Angus Energy

Lower Stumble Exploration Site, Balcombe

Hydrogeological Risk Assessment

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RSK GENERAL NOTES

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Client: Freddie Holt, Angus Energy, Lower Stumble Exploration Site, London Road, Balcombe, West Sussex, RH17 6JH

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1 INTRODUCTION

1.1 Commissioning

RSK Environment Limited (RSK) was commissioned by Angus Energy Weald Basin No.3 Ltd (hereafter 'Angus Energy'), to provide a Hydrogeological Risk Assessment (HRA) to support a planning application for the proposed removal of drilling fluids and an Extended Well Test (EWT) on land at Lower Stumble Wood, Hydrocarbon Exploration Site, London Road, Balcombe, Haywards Heath, RH17 6JH (hereafter 'the site').The HRA forms an update to a previously issued Environmental Statement (ES) for the Site, which supported a previous planning application (ref: WSCC/040/17/BA).

This revised HRA has been produced following receipt of consultation from the Environment Agency (EA), dated 11 November 2019 (HA/2019/121694/01-L01), see Section 1.7.

This report is subject to the RSK service constraints given in Appendix A and limitations that may be described through this document.

1.2 Site history

The site has an established planning history, having been first used for exploratory drilling from 1986-1987 with the pad subsequently retained for use by Balcombe Estate (the current landowners) for forestry product storage.

The Balcombe 2Z Hydrocarbon Borehole was established in 2013 for gas and oil exploration, and the site has since been subject to several planning applications.

More recently, Angus Energy submitted an application for planning permission (planning ref. WSCC/071/19) in September 2019 for a two-stage activity, firstly to remove previously used drilling fluids from the wellbore, followed by an EWT to be carried out over a period of three years. This application was subsequently withdrawn.

1.3 Application details

The proposed work on the Balcombe 2Z Well will take place in four distinct phases, with planning and regulatory approvals at each phase. These are as follows, with Phases 1 to 3 discussed further in Section 4:

- **Phase 1 – Removal of Wellbore Fluids:** phase 1 of the works has been designed to remove wellbore fluids which are currently preventing the natural formation fluids from entering the well. This phase would effectively clean up the well in preparation for undertaking an EWT.
- **Phase 2 – Pad Membrane:** For the site to meet established onshore oil and gas standards, an impermeable membrane and perimeter bund will be installed by a civil engineering contractor within the area of the active well site.

- **Phase 3 – Extended Well Test:** The objective of the EWT is to enhance subsurface data so Angus Energy can start estimating potential production reserves, assess the commerciality of the well and obtain empirical data e.g. water cut data, flow rates and hydrocarbon composition. The EWT is a continuation of the exploration phase to prove that a hydrocarbon resource exists.
- **Phase 4 – Plug and Site Restoration:** Phase 4 involves removing all of the surface plant and equipment from the site as well as plugging the wellbore to the prevailing HSE standards. Upon completion the site will be restored, with 50% of the pad to become deciduous woodland in accordance with the High Weald AONB Management Plan 2019-2024.

In order to demonstrate exceptional circumstances and ensure that the development does not compromise the landscape qualities of the High Weald AONB, the proposal has been modified to decrease impact to visual amenity, and a habitat restoration plan will be implemented during Phase 4 of the operation. Please refer to the Landscape and Visual Appraisal and associated plans and drawings for further details.

1.4 Scope of works

The scope of works for the HRA has included the following, in order to sufficiently assess possible risks to groundwater quality/receptors during the above works:

- review the environmental setting of the Site and update any changes that may have been noted since the previous assessment was undertaken and reported as part of the previous ES (ref: RSK/MA/P661310-04-rev02)
- review the chemical test data for groundwater sampling on site between 2015 and 2019
- review the environmental permit issued by the EA
- review the proposed site layout including Phase 1, Phase 2 and Phase 3 infrastructure and ground conditions
- summarise the proposed site operations, including details of any chemicals proposed for use and storage, maintenance and operating
- review the details of design embedded mitigation measures and present details of proposed mitigation measures where these are considered necessary
- include as appendices, plans and chemical test data as appropriate

1.5 Existing reports

The following reports detailing previous site assessment and planning documents were made available for review:

- RSK. Balcombe 2z Hydrocarbon Well Testing, Environmental Report, Chapter 10: Hydrogeology and Pollution Control, RSK/MA/P661310-04-rev02, October 2017
- Angus Energy. Planning Permission, WSCC/040/17/BA, January 2018

- Heatons/Angus Energy. Planning Statement, Lower Stumble Exploration Site, London Road, Balcombe, West Sussex, RH17 6JH, September 2019
- EA. Lower Stumble Exploration Site off London Road, Balcombe, RH17 6JH. Environmental Permit Review Letter, WSCC/071/19, 11 November 2019

1.6 Consultation

As consultees to the planning application, the EA previously provided comments on their position and outlined the reasoning behind the stated position. The EA correspondence is dated 11 November 2019 (ref. HA/2019/121694/01-L01).

The EA stated that they had no objection in principal to the previously proposed Site development although they did present objection on the grounds of insufficient information being made available. The reason being that the proposal did not include an HRA, assessing risk to groundwater at the application stage.

The EA helpfully identified a previous risk assessment (RSK/MA/P661310-04-rev02, October 2017), which was completed in support of a historic planning application (WSCC/040/17/BA) and advised that that assessment appeared sufficient. However, the application related to a longer period of testing and so an updated assessment was deemed to be required.

2 SITE DETAILS

2.1 Background

The Site is approximately 8km south east of Crawley near the village of Balcombe. The oil accumulation within the underlying geological strata lies on the downthrown side of the Borde Hill Fault, with dip closure present both to the east and the west at Upper Jurassic Level. The field is positioned in a prime central location of the Weald Basin, where buried rock intervals are at their thickest, and oil source rocks at their most mature.

A discovery well (Balcombe-1) was first drilled in 1986 by Conoco, targeting the Great Oolite, Portland Sandstone and Kimmeridge limestones. Approximately 569m of Kimmeridge Clay was encountered in the well, including thick micritic limestone layers. Balcombe-2 and its associated side-track Balcombe-2Z completed drilling in September 2013 to a vertical depth of 670.5m, and horizontally through the Kimmeridge upper limestone to a length of some 522.4m.

Following approval of a 2018 planning application (ref: WSCC/040/17/BA), a seven day well test was completed on Balcombe-2Z. While on test, the well achieved a maximum metered flow rate of 254m^3/day (1,600 bbls/day) with a water cut averaging 6.63%, thus proving the presence of light moveable oil in the Kimmeridge Upper Limestone and the possibility to achieve commercially viable production rates.

During the flow periods, where oil was being produced to surface, the well eventually died and returns went back to being almost 100% water. Following post-test analysis, Angus Energy believe that the produced water is not formation water but drilling fluid that has remained in the well. The intention of the proposed Phase 1 operation is to remove this remaining fluid from the wellbore, after which oil may begin to be produced and the Phase 3 EWT will commence.

