BROCKHAM OIL WELL

Waste Management Plan

Prepared for: Angus Energy Limited

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REVISION SCHEDULE

Revision	Date	Reason
0	May 2017	Original
1	February 2018	Revised to address Schedule 5 Notice dated 16th November 2017
2	June 2018	Revised to address Schedule 5 Notice dated 3rd May 2018

1.0 Introduction

SLR Consulting Limited (SLR) has been instructed by Enviro Resource Consultants Limited to prepare a Waste Management Plan in support of an environmental permit variation application for activities occurring at the onshore Brockham Oil Well in Surrey (the Site).

A Regulation 60 notice requesting information on activities taking place at Brockham Oil Well was issued as part of the Environment Agency's regulatory reviews with respect to regularising the permits issued to the onshore oil and gas sector. This process has identified the need for the following activities undertaken at the Site to be regulated as mining waste activities:

- Venting from oil storage tanks;
- Well workover operations (Hot Oil Wash and Acid Wash only); and
- Re-injection of produced waters.

This document is one of a series which have been compiled to support the environmental permit variation application. It has been written to be as self-contained as possible to facilitate review by the Environment Agency and hence repeats information contained in other documents.

In accordance with Article 5 of the Mining Waste Directive (MWD), this Waste Management Plan describes how extractive wastes will be minimised, treated, recovered and disposed of at the site.

This Waste Management Plan should be read in conjunction with the other documents submitted in support of the application.

1.1 Objectives

This Waste Management Plan demonstrates that the requirements of the EA guidance in Part C5 of the application forms and Onshore Oil and Gas Guidance[1] will be met.

Specifically, the EA guidance requires the plan to describe how the objectives as described in Article 5.2 of the MWD will be met and provide the information as required by Article 5.3 of the Directive.

The objectives of Waste Management Plans as described in Article 5.2 of the MWD can be summarised as follows:

- to prevent, or where this is not possible, reduce waste production and its harmfulness;
- to encourage the recovery of extractive waste in an environmentally sound manner; and
- to consider the design, management during the operation and post-closure of the site such that extractive wastes are disposed of safely in both the short and long term.

The information required to be included in the Waste Management Plan as described in Article 5.3 of the MWD can be summarised as follows:

- classification of the operation as Category A or otherwise;
- characterisation of the waste streams and estimated quantities to be produced during operations;
- a description of the process producing the waste;
- an environmental risk assessment;
- mitigation measures to be employed to prevent deterioration of water status in accordance with the Water Framework Directive and for prevention or reduction of soil and atmospheric pollution;

[1] Environment Agency – Onshore Oil & Gas Sector Guidance, Version 1 August 2016.

- control and monitoring procedures;
- closure plan; and
- a site condition report.

2.0 Operations

2.1 Site Location and History

The on shore producing oil well (the Site) is located approximately 1.6km south-west from Brockham in Weald Basin, just off Old School Lane, 2km east of Dorking in Surrey. The site is centred on National Grid Reference (NGR) TQ 18840 48672, the postcode for the site access is RH3 7AU. The location of the site is shown on Drawing HRA1 and the site layout on Drawing HRA2. The site is currently mothballed and there are no production activities taking place.

The drilling history at the site is complex with a number of wells, sidetracks to those wells and well renaming. A summary of the history is given in Table 1.

The first well at the site BRX1 was drilled in 1987 and has since been plugged but contains a sidetrack which is used as a water injection well; this well is now referred to as BRX3. A second production well BRX2 was drilled in 1998, this how now been plugged but contains a sidetrack well BRX2-Y which is a production well. It also contained a second sidetrack BRX2-Z which has been plugged. A third production well at the site BRX4 was drilled in 2007, this has now been plugged but contains a sidetrack well BRX4-Z drilled in 2017 which is a proposed future production well.

This Waste Management Plan will consider the mining waste activities associated with the operation of the following three active wells:

- BRX2-Y Production well sidetrack from BRX2;
- BRX3 Water injection well sidetrack from BRX1; and
- BRX4-Z Production well sidetrack from BRX4.

The management of extractive waste, not including a waste facility, generated from onshore oil and gas prospecting activities including drilling, coring, leak off testing (LOT), acid wash and decommissioning but excluding hydraulic fracturing for the production of oil or gas (using oil and water based drilling mud) has to date been regulated under a SR2015 No1 standard rules permit (ref. EB3604MZ/A001) but is being consolidated as part of this permit variation. It is proposed that the ongoing need for well workovers and decommissioning activities associated with prospecting will continue to be managed in accordance with the EA's WMP3 Waste Management Plan for the management of extractive waste not involving a waste facility, generated from onshore oil and gas prospecting activities of drill, core, leak off well testing, acid wash and decommissioning without well stimulation (using oil and waste based drilling mud). A copy of which is enclosed as Appendix 1.

