution to produce Carbon Dioxide (CO_2), water (H_2O) and chloride ions (Cl). The chloride ions exist in the water and pair to form calcium chloride ($CaCl_2$). The chemical equation is as follows:

$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$

Calcium chloride (salt) is not a hazardous substance and must therefore be considered as a non-hazardous pollutant.

A similar reaction will take place for the acetic, citric and formic acid, as for the HCl insofar as non-hazardous salts being produced alongside water and carbon dioxide.

Formation water produced in petroleum production wells in North Yorkshire from the Permian interval is considered representative of the formation water anticipated within the Permian interval at West Newton A, with a natural salinity of some 349,000mg/l. The Permian interval lies at a depth of some 1,400m below ground level and is isolated from near surface aquifers, groundwater and those users and the environment dependent on them by some 1,150m of overlying low permeability formations.

Deeper aquifers within the Jurassic, Triassic and Permian are not considered to be important receptors due to their depth and high salinity or mineralised groundwater quality.

The quantity and concentration of acid introduced to the formation must be considered in the context of the naturally occurring concentrations in the receiving water. In this case, given the natural salinity levels of the Permian interval in the North Yorkshire wells and this being considered representative of the same formation at West Newton A, the receiving water is hyper-saline and the addition of the calcium carbonate as a result of introducing acid to the formation will obviate any present or future danger of deterioration in the quality of the receiving groundwater.

Whilst the injection of acid within deep saline water bearing formations is a 'groundwater activity', the activity is considered de minimis and can be excluded under Schedule 22 3 (3) of EPR2016. The acid wash/squeeze within the Permian Carbonate does not, therefore, require a groundwater permit.

6.7.2 Alkali Treatment

As an alternative to using hydrochloric acid, an alkali product is also being proposed. Evaluation of core samples As an alternative to using hydrochloric acid, an alkali product is also being proposed. Evaluation of core samples obtained as part of the drilling operations have concluded that whilst the target formation reacts with the HCl, the reaction takes place very quickly and does not provide enough residence time to clean up the full extent of any skin damage, as it reacts immediately with the face of the formation, and not the full extent of the near wellbore natural fractures.

Rathlin is proposing to use an alkali based product (Dissolvine Stimwell DDH-P) which has been tested on core samples and provides longer residence, times allowing the full extent of the small near wellbore channels to be cleaned out.

As with an acid wash, the alkali wash involves the solution being pumped down the well and circulated around the annulus, washing the 'face' of the formation, exposing any nearby perforations. A squeeze is a similar technique insofar as the alkali being pumped down the well, it is then applied with pressure (not exceeding fracture pressure) so as to squeeze through the natural fractures within the formation, having been potentially blocked by previous drilling activities. The squeeze operation is applied so as to treat the near wellbore area only, cleaning out existing fractures, not creating new fractures.

As with hydrochloric acid, the injection of Dissolvine within deep saline water bearing formations is a 'groundwater activity'. However, it is again expected that the activity is considered de minimis and can be excluded under Schedule

22 3 (3) of EPR2016. The alkali wash/squeeze, utilising the Dissolvine is therefore not expected to require a groundwater permit.

It is anticipated that the alkali wash and squeeze process may be undertaken a number of times depending on the discrete zones perforated. Each squeeze would involve the application of up to $1m^3$ of 25% alkali solution per 1m of perforation, with no more than 30m of formation being treated.

Following the retrieval of alkali to surface it is anticipated that it will be considered 'spent' i.e. neutralised following the chemical reaction with the formation. As a contingency, the returns will be tested at the choke to determine pH by using litmus papers. In the event the alkali is not fully spent and remains slightly alkali Rathlin will treat the alkali using citric acid. The citric acid will be used at surface and will not be used within the well. The anticipated pH levels are uncertain due to the 25% mixture being diluted in water from the well and in the tank. Citric acid will be added in stages and tested with litmus paper until the waste volume is neutralised.

As with the acid wash and squeeze, the alkali wash and squeeze may need to be repeated throughout the lifetime of the well. As with the fractures becoming blocked by the initial drilling activity, subsequent well testing or production operations (production not currently permitted) may cause particulates to build up within the natural fractures overtime reducing near wellbore permeability.

6.7.3 Treatment of Surplus Acid or Alkali

Following the retrieval of acid or alkali to surface it is anticipated that it will be considered 'spent' i.e. neutralised following the chemical reaction with the formation. As a contingency, the returns will be tested at surface to determine pH. In the event the acid is not fully spent, Rathlin will treat the acid using soda ash (sodium carbonate) and surplus alkali with citric acid. The treatment will take place at surface and will not be used within the well.

In the event the acid or alkali is not fully spent Rathlin will treat each substance accordingly. Any acid remaining unspent shall be neutralised with soda ash, whilst any unspent alkali shall be neutralised with citric acid.

The anticipated pH levels are uncertain due to the mixture being diluted in water from the well and in the tank. Soda ash will be added in stages and tested with litmus paper until the waste volume is neutralised.

6.8 Reservoir Stimulation

In order to re-establish permeability within the target formation, it may be necessary to undertake a reservoir stimulation, which is designed to create channels of communication through the near wellbore formation, the natural permeability having been impeded by formation damage as a result of the initial drilling and completion operation. For clarity, the primary purpose of the reservoir stimulation is to re-establish permeability, however, due to the design of the reservoir stimulation, although as minimal as is reasonably practicable, the reservoir stimulation will extend beyond the near wellbore damage, providing some degree of secondary benefit in the form of enhanced permeability within the target formation.

In the case of WNA operations, a reservoir stimulation involves a slurry of proppant (typically 20/40 grade sand) and a gelled hydrocarbon-based fluid (carrier fluid) being pumped through the perforations into the target formations at a pressure exceeding the fracture pressure of the formation. Injecting pressure and pump rates high enough to propagate a fracture in the formation creates channels of communication through the near wellbore formation damage. When the pressure is released, the proppant remains in situ propping open the small fractures, through which hydrocarbons can flow at enhanced rates. Unlike high volume hydraulic fracturing, the proposed reservoir stimulation is designed to overcome skin damage and requires the use of only small volumes of proppant and carrier fluid, as it seeks to only bypass the formation damage rather than to specifically enhance the natural permeability of the formation.

The reservoir stimulation will be carried out as a single stage treatment in the WNA-2 borehole. Carrier fluid volumes for a single stage treatment are $60m^3$ - $70m^3$ with 12.5 tonnes of proppant entrained. The fluid mix is injected at a surface pressure of 9,000psi at a low rate for less than one (1) hour, then flowed back to surface in a controlled manner through well clean-up equipment.

A DFiT may be undertaken using up to 15m3 of gelled hydrocarbon-based fluid prior to the main reservoir stimulation to determine the breakdown pressure, propagation pressure and carrier fluid leak-off rate, which, in turn, will inform the main proppant treatment. Should the DFiT indicate that the main proppant treatment may extend further than

the design, the fluid volumes, proppant size and amount, and pressures will be adjusted accordingly to ensure the design objective is achieved. This calibration process will be documented within the Hydraulic Fracture Plan (HFP).

As the reservoir stimulation will involve pressures exceeding fracture gradient, the use of gelled hydrocarbon based fluid and proppant, an HFP must be submitted and assessed independently by both the North Sea Transition Authority and the Environment Agency, with the Health and Safety Executive having opportunity to comment, in advance of the operation being undertaken.

The reservoir stimulation within the WNA-2 borehole is designed to extend circa 16.4m in a lateral direction and 30m in a vertical direction and will be confined to the primary target formation (Kirkham Abbey), which is 60m in thickness, as indicated in Figure 6.1. The target formation overlays 200m of Hayton Anhydrite and underlays 45m of Fordon Evaporites, both of which provide an impermeable seal. The formation beyond the reservoir, in the basinal and lagoonal depositional environments, reduces in permeability to such an extent that the 'West Newton' reservoir is hydraulically isolated from the surrounding Kirkham Abbey formation.