2.2 Site setting and description

The Site, often referred to as the Lower Stumble Exploration Site, is situated off London Road (B2036) approximately 800m to the south of the village of Balcombe and approximately 8km south east of Crawley. The Site covers an area of 0.58 hectares, comprising the surface pad and access road linking to London Road.

The Site is situated in a predominantly rural area and is bounded by the B2036 to the west, an area of forestry to the north and existing access is to the south and east. Further east is the London to Brighton railway line. The Site is surrounded by Lower Stumble Wood and Lower Beanham Wood, both of which have been designated as ancient woodland.

The present site construction comprises a crushed stone pad which accommodates the Balcombe-2Z borehole, a storage crate over the wellhead, several intermediate bulk containers (IBC's) of 1m^3 volume for liquid storage and a groundwater monitoring well. To prevent unauthorised access to the Site, two-metre high security fencing currently surrounds the Site on all sides.

There are no public rights of way effecting the proposed development with the closest public footpath approximately 0.5 kilometres northwest of the Site.

3 HYDROGEOLOGICAL RISK ASSESSMENT

3.1 Legislation, Policy and Guidance

The following policy and legislation are considered relevant to the assessment of potential impacts to groundwater and soils. A summary is given to the more significant legislation:

Directive establishing a framework for community action in the field of water policy - Water Framework Directive (WFD) (2000/60/EC) and the Groundwater Daughter Directive to the Water Framework Directive (2006/118/EC):

The WFD is designed to enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands that depend on the aquatic ecosystems, to promote the sustainable use of water, to reduce pollution of water, especially by “priority” and “priority hazardous” substances and to ensure progressive reduction of groundwater pollution. The WFD requires a management plan for each river basin be developed every six years.

- **Priority Substances Daughter Directive to the Water Framework Directive (2008/105/EC)**

  The Priority Substances Directive (PSD) 2008/105/EC is a “Daughter” Directive of the WFD, which sets out a priority list of substances posing a threat to or via the aquatic environment. The PSD establishes environmental quality standards for priority substances, which have been set at concentrations that are safe for the aquatic environment and for human health. In addition, there is a further aim of reducing (or eliminating) pollution of surface water (rivers, lakes, estuaries and coastal waters) by pollutants on the list. The WFD requires that countries establish a list of dangerous substances that are being discharged and an Environmental Quality Standard (EQS) for them. In England and Wales, this list is provided in the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. In order to achieve the objectives of the WFD, classification schemes are used to describe where the water environment is of good quality and where it may require improvement.

- **Water Resources Act (1991)**

  The Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009 updated the Water Resources Act 1991, which introduced the offence of causing or knowingly permitting pollution of controlled waters. The Act provides the EA with powers to implement remediation necessary to protect controlled waters and recover all reasonable costs of doing so.

- **Environmental Protection Act (1990: Part IIA)**

  Part IIA of the Environmental Protection Act 1990 (EPA) and its associated contaminated Land Regulations 2000 (SI 2000/227), which came into force in England on 1 April 2000, form the basis for the current regulatory framework and the statutory regime for the identification and remediation of contaminated land. Part IIA of the EPA 1990 defines contaminated land as ‘any land which appears to the local authority in whose area it is situated to be in such a condition by reason of substances in, on or under the land, that significant harm is being caused, or that there is significant

possibility of significant harm being caused, or that pollution of controlled waters is being or is likely to be caused'. Controlled waters are considered to include all groundwater, inland waters and estuaries; In August 2006, the Contaminated Land (England) regulations 2006 (SI 2006/1380) were implemented, which extended the statutory regime to include Part IIA of the EPA as originally introduced on 1 April 2000, together with changes intended chiefly to address land that is contaminated by virtue of radioactivity. These have been replaced subsequently by the Contaminated Land (England) (Amendment) Regulations 2012, which now exclude land that is contaminated by virtue of radioactivity; and The intention of Part IIA of the EPA is to deal with contaminated land issues that are considered to cause significant harm on land that is not undergoing development (see Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, April 2012). This document replaces Annex III of Defra Circular 01/2006, published in September 2006 (the remainder of this document is now obsolete).

- **Directive on the management of waste from extractive industries – Mining Waste Directive (2006/21/EC)**

  Directive on environmental liability with regard to the prevention and remedying of environmental damage - Environmental Liability Directive (2004/35/EC)

- **The Environmental Permitting (England and Wales) Regulations 2016. (2016 No. 1154)**

- **Offshore Installations and Wells (Design and Construction, etc) Regulations (1996)**

- **West Sussex. Joint Minerals Local Plan (July 2018)**

  The County Council is the mineral planning authority for West Sussex and is responsible for all mineral planning matters throughout the county. The plan identifies hydrocarbons as economic minerals that it seeks to allow production and management in a sustainable way. The plan identifies the Site (Balcombe) as being inactive.

  The plan presents the relevant strategic objective for oil and gas as being to protect the environment and local communities in West Sussex from unacceptable impacts of any proposal for oil and gas development, whilst recognising the national commitment to maintain and enhance energy security in the UK. The plan also highlights that planning permission is only one stage of the process of securing consent to drill and lists the other regulatory bodies that are involved in the process through consultation and who are assumed to operate as intended.

  Policy 26 (oil and gas exploration, appraisal and/or development) and Policy 27 (hydrocarbon exploration) of the previous Plan have been replaced by Policy M7 (Hydrocarbons). Policy M7 is split into 'a' and 'b' with Policy M7a referring to hydrocarbon development not involving hydraulic fracturing and Policy M7b covering hydrocarbon development involving hydraulic fracturing. Only Policy M7a is therefore relevant.

  Policy M7a states that proposals for oil and gas exploration and appraisal, including extensions to existing sites will be permitted provided that:

I. if the development is deemed to be major, the Site is located outside designated area unless exceptional circumstances can be demonstrated to be appropriate and it is in the public interest, and in accordance with Policy M13

II. the Site represents an acceptable environmental option in comparison to other deliverable alternative sites from which the target reservoir can be accessed

III. any unacceptable impacts including (but not limited to) those to air quality and the water environment, can be minimised, and/or mitigated, to an acceptable level

IV. restoration and aftercare of the Site to a high quality would take place in accordance with Policy M24 whether oil or gas is found or not

V. no unacceptable impacts would arise from the on-site storage or treatment of hazardous substances and/or contaminated fluids above or below ground

For sites in the production phase of operation, permission will be granted if they accord with (I-IV) above as well as there being no unacceptable impacts to arise from the transport of oil/gas and water consumables and waste from the Site.

3.2 Assessment Methodology

The assessment methodology follows that presented in the 2017 ES (RSK/MA/P661310-04-rev02) and includes an update to incorporate the revised site operations and baseline condition.