Table 1
Summary of Wells on Site

Well	Date	Total Depth	Approx. range of Inclination (degrees from vertical)	Approx. Direction	Status and Description	Formation at Base
BRX1	15/08/87	2123.8 m bgl TVD	0 – 21.5 variable	South	Original production well plugged but includes sidetrack BRX3 used to reinject produced waters	Devonian/ Carboniferous
BRX2	26/04/98	761 m bgl TVD	0 – 56 variable 52 at TD	WSW	Second production well now plugged but includes sidetrack BRX2-Y which was a failed production well	Kimmeridge Clay
BRX2-Z	12/05/98	626m bgl TVD	0 – 95 variable 95 at TD	SW	Sidetrack from BRX2. Kicked off at 629 m rkb, failed production well, now plugged	Lower Purbeck Anhydrite
BRX2-Y	16/11/03	631 m bgl TVD	0 - 86.6 variable	SW	Sidetrack from BRX2Z. Kicked off at 629 m rkb operational production well	Portland Sandstone
BRX3	July 2007	736 m bgl TVD	Unknown	SW	Water injection well sidetracked from BRX1. Kicked off at 618.9 m bgl drilled to 750.2 m bgl TVD. BRX1 sealed by a 22.3m long cement plug.	Portland Beds (Unit 1)
BRX4	24/07/07	689 m bgl TVD	0 – 96 variable 89 at TD	SW	Third production well was intermittent producer now plugged but includes sidetrack BRX4-Z used as a production well	Portland Sandstone
BRX4Z	January 2017	1197m m bgl TVD	75 at kick-off 0 at TD	SW	Future operational production well	Oxford Clay

Notes: m bgl TVD metres below ground level true vertical depth

m rkb metres below rotary kelly bushing measured depth

2.2 Overview of Historical Operations

The site is currently moth-balled and there are no production activities taking place. Previously installed production equipment has been removed but the site's surfacing and containment infrastructure was retained.

Crude oil was extracted from well BR2-Y and BRX4 from the Portland Beds using 'nodding donkey' beam oil abstraction pumps (see Table 2 for well production depths). BRX4 has now been plugged but contains a sidetrack into the Kimmeridge Clay. The crude oil, a mixture of oil, gas and water was conveyed, when the site was in production, through the cellar wellheads into production tubing at the surface.

Table 2
Well Details

Well ID	Operation	Approximate Production Intervals (m bgl TVD)	Reservoir
BRX2-Y	Production Well	616.10 – 631.32	Portland Beds (limestone and sandstone unit)
BRX3	Injection Well	700.1 - 750.2	Portland Beds (Unit 1)
BRX4-Z	Production Well	The casing in the well is currently unperforated (see final well schematic in Appendix 03)	Not applicable as casing unperforated but intention is to produce from the Kimmeridge Clay

Water in the crude oil was allowed to separate out by gravity. This water was then pumped to a produced water tank before being re-injected into the oil reservoir via well BRX3.

A number of chemicals were added downstream of the cellar wellhead including: hydrogen sulphide (H_2S) scavenger to assist in reducing the H_2S content of the produced fluids to meet tanker specifications, demulsifier to separate the water-oil mixture produced from the reservoir, and pour point depressants to reduce the viscosity of the crude, particularly in cold weather and to prevent the formation of waxes.

The crude oil was temporarily stored on-site within one of 800-barrel ($128m^3$) capacity storage tanks allowing stabilisation (oil and water separation) via gravity. The combined storage capacity for oil at the Site was 3200 barrels ($512m^3$), the equivalent of 10 days' worth of production.

Once separated, the produced water was routed off from the bottom of the oil storage tanks towards a dedicated water storage tank (approximate capacity of 800 barrels ($128m^3$)). The produced oil was

pumped to an oil export tank where it was tested for water, H_2S and sediment content to ensure that it met tanker export and refinery acceptance specifications. The produced water was reinjected into the BRX3 well and the oil was exported by road tanker to the Hamble Refinery.

The displaced head space air from any of the tanks flowed to a vent stack via an ammonia filled vapour liquid separator. This removed any further H_2S. Permanent H_2S sensors were located on site, including on the vent stack itself, to ensure that the volumes are low.

2.3 Proposed Activities

Going forwards, it is proposed that production activities will recommence at the site. It is proposed that production will take place from the Portland Beds via well BRX2-Y and the limestone bands within the Kimmeridge Clay via well BRX4-Z with re-injection of produced waters via well BRX3 to the Portland Beds.

Looking forward to commencing production at the site, the site's surfacing and containment infrastructure has been refurbished and as such the site is provided with appropriate drainage, a bunded area for well production equipment and a separate bunded area for tanker loading and new electrical equipment.