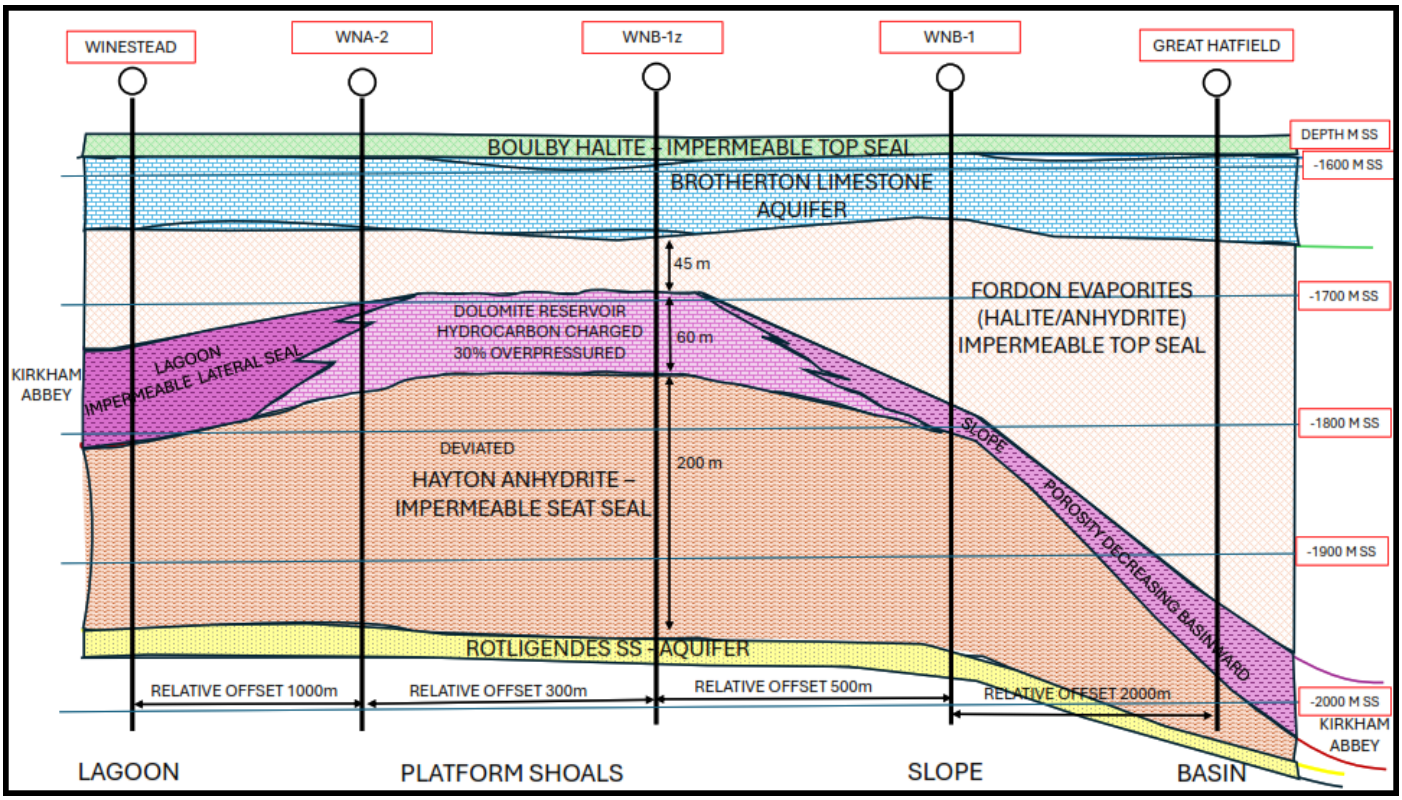

Figure 6.1: Cross Section Schematic

A reservoir stimulation falls within the definition of a 'groundwater activity' under Schedule 22, 8(l) of EPR2016, namely the injection of any substance into groundwater to increase the flow of fluids or gas to a well or borehole in connection with the extraction or use of any energy source. Whilst the definition provides for the injection of 'any substance', the Environment Agency has indicated that it will still take a risk-based approach when considering whether to issue a groundwater activity permit, including the carrier fluids proposed and the rationale for not using, for example, a water-based fluid. In the case of the WNA reservoir stimulation, the carrier fluid proposed is a hydrocarbon-based fluid, having been selected following extensive studies into the compatibility of well treatment fluids with the target formation, previously undertaken at the WNA and WNB wellsites. The studies consistently indicate that the target formation is highly sensitive to aqueous fluids, with testing of preserved core samples taken from the target formation during the previous drilling operations identifying that water-based acid treatments reduce conductivity of the natural fractures by approximately 45%. As such, previous near wellbore treatments are likely to have been ineffective. The studies conclude that a reservoir stimulation using a hydrocarbon-based fluid is the most effective treatment to overcome skin damage.

6.8.1 Flowback Fluid and Disposal

Approximately 30% to 50% of the proppant carrier fluid will be returned to surface via the well clean-up equipment and stored on site for subsequent offsite transfer to an Environment Agency approved waste treatment facility for disposal in accordance with the receiving waste treatment facility's environmental permits.

Flowback fluid has the potential to contain low levels of NORM. Samples of the flowback fluid will be sent to a laboratory holding the appropriate accreditations for radionuclide analysis by gamma spectrum. Depending on the outcome of radionuclides analysis, the flowback fluid will be transported via a licenced haulier to either an Environment Agency permitted waste water treatment works facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility, or to a bespoke RSR permitted waste treatment facility for treatment and disposal in accordance with the BAT.

6.8.2 Retained Fluid within the Target Formation

The remaining 50% to 70% of the proppant carrier fluid will be retained in the target formation. As such, the target formation will be classified as a waste facility under Schedule 20 (2)(1) of EPR2016.

Whilst the proppant carrier fluid will contain substances that fall within the classification of hazardous waste, its location (deep underground) will not give rise to a major incident nor does its quantity exceed the prescribed threshold. As such, the mining waste facility will not be classified as a Category A Waste Facility.

6.9 Well Lifting Techniques

If the well does not flow (lift) naturally, the following techniques are available to artificially lift hydrocarbons to surface:

- Nitrogen or Carbon Dioxide lift (Gas Lift); and/or
- Mechanical lift.

The anticipated extractive wastes during this phase includes:

- Circulation Fluid / Suspension Brine;
- Nitrogen;
- Carbon Dioxide;
- Formation Water; and
- Natural Gas.

6.9.1 Nitrogen Lift

To aid the initial flow of hydrocarbons (oil and gas), Nitrogen may be injected into the wellbore to displace wellbore fluids, reducing its hydrostatic weight. Nitrogen is classified as an inert waste and venting of such considered a closed loop system, insofar as Nitrogen is extracted from the atmosphere and is vented back atmosphere. No Nitrogen would remain in the formation.

6.9.2 Carbon Dioxide Clean Out

The purpose of CO_2 cleanout is to assist in the removal of all wellbore fluids and near wellbore debris sustained during the drilling operation, thus restoring near wellbore permeability. In comparison to Nitrogen lifting, a CO_2 cleanout allows for greater debris lifting as it is circulated down as a liquid and produced back as a gas. The liquified CO_2 is pumped down the well at a pressure high enough to facilitate the liquified form of the CO_2. The pressure is maintained within the well as it is pumped down to the target area and is left under pressure to permeate in its liquid form behind the debris of the near wellbore formation, this is applied below the fracture gradient of the formation.

The well is then opened at surface in a controlled manner to reduce the pressure within the wellbore and in turn cause the downhole liquid CO_2 to rapidly change from a liquid to a gas. This process results in a rapid expansion of CO_2, which forces the near wellbore debris from the perforations into the wellbore and back to surface. All liquid CO_2 injected into the formation will return to surface in a gaseous state and will be passed through the three-phase phase separator.

Whilst the pumping of liquid CO_2 into the perforations within deep saline water bearing formations is a 'groundwater activity', the liquid CO_2 will return to surface in a gaseous state. No injected CO_2 will remain in the formation and therefore the injection of liquid CO_2 is considered de minimus and can be excluded under Schedule 22 3 (3) of EPR2016 from requiring a groundwater activity permit.

Waste classification and quantities are estimated in Section 7.3 of this Waste Management Plan.

6.9.3 Mechanical lift

In the event the well(s) are not able to flow to surface naturally a number of lifting techniques are available to the onshore oil and gas industry, including the aforementioned Nitrogen / Carbon Dioxide lift. Another lifting technique is a mechanical lift. The use of mechanical lifting techniques is common place within oil production wells and can take a number of forms.

As a contingency Rathlin may use a mechanical lifting technique known as swabbing to aid in the lifting of wellbore fluids to surface. Swabbing is performed by unloading liquids from the well using a specific tool string incorporating a swab cup assembly that can be run into the wellbore by various means (wireline, coiled tubing or drillpipe).

When the assembly is run, the specially shaped swab cups have a tight tolerance on the wellbore casing or tubing and allow both lifting of the liquids from the wellbore and temporary removal of the hydrostatic column within the well.

The methods of longer term mechanical lifting include ‘Beam Pump’, ‘Rod Pumping Hydraulic Pump Jack’ and an ‘Electric Submersible Pump’ all of which are lifting techniques Rathlin has identified as being suitable for the well(s). The techniques involve either running a rod string into the well attached to a downhole pump located in the bottom of the tubing string and the rods are then lifted and lowered into the well by the surface equipment, or by pumping liquids up the tubing from downhole.

A downhole pump does not work effectively when completing a gas reservoir. Downhole pumps are required to be submerged in liquid to avoid becoming 'gas locked'. Therefore, the operator requires certainty that the reservoir fluids to be lifted are mainly liquids prior to running a completion with a downhole pump.

As it is not possible to be certain of the reservoir fluids that will be encountered in an exploration well, a gas lift may be necessary to evacuate the borehole of wellbore liquids to flow reservoir fluids into the well to ascertain their composition in the first instance.

Furthermore, if the reservoir liquids are known to have a high concentration of gas, a downhole pump would not be run but a means to evacuate the wellbore of liquids maybe required. In this instance a gas lift may be deemed the most effective method.

The Leak Detection and Repair Plan and Fugitive Risk Assessment provides for review following installation of the well test equipment and shall therefore be revised following installation of equipment, prior to commencement of operations and as part of its inspection programme. The mechanical lifting equipment will be included within the Leak Detection and Repair Plan, the Odour Risk Assessment and the Environmental Risk Assessment. The waste associated with this operation is the same as previously assessed and will be managed at surface as previously described.

Once at surface, fluids will be diverted by temporary pipework to a three (3) phase separator, which will separate out oil, gas and produced fluids. Oil and produced fluids will be diverted via temporary pipework to dedicated storage tanks onsite for subsequent offsite removal for sale and disposal respectively. Oil, which for clarity is not considered a waste, will be transported by a licenced haulier to a permitted refinery for sale. Formation water cannot be reused onsite due to unknown components within the formation water and high salinity. Therefore, formation water is considered a waste, and will be tested at a laboratory and its components determined and will be transported by a licenced haulier to an Environment Agency permitted water treatment facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility.