Once the updated baseline environmental conditions are established, the potential for the proposed development to generate environmental effects is assessed. This includes the potential impacts of the proposed works on the surrounding environment, specifically the groundwater regime and ground conditions from potential sources of contamination. The sources of contamination can be from the proposed works or they can already be present in the baseline environment and have an effect on the proposed works or the environment as a result of the proposed project being undertaken.

3.2.1 Magnitude of impact

For the assessment of potential impacts to groundwater and ground conditions the magnitude of potential impact at any of the identified sensitive receptors, as defined within the baseline condition, is set out in Table 1. It is worth noting that impacts can be beneficial to the Site and the surrounding area as well as adverse.

Table 1: Criteria grading for determining the potential magnitude of impact

Magnitude	Description
Major	Irreversible or long-term change well outside the range of natural variation where recovery could be protracted (>10 years) to a large area or an area remote from the development. Potential hazard to human health.

Magnitude	Description
Moderate	A change outside the bounds of natural variation to a large area or an area remote from the development, which will recover over a medium period of time (5-10 years)
Minor	A change within the bounds of natural variation to an area in close proximity to the Site, which will recover over a short period (0-5 years)
Negligible	A change well within the bounds of natural variation. No effect detectable or recovery within a short timescale (<1 year)
No change	No loss or alteration. Change does not affect fabric of asset, contribution setting makes to significance of asset, or extent to which significance can be experienced.

3.2.2 Sensitivity of receptors in the physical environment

In order to evaluate the relative sensitivity of receptors to the proposed works a reference list defining the degree of sensitivity is indicated in Table 2.

Table 2: Receptor sensitivity

Receptor Sensitivity	Surrounding Environment	Site End Users / Operators
High	Groundwater in principal aquifer and in an area with groundwater of high vulnerability and thin superficial cover material. Areas of contaminated land. Areas of previous mineral extraction or areas designated as safeguarded for mineral extraction. Areas of known/confirmed groundwater contamination.	Residential with gardens used for vegetable gardening. Allotments and other operations for growing plants for consumption. Groundwater used for potable consumption. Construction workers.
Medium	Groundwater in secondary (A, B or undifferentiated) aquifer and in areas with intermediate groundwater vulnerability and moderate superficial cover material. Soils with a moderate risk of damage during construction.	Public open-space and residential development with limited garden. Schools and playing fields. Buildings and building material
Low	Groundwater in non-aquifer and in areas with low groundwater vulnerability and significant cover of superficial soils. Soils with low risk of damaging during construction.	Commercial or industrial end use. Site construction plant.

3.3 Environmental Baseline

Environmental baseline data, which is considered relevant to hydrogeology and pollution control, is presented in part from publicly available data and site-specific information, from

works undertaken on site in 2013 and from April 2015 to July 2019. Baseline environmental data includes details about ground conditions (geology), potential sources of contamination, the hydrogeological regime and potentially sensitive receptors (human health and the environment).

3.3.1 Geology

According to the published geological map (solid and drift) from the British Geological Survey (BGS) – Sheet 302 (Horsham), the Site is underlain by Head deposits, which overlie the Wadhurst Clay Formation of the Hastings Beds. Head deposits are described as comprising poorly sorted gravel, sand and clay deposits derived from solifluction and/or hillwash and soil creep.

Two borehole records from the BGS have been obtained to confirm the shallow geology of the area. The general stratigraphy of the geology beneath the Site has been determined from a geological log produced from drilling 'the borehole' in 2013. The following data confirms shallow geology:

- Borehole referenced TQ32NW6[1] is located about 100m northwest of the Site. Completed in 1986 by G. Stow Co. Limited the borehole extends to 15.2m below ground (bgl). The log records Wadhurst Clay, described as blue clay and slates (0.0m to 10.6m bgl) and blue clay and mudstones (10.6m to 15.2m bgl). It is noted that the borehole record shows groundwater was struck at 21m bgl and rest water level was recorded at 3.83m bgl. There is uncertainty over the accuracy of the water strike measurement as the total well depth was recorded as 15.2m bgl.
- Borehole referenced TQ32NW7 (see Appendix B) is located approximately 650m north of the Site. Completed in 1933 this borehole confirms Lower Tonbridge Wells Sand to 75'6" (23.01m) and Wadhurst Clay for the remainder of the depth to 184' (56.08m). Water is recorded at 152' (46.33m) with a rest water level of 129' (39.32m). A pumping test was undertaken upon completion of the drilling works with a pump suction depth of 160' (48.77m) and a reported yield of 700 gallons per hour (3.18m^3/hour).

Two boreholes were drilled on site, including a vertical borehole and a directionally drilled borehole. Geological details collected during drilling operations for the vertical borehole (Balcombe 2z) have been used to confirm the geological succession, which is presented in Table 3.

Table 3: Generalised stratigraphic succession from Balcombe 2z borehole

Chronostratigraphy	Lithostratigraphy	Formation [EA aquifer designation]	Depth range
	Wealden Group	Wadhurst Clay [Unproductive]	0.0m – 50m
		Ashdown Beds [Secondary]	50m – 250m

[1] This borehole log was not available on the BGS mapping viewer when accessed in December 2019.

Chronostratigraphy	Lithostratigraphy	Formation [EA aquifer designation]	Depth range
Cretaceous (lower)	Purbeck Group	Durlston Formation [Secondary]	250m – 270m
		Lulworth Formation [Secondary]	270m – 470m
		Purbeck Evaporites [Secondary]	470m - 495m
Jurassic (upper)	Portland Group	Portland Beds [Secondary]	495m – 560m
	Kimmeridge Clay [Target formation]	Kimmeridge Clay [Unproductive]	560m – 820m

Note: The Kimmeridge Clay Formation contains two layers of micrite, called Kimmeridge I Micrite and Kimmeridge J Micrite at depths of approximately 760m bgl and 790m bgl respectively. Aquifer designations provided by the EA are indicated with the formation name.

The Wadhurst Clay formation is described as comprising soft, dark grey thinly bedded mudstones (shales) and mudstones with subordinate beds of pale grey siltstone, fine grained sandstone, shelly limestone, clay ironstone and rare pebble beds. The Ashdown Beds Formation comprises siltstones and silty fine-grained sandstones with subordinate amounts of finely-bedded mudstone.

The Purbeck Group, comprising interbedded mudstones, limestones and evaporates of marginal freshwater, brackish and marine origin is underlain by the Portland Group comprising layers of predominantly limestone with the lower parts predominantly dolomitic sandstones and sands with some mudstones/shales and thin beds or nodular layers of micrite.

The Kimmeridge Clay Formation is the target formation for the Balcombe-2z borehole and it includes mudstones with thin siltstone and cement stone beds and locally occurring layers of sands and silts. Micrite bands within the clay formation have been identified and the Balcombe-2z borehole extends within one of these bands (I Micrite) and the log records no significant faults or structures having been identified.