At the time of writing (February 2018), the production facilities for production from BRX4-Z and re-injection via BRX3 have been designed but the design of production facilities for BRX2-Y are yet to be completed.

Please refer to the Kimmeridge Production Equipment Plan enclosed as Appendix 2 for information on the infrastructure to be in place to manage production from BRX4-Z.

To manage production from BRX2-Y it is anticipated that infrastructure similar to that proposed for producing from BRX4-Z will be installed.

Continuous monitoring of oil, gas and water rates, well head and separating conditions plus basic sediment and water (BS&W) and other basic parameters will be provided. Sampling points will also be provided to enable sample collection.

When production is re-started the following processes will be undertaken:

- The crude oil, a mixture of oil, gas and water will be conveyed through the cellar wellheads into production tubing at the surface.
- Water in the crude oil will be separated out in a three phase separator. The water will then be pumped to a produced water tank before being re-injected into the Portland Beds (Unit 1) oil reservoir via well BRX3.
- A number of chemicals will be added downstream of the cellar wellhead including: hydrogen sulphide (H_2S) scavenger to assist in reducing the H_2S content of the produced fluids to meet tanker specifications, demulsifier to separate the water-oil mixture produced from the reservoir, and pour point depressants (DAE Wax / Sludge Dispersant, 70-90% xylene) to reduce the viscosity of the crude, particularly in cold weather and to prevent the formation of waxes.
- The crude oil will be temporarily stored on-site within storage tanks allowing stabilisation (oil and water separation) via gravity.

- Once separated, the produced water will be routed off from the bottom of the oil storage tanks for re-injection into the Portland Beds (Unit 1) oil reservoir via well BRX3.
- Produced oil will be pumped to an oil export tank where it will be tested for water, H_2S and sediment content to ensure that it meets tanker export and refinery acceptance specifications.
- The displaced head space air from the oil and produced water tanks will flow to a vent stack via an ammonia filled vapour liquid separator. This will removed H_2S. Permanent H_2S sensors will be located on site, including on the vent stack itself, to ensure that the concentration is low.

Material data safety sheets for chemicals to be used at the site are provided in Appendix 3. All chemicals will be stored in the bunded area of the site.

2.3.1 Site Design

The site's layout is shown on drawing HRA2. And photographs of the site are provided in Appendix 4.

The site was recently extended and refurbished.

An impermeable membrane was installed as part of the refurbishment of the site. There are no records of the location of this membrane and an investigation was undertaken in February 2018 to determine its location and condition. Trial holes were excavated at the locations shown in Appendix 07 to expose the membrane and the pit was filled with water and left for a period of 24 hours to determine if it was water tight. The membrane was encountered in all holes except for locations 1 and 6 outside of the cutoff drain. It has therefore been proven to exist within the cutoff drain and was also found in a location to the west of the cutoff drain (location 11). The extent of the membrane is shown on in Appendix 5. The condition of the membrane was found to be good and infiltration testing indicates it is water tight. Infiltration testing of locations 1 and 6 excavated into the underlying clay strata, external to the membrane indicate that the clay underlying the membrane has a very low infiltration rate see Appendix 5).

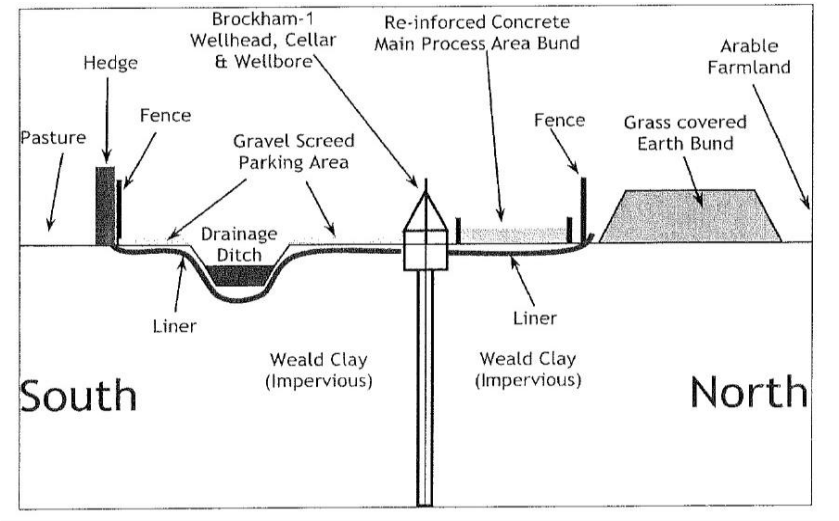

Figure 1
Schematic Site Cross Section

The main process area, including liquid storage (crude, chemicals and produced water) and process equipment, will be located in a reinforced concrete bund which meets CIRIA 736[2] specifications. The total capacity of this concrete containment bund is 485 m^3. Sufficient storage capacity for production will be provided in the event that tankers cannot visit the site. Diesel fuel for the electric power generator and chemicals for routine production operations will also be stored in dedicated tanks situated within the main process bund. The volume of the containment bund will be > 110% of the largest volume contained in a single container on site and > 25% of the total volume of stored liquids on site.