Natural gas separated during the three (3) phase separation will be diverted by temporary pipework and managed in accordance with the identified Best Available Technique as Identified within the Waste Gas Management Plan.

6.10 Production Operations

The main phase of the proposed development is the production of oil and/or gas from the WNA Wellsite. During the development it is anticipated that an increasing number of wells will be drilled and eventually brought online into production. Production will be conducted through surface-based equipment, which provides for:

- Shutting in the well at any time with a remotely operable safety valves;
- Control of the production via a “choke manifold”;
- Flow of produced reservoir fluids through pipework;
- Separation of the produced fluids into individually controllable and metered flow streams; and

- Storage of produced oil and produced water in segregated, vented tanks.

Produced fluids (oil and production water) will either free flow to the surface naturally or with the aid of surface pumps, artificially lifting fluids to surface. Once at surface, produced fluids and natural gas will be diverted by pipework for processing. The processing will involve the physical separation of oil, gas and water which will be each independently pumped to their respective storage vessels (oil and water) and to the identified gas management techniques (gas).

Prior to physical separation, an oil heater may be used to apply heat to the fluid to aid in the separation process. The oil heater is also commonly referred to as a bath heater and is commonplace within the onshore oil and gas industry.

Oil, which for clarity is not a waste, will be diverted via pipework to dedicated storage tanks onsite for subsequent offsite removal by a licenced haulier to a permitted refinery for sale.

Water, if present, will be diverted via pipework to dedicated storage tanks onsite for subsequent offsite removal by a licenced haulier to either Environment Agency permitted water treatment facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility.

Water produced during hydrocarbon production has the potential to contain low levels of Naturally Occurring Radioactive Material (NORM). A competent Radiation Protection Supervisor (RPS) and/or Radioactive Waste Advisor (RWA) shall be appointed to ensure that NORM is managed correctly.

During production operations drilling and testing on subsequent wells may also be taking place resulting in simultaneous operations.

Waste Natural Gas will be managed in accordance with BAT as disclosed within the Waste Gas Management Plan.

The anticipated extractive wastes during this phase includes:

- Formation Water; and
- Natural Gas.

6.10.1 Treatment of Crude Oil

During the proposed well testing operations crude oil will be stored within storage tanks pending collection. As a contingency Rathlin are proposing to include for the use of a H_2S scavenger to remove any trace of H_2S which maybe present within the oil. This will only be used if deemed necessary once a sample of any recovered oil can be analysed at surface.

The scavenger will be injected into the flow line and through to the storage tanks after the wellhead. This material will not be introduced to the well or into the formation and will only be added to the produced fluids prior to storage and subsequent transportation.

Environmental Permit EPR/BB3001FT allows Rathlin to undertake the following activity *'The loading, unloading, handling or storage of, or the physical, chemical or thermal treatment of crude oil'*.

6.10.2 Hot Oil Wash

Crude oil generally contains dissolved waxes that can precipitate between the producing formation and surface, restricting the flow of hydrocarbons to the well. Paraffin is one such wax, primarily consisting of long chain, saturated hydrocarbons.

Hot oil washing is a process of removing the build-up of paraffin precipitates within the production tubing. Hot oil (or water) is pumped from storage tanks onsite, via a mobile hot oil pump (which could be the existing bath heater), which heats the oil prior to circulating down the well. Hot oil is pumped down the tubing to immediately above the perforations and circulated back to surface, dissolving or dislodging paraffin precipitates. Paraffin precipitates dissolved or dislodged within the hot oil are diverted from the well at surface back to the onsite oil storage tanks where it is comingled with the produced oil. Produced oil is subsequently transferred to road tankers and removed from site by a licenced haulier to a permitted refinery for sale.

For clarity, no hot oil is pumped into the formation and no mining waste is generated, therefore, a groundwater activity permit is not required nor does the activity fall to be considered a mining waste activity.

6.11 Well Abandonment and Partial Well Abandonment

In the event that the well(s) is not successful in establishing commercially producible petroleum or the well comes to the end of its producing life, the well(s) will be abandoned in accordance with Oil & Gas UK Guidelines for the suspension and abandonment of wells.

In addition to the Oil & Gas UK Guidelines for the suspension and abandonment of wells, the well abandonment(s) will be undertaken in accordance with the following regulations:

- The Borehole Sites and Operations Regulations 1995;
- Offshore Installations and Wells (Design & Construction) Regulations 1996; and
- Any other legislation relevant at the time.

The Oil and Gas UK guidelines stipulate a well must be constructed by taking into consideration the abandonment of the borehole. Therefore, the initial design and construction of the well(s) takes into consideration the permeable zones encountered during the drilling operation and whether any of these zones are hydrocarbon-bearing or over-pressured and water-bearing.

Based on a borehole construction, which complies with Oil & Gas UK guidance for the suspension and abandonment of wells, the internal section of last cemented casing sting will be subject to well abandonment. The operation involves the setting of cement barriers, extended above and below the permeable zone(s). Once the well(s) is abandoned, the casing strings will be mechanically cut off at 1.5m below original ground level and a steel plate welded over the top. The pre-cast concrete drilling cellar would then be removed, and the site restored to its former use.

7. EXTRACTIVE AND NON EXTRACTIVE WASTE MANAGEMENT

The following section describes the various extractive wastes arising from the WNA operation, their classification and anticipated quantities. Non-extractive wastes, which are not subject to environmental permits under the Mining Waste Directive, are listed in Section 7.3.1. of this Waste Management Plan.

This section also describes the objectives of Rathlin to appropriately manage waste and how these objectives are achieved through waste minimisation, methods of treatment and disposal.

7.1 Operator Waste Objectives

The Rathlin policy on waste Duty of Care, waste segregation, waste handling and waste transfer are set out in the Rathlin Environmental Policy Manual.

The site waste champion for the WNA Wellsite is the Rathlin HSE Adviser. He will:

- Promote awareness of the Waste Management Plan;
- Monitor and report on waste generation;
- Monitor and enforce waste segregation;
- Monitor the effectiveness of the Waste Management Plan;
- Form a good working relationship with the waste management contractor; and
- Encourage suggestions for better waste management onsite.

7.2 Waste Prevention and Minimisation

Article 4 of the Waste Framework Directive provides a Waste Hierarchy and is described below in order of priority for waste prevention.

Figure 7.1 Hierarchy of Waste Management

7.2.1 Waste Prevention

Every effort will be made to eliminate the waste produced at source. Control measures will include:

- Calculating quantities of required products;
- Avoiding packaged material where practicable;
- Ordering correct quantities;
- Avoiding damage by handling and storing correctly; and
- Using fewer materials in designs and manufacturing.

7.2.2 Preparing for Re-Use

Only dispose of waste which cannot economically or practically be re-used or recycled. Checking, cleaning, repairing and refurbishing of items and spare parts for subsequent re-use.

7.2.3 Recycle

Waste is to be segregated onsite to allow for recycling offsite. Additionally, materials that are recycled shall be procured for use onsite where practicable and where specification permits. Turning wastes into a substance or product including composting subject to quality protocols.

7.2.4 Other Recovery

Other recovery includes anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste.

7.2.5 Disposal

Waste that cannot be reused or recycled practicably shall be disposed of responsibly and in compliance with Rathlin's duty of care obligations. All waste shall be removed from site by a licensed waste carrier to a licensed waste facility.

7.3 Waste Description and Management Arrangements

An assessment of the potential extractive waste arising from the WNA exploratory operations has been undertaken. The potential waste, together with its classification, anticipated quantities, prevention, minimisation, treatment and disposal is provided within this section.

- Table 7.1 – Waste Clays and Sand;
- Table 7.2 – Water Based Rock Cuttings;
- Table 7.3 – Fresh Water Drilling Muds and Waste;
- Table 7.4 – Salt Saturated and KCl Rock Cuttings;
- Table 7.5 – Chloride Containing Drilling Muds and Waste (Exploratory Well);
- Table 7.6 - Oil Based Rock Cuttings;
- Table 7.7 - Oil Based Drilling Muds and Waste;
- Table 7.8 – Spent Acid;
- Table 7.9 - Spent Alkali;
- Table 7.10 - Hydrocarbon-Based Carrier Fluid (Diesel Retained in Formation);
- Table 7.11 - Hydrocarbon-Based Carrier Fluid (Base Oil Retained in Formation);
- Table 7.12 - Hydrocarbon-Based Carrier Fluid (Flowback Diesel);
- Table 7.13 - Hydrocarbon-Based Carrier Fluid (Flowback Base Oil);
- Table 7.14 – Proppant (Sand);
- Table 7.15 – Well Suspension Brine;
- Table 7.16 – Carbon Dioxide;
- Table 7.17 – Nitrogen;
- Table 7.18 – Formation Water; and
- Table 7.19 – Natural gas.

Waste Clays and Sand		
Waste Classification, Quantity and Storage	**Default Classification**	Non Hazardous
	EWC Code	01 04 09
	Potential Classification	
	EWC Code	
	Estimated Quantity	200m^3
	Onsite Storage	1 x 31m^3 Open Square Tank
	Storage Duration	Maximum 7 Days
	Odour Potential	No Odour Anticipated
Operation / Activity	The drilling of borehole(s) will commence with the installation of a casing string known as a surface conductor. The drilling operation will be carried out using a geotechnical drilling rig which will auger or conventionally drill the near surface clays and sands within which the surface conductor casing will be set and cemented into position. The clay and sand will be circulated out of the well using either an auger or water based drilling fluids and return to the surface.	
Waste Prevention and Minimisation	The ability to prevent or minimise clay and sand recovery is limited given that the formation needs to be removed to allow the conductor casing to be installed. The selection of the drilling bit will be such that it minimises the hole size required to install the conductor casing which in turn keeps the clay and sand recovery to a minimum.	
Waste Treatment and Disposal	The clay and sand will be transported offsite via a licenced haulier to a permitted composting facility where it is blended into compost after compost has been sanitised.	
Waste Remaining in the Formation	None. Extractive process only.	
Monitoring	Rathlin provides competent supervision to ensure the operation is carried out in accordance with an approved drilling programme. An inspection of the open square tank that contain the clay and sand shall be carried out prior to being used and will be subject to visual weekly inspections and annual thickness checks.	