The rocks of the Weald are folded into a pericline with its major axis roughly from west-northwest to east-southeast and as a result of this pericline the oldest rocks are exposed at the centre away from which the rocks dip in all directions. Subsequent weathering has exposed sandstone ridges overlooking clay bottomed valleys. The structure of the Weald principally reflects the generally extensional regime of the underlying faulting of the Jurassic strata. Consequently, the Wealden strata are affected by valley bulge and cambering (particularly in the central Weald) and this process can locally cause great disruption of strata and groundwater flow through these disturbed sequences is very complicated.

Between 1000m and 1500m south of the Site are two regional faults, which trend in an east to west direction and both with downthrow to the south. The closest is the Pilstye Farm Fault and the farthest is called the Sidnye Farm Fault. The Pilstye Farm Fault truncates a series of north to south trending faults, one of which passes very close to the

Site. The BGS map (Sheet 302) provides no name for this fault. The faulting complicates regional groundwater flow with the juxtaposition of different aquifer units on either side of the fault to create a mixture of unproductive and highly productive planar features that are poorly investigated.

3.3.2 Hydrogeology

The Wadhurst Clay Formation separates the overlying Tunbridge Wells Formation (absent beneath the Site) and the Ashdown Formation. The Wadstone Clay is understood to act as an aquiclude, confining groundwater within the underlying Ashdown Formation, which is classified as a secondary aquifer at a regional scale. The primary recharge mechanism for the Ashdown Formation is direct recharge at outcrop owing to the overlying confining clay.

The hydrogeology of the Ashdown Formation is complex and not well understood. The aquifer is thought to be a stack of discontinuous layers allowing groundwater movement between and through them. The lack of correlation of water levels even between closely situated boreholes is a further indication of a patchy, multi-layered aquifer, without a single water table. This description is typical of the Lower Cretaceous/Upper Jurassic aquifers, which are dominantly sands or poorly cemented sandstones and water movement is principally through the matrix. As rock sequences, these strata comprise alternating sands and mudstones frequently forming multi aquifer systems although the layers are not always laterally extensive, which adds further to the complexity of the aquifer system.

The structural geology of the Weald has a significant influence on groundwater flow. Groundwater tends to flow down dip towards the axis of synclines and away from the axis of anticlines. The presence of faulting in the area causes large variations in water level, which have not been well studied or documented. For example, where faulting inhibits groundwater flow, rest water levels in boreholes either side of faults may be very different. Consequently, it is often difficult to predict the potentiometric levels in boreholes.

Beneath the Wealden Group is the Purbeck Group, comprising the Lulworth Formation and the overlying Durlston Formation. The lower part of the Lulworth Formation is dominated by a thinly bedded fine grained limestone with some marley layers and evaporates. Limestones of the Lulworth Formation are classified as Secondary aquifers on a regional scale containing water of limited importance for supply due to their very limited outcrop. Whilst fractured limestone within the Lulworth Formation have been recorded as high yielding close to outcrop, the formation at the Site is confined beneath 270m of overlying geological formations, including 50m of unproductive clay of the Wadhurst Clay. Any water present within the Lulworth Formation at the Site is likely to be very old and therefore of poor quality, with minimal or no resource value.

The Durlston Formation mainly comprises limestone and shales.

The Purbeck Group and Portland Group can logically be regarded as part of the same aquifer system where groundwater movement is generally intergranular with some fracture flow in the limestone horizons. Large volumes of water can be released from the fractured limestone although it can be very hard due to contact with the limestone and the evaporates and it is of limited importance for supply as the outcrop is very limited.

Background groundwater quality information from 2013 has been obtained by Ground Gas Solutions Ltd. (GGS) through the collection of a series of groundwater samples from a monitoring well located on the Site. It is understood that the monitoring well is screened within the Ashdown Beds (secondary A aquifer), which is confined by the overlying Wadhurst Clay (unproductive strata). The monitoring well is located within the southern part of the Site, which is assumed to be down hydraulic gradient assuming groundwater flow is to the south-southeast. GGS confirm the groundwater at this location is artesian.

GGS collected groundwater samples on four separate occasions during July and August 2013. They conclude from their data set that the majority of analytes are below the relevant quality criteria although for some determinants, particularly metals and sodium these criteria were exceeded. GGS conclude these values are indicative of potentially poor-quality water. It is unsurprising that the water quality in these strata is poor given the low yield and the lack of local connection to surface recharge mechanisms.

GGS also state the presence of dissolved carbon dioxide, methane and ethane and they identify the lack of current UK standards for these gases in groundwater but confirm the results are relatively elevated. The following range of dissolved gas results are presented by GGS:

- methane (CH_4) – 6.72-12.4mg/l
- carbon dioxide (CO_2) – 0.67-14.96mg/l
- ethane (C_2H_6) – 0.28-1.05mg/l

The Conoco well, drilled in 1986 (Balcombe 1) identified that the Ashdown Beds contained groundwater that has a relatively high methane and ethane concentration.

The following results were reported:

- methane (CH_4) – 54,000ppm (38.54 mg/l)
- ethane (C_2H_6) – 1,335ppm (1.79 mg/l)

In addition, the BGS has undertaken a survey of UK groundwater to establish background dissolved methane concentrations. The reported concentrations for the Ashdown Formation are approximately 0.05mg/l (70ppm), which is less than the concentration reported from the Conoco boreholes and from GGS in 2013. The GGS data and Conoco borehole (Balcombe 1) relate to the Ashdown Beds at roughly the same location but the exact position of the BGS borehole used to collect their data is not known.

More recent (2015-2019) background groundwater quality information was obtained from GGS, through groundwater monitoring. Samples were collected from the same on site monitoring well as per the monitoring undertaken in 2013 and the same sampling methodology was also adopted. This more recent period of monitoring covers the period before, during and after the well test of September 2018.

GGS collected three-monthly groundwater samples, typically in the months of January/February, April, July and October from 2015 to 2019. Monitoring comprised two rounds in 2015, one round in 2016, three rounds in 2017, four rounds in 2018 and three rounds in 2019. The results of each monitoring round are presented as ‘pre’ and ‘post’ purge values, i.e. samples taken both before and after the well volume having been purged. The data shows elevated concentrations of sodium, which is indicative of the poor

groundwater quality due to the nature of the geological formation. Aluminium concentrations peaked at 620µg/l in April 2018 as did dissolved zinc (342µg/l) concentrations. Dissolved iron (560µg/l) concentrations peaked in October 2016. These peaks were short-lived with recovery to background concentrations during subsequent round.

There are no licensed groundwater abstractions within 1km of the Site and the Site is not within a groundwater source protection zone (SPZ) and since groundwater quality is generally considered too poor for drinking in the area the relevant assessment criteria to compare groundwater quality data is the EQS values.