The operational area slopes towards an interceptor ditch to the west and south, constructed as shown in Figure 2. The ditch collects all surface drainage and rainfall from the lined wellsite footprint. The site catchment area is 5,000 m^2 and the interceptor is designed to contain runoff from this area. The interceptor discharges to the ditch on the southern boundary of the site, referred to above.

[2] CIRIA (2014). Design of Containment Systems for the Prevention of Water Pollution from Industrial Accidents. CIRIA 736.

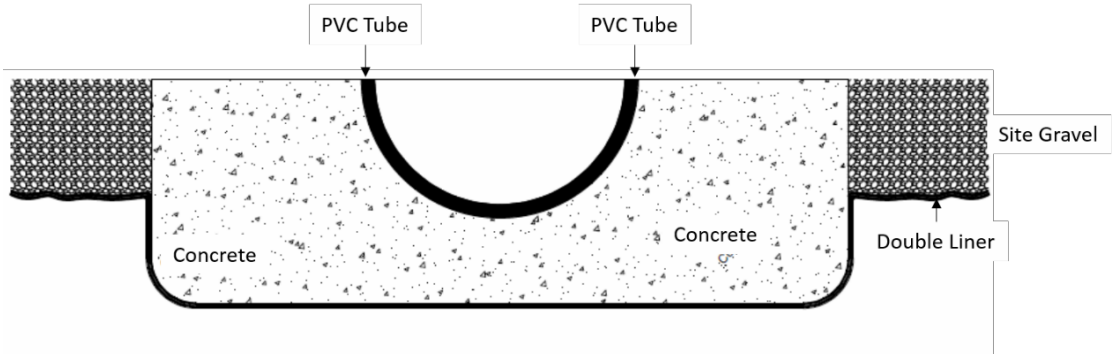

Figure 2
Drainage Ditch Cross Sectional Detail

During normal production operations any contaminated water (separated produced water fluids, water from bunds and cellars) will be reinjected into well BRX3. Uncontaminated rainwater will be discharged via an interceptor to a ditch to the south of the site (see Drawing HRA2). This discharge is controlled by a valve which remains closed unless there is high rainfall and the water is clean in which case it is opened and discharged from the site.

There are three principal containment areas at the Site:

- The well cellars, which will retain any oil spillages from pumping and pump maintenance operations;
- The tank storage area bund, which will accommodate the oil tanks and produced water tank and can be used for the storage of chemical dosing equipment. The bunds will also be used to store drums of oily wastes generated during maintenance activities; and
- Road tanker loading area, which will direct any spillages during transfer of oil and water from storage to the road tankers. The area may also be used for the storage of hydrogen sulphide scavenger, biocide and corrosion inhibitor dosing equipment and oily waste stored in drums.

2.4 Waste Generating Activities

2.4.1 Venting from Oil and Produced Water Tanks

The oil and produced water tanks include venting that enable the release of vapour and air from the tanks during filling and increases in temperature to prevent over pressurisation.

The pressure release vents discharge via a common stack incorporating vapour recovery via an ammonia filled vapour liquid separator. This recovers production fluids and delivers them back to the storage tanks.

2.4.2 Well Maintenance

To prevent a degradation of well productivity and the loss of abstracted fluids, well maintenance activities must be routinely carried out in the pumping system. This includes two operations:

- Flushing the well with hot oil. Similar technique to hot water flushing however abstracted crude oil is used.

- Acid treatment.

It is not proposed to use hot water washing at the site.

Hot Oil Wash

Various solids can crystallise out of well fluids in the wellbore and precipitate on the downhole equipment such as pumps, sucker rods and tubing. These deposits may include ashphaltines and paraffin waxes from the crude oil (some estimates suggest that up to 80% of oil wells globally suffer from wax deposition) and scales from any produced water in the well fluids. These deposits will foul pumps and block tubing if left un-remediated.

Methods of removing waxes, ashphaltines and scales include mechanical (scraping or jetting the deposits off), thermal (heating the waxes or ashphaltines) or chemical (dissolving the scales or waxes or ashphaltines). Wax or scale removal from downhole tubing and equipment is a routine operation, especially on low cost land wells where expensive inhibition methods or treatments are uneconomic.

As part of well maintenance, thermal treatment is the method adopted for the removal of waxes in the wellbore. Hot crude oil (from the target formation) is circulated around the well. Hot crude oil is used as it will dissolve the wax as well as melt it. While the well is producing, the hot oil is circulated down the 'A' annulus between the production casing and the tubing, in through the bottom of the tubing and then up the tubing to the surface.