Table 7.1: Waste Clays and Sand

Water Based Rock Cuttings		
Waste Classification, Quantity and Storage	**Default Classification**	Non Hazardous
	EWC Code	01 05 04
	Potential Classification	
	EWC Code	
	Estimated Quantity	200m^3
	Onsite Storage	1 x 31m^3 Open Top Fluid Separator Tank (Drill Cuttings); and 1 x 20m^3 Open Top Tank (Centrifuge)
	Storage Duration	Maximum 7 Days
	Odour Potential	No Odour Anticipated
Operation / Activity	Drilling muds are used in a closed loop system, within which the rock cuttings are circulated to surface and removed by vibrating screens (shakers) into an open top tank, which is also a fluid separator tank. Finer particles of rock cuttings are then extracted from the drilling mud by a centrifuge and the drilling mud is circulated back down the well.	
Waste Prevention and Minimisation	The ability to prevent or minimise rock cuttings recover is limited given that the formation needs to be removed to allow the casing to be installed. The selection of the drilling bit will be such that it minimises the hole size required to install each string of casing which, in turn, keeps the recover to a minimum. The rock cuttings tank is a fluid separator tank (perforated false floor), which allows drilling mud coating the rock cuttings to percolate down through the false floor where it is collected and pumped back into the closed loop mud system.	
Waste Treatment and Disposal	Rock cuttings will be transferred from the rock cuttings tank to a sealed road bulker by a hydraulic grab arm fitted to the rock cuttings tank and transported offsite via licenced haulier to a permitted composting facility where it is blended into compost after compost has been sanitised.	
Waste Remaining in the Formation	None. Extractive process only.	
Monitoring	Rathlin provides competent supervision to ensure the operation is carried out in accordance with an approved drilling programme. An inspection of the rock cuttings tanks shall be carried out prior to being used and will be subject to visual weekly inspections and annual thickness checks.	

Table 7.2: Water Based Rock Cuttings

Fresh Water Drilling Muds and Waste		
Waste Classification, Quantity and Storage	**Default Classification**	Non Hazardous
	EWC Code	01 05 04
	Potential Classification	
	EWC Code	
	Estimated Quantity	500m^3
	Onsite Storage	Minimum 95m^3 Open Top Active Tank System on Rig. 1 x 31m^3 Open Top Tank (Drill Cuttings) and 1 x 20m^3 Open Top Tank (Centrifuge)
	Storage Duration	Maximum 7 Days
	Odour Potential	No Odour Anticipated
Operation / Activity	Drilling muds are used to aid in the drilling process by lubricating the drill bit, circulating to surface the rock cuttings from the drilling process and for well control by maintaining a prescribed hydrostatic pressure within the well to prevent the uncontrolled release of natural gas or formation pressure. Drilling muds are used in a closed loop system, within which the rock cuttings are circulated to surface and removed by vibrating screens (shakers). Finer particles of rock cuttings are then extracted from the drilling mud by a centrifuge and the drilling mud is circulated back down the well.	
Waste Prevention and Minimisation	Drilling mud waste is minimised by continually reusing the mud in a closed loop system and sustained by way filtering out rock cuttings and finer particles of rock. The rock cuttings tank is a fluid separator tank (perforated false floor), which allows drilling mud coating the rock cuttings to percolate down through the false floor where it is collected and pumped back into the closed loop mud system. Whenever the drilling mud weight exceeds the prescribed mud weight, due to finer particles of rock cuttings in the mud, the drilling mud needs to be diluted. Dilution may require the removal of a prescribed volume of active drilling mud and diluting the remaining volume with new drilling mud. Periodically, the drilling mud system will be completely changed, which will depend on the formation being drilled.	
Waste Treatment and Disposal	Drilling muds are used in a closed loop system and become a waste when no longer required for use in the operation. In such an event the drilling mud will be transferred from the active mud system on the drilling rig to a vacuum tanker for removal offsite via licenced haulier to a permitted composting facility where it is blended into compost after compost has been sanitised.	
Waste Remaining in the Formation	None. Any drilling muds remaining within the formation exist as a filter cake on borehole wall and forms part of the well construction. It is not considered a waste.	
Monitoring	Rathlin provides competent supervision to ensure the operation is carried out in accordance with an approved drilling programme. An inspection of the mud tank system, including transfer lines, hoses etc. shall be carried out prior to being used and will be subject to visual weekly inspections and annual thickness checks.	

Table 7.3: Fresh Water Drilling Muds and Waste

Salt Saturated and KCL Rock Cuttings		
Waste Classification, Quantity and Storage	**Default Classification**	Non Hazardous
	EWC Code	01 05 08
	Estimated Quantity	1400m^3
	Onsite Storage	1 x 31m^3 Open Top Fluid Separator Tank (Drill Cuttings) and 1 x 20m^3 Open Top Tank (Centrifuge)
	Storage Duration	Maximum 7 Days
	Odour Potential	No Odour Anticipated
Operation / Activity	Drilling muds are used in a closed loop system, within which the rock cuttings are circulated to surface and removed by vibrating screens (shakers) into an open top tank, which is also a fluid separator tank. Finer particles of rock cuttings are then extracted from the drilling mud by a centrifuge and the drilling mud is circulated back down the well.	
Waste Prevention and Minimisation	The ability to prevent or minimise rock cuttings recover is limited given that the formation needs to be removed to allow the casing to be installed. The selection of the drilling bit will be such that it minimises hole size required to install each string of casing which in turn keeps the waste recover to a minimum. The rock cuttings tank is a fluid separator tank (perforated false floor), which allows drilling mud coating the rock cuttings to percolate down through the false floor where it is collected and pumped back into the closed loop mud system.	
Waste Treatment and Disposal	Rock cuttings will be transferred from the rock cuttings tank to a sealed road bulker by a hydraulic grab arm fitted to the rock cuttings tank and transported offsite via licenced haulier to a permitted composting facility where it is blended into compost after compost has been sanitised.	
Waste Remaining in the Formation	None. Extractive process only.	
Monitoring	Rathlin provides competent supervision to ensure the operation is carried out in accordance with an approved drilling programme. An inspection of the rock cuttings tanks shall be carried out prior to being used and will be subject to visual weekly inspections and annual thickness checks.	

Table 7.4: Salt Saturated and KCl Rock Cuttings

Chloride Containing Drilling Muds and Waste		
Waste Classification, Quantity and Storage	**Default Classification**	Non Hazardous
	EWC Code	01 05 08
	Estimated Quantity	6200m^3
	Onsite Storage	Minimum 95m^3 Open Top Active Tank System on Rig. 1 x 31m^3 Open Top Tank (Drill Cuttings) and 1 x 20m^3 Open Top Tank (Centrifuge)
	Storage Duration	Maximum 7 Days
	Odour Potential	No Odour Anticipated
Operation / Activity	Drilling muds are used to aid in the drilling process by lubricating the drill head, circulating to surface the rock cuttings from the drilling process and for well control by maintaining a prescribed hydrostatic pressure within the well to prevent the uncontrolled release of natural gas or formation pressure. Drilling muds are used in a closed loop system, within which the rock cuttings are circulated to surface and removed by vibrating screens (shakers). Finer particles of rock cuttings are then extracted from the drilling mud by a centrifuge and the drilling mud is circulated back down the well.	
Waste Prevention and Minimisation	Drilling mud waste is minimised by continually reusing the mud in a closed loop system and sustained by way filtering out rock cuttings and finer particles of rock. The rock cuttings tank is a fluid separator tank (perforated false floor), which allows drilling mud coating the rock cuttings to percolate down through the false floor where it is collected and pumped back into the closed loop mud system. Whenever the drilling mud weight exceeds the prescribed mud weight, due to finer particles of rock cuttings in the mud, the drilling mud needs to be diluted. Dilution may require the removal of a prescribed volume of active drilling mud and diluting the remaining volume with new drilling mud. Periodically, the drilling mud system will be completely changed, which will depend on the formation being drilled.	
Waste Treatment and Disposal	Drilling muds are used in a closed loop system and become a waste when no longer required for use in the operation. In such an event the drilling mud will be transferred from the active mud system on the drilling rig to a vacuum tanker for removal offsite via licenced haulier to a permitted composting facility where it is blended into compost after compost has been sanitised.	
Waste Remaining in the Formation	None. Any drilling muds remaining within the formation exist as a filter cake on borehole wall and forms part of the well construction. It is not considered a waste.	
Monitoring	Rathlin provides competent supervision to ensure the operation is carried out in accordance with an approved drilling programme. An inspection of the mud tank system, including transfer lines, hoses etc. shall be carried out prior to being used and will be subject to visual weekly inspections and annual thickness checks.	