Background concentrations of zinc are generally above the EQS and the peak recorded concentration is below the DWS concentration. The peak zinc concentration is still lower than the relevant drinking water standard and most of the recorded zinc concentrations were greater than the EQS. Concentrations of aluminium were not recorded before 2018 and the highest recorded concentrations were recorded on the first round of monitoring. There is no EQS for aluminium, but the peak recorded concentration exceeded the DWS temporarily. Iron concentrations were mostly below the limit of detection but occasionally this was exceeded but none of the recorded concentrations (including the peak concentration) exceeded the EQS concentration.

None of the groundwater samples were found to contain hydrocarbons above the laboratory lower limit of detection.

As in 2013, GGS also record dissolved carbon dioxide, methane and ethane concentrations, although these analytes were only tested in the April and July 2019 samples. The following range of dissolved gas results are presented by GGS:

- methane (CH_4) – 0.001-17.57mg/l
- carbon dioxide (CO_2) – 19.67- 44.83mg/l
- ethane (C_2H_6) – 0.001-2.20mg/l

The Site is not within a groundwater safeguarding zone. These are zones that have been designated by the EA in which the use of certain substances must be carefully managed to prevent the pollution of raw water sources that are used to provide drinking water. The safeguard zones are an initiative between the EA and the water companies, and they are one of the main tools for delivering the drinking water protection objectives for the WFD.

According to EA data, shallow soils beneath the Site and in the immediate surrounding area have a low sensitivity to surface contamination.

The head deposits beneath the Site, which are very limited in aerial extent, are classified as a secondary (undifferentiated) aquifer, which is typical of units that have a variable hydraulic conductivity and where it has not been possible to fully characterise the rock. The thin ribbon of alluvium associated with the tributary to the River Ouse is classified as a secondary A aquifer, which is capable of providing localised base flow to surface water and local groundwater abstraction.

The Wadhurst Clay is classified as an unproductive aquifer due to its low hydraulic conductivity and negligible significance for water supply or river base flow. The shallower geological units (Lower Tunbridge Wells Sand) on higher ground to the northeast of the Site are classified as a secondary A aquifer. These aquifers are described as permeable

layers that can support water supplies and river base flow on a local scale only. Indeed, a spring-line is present at the base of the overlying Lower Tonbridge Wells Sand and is likely to represent under drainage from this unit.

3.3.3 Former land use

According to historical maps, the Site does not appear to have been previously developed (before the Balcombe 1 (Conoco) drilling works were undertaken in 1986). Lower Stumble Wood to the north and Lower Beanham Wood to the south may have been forested at some time but no other significant industry is understood to have taken place on site or within the immediate surrounding area.

3.3.4 Landfill

According to EA data there is a former landfill site approximately 660m north of the Site referred to as Oldlands Avenue landfill site. It is understood that the Site was operated between 31 December 1962 and 31 December 1984. The exact nature of waste imported onto the is unclear but the EA data shows this to include inert (e.g. glass, concrete, bricks, tiles, stones and soil), commercial (e.g. waste from trade premises, businesses, sporting facilities and recreation or entertainment venues) and household waste (e.g. waste dwellings of various types including houses, caravans, houseboats, campsites, prisons and waste from educational establishments).

Details of the site operator are not available, and the construction method used for the landfill is also unknown, i.e. it is not known if a base or cap layer has been engineered to limit leachate and gas generation. The landfill is located about 105m above ordnance datum (AOD), compared to the Site, which is located at 55m AOD.

3.3.5 Pollution

The EA data confirms the presence of a permitted industrial activity (code A30) on the Site for the mining and waste industry. The permit (reference - 400553) covers two time periods – calendar year 2013 and January to September 2014. The EA compliance rating scores for the two-time periods shows no breaches of the permit for the operational period.

3.3.6 Surface water

A tributary to the River Ouse flows northwest to southeast approximately 100m southwest of the Site. The tributary receives water from several springs in the area, which appears at the boundary of the Wealden Clay (impermeable) and the overlying Lower Tunbridge Wells Sand (permeable). The point at which the tributary enters the River Ouse is approximately 950m to the southeast of the Site.

The Site is within a surface water safeguard zone (SWSGZ4008), which is designated on the basis of risks from pesticides (Metaldehyde) and turbidity.

4 DEVELOPMENT PROPOSALS

4.1 Introduction

The proposed site development will take place in a phased approach and these are presented in the planning statement (Angus Energy, Planning Statement. Lower Stumble Exploration Site, London Road. June 2020). Generally, Phase 1 will comprise pumping operations, which are anticipated to take up to four weeks and will use a minimum amount of equipment. Assuming this is successful Angus would then move on to Phases 2 and 3, which includes the installation of an impermeable membrane in the proposed active well site surrounded by a containment ditch around the perimeter, and an EWT for approximately 12-14 months.

The well is currently suspended following the demobilisation of equipment after the Autumn 2018 well test. Pressures on the well are monitored. The level of proposed site equipment is unchanged from approved planning application ref: WSCC/040/17/BA.

4.1.1 Phase 1

The equipment for Phase 1 will include a pump, a surge tank, a storage tank for brine and a slops tank for any contaminated brine. A pressurised tank will also be on site for fluid export and vapour recovery. All the equipment will be located in a small bunded area adjacent to the well head and will comply with industry best practice guidelines.

A plan of the Site with the equipment set-up for Phase 1 is included in Appendix C.

The fluids produced from the well will pass through a control valve to the surge tank, which is there to control variations in flow rate. Fluids will then flow to the brine tank and any contaminated brine containing traces of oil will pass to the contaminated fluid tank. It is anticipated that the fluid pumping operation would take around seven days with equipment mobilisation and demobilisation either side of this. In total, Phase 1 could take four weeks.

Angus Energy intend to carry out the Phase 1 operation with the minimum equipment in order to minimise environmental impacts and reduce any disruption to the local environment. Ancillary equipment for Phase 1 will include a generator and a small welfare unit.

Once the well has been cleaned up and oil begins to be seen the Phase 1 operation will cease and the well suspended as per its current state before Phase 2 begins. During both operational phases all fluids will be trucked offsite to a licensed and approved facility.

4.1.2 Phases 2 and 3

Assuming Phase 1 is completed successfully, a 2mm impermeable membrane will be installed by a civil engineering contractor in the proposed active well site, which is to be surrounded by a containment ditch around the perimeter.

An EWT will commence once the impermeable membrane has been commissioned. The objective of the EWT is to ascertain whether commercial hydrocarbon rates can be achieved. The test will involve several flowing and shut-in periods to enable full analysis of the reservoir. It is intended that during the EWT the only equipment on the Site will be

the well test spread and storage tanks. However, should contingency options be required to aid the flow of the well, a coiled tubing unit would be mobilised. This is exactly the same set of equipment that was used during the Autumn 2018 work.

4.1.3 Proposed Equipment Details

The intention is to minimise our plant and equipment footprint. The reasoning for this is to keep a simple on site set up and to minimise disruption to the local community from HGV movements etc. Indicative equipment details are outlined below. An indicative site layout plan is also provided as part of the planning statement.