Hot crude oil will enter through the bottom of the tubing. It is at the bottom of the tubing that the highest molecular weight, hardest to remove waxes precipitate, but it is the bottom of the tubing that receives the least heat input during hot oiling, so it is vital to circulate sufficient oil around the well to remove all the wax from the well. It is also essential that none of the wax-laden hot oil reaches the reservoir, as the wax may then precipitate in the reservoir causing severe, irreversible damage to the reservoir permeability. By keeping the well on production during the hot oil treatment, and by keeping the circulation pressure of the hot oil at the correct value, none of the hot oil will reach the reservoir.

The hot oiling does not produce any waste as the crude used to remove the wax is brought back up the wellbore and put in the storage stacks to be tankered away to a refinery.

Acid Wash

During the abstraction process scale from minerals in the produced water (primarily calcium carbonate) can deposit on rods, tubes, pumps and casing perforations. Chemical treatments are commonly used to remove scales from tubing. This scale is typically dissolved from the system by using a 15% solution of hydrochloric acid including a corrosion inhibitor (Protekt-15 Plus) (to protect steel tubing) to treat carbonate scales and a chelating agent such as EDTA to treat sulphate scales, known as an “acid wash”. The water carrying the dissolved scale is returned to surface and disposed of off-site. This operation does not involve the pressurisation of the circulating fluid so it does not therefore penetrate the reservoir.

There are no plans to acid wash, unless the wells do not flow, and hence the volume of acid required has not been calculated. However details are given below so that the proposed process is clear.

When the well is shut, so it is not producing, the calculated tubing volume of acid or a chelating agent (sometimes both) are 'bull-headed' or pumped into the tubing and then left to soak, reacting with the scales to remove them. As the scales are often a mixture of different minerals (calcite, aragonite,

barium sulphate, halite, iron sulphite etc.) the reactions can be complicated and the reaction products may be a gelatinous insoluble mass, so it is essential that the acid wash treatment does not reach the reservoir as permanent reservoir damage may occur; therefore only a tubing volume of acid is pumped during an acid wash. However as most scale deposition is pressure dependent rather than temperature dependent, scale often forms in the shallower parts of the tubing, so there is no need to pump large volumes of acid during an acid wash, and as the bullhead pressure is not high enough to force the acid into the formation, there is no risk of the acid reaching the formation.

To be clear, it is not proposed to undertake matrix acidisation or acid fracturing at the Brockham site.

The Material Safety Data sheets for the treatment fluids are provided in Appendix 3. Two chemicals are proposed for the acid wash; a simple HCl solution and an HCl solution with corrosion inhibitor.

Invasive Well Maintenance

While limited by the preventative maintenance measures outlined above, there will be instances where invasive well maintenance is required to be undertaken.

Typical mechanical failures include:

- Broken rod;
- Seized pumps; and
- Plugged tubulars.

2.4.3 Produced Waters

'Produced water' refers to all waters that are derived during the oil and gas extraction process. The water is primarily derived from the phase separator but may also include some water from tank drains and sumps. Due to drilling operations and the depth of the wells, the produced water is often highly saline and contains dissolved or emulsified hydrocarbons and suspended solids. No process chemicals other than those used for the extraction of hydrocarbons are permitted to be discharged to the Portland Beds (Unit 1) oil reservoir.

Angus Energy will be producing from the Kimmeridge and the Portland Beds. Estimates of the volumes of produced water have been made by Angus Energy based on the known typical water cut as described below:

- BRX2Y – 150 barrels of fluid at 60% water cut which gives 55-60 barrels crude and therefore 90 – 95 barrels of produced water.
- BRX4Z – 350 barrels of fluid with a maximum estimated water cut of 15% which gives an estimated 300 barrels of crude and therefore 50 barrels of produced water.

Total volume of estimated produced water per day is therefore between 140 to 145 barrels per day (or 22 to 23m^3/day).

Guidance provided by the EA states that the produced water should not be discharged to surface water or soakaway. Produced water must be reinjected into geological formations from which

hydrocarbons have been extracted, or those which the EA has designated as permanently unsuitable, as to allow further production of hydrocarbons.

Re-injection will be into the oil-bearing Portland Beds (Unit 1) strata via a dedicated well, which is fully segregated from any potable aquifer or casing layers. It should be noted that reinjection is itself considered

3.0 Waste Generation and Management

3.1 Waste Generation

This section identifies and estimates the quantities of extractive wastes which will be produced as a result of the operations at Brockham Oil Well. In addition, it describes how waste streams will be managed at the site.

The definition of waste is as described in the MWD and Waste Framework Directive as follows:

'"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'.