Table 7.5: Chloride Containing Drilling Muds and Waste

Oil Based Rock Cuttings		
Waste Classification, Quantity and Storage	**Default Classification**	Hazardous
	EWC Code	01 05 05*
	Estimated Quantity	1400m^3
	Onsite Storage	1 x 31m^3 Open Top Fluid Separator Tank (Drill Cuttings) and 1 x 20m^3 Open Top Tank (Centrifuge)
	Storage Duration	Maximum 7 Days
	Odour Potential	No Odour Anticipated
Operation / Activity	Drilling muds are used in a closed loop system, within which the rock cuttings are circulated to surface and removed by vibrating screens (shakers) into an open top tank, which is also a fluid separator tank. Finer particles of rock cuttings are then extracted from the drilling mud by a centrifuge and the drilling mud is circulated back down the well.	
Waste Prevention and Minimisation	The ability to prevent or minimise rock cuttings recover is limited given that the formation needs to be removed to allow the casing to be installed. The selection of the drilling bit will be such that it minimises hole size required to install each string of casing which in turn keeps the waste recover to a minimum. The rock cuttings tank is a fluid separator tank (perforated false floor), which allows drilling mud coating the rock cuttings to percolate down through the false floor where it is collected and pumped back into the closed loop mud system.	
Waste Treatment and Disposal	Rock cuttings will be transferred from the rock cuttings tank to a sealed road bulker by a hydraulic grab arm fitted to the rock cuttings tank and transported offsite via licenced haulier to a permitted composting facility where it is blended into compost after compost has been sanitised.	
Waste Remaining in the Formation	None. Extractive process only.	
Monitoring	Rathlin provides competent supervision to ensure the operation is carried out in accordance with an approved drilling programme. An inspection of the rock cuttings tanks shall be carried out prior to being used and will be subject to visual weekly inspections and annual thickness checks.	

Table 7.6: Oil Based Rock Cuttings

Oil Based Drilling Muds and Waste		
Waste Classification, Quantity and Storage	**Default Classification**	Hazardous
	EWC Code	01 05 05*
	Estimated Quantity	6200m^3
	Onsite Storage	Minimum 95m^3 Open Top Active Tank System on Rig. 1 x 31m^3 Open Top Tank (Drill Cuttings) and 1 x 20m^3 Open Top Tank (Centrifuge)
	Storage Duration	Maximum 7 Days
	Odour Potential	No Odour Anticipated
Operation / Activity	Drilling muds are used to aid in the drilling process by lubricating the drill head, circulating to surface the rock cuttings from the drilling process and for well control by maintaining a prescribed hydrostatic pressure within the well to prevent the uncontrolled release of natural gas or formation pressure. Drilling muds are used in a closed loop system, within which the rock cuttings are circulated to surface and removed by vibrating screens (shakers). Finer particles of rock cuttings are then extracted from the drilling mud by a centrifuge and the drilling mud is circulated back down the well.	
Waste Prevention and Minimisation	Drilling mud waste is minimised by continually reusing the mud in a closed loop system and sustained by way filtering out rock cuttings and finer particles of rock. The rock cuttings tank is a fluid separator tank (perforated false floor), which allows drilling mud coating the rock cuttings to percolate down through the false floor where it is collected and pumped back into the closed loop mud system. Whenever the drilling mud weight exceeds the prescribed mud weight, due to finer particles of rock cuttings in the mud, the drilling mud needs to be diluted. Dilution may require the removal of a prescribed volume of active drilling mud and diluting the remaining volume with new drilling mud. Periodically, the drilling mud system will be completely changed, which will depend on the formation being drilled.	
Waste Treatment and Disposal	Low toxicity oil-based drilling fluids are not treated at the wellsite. They are either returned back to the supplier for treatment or to another permitted treatment facility. A small volume of low toxicity oil-based mud, contaminated with clean up fluid results from rig tank and equipment cleaning, which is transferred to a vacuum tanker for removal offsite via licenced haulier to a permitted disposal facility.	
Waste Remaining in the Formation	None. Any drilling muds remaining within the formation exist as a filter cake on borehole wall and forms part of the well construction. It is not considered a waste.	
Monitoring	Rathlin provides competent supervision to ensure the operation is carried out in accordance with an approved drilling programme. An inspection of the mud tank system, including transfer lines, hoses etc. shall be carried out prior to being used and will be subject to visual weekly inspections and annual thickness checks.	

Table 7.7: Oil Based Drilling Muds and Waste

Spent Acid		
Waste Classification, Quantity and Storage	**Default Classification**	Non Hazardous
	EWC Code	01 05 08
	Estimated Quantity	15m^3 Per Wash and Squeeze
	Onsite Storage	Cylindrical Tanks
	Storage Duration	Maximum 14 Days
	Odour Potential	Refer to Odour Management Plan
Operation / Activity	Hydrochloric or Acetic acid is used to wash and clean out natural fractures within carbonate formations, which may be blocked as a result of the initial drilling operations. In addition, hydrochloric acid is squeezed into the natural fractures of the carbonate formation under pressure, increasing the near wellbore permeability. The reaction of the acid with the calcite produces chlorides and is unavoidable, which is classified as non-hazardous. The chloride, a result of the reaction with the carbonate formation will be reverse circulated out of the wellbore into 1m^3 IBC containers and stored onsite for subsequent removal via a licenced haulier to an Environment Agency permitted waste water treatment works facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility.	
Waste Prevention and Minimisation	The acid will be used in stages to ensure its use is minimised. The reaction of the acid with the calcite produces chloride. This reaction, and in turn the waste generated, is unavoidable. Careful planning will be taking prior to any acid wash or squeeze being undertaking to ensure Rathlin minimises the amount of acid used, which in turn reduces the amount of waste generated by the operation.	
Waste Treatment and Disposal	The chloride will be reverse circulated out of the wellbore into a number of 1m^3 IBC containers and stored onsite for subsequent removal via a licenced haulier to an Environment Agency permitted waste water treatment works facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility.	
Waste Remaining in the Formation	None. The reaction of the acid with the calcite produces chlorides, which is classified as non-hazardous. The chloride will be reverse circulated out of the formation and collected at surface.	
Monitoring	Rathlin provides competent supervisors to oversee the operation ensuring the correct volumes of hydrochloric acid are used. The IBC containers will be inspected prior to use to ensure they are suitable for holding chloride.	

Table 7.8: Spent Acid

Spent Alkali		
Waste Classification, Quantity and Storage	**Default Classification**	Non Hazardous
	EWC Code	01 05 08
	Estimated Quantity	15m^3 Per Wash and Squeeze
	Onsite Storage	Cylindrical Tanks
	Storage Duration	Maximum 14 Days
	Odour Potential	Refer to Odour Management Plan
Operation / Activity	The purpose of an alkali wash is to clean the well after drilling and results in improved permeability. The fine particles and drilling muds may block, or bind, the natural pore spaces in the rock. An alkali wash is used to clean the well out following drilling in order to return the natural porosity and permeability of the damaged formation. The proposed dilution of Dissolvine Alkali is 25%. An "alkali squeeze" is a term that is generally used when the intention is for the alkali to remain local to the well in to the geological formation. An alkali squeeze results in the alkali being squeezed in to the rock formation and dissolving the rock. The chemical reaction between the formation and acid can be represented by the following formula: CaCO3 (Calcium Carbonate) + Dissolvine = Calcium Salt + Magnesium Salt + Carbonate Ion Once the alkali has reacted with the formation it will form a waste stream known as 'Spent Alkali' which, following the completion of the squeeze, will be recovered (circulated) back to surface.	
Waste Prevention and Minimisation	The alkali will be used in stages to ensure its use is minimised. The reaction of the alkali with the calcite produces Salts. This reaction, and in turn the waste generated, is unavoidable. Careful planning will be taken prior to any alkali wash or squeeze being undertaking to ensure Rathlin minimises the amount of alkali used, which in turn reduces the amount of waste generated by the operation.	
Waste Treatment and Disposal	The salts will be circulated out of the wellbore into a storage tank and stored onsite for subsequent removal via a licensed haulier to an Environment Agency permitted waste water treatment works facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility. Should it be identified that not all of the alkali is spent, it will be neutralised at surface using soda ash, before being removed from site.	
Waste Remaining in the Formation	None. All alkali is spent or otherwise is expected to return to surface.	
Monitoring	An inspection of the fluid tanks that contain the spent alkali shall be carried out prior to being used and will be subject to visual inspections and annual thickness checks.	

Table 7.9: Spent Alkali

Hydrocarbon-Based Carrier Fluid (Diesel Retained in Formation)		
Waste Classification, Quantity and Storage	**Default Classification**	Hazardous
	EWC Code	13 07 01*
	Estimated Quantity	60m^3 (up to 70% of total volume of carrier fluid)
	Onsite Storage	Not Applicable
	Storage Duration	Indefinitely
	Odour Potential	Not Applicable
Operation / Activity	In order to re-establish permeability within the target formation, it may be necessary to undertake a reservoir stimulation, which is designed to create channels of communication through the wellbore formation, having been blocked as a result of the initial drilling and completion operation.	
Waste Prevention and Minimisation	Due to the nature of the target formation, it is anticipated that up to 50% will return to surface. The remaining fluid will be retained in the target formation and, as such, is classified as a Hazardous Mining Waste Facility.	
Waste Treatment and Disposal	Not Applicable	
Waste Remaining in the Formation	No less than 50% of the proppant carrier fluid will be retained in the target formation.	
Monitoring	Fracture growth will be determined through a combination of fracture modelling and DFiT calibration, which will inform the height and distance of the Hazardous Mining Waste Facility. Details of the monitoring will be set out in the Hydraulic Fracture Plan.	