4.1.3.1 Phase 1 - Pumping remaining drilling fluids

There is no new equipment proposed compared to what was used in the Autumn 2018 well test. It is anticipated that there will be considerably less equipment on site given that the coiled tubing unit is not anticipated to be mobilised, but it remains part of the contingency planning. The following equipment would be on site for the Phase 1 pumping operation. This is a minimal well test package and tanks. All equipment will be bunded as per CIRIA guidelines.

- surge tank – low pressure separator
- associated pipework and manifolds
- oil and waste storage tanks
- linear rod pump
- vapour recovery tank (as per EA specifications)

4.1.3.2 Phase 3 – Extended Well Test

The following well test package will be mobilised for the Phase 3 (EWT)

- test separator unit, MAWP 1440 psig;
- on board data acquisition and reporting system
- associated pipework and manifold package
- surface ESD system
- choke manifold
- surge tank - second stage separator
- oil and waste storage tanks
- linear rod pump
- vapour recovery tank (as per EA specifications)
- Shrouded Flare Stack

4.1.3.3 Contingency equipment

The following equipment are not anticipated for the EWT, but they are considered as part of the contingency planning for the test duration.

Contingency (1) – Nitrogen Lift. If Nitrogen lift is required, the following additional equipment on top of the above list will be mobilised.

- coiled tubing (CT) unit including injector head and reel. Note the use of a CT unit is exactly the same as was used in the Autumn 2018 test
- nitrogen convertor
- 2 to 4 nitrogen tanks

If Nitrogen is not to be used via Coiled Tubing, the nitrogen will be discharged down the well via lines from commercially available racks.

Contingency (2) - Acid Wash with CT. If an acid wash is required, this will be done with the CT equipment as above, with the following additions:

- HCl acid truck (on site only for the day).

Contingency (3) – Inflatable bridge plug with CT. If a bridge plug is required, this will be run on the CT equipment as per Contingency (1).

4.2 Mitigation

This section presents the embedded mitigation that is already part of the site infrastructure design and the process methodology that will be adopted during the site works (Angus Energy Planning Statement, June 2020). The mitigation is designed to provide protection to human health and the environment, including soil quality and groundwater.

4.2.1 Environmental setting

The conceptual understanding of the geology beneath the site demonstrates a relatively complex structure, comprising faulted blocks with permeable strata juxtaposed against less permeable strata and fault lines acting as both planes of increased or reduced permeability. The Wadhurst Clay, which is 50m thick beneath the site, provides a layer of protection between the surface and the groundwater within the underlying Ashdown Beds. GGS has confirmed groundwater within the Ashdown Beds to be artesian and therefore an upward hydraulic gradient is established between these strata and shallow soils. The Ashdown Beds are classified as a secondary aquifer and groundwater quality may be low (saline) with poor sustainable yields therefore it is considered to have medium to low sensitivity. Groundwater within the vicinity of the site is not used for domestic or industrial water supplies and according to the EA the shallow soils are not considered sensitive to surface contamination.

4.2.2 Well integrity

The Balcombe 2z well is constructed using a series of concentric steel casing and cement sheathes with other mechanical isolation devices installed as part of the well construction process. The cementing programme is designed as a standard approach to providing life-of-well barriers, according to the Oil & Gas UK Well Integrity Guidelines. The construction of the well has been designed to prevent the migration or transport of fluids between different aquifer layers that are not normally hydraulically connected. The steel casing strings are run and cemented into place as each section of the well is being drilled. The cement forms an impermeable barrier between the rock and the steel casing and seals

up any conduit, which may connect different aquifer units or the ground surface that would normally be isolated by layers of lower permeable clay (e.g. Wadhurst Clay). The quality of the cement in the well has been verified by a CBL (Cement Bond Log) tool to ensure that all casing strings are cemented properly and provide sufficient isolation to the surrounding formations As the borehole is advanced through deeper drilling, smaller diameter steel casing strings are installed with additional layers of cement grout between the new and previously installed steel casing and the surrounding rock. The steel and concrete layers provide multiple layers of protection for aquifer units, each of which limits the likelihood that hydrocarbons from the target layer will migrate from within the well to shallower units.

4.2.3 Chemical fluids

Similar to the Autumn 2018 well test, the volume of maximum dilution of up to 15% hydrochloric acid (HCl), a non-hazardous substance to groundwater, is expected to be in the order of 20m^3. The diluted hydrochloric acid reacts primarily with carbonate solids to produce carbon dioxide and water. The wellbore was drilled through the Micrite which is an argillaceous carbonate. The argillaceous material is unaffected by HCl. The purpose of a “diluted acid wash” is to clean the immediate wellbore area and is considered only as a contingency option during the proposed site works. Typical radial penetration from the wellbore is less than six inches and can only be to natural permeability (in this case in the form of natural fractures). No fractures are induced hydraulically during this treatment.

For Phase 1, an impermeable membrane/bund (underlying felt liner overlain by High Density Polyethylene, HDPE and a second felt liner on the top) will be constructed on the site. The membrane will prevent vertical infiltration of surface water into the ground. Following a successful Phase 1, a new impermeable subbase will be constructed to prevent vertical migration of surface contaminants into the ground and to assist with the management of surface water on the Site. Details of the membrane/subbase are included in Section 4.2.4. Water falling onto the site is intercepted and directed to a collection chamber, from which it is pumped and removed off site. Water intercepted by the membrane includes rainwater, fire water and liquid spills, etc. The membrane will prevent water impacting shallow soils where it may have a negative effect on soil quality. The impermeable membrane and underlying 50m of natural clay along with the likely upward hydraulic gradient from the groundwater within the Ashdown Beds will also prevent water entering the secondary aquifer.

4.2.4 Basal liner

A fully engineered impermeable subbase is to be retrospectively installed, contingent upon the success of Phase 1. The fully engineered impermeable subbase construction plan is as follows:

- removal of the existing 300mm granular platform surface material, existing polypropylene geo-grid and existing geotextile
- if required, screen existing granular material, removing large cobles (>50mm dia.)
- a ‘V-Type’ perimeter containment ditch and HDPE impermeable membrane anchor berm surrounding the active area of the wellsite

- fully welded 2mm thick HDPE impermeable membrane laid across the active area of the wellsite and perimeter containment ditch
- protective geotextiles laid below and above the HDPE impermeable membrane to assist with puncture resistance
- fixing the HDPE impermeable membrane to existing concrete pad, which surrounds the Balcombe-2z drilling cellar
- twin-wall perforated pipe and rodding/jetting points laid within the perimeter containment ditch, above the HDPE impermeable membrane and protective geotextiles, back filled to finished platform level using 40mm single size granular material
- a connection from the twin-wall perforated pipe system to the existing interceptor and installation of isolation valves (up and down stream of interceptor) and a sampling point downstream of the interceptor
- a layer of extruded polypropylene geo-grid across the active area of the wellsite, above the HDPE impermeable membrane and protective geotextiles, for additional structural support
- 300mm thick layer of compacted granular material above the protective geotextile and geo-grid, providing the finished wellsite platform with nominal fall toward the perimeter containment ditch

The objective of the fully engineered impermeable subbase is to provide full hydraulic containment of the wellsite platform, preventing contaminated surface water and/or pollutants from entering the ground. Subject to obtaining the relevant surface water discharge permits from the EA, it also provides the ability to discharge 'clean' run-off water. For clarity, the pipework connecting the perimeter containment ditch to the interceptor needs to be included in the fully engineered impermeable subbase, thus future proofing the containment system, negating the need to modify the system at a later date (if the Site continues to operate, subject to future consents).