In accordance with Article 2.2(b) of the MWD, waste which is not directly generated as a result of the operations has been excluded from the assessment.

The production and maintenance operations at Brockham produce extractive wastes including:

- Gaseous wastes from venting of oil storage tanks;
- Produced waters; and
- Waste acid from acid treatment during well maintenance.

Table 4 identifies the volume and European Waste Catalogue (EWC) code of extractive wastes which are anticipated to be produced as a result of operational and maintenance activities at the site.

The management of extractive waste, not including a waste facility, generated from onshore oil and gas prospecting activities including drilling, coring, leak off testing (LOT), acid wash and decommissioning will continue to be managed in accordance with the EA's WMP3 Waste Management Plan. A copy of which is enclosed as Appendix 1.

Table 3
Generated Wastes

EWC Code	Hazard Status[3]	Waste Catalogue Description	Description of Waste Generated	Estimated Generation Volume (m^3 per annum)
16 05 04*	AH	Gases in pressure containers (including halons) containing hazardous substances	Gaseous emissions from oil and produced water storage tank vents	219
16 10 01*	MH	Aqueous liquid wastes containing hazardous substances	Produced water	8,030-8,395

[3] According to EA Guidance WM3 Guidance on the classification and assessment of waste, 1st edition, 2015 i.e. AN = Absolute Non-hazardous, MH = Mirror Hazardous, MN = Mirror Non-hazardous, AH = Absolute Hazardous.

EWC Code	Hazard Status[3]	Waste Catalogue Description	Description of Waste Generated	Estimated Generation Volume (m^3 per annum)
01 05 05*	AH	Oil containing drilling muds and wastes	Acid wash returns	30
17 04 09 17 04 10	MH	Metal waste contaminated with hazardous substances Cables containing oil, coal tar and other hazardous substances	Subsurface well equipment from work overs not contaminated with Naturally Occurring Radioactive Materials (NORM)	Unable to estimate*[1]

*[1]Well workovers will be limited to events to where an equipment failure necessitates invasive maintenance due to the complexity and expense associated with such operations. As a result, it is not possible to estimate the amount of waste generated from this activity.

3.2 Waste Storage and Handling

3.2.1 Venting from Oil and Produced Water Tanks

The oil and produced water tanks will include vents that enable the release of vapour and air from the tanks during filling and increases in temperature to prevent over pressurisation.

The pressure release vents discharge via a common stack incorporating vapour recovery via an ammonia filled vapour liquid separator. This recovers production fluids and delivers them back to the storage tanks.

3.2.2 Acid Wash

100% returns of the chemicals used in the acid wash, the simple HCl solution and an HCl solution with corrosion inhibitor, are expected. Upon return, the acid solution will be collected and transported off-site by tanker for treatment at a suitably licenced waste management facility.

Waste materials associated with this waste stream will be temporarily stored and handled at the site only so as to enable the collection and transportation of the materials off-site. Whilst the storage of the materials will be only temporary in nature, Angus Energy will employ measures to ensure that the wastes are handled in an environmentally sound and safe manner.

Throughout the operations, all wastes will be stored in secure containers that will be inspected at least once a day to ensure the following:

- that all waste types are segregated and placed in the correct containers;
- to prevent the overfilling of containers; and
- to prevent spillages occurring.

All storage containers will be stored within the area benefiting from secondary containment.

All storage containers will be removed by a registered waste carrier to an authorised waste management facility as soon as reasonably practicable.

3.2.3 Produced Water

At Brockham, water present within the crude oil will be allowed to separate out by gravity within a separator located within the bunded area before being pumped to a dedicated produced water storage tank. Produced water will also separate out from oil stored within the oil storage tanks.

Re-injection will be made via well BRX3 into the Portland Beds (Unit 1) at a depth of between 700 and 750m below ground level, which is fully segregated from any potable aquifer or casing layers. Re-injection will be undertaken as a groundwater activity.

Details of the sub-surface completion of the well are provided in Appendix 6.

3.2.4 Sub-surface Well Equipment from Maintenance Activities

Where possible the removed well infrastructure will be re-used for other well completions. If in the event it is not possible to re-use the equipment it will be handled as a waste material and tested for the presence of NORM using a portable Geiger counter. If it is established that the equipment exhibits concentrations of NORM requiring it to be handled as a radioactive substance then it will be segregated and temporarily stored on site in a secure sealed skip and managed in accordance with the conditions of the site's Radioactive Substances Activity environmental permit. The equipment will then be subject to additional laboratory testing of scale samples to identify and arrange removal to an appropriated licenced facility for its management and onwards recycling or, where not feasible, disposal.

Waste materials associated with this waste stream will be temporarily stored and handled at the site only so as to enable the collection and transportation of the materials off-site. Whilst the storage of the materials will be only temporary in nature, Angus Energy will employ measures to ensure that the wastes are handled in an environmentally sound and safe manner.