Table 7.10: Hydrocarbon-Based Carrier Fluid (Diesel Retained in Formation)

Hydrocarbon-Based Carrier Fluid (Base Oil Retained in Formation)		
Waste Classification, Quantity and Storage	**Default Classification**	Hazardous
	EWC Code	01 05 05*
	Estimated Quantity	60m^3 (up to 70% of total volume of carrier fluid)
	Onsite Storage	Not Applicable
	Storage Duration	Indefinitely
	Odour Potential	Not Applicable
Operation / Activity	In order to re-establish permeability within the target formation, it may be necessary to undertake a reservoir stimulation, which is designed to create channels of communication through the wellbore formation, having been blocked as a result of the initial drilling and completion operation.	
Waste Prevention and Minimisation	Due to the nature of the target formation, it is anticipated that up to 50% will return to surface. The remaining fluid will be retained in the target formation and, as such, is classified as a Hazardous Mining Waste Facility.	
Waste Treatment and Disposal	Not Applicable	
Waste Remaining in the Formation	No less than 50% of the proppant carrier fluid will be retained in the target formation.	
Monitoring	Fracture growth will be determined through a combination of fracture modelling and DFiT calibration, which will inform the height and distance of the Hazardous Mining Waste Facility. Details of the monitoring will be set out in the Hydraulic Fracture Plan.	

Table 7.11: Hydrocarbon-Based Carrier Fluid (Base Oil Retained in Formation)

Hydrocarbon-Based Carrier Fluid (Flowback Diesel)		
Waste Classification, Quantity and Storage	**Default Classification**	Hazardous
	EWC Code	13 07 01*
	Estimated Quantity	43m^3 (up to 50% of the total volume of carrier fluid)
	Onsite Storage	1 x 60m^3 Horizontal Cylindrical Closed Tank
	Storage Duration	Maximum 28 days
	Odour Potential	Refer to Odour Management Plan
Operation / Activity	In order to re-establish permeability within the target formation, it may be necessary to undertake a reservoir stimulation, which is designed to create channels of communication through the wellbore formation, having been blocked as a result of the initial drilling and completion operation.	
Waste Prevention and Minimisation	Due to the nature of the target formation, it is anticipated that up to 50% will return to surface.	
Waste Treatment and Disposal	Disel carrier fluid at the end of its usage is returned to the supplier for treatment and reuse. A small volume of diesel carrier fluid may be contaminated with other fluids, which will be transferred to a vacuum tanker for removal offsite via a licenced haulier to an Environment Agency permitted facility.	
Waste Remaining in the Formation	Not Applicable	
Monitoring	The 'Operator' provides onsite competent supervision to ensure the operation be carried out in accordance with an approved work programme. An inspection of the storage tanks that contain flowback diesel shall be carried out prior to being used and will be subject to regular visual inspections and annual thickness checks.	

Table 7.12: Hydrocarbon-Based Carrier Fluid (Flowback Diesel)

Hydrocarbon-Based Carrier Fluid (Flowback Base Oil)		
Waste Classification, Quantity and Storage	**Default Classification**	Hazardous
	EWC Code	01 05 05*
	Estimated Quantity	43m^3 (up to 50% of the total volume of carrier fluid)
	Onsite Storage	1 x 60m^3 Horizontal Cylindrical Closed Tank
	Storage Duration	Maximum 28 days
	Odour Potential	Refer to Odour Management Plan
Operation / Activity	In order to re-establish permeability within the target formation, it may be necessary to undertake a reservoir stimulation, which is designed to create channels of communication through the wellbore formation, having been blocked as a result of the initial drilling and completion operation.	
Waste Prevention and Minimisation	Due to the nature of the target formation, it is anticipated that up to 50% will return to surface.	
Waste Treatment and Disposal	Low toxicity oil-based carrier fluid at the end of its usage is returned to the supplier for treatment and reuse. A small volume of low toxicity oil based carrier fluid may be contaminated with other fluids, which will be transferred to a vacuum tanker for removal offsite via a licenced haulier to an Environment Agency permitted facility.	
Waste Remaining in the Formation	Not Applicable	
Monitoring	The 'Operator' provides onsite competent supervision to ensure the operation be carried out in accordance with an approved work programme. An inspection of the storage tanks that contain flowback base oil shall be carried out prior to being used and will be subject to regular visual inspections and annual thickness checks.	

Table 7.13: Hydrocarbon-Based Carrier Fluid (Flowback Base Oil)

Proppant (Sand)		
Waste Classification, Quantity and Storage	**Default Classification**	Hazardous
	EWC Code	01 05 05*
	Estimated Quantity	$8m^3$
	Onsite Storage	Enclosed Tank
	Storage Duration	Maximum 28 days
	Odour Potential	Refer to Odour Management Plan
Operation / Activity	Carrier fluid returning to surface will contain proppant (sand,) which is removed at surface.	
Waste Prevention and Minimisation	The objective is to retain as much of the proppant in the fracture channels as possible, the ability to prevent or minimise sand recovery in the returning carrier fluid is limited. There is a potential for screen-out to occur, which results in the sand being blocked in the borehole, resulting in a greater amount of waste proppant. Avoiding screening will prevent unnecessary waste being generated.	
Waste Treatment and Disposal	Sand will be transferred from the returns tank to a sealed road bulker by a hydraulic grab arm or vacuum transfer. Sand is transported offsite via a licenced haulier to an Environment Agency permitted composting facility where it is blended into compost after the compost has been sanitised.	
Waste Remaining in the Formation	Not Applicable	
Monitoring	The 'Operator' provides onsite competent supervision to ensure the operation be carried out in accordance with an approved work programme. An inspection of the storage tanks that contain the sand shall be carried out prior to being used and will be subject to regular visual inspections and annual thickness checks.	

Table 7.14: Proppant (Sand)

Well Suspension Brine / Circulation Fluid		
Waste Classification, Quantity and Storage	**Default Classification**	Non Hazardous
	EWC Code	01 05 08 (01 05 06* if Solvent Entrained)
	Estimated Quantity	116m^3 per well
	Onsite Storage	1 x 60m^3 Horizontal Cylindrical Closed Tank
	Storage Duration	Maximum 7 Days
	Odour Potential	Refer to Odour Management Plan
Operation / Activity	The WNA well will be subject to a period of suspension using suspension brine and mechanical plugs. The brine is measured at 988g/ltr and is used to fill the wellbore. Following suspension any further operations will require the suspension brine to be circulated out of the well to an onsite storage tank via temporary surface pipework.	
Waste Prevention and Minimisation	The suspension brine will be stored onsite for subsequent reuse as a suspension brine for the WNA well at a later date when the well will need to be suspended again.	
Waste Treatment and Disposal	Once the suspension fluid has fully served its purpose at the wellsite, the suspension brine will be removed from site via a licenced haulier to an Environment Agency permitted waste water treatment works facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility.	
Waste Remaining in the Formation	None. Suspension brine is circulated out prior to well intervention and/or flow testing.	
Monitoring	An inspection of the fluid tanks that contain the suspension fluid shall be carried out prior to being used and will be subject to visual weekly inspections and annual thickness checks.	

Table 7.15: Well Suspension Brine

Carbon Dioxide (CO_2)		
Waste Classification, Quantity and Storage	**Default Classification**	Not Classified
	EWC Code	16 05 05
	Estimated Quantity	Circa 2m^3 and 3m^3 per 10m interval being treated
	Onsite Storage	None – Vented to Atmosphere
	Storage Duration	Not Applicable
	Odour Potential	No Odour Anticipated
Operation / Activity	Liquid Carbon Dioxide is injected into the well to assist in the removal of all wellbore fluids and near wellbore debris sustained during the drilling operation, thus restoring near wellbore permeability.	
Waste Prevention and Minimisation	The use of liquid Carbon Dioxide can be classified as a closed loop system due to the Carbon Dioxide having been first taken from the atmosphere during its manufacture process where it is cooled to a liquid state before being injected into the well. The temperature of the formation changes the state of the Carbon Dioxide from a liquid to a gas, which is then returned to surface and vented back into the atmosphere.	
Waste Treatment and Disposal	Carbon Dioxide that has been extracted from the atmosphere will be vented back into the atmosphere via the ground flare without any treatment being necessary.	
Waste Remaining in the Formation	None. Liquid Carbon Dioxide injected into the well to assist in the removal of wellbore fluids and near wellbore debris will flow to surface in a gaseous state.	
Monitoring	The volumes of Carbon Dioxide will be monitored both in and out of the well.	

Table 7.16: Carbon Dioxide

Nitrogen (N_2)		
Waste Classification, Quantity and Storage	**Default Classification**	Inert
	EWC Code	01 05 99
	Estimated Quantity	Not Known at this Time
	Onsite Storage	None – Vented to Atmosphere
	Storage Duration	Not Applicable
	Odour Potential	No Odour Anticipated
Operation / Activity	Nitrogen is injected into the well to aid the initial lifting of wellbore fluids, thus reducing the hydrostatic pressure and allowing petroleum to flow to surface.	
Waste Prevention and Minimisation	The use of Nitrogen can be classified as a closed loop system due to the Nitrogen having been first taken from the atmosphere during its manufacture process and then returned to surface and vented back into the atmosphere. The quantities of Nitrogen required are small and a detailed measurement cannot be provided at this stage.	
Waste Treatment and Disposal	As an inert gas, Nitrogen that has been extracted from the atmosphere will be vented back into the atmosphere via the ground flare without any treatment being necessary.	
Waste Remaining in the Formation	None. Nitrogen injected into the well to aid the initial lifting of wellbore fluids will flow to surface.	
Monitoring	The volumes of Nitrogen will be monitored both in and out of the well.	