Key to the robustness of the proposed containment system and to provide protection for the underlying groundwater a construction quality assurance (CQA) plan will be prepared for the retrospective installation of a fully engineered impermeable subbase. The CQA plan will be developed in conjunction with the specialist installation requirements of the HDPE impermeable membrane manufacturer and construction contractor. A British Geomembrane Association (BGA) specialist sub-contract installer with the relevant Thermal Welding Institute (TWI) experience and qualifications shall be appointed to install the HDPE impermeable membrane.

As a minimum, the CQA plan will contain the following:

- seam and weld testing of the liner
- air testing of the liner welds, spark test over panel before covering
- liner panel layout plan, showing joint locations, roll number, repairs and penetrations etc.
- air testing of drainage ditch to interceptor and discharge;

- in-situ plate bearing tests on prepared subgrade and platform following pre/post installation
- as-built topographic survey on completion of the installation works.

For Phase 1, a temporary bund will also be constructed and lined with an impermeable membrane on which all equipment will be located, adjacent to the well head. The design and materials used for the bund will be the same as constructed for the original well test in Autumn 2018. Within the bunded area timber bog mats will be laid to provide a stable platform on which to position equipment and to maintain integrity of the barrier during the short pumping phase. The area and height of the containment will be built to comply with the CIRIA 736 (2014) guidance which requires a bund to be of 110% of the volume of the largest tank or 25% of the total capacity of all tanks whichever is the greater. If Phase 1 is successful, this temporary containment will be removed, and the Phase 2 containment described above will be constructed.

4.2.5 Chemical storage

The storage of diesel and other fuels, which may be required to power site equipment such as pumps and generators, etc will be undertaken in accordance with the Control of Pollution (Oil Storage) Regulations (2001). The storage containers will be double skinned so that leaks will be contained within the tank construction. The tanks will be inspected daily for the occurrence of leaks or water entering the secondary containment. All storage containers will be labelled with the capacity of the tank and its content. No fuel will be stored underground.

All refuelling operations will be undertaken during day time hours and by a person qualified to undertake the works. This will prevent overtopping from occurring. A secondary containment will be located below the fuel lines or temporary storage container spill to prevent spillage of fuels to ground and a spill kit will also be present at all times in the event that a spill occurs. The mobile secondary containment units will be removed immediately after use to prevent a build-up of rainwater, which will reduce the efficiency when they are used during fuelling operations.

All liquids removed from the test well (brine solution and contaminated brine from Phase 1 drilling fluid pumping, spent acid (<10% solution), if required and predominantly oil from the Phase 3 EWT) will be collected and stored in individual containers, which will be located on the impermeable membrane and within the temporary bund. The containers will be labelled and subject to the site liquid management policy. They will be checked daily for integrity until their removal from site for disposal. Any spills or leaks from these containers will be captured by the site drainage system, which is above the impermeable membrane and the liquids will be diverted to the collection chamber where they will be removed and removed from site for disposal. No spilled liquids on site will enter the underlying soil or groundwater.

To reduce the likelihood of stored chemicals impacting the ground all liquids that could adversely impact the environment will be stored in accordance with the manufacturers recommendation and will include the use of bunds and drip trays. All drip trays will be routinely inspected for liquid contents and emptied as necessary to maintain an adequate detention volume should spills or leaks occur. Material safety data sheets (MSDS) from the supplier will be retained on site for use in an emergency and safety procedures,

including tool box talks will be provided to all site staff to raise awareness of actions to be taken in the event of an incident.

Again, during all operations tanks will be emptied by an approved waste removal company and trucked to a similarly approved facility. At the end of the operation the tanks will then be professionally cleaned and returned to the contractor. The very same pressurised tank that was used during the initial Autumn 2018 well test will also be installed for vapour recovery in compliance with our obligations as outlined in the wellsite EPR permit under The Environmental Permitting (England and Wales) Regulations 2016.

4.2.6 Emergency response – fire

The Site has an emergency response procedure in place, and this will be implemented in the event of a fire. Should any emergency situation occur, the well would be instantly shut in at the wellhead. The adoption of normal emergency procedures applicable to oilfield operations ensure compliance with the UK onshore environmental and safety control regime. Site specific emergency response procedures are in place in consultation with the emergency services and tested prior to the commencement of any work.

It is likely that any fire on site will be tackled through the use of water. Fire-fighting water will initially be contained on site and directed to the collection sump. A 24-hour emergency spill response contractor will bring a tank to site to assist the emergency services so that all water from within the Site can be removed for off-site disposal. The tanker will operate as long as fire water is being generated and as long as disposal or storage of water is required.

4.2.7 Groundwater monitoring

GGS groundwater monitoring was undertaken at a maximum of four times per year from 2015-2019 and satisfied the monitoring frequency of three monthly, as outlined in Table S3.2 of the 2016 Environmental Permit (EPR/GB3609KQ/T001). Water samples were collected utilising an inverted Volatile Organic Analysis (VOA) sampling methodology to prevent the de-gassing of dissolved gases from the water at surface.

The same monitoring well will be used for ongoing monitoring throughout the proposed operations.

The following information will be collected:

- dissolved carbon dioxide, heavy metals, strontium, earth metals, dissolved ethane, dissolved methane, dissolved propane, dissolved butane, ammoniacal nitrogen, nitrite and nitrate, BOD, COD, pH, salinity, total dissolved solids, total petroleum hydrocarbons, total suspended solids

4.2.8 Land quality

Soils samples were taken at the Site prior to any development works taking place. The purpose of this baseline sampling was to determine the soil quality prior to the proposed works. Upon completion of all site works, including decommissioning and the removal of the basal protector layer, additional soil samples will be collected to confirm the nature of the soil quality. The results from the chemical analysis will be assessed against current standards that are appropriate to the proposed end use of the Site and the results will be

provided to the EA as soon as practicable after the assessment. The following analysis is envisaged, and it will be presented to the EA for approval before the sampling commences:

- metals, pH, total petroleum hydrocarbons

4.3 Predicted Effects

Embedded mitigation, which is incorporated into the Phase 1 to Phase 3 operations are designed to significantly reduce the potential impact on site soils and underlying groundwater. Hazardous substances will be stored, used and produced on site and the proposed mitigation is designed to prevent these chemicals from entering the ground and subsequently migrating to controlled waters (groundwater and surface water).