Throughout the operations, all wastes will be stored in secure containers that will be inspected at least once a day to ensure the following:

- that all waste types are segregated and placed in the correct containers;
- to prevent the overfilling of containers; and
- to prevent spillages occurring.

All storage containers will be stored within the bunded area benefiting from secondary containment.

All storage containers will be removed by a registered waste carrier to an authorised waste management facility as soon as reasonably practicable.

4.0 Site Classification

The site will be classed as a mining waste operation not involving a mining waste facility. This is because the waste streams generated will be stored at the site on a temporary basis and only so as to allow the collection and transportation of the materials from the site. In summary:

- generated non-hazardous wastes will be stored for a period not exceeding the 1 year threshold specified in the MWD; and
- generated hazardous extractive waste will be stored and removed from site as soon as reasonably practicable.

5.0 Waste Hierarchy

Angus Energy will take appropriate measures to ensure that:

- the waste hierarchy (referred to in Article 4 of the Waste Framework Directive) is applied in the generation of waste on site by the activities (see Figure 3 below);
- any waste generated by the activities is treated in accordance with the waste hierarchy; and
- where disposal is necessary, that it is undertaken in a manner which minimises its impact on the environment.

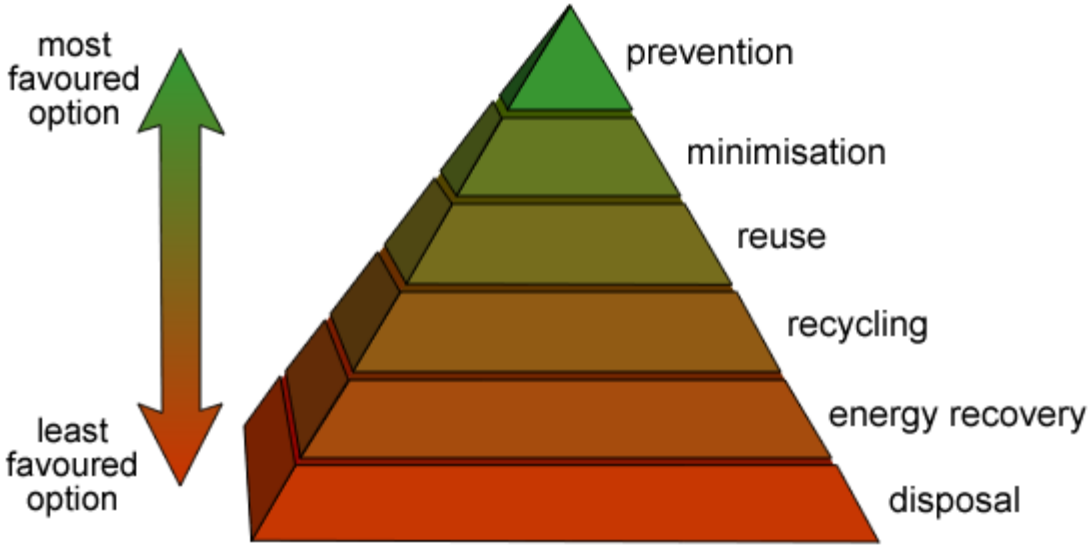

Figure 3 Waste Hierarchy

Figure 3 above illustrates the waste hierarchy, which will be applied by Angus Energy to the generation of waste. There are six possible methods of waste management, from the most favoured to the least favoured, with the prevention of waste being the most and the disposal of waste being the least.

Angus Energy will review and record at least every four years whether changes to those measures should be made and take any further appropriate measures identified by the review. Waste production will be avoided wherever possible. Any waste produced on site will be recovered, unless there are instances whereby it is not technically or economically practicable to do so.

All controlled waste will be managed in accordance with the duty of care requirements and sent to suitably licensed facilities.

6.0 Risk Management Measures

All appropriate measures will be employed to avoid pollution as a result of the operations. Further information on the measures to be employed at the site is available within the Environmental Risk Assessment included in the application.

A summary of the measures to be employed at the site are provided below:

- Staff will be trained on all stated procedures and plans prior to the commencement of work.
- Staff will be fully trained on all operational procedures prior to the commencement of operations to minimise the risk of accident.
- An Environmental Protection Plan will be in place prior to the commencement of operations.
- The site will be maintained seasonally for harmful weeds that may pose a danger to nearby agricultural land and flora/fauna or impact operations.
- There is a closed drainage system on site to prevent leachate off site.
- Emergency and Fire Response Procedures will be implemented prior to the commencement of operations.
- Spillage Procedures will be implemented prior to the commencement of operations whilst spillage response kits will be located on site for immediate response.
- Daily site inspections will take place to identify spillage of produced fluids.
- Regular inspections of pipelines, Pipeline Movement Surveys, weekly pipeline walks and thickness tests will be undertaken to ensure integrity of material and identify potential sources of spillages.
- Should a spillage or leak be identified, a suction tanker is on standby to empty cellars.
- All storage tanks contain inbuilt automatic shutdown valves to prevent overflowing or filling.
- All well service operations are supervised by fully trained staff.
- Wells will be serviced regularly and undergo hydrostatic testing and pressure tests to ensure integrity.
- Staff will carry out regular visual inspections of well cellar integrity to ensure suitability and provide secondary containment storage for well service chemicals.
- To minimise noise pollution all operations on site, including vehicular movement, are limited to daytime hours. Moreover a noise dampener is implemented on site to mitigate the impact of operations.
- A Waste Procedure and Site Operations procedure are implemented to ensure the correct disposal of equipment.
- Any equipment waste with unacceptable levels of NORM from well workovers is stored in secure sealed skips and sent on for laboratory testing to prevent contamination
- Storage tanks utilise chemicals such as Hydrogen Sulphide Scavenger to reduce the H_2S content of the produced fluids.
- H_2S is removed from gaseous emissions via ammonia vapour liquid separators inside the oil tank vent stacks.
- Emissions monitoring is in place to ensure H_2S remains below permit threshold.

7.0 Control and Monitoring

7.1 Spills and Pollution Control

The entire site will benefit from an impermeable secondary containment bund and drainage system.

An Environmental Prevention Plan will be in place to ensure that any material spilt on site will be contained and removed such that this minimises the potential for environmental harm.

Relevant staff will be trained in the deployment and use of spill kits prior to commencement of drilling operations. All equipment used on site for the movement of fluid materials will have spill kits available and be operated by or supervised by staff trained in their use.

The pipework and storage tanks of the drilling mud system will be inspected daily for leaks and damage. Where leaks or damage are identified the equipment will be immediately repaired or taken out of service. Any spills will be cleaned up and recorded.

Details of all spills/accidents will be notified to the EA in accordance with permit requirements.

7.2 Odour

The venting from oil storage tanks may give rise to odour if unabated. As such, ammonia filled vapour liquid separators are provided in the vent stacks which will abate odours associated with this source.

Additional measures will be taken to minimise all fugitive emissions which may cause odours including daily olfactory monitoring.

7.3 Waste Management

Records will be made of the quantity of waste materials removed off site. These records will be retained and made available to the EA on request.

7.4 Water Management

Records will be made of the volume of water collected, reused and disposed and made available on request to the EA.

7.5 Natural Gas or Oil

Angus Energy will notify the EA and HSE in the event oil or gas is unexpectedly released. Records made will include the volume of oil or gas released, along with measures taken. These records will be retained and made available on request to the EA.

7.6 Complaints

Complaints will be handled in accordance with the Angus Energy's Management System. Without delay, Angus Energy will record, investigate and respond to any complaint. Within three days Angus Energy will inform the EA and outline their plans to resolve the issue.

7.7 Site Closure Reporting

Monitoring information collected by Angus Energy throughout the site's operation will be used to update the site's Site Condition Report. The information will include:

- waste disposal records;
- waste storage records;
- spill records.

Once updated, the Site Condition Report will be used to support the site's surrender.

8.0 Proposed Plan for Closure

Upon closure of the site, the well will be abandoned in accordance with relevant legislation and guidance including the:

- EA Guidance: Developing a Management System, February 2016;
- EA Guidance: Controlling and Monitor Emissions for your Environmental Permit, February 2016;
- EA Guidance: How to Comply with your Environmental Permit. Additional Guidance for: Mining Waste Operations, February 2011;
- EA Guidance: Risk Assessments for your Environmental Permit, February 2016;
- EA Guidance H5: Site Condition Report Guidance and Template, May 2013
- EA Guidance: Onshore Oil and Gas Sector Guidance, November 2016
- A guide to the Borehole Sites and Operations Regulations, 1995;
- A guide to the well aspects of the Offshore Installation and Wells (Design and Construction, etc) Regulations 1996;
- UK Onshore Operators Group (UKOOG), UK Onshore Shale Gas Well Guidelines (Issue 1 February 2013)
- Oil and Gas UK Guidelines for the abandonment of wells, Issue 5, July 2015;
- Oil and Gas UK Guidelines on qualification of materials for the suspension and abandonment of wells Issue 2 October 2015;
- Oil and Gas UK Well Life Cycle Integrity Guidelines March 2016;
- DEFRA Guidance Note for control of pollution (Oil Storage) 2001;
- API standards; and
- The Applicant's production licence PL241.

Following site closure, the Applicant will prepare a Site Closure Plan that meets the requirements of the EA's How to Comply with your Environmental Permit guidance.

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