Table 7.17: Nitrogen

Formation Water		
Waste Classification, Quantity and Storage	**Default Classification**	Non Hazardous
	EWC Code	16 10 02
	Estimated Quantity	TBC
	Onsite Storage	4 x 60m^3 Horizontal Cylindrical Closed Tank
	Storage Duration	Up to 3 Months to Allow for Radionuclide Analysis
	Odour Potential	Refer to Odour Management Plan
Operation / Activity	Formation water may be produced together with petroleum. Formation water is separated from the petroleum on surface using fluid separation equipment and transferred to cylindrical storage tanks located onsite for offsite removal. The formation water has the potential to contain low levels of Naturally Occurring Radioactive Material (NORM). Samples of formation water will be sent to a laboratory holding the appropriate accreditations for radionuclides analysis by gamma spectrum.	
Waste Prevention and Minimisation	The ability to prevent or minimise recovery of formation water is extremely limited. Formation water cannot be reused onsite due to unknown components within the formation water and high salinity.	
Waste Treatment and Disposal	Depending on the outcome of radionuclides analysis formation water will be transported via a licenced haulier to either an Environment Agency permitted waste water treatment works facility or a bespoke RSR permitted waste treatment facility where it is processed, treated and discharged in accordance with the permitted controls of the treatment facility.	
Waste Remaining in the Formation	None. Formation water naturally occurs within the formation and is only considered as a waste when produced from the well.	
Monitoring	A contamination monitoring programme will be devised and include the wellhead, separator equipment and storage tanks. Consignment of formation water will be screened externally for contamination prior to leaving site. An inspection of the fluid tanks that contain the formation water shall be carried out prior to being used and will be subject to visual weekly inspections and annual thickness checks.	

Table 7.18: Formation Water

Natural Gas		
Waste Classification, Quantity and Storage	**Default Classification**	Hazardous
	EWC Code	16 05 04
	Estimated Quantity	13,082 Tonnes
	Onsite Storage	None – Incineration by Ground Flare
	Storage Duration	Not Applicable
	Odour Potential	Refer to Odour Management Plan
Operation / Activity	During WCU / EWT operations there is a likelihood of natural gas being produced from the formation and flowed at different rates to determine the characteristics of the formation, allowing Rathlin to determine whether or not the reservoir is capable of producing commercial quantities of natural gas. A period of flowing the natural gas is followed by a period of shutting in the well to monitor pressure build up. At the point of incineration natural gas is considered a waste.	
Waste Prevention and Minimisation	The ability to prevent or minimise natural gas is extremely limited during this operation as it is required to allow Rathlin to determine the condition and state of the reservoir. Given that the operation is exploratory, no consideration has been given at this stage to capture the gas for sale and transportation for reuse as a fuel or other means of generating energy. Due to the unknown composition, quantity and pressure of any natural gas encountered during the WNA exploratory operations, the generation of electricity by means of a gas powered generator and connection to the national grid is not considered feasible for such a temporary operation. Due to the infrastructure required to suitably store natural gas onsite in a liquid state for subsequent offsite transfer to a liquid natural gas receiving facility it is not feasible for such a temporary operation.	
Waste Treatment and Disposal	Natural gas is separated from produced fluids at surface and diverted via temporary pipework to a ground flare located onsite for incineration. The ground flare will be fitted with a pilot and an electrical ignition system. The flare will also be continuously propane fed to allow for a continuous flame. The incineration of natural gas is subject to a separate air modelling and dispersion report included within the Waste Gas Management Plan (RE-EPRA-WNB-WGMP-010).	
Waste Remaining in the Formation	None. Natural gas naturally occurs within certain hydrocarbon bearing formations and is only considered as a waste when produced from the well.	
Monitoring	During WCU / EWT operations the flare will be supervised during periods of flaring activity to ensure its effectiveness to incinerate the natural gas. In addition, air emissions monitoring will be carried out and includes: • H_2S • BTEX / VOCs • Methane • Sulphur Dioxide • Nitrogen Oxide • Ozone	

Table 7.19: Natural Gas (WCU/ EWT)

7.3.1 Non-Extractive Waste

During the WNA exploratory operations there will be a number of non-extractive waste stream generated onsite including:

- Surface run-off water;
- Waste water and sewage;
- Potential minor fuel oil spills;
- Waste engine, gear and lubricating oils;
- Waste hydraulic oils;
- Oil rags and absorbents;
- Waste oil filters;
- Paper and cardboard;
- Canteen waste;
- Cement;
- Wood;
- Mixed Municipal waste; and
- Metal.

There will be no treatment or disposal of non-extractive waste onsite and any storage will be limited to temporary storage, pending collection. No temporary storage of non-extractive waste will exceed 12 months.

7.3.2 Waste Supervision and Carriers

Rathlin is ultimately accountable for waste management at the wellsite. During operations, the management of waste generated at the wellsite will be delegated to the Wellsite Supervisor, appointed by Rathlin to exercise overall control of the wellsite operations, in accordance with the Borehole Sites and Operations Regulations 1995 and the Waste (England and Wales) Regulations 2011.

The management of waste onsite will include:

- Management of waste in accordance with the waste hierarchy, as set out in the Waste (England and Wales) Regulations 2011;
- Monitoring of all waste storage units such as skips and storage tanks;
- Liaison with third party waste advisors with respect to sampling and analysis of waste;
- Compiling all waste transfer notes; and
- Managing the collection and offsite disposal of all waste streams.

Rathlin will appoint competent waste dealers or brokers and carriers, responsible for the transportation of all waste streams to the relevant Environment Agency permitted waste treatment facility. Waste dealers or brokers and carriers will hold relevant certificates issued by the Environment Agency, which shall be inspected prior to being appointed.

8. ENVIRONMENTAL AND HUMAN IMPACT

The wellsite has been designed with consideration for both environmental and human impacts. All permitted activities will take place within the contained area of the well site.

The wellsite has been designed to ensure complete containment of any spillages in the unlikely event they occur onsite. An enclosed perimeter containment ditch will be excavated and installed around the perimeter of the wellsite, with all storage tanks being installed within contained bunded areas.

Following the excavation of the perimeter containment ditch, the wellsite will be overlaid with an impermeable membrane to provide wellsite integrity and ensure that any surface run off liquids, either rain water or spillages, flow to the perimeter containment ditch.

Details of the proposed construction and installation of the impermeable membrane are detailed within the Site Condition Report provided in support of the environmental permit application to vary the existing permit.

During operations, all hazardous substances will be stored within the wellsite, ensuring that in the unlikely event of a spillage, hazardous substances will be contained within the wellsite, preventing the migration or percolation of hazardous substances offsite. No hazardous substances shall be stored outside of the active area of the wellsite.

An Environmental Risk Assessment has been undertaken in accordance with Environment Agency guidance.

The structure of the Environmental Risk Assessment follows the Environment Agency guidance using a source – pathway – receptor model and includes:

- Identifying the risk from the site;
- Assessing risks and checking they are acceptable;
- Justifying appropriate measures to control the risk (if needed); and
- Presenting the risk assessment.

The Environmental Risk Assessment has included the following items, which have been reviewed for applicability within the proposed operations.

- Accidents & Incidents;
- Air Emissions;
- Dust;
- Fugitive Emissions;
- Noise;
- Odour;
- Releases to Water;
- Global Warming Potential; and
- Waste.

The Environmental Risk Assessment is based on a qualitative assessment and details the activities and events that may lead to environmental impact on one or more receptors.

A copy of the environmental risk assessment, together with a supporting statement and conventional model is included within 'WNA Wellsite Environmental Risk Assessment' provided in support the environmental permit application.

9. MEASURES TO MINIMISE ENVIRONMENTAL IMPACT

Measures to minimise the environmental impact of the operation have been incorporated as part of the initial site selection process, site design and construction through to subsequent exploration operations. The measures to mitigate long term environmental impact are:

- Site located suitable distance from residential properties;
- Site located away from any statutory designated areas;
- Baseline monitoring of ecology, noise, water;
- Hydrogeological risk assessment;
- Site design to include impermeable membrane and containment ditches;
- Wellbore lifecycle design to protect groundwater;
- Hierarchy of waste management;
- Operating procedures and inductions;
- Waste handling, storage and disposal regime;
- Continuous Training and development;
- Environmental monitoring; and
- Restoration and aftercare.

10. CONTROL AND MONITORING OF WASTE AND EMISSIONS

The environmental risk assessment has identified the requirement to control and monitor waste generated from the exploratory operation. The following waste shall be monitored:

10.1 Releases to Groundwater

The potential for a release to groundwater exists both at surface and within the subsurface and have been assessed and included within the Environmental Risk Assessment, provided in support of the environmental permit application.

10.1.1 Surface Release

The potential for a release to ground water exists both at surface and within the subsurface.

Incorporated into the design of the wellsite is an impermeable membrane constructed using fully welded HDPE, protected above and below with non-needle punch geotextile. The impermeable membrane prevents surface fluids (mainly rainwater) penetrating the underlying subsoils. Surface fluids will migrate along the surface of the impermeable membrane to a perimeter ditch, where it will be contained.

Daily inspections of the drainage ditch will be undertaken to ensure the level does not exceed the maximum containment of the ditch. If the level is close to reaching the maximum containment of the ditch, the surface fluids will be tested. Disposal method will be as follows:

- During periods of activity within the active area of the wellsite, all water contained within the perimeter containment ditches contained and tested prior to discharge id proven clean or will be removed via road tanker and disposed at an Environment Agency licenced waste facility if contaminated above screening criteria.
- During periods of inactivity within the active area of the wellsite, water contained within the perimeter containment ditch will be tested to confirm it is suitable for discharge via the Class 1 SPEL oil-water separator to an adjacent land drain, in accordance with the Surface Water Management Plan.
- If the results of the test identify that the surface run-off water is not suitable for discharge, the water will be removed via road tanker and disposed at an Environment Agency licenced waste facility.

A daily inspection of all tanks and other waste storage containers shall be undertaken to ensure they remain fit for purpose. The inspections will aid early identification of any potential release to site from equipment which deteriorates over time.

10.1.2 Subsurface Release

Drilling muds and other fluids used in well operations will be strictly monitored to ensure an accurate understanding of fluid volumes lost, gained or, in the case of cement, placed in the subsurface. During drilling operations, the volumes of fluids pumped, together with the volumes of fluid within the tanks will be continually monitored by a geological logging company (mud loggers). Such monitoring can identify loss of drilling muds to the formation. In the event that subsurface fluid losses occur, lost circulation material is provided onsite to stem the losses.

Subsurface releases are mitigated by adopting the best practice approach to wellsite construction and wellbore construction. Dilute acid/alkali will be introduced to the formation at levels considered de-minimis and will not constitute a ground water activity.

All fluids introduced to the formation(s) by Rathlin shall be recovered and will not remain within the formation (subsurface).

10.1.3 Foul Water and Sewage

During operations on the site temporary welfare units shall be provided, providing kitchen and washroom facilities. Foul water and / or Sewerage shall be collected regularly by a licenced waste carrier to an Environment Agency approved waste facility.

The criteria for determining whether waste generated at the wellsite will be recycled or disposed of will be determined by the receiving waste treatment facility upon receipt of the waste at the treatment facility. The waste will be tested by the waste treatment facility, the results of which will determine the treatment and/or disposal method to be used. Such treatment and/or disposal method will be in accordance with the waste treatment facility's environmental permits.

10.2 Releases to Air

An Air Quality Impact Assessment (AQIA) has been undertaken to assess the impact of emissions on air quality and is included within the Environmental Risk Assessment provided in support of the environmental permit application.

A scheme of air quality monitoring will be agreed with the Environment Agency prior to the commence of the permitted activities and implemented prior to the well being constructed, which will provide a baseline for air quality. The scheme will be implemented during well construction and will be conducted during the subsequent exploratory operations. The potential of releases to air has been assessed by way of an Air Dispersion Modelling and Report, which is included within the Waste Gas Management Plan.

10.3 Noise

Planning permission for the WNA Wellsite will require the submission of a Noise Impact Assessment. Noise monitoring was undertaken during fourth quarter of 2021 at the nearest residential locations. The Noise Impact Assessment concludes that noise levels associated with the operation (including all operations associated with extractive waste) are relatively low.

10.4 Release of Odorous Emissions

Extractive wastes generated are not ordinarily malodorous, nor are any of the associated processes that will be performed. Measures will be taken to minimise all fugitive emissions which may cause odours. The potential of odour release has been assessed within the Odour Management Plan provided in support of the environmental permit application.

10.5 Waste Management

The quantity of each waste will be recorded as it is removed from site. All records of waste movements (extractive and non-extractive wastes) will be retained by the Operator and made available for inspection by the Environment Agency on request.

10.6 Natural Gas or Oil

In the event of any unexpected release of natural gas or oil releases, the Environment Agency will be notified in accordance with the environmental permit requirements. Details of the quantities of unexpected releases will be recorded by the Operator along with the measures taken to manage them and made available to the Environment Agency on request.

10.7 Contractor Performance

Rathlin is ultimately responsible for any waste generated onsite during the operations and will not delegate its responsibilities or accountabilities as Operator to a contractor. Contractors, who are involved in the generating of waste and subsequent reuse, recycle or disposal will first have been selected in accordance with the Rathlin management system.

10.8 Security

Security of the wellsite will be provided in the form of a security fence and lockable access gates. The positioning of, both permanent and temporary equipment, will be within the confines of the security fence. During operations it may be necessary to have manned security. Manned security will control access and egress to the wellsite and will play a key role in the control of personnel in the event of an emergency situation.

10.9 Complaints

In the event that a complaint is received from stakeholders, including neighbours, the complaint shall be recorded and investigated in accordance with Rathlin's complaints process. Complaints relating to the environment will be reported to the Environment Agency within the required timescales, as determined by the severity and environmental impact of the incident initiating the complaint and/or permit conditions. In some cases, permit conditions will require notification to the Environment Agency within 24 hours or without delay for a potentially polluting incident.

Following notification, measures to prevent reoccurrence will be agreed with the Environment Agency, together with a programme for implementation. Implementation of the actions will be monitored and the Environment Agency informed.

11. ENVIRONMENTAL INCIDENT MANAGEMENT

The potential for an environmental incident to occur during the operation is minimal. The wellsite and operations undertaken therein are designed to contain the source of any such incident within the wellbore and/or the wellsite.

11.1 Containment within the Wellbore

Well control equipment is deployed on the well in accordance with API RP53 'Recommended Practice for Blowout Prevention Equipment Systems for Drilling Wells'. Primary well control is achieved by the hydrostatic weight of the fluid column in the wellbore. Blowout prevention equipment is considered secondary well control in the event that the primary well control is compromised and is subject to a schedule of certification and testing, together with a requirement for those operating the equipment to be certified competent.

11.2 Wellsite Containment

Incorporated into the design of the well site is a HDPE impermeable membrane. The impermeable membrane prevents surface fluids (mainly rainwater) from penetrating the underlying subsoils. Surface fluids migrate along the surface of the impermeable membrane to a perimeter ditch, where it is contained.

In addition, general spill containment and clean up equipment shall be provided onsite. In the very unlikely event of an environmental incident occurring beyond the capabilities of the equipment or personnel onsite then a specialist contractor will be called to assist Rathlin in dealing with the incident.

11.3 Fire Response

Whilst a fire is associated more so with the health and safety of the personnel onsite, a fire does have the potential to lead to an environmental incident. It is imperative, therefore, that any potential for a fire and subsequent emergency response is identified and included in the operational planning. The Site Safety Document, which is a requirement under Regulation 7 of the Boreholes Sites and Operations Regulations 1995, specifies the arrangements for identification and mitigation in the event of a fire, including consultation with the local Fire & Rescue Service.

Containment of any firefighting fluid is provided by the impermeable membrane incorporated in to the design of the wellsite. In the event that such requirements were to be necessary, continued monitoring of the containment ditch shall be implemented to ensure it does not exceed its containment capacity.

Additional water is available onsite and should be used to keep the areas adjacent to the fire cool to avoid any damage being sustained to the impermeable membrane.

11.4 Incident Reporting and Investigation

All incidents, no matter how minor, are reported in accordance with Rathlin's Incident Accident Reporting and Investigation Standard. The standard provides for the investigation of all incidents to ensure lessons are captured and actions implemented to avoid reoccurrence.

In addition, the standard provides for the notification to the relevant Regulatory Authority in the event of an incident which extends beyond the containment of the wellsite.

Environmental incidents will be reported to the Environment Agency within the required timescales, as determined by the severity and environmental impact of the incident and/or permit conditions. In some cases, permit conditions may require notification the Environment Agency within 24 hours or without delay for a potentially polluting incident.

Following notification, measures to prevent reoccurrence will be agreed with the Environment Agency, together with a programme for implementation. Implementation of the actions will be monitored and the Environment Agency informed.

12. ALTERATIONS TO THE PLAN

No changes to or deviations from this plan are to be implemented until the required changes or deviations have been reviewed and approved by Rathlin and the relevant approvals obtained in writing from the Environment Agency for any changes to the plans and operating techniques approved under the environmental permit to be issued.

Within the environmental permit there will be a requirement the Operator, Rathlin, to review the Waste Management Plan every five (5) years and amend where necessary. The review date shall take place five (5) years from the date of permit issue. Reviews and amendments will also be required in the event of a substantial change(s) to the operations taking place onsite.

In some cases, changes to operations may require the environmental permit to be varied in order to accommodate such changes. In this instance an application will be made to the Environment Agency to vary the existing permit or apply for a new permit.

13. PLAN FOR CLOSURE

Following the cessation of operations a decision may be made to close the site resulting in subsequent wellbore abandonment and wellsite restoration.

13.1 Well Abandonment

If a decision is made to restore the well site, the boreholes will be abandoned in accordance with Oil & Gas UK Guidelines for the abandonment of wells.

In addition to the Oil & Gas UK Guidelines for the abandonment of wells, the borehole abandonment(s) will be undertaken in accordance with the following regulations:

- The Borehole Sites and Operations Regulations 1995;
- Offshore Installations and Wells (Design & Construction Regulations 1996; and
- Petroleum Act 1998 (Petroleum Exploration and Development Licence).

Prior to any abandonment a full wellbore abandonment programme will be submitted to the HSE and the appointed Independent Well Examiner for review and examination. The wellbore abandonment programme does not form part of the Well Testing programme.

13.2 Well Site Restoration

All extractive waste brought to surface will be stored temporarily on site as detailed within Section 7.3 of this Waste Management Plan. No extractive waste brought to surface or non-extractive waste generated at surface shall remain onsite following completion of the operations.

The purpose of the site restoration is to ensure that the well site is returned to its former use, in a condition that is as close as reasonably practically possible to its original condition, prior to well site construction.

The well site will be restored following the abandonment of the boreholes and removal of surface equipment. Full details of the proposed well site restoration will be included within the Site Condition Report, which will be submitted as part of an application to surrender the environmental permit.