Accidental spills from mobile chemicals that are either being used or stored on site will be contained within the proposed basal liner and perimeter bund and they can be controlled from the collection sump. It is envisaged that stored chemicals will include fuel, hydrochloric acid ($20m^3$), water/hydrocarbon mix and spent chemicals, etc. Impact to soils from surface contamination is unlikely to occur as the basal liner and perimeter bund will prevent mobile chemicals from penetrating into the ground. In addition, the underlying 50m thick natural clay layer, which has a low permeability and low sensitivity to surface contamination will also limit the vertical migration of mobile contaminants. The upward hydraulic gradient will also prevent dissolved contaminants from penetrating a significant depth into the clay. The impermeable membrane installed on the Site for Phase 3 will be constructed by competent contractors and the membrane integrity will be confirmed through a rigorous quality assurance process requiring mitigation to be implemented if defects are discovered. The membrane will not be certified as suitable until any identified defects are rectified.

Other mitigation measures are in place to control the safe storage and use of chemicals on the Site as well as the management of water levels above the impermeable membrane. The indirect consequence of mobile contamination affecting shallow soils may result in a lateral spread of these chemicals with an anticipated minimal penetration into the clay. The EA has classified the soils in the area as having a low sensitivity to surface contamination.

The proposed mitigation measures described above, along with the natural geology and groundwater regime beneath the Site means that the magnitude of the predicted effects from surface contamination is likely to be temporary and easily dealt with during decommissioning (i.e. reversable). The likelihood of surface contamination or hazardous chemicals effecting groundwater within the underlying secondary aquifer is very low.

The duration of the proposed Phase 3 (up to 12-14 months) is unlikely to be significant since the basal membrane and bund integrity will not be affected by the proposed timescales and the implementation of ongoing monitoring as required by the permit will allow any changes in groundwater quality to be monitored through the testing phase.

Hydrocarbons and dissolved gases are already present within the Kimmeridge Clay (target formation for the test bore) and the overlying Ashdown Beds (determined by the EA, the monitoring well on site and the Balcombe 1 borehole (Conoco borehole)). Release of gas into the surrounding geology is unlikely to occur due to the mitigation from the well

design (steel casing and cement sheaths), which have been proven to have good integrity from the results of CBL testing. The construction of the well is entirely directed to prevent the migration or transport of fluids between subsurface layers of impermeable rock formations that lie between the hydrocarbon producing formations and the shallow groundwater. Therefore, the magnitude of change is likely to be negligible or minor and any residual effects over the medium to long term will also be negligible. Due to the low sensitivity of the aquifer and the low likelihood of impact occurring it is unlikely that the magnitude of the impact will exceed low/moderate.

Acids are not presently found in the formations naturally so release from the test bore, should Contingency 2 be required, will have an immediate and direct impact to the surrounding rock – this is planned and an intended interaction. The construction method and proven well integrity from the CBL shows that acid release into non-targeted formations is unlikely. However, the nature of low sensitive formations is such that if the release is within the Wadhurst Clay the impact would be extremely limited in extent from the well and therefore the effect would be of negligible magnitude and occurring for a medium period of time. The likelihood of diluted acid being released in to the clay is very low.

4.4 Conclusion

Shallow soils are classified by the EA as having a low sensitivity to surface contamination. The presence of an impermeable membrane and perimeter bund beneath the area of the active well site and the implementation of liquid management plans on site will also significantly reduce the likelihood of impacting shallow soils. The integrity of the impermeable membrane is to be checked following construction through implementation of a quality assurance process and so any impact of shallow soils is likely to be extremely limited in aerial and vertical extent and easily characterised and managed during the Site decommissioning.

Although the underlying geology and groundwater movement beneath the Site is relatively complex it is not locally used for economic purpose and the EA states it has a low sensitivity to surface contamination. All the proposed mitigation measures embedded into the well design will reduce the likelihood of liquid or gaseous escape into the surrounding formations. However, these formations already contain similar material as that proposed to be extracted and therefore additional non-hazardous chemicals in significant quantity are not being injected into the formation. The Phase 1 removal of drilling fluids is very short (up to four weeks) and the Phase 3 EWT is for a relatively short period (up to 12-14 months). The well construction has a design lifespan far in excess of the 12-14 months of the test and therefore risks to groundwater from failed well integrity are considered to be very low. Therefore, any predicted effects on the deeper geology and groundwater quality are likely to be negligible despite them potentially being permanent.

Groundwater monitoring in accordance with the environmental permit will be ongoing and this will allow the Site operators and the regulators to continually assess the groundwater quality during the proposed development phases.

Any predicted effects on shallow soil conditions will be localised and easily managed during sampling and assessment within the decommissioning phase of the proposed development. Groundwater quality is already impacted by dissolved gasses and saline

conditions, which are natural characteristics of the aquifer material. These characteristics generally prevent groundwater from being utilised. There is a very low likelihood of groundwater impact from the development and this will be monitored and managed during the work and as part of the decommissioning with the full engagement of the EA during all phases of the project.

FIGURES

529000 530000 531000 532000 533000

130000 129000 128000

Little Coopers Cottage
B2036
Haywards Heath Road
Southfield Gill
123 West Hill
The Mill House
Mill Lane
Pearment's Farm
West Hill
Studio Cottage
Westup Farm
Rocks Lane
Balcombe
Balcombe
Furzefield
Brook Cottage
Northlands Wood
Brook Cottage
Kemps Farm
Unitroy Cottages
Rowhill House
Rowhill Lane
London Road
Northlands Farm
Washlands Farm
Bowder's Farm
North Lodge
Balcombe Place
Garden Cottage
Ardingly Reservoi
White House Cottages
New Barns
White House
Upper Pilstye Cottages
B2036
Batchelor's Cottages
Haywards Heath Road
Stonehall Farm
Pilstye Farm
Sidnye Cottages
Sidnye Cottages
Sidnye Farm
Cherry Lane
Wharf Cottages
River's W
Bordehill

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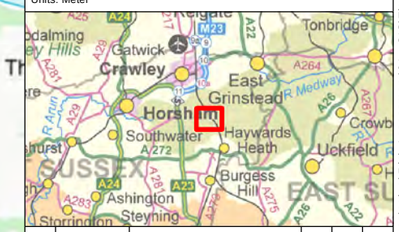
Legend:

Site Boundary - Above Ground Works

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter



Rev	Date	Description	Drn	Chk	App
00	02/12/2019	First Draft	DR	JS	GS

Angus Energy
Lower Stumble Hydrogeological Risk Assessment

RSK

TITLE:
Figure 1:
Site Location Plan

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Kilometres
SCALE: 1:12,500 @ A3

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APPENDIX A
SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Angus Energy (the "Client") in accordance with the terms of a contract between RSK and the Client, dated 26 November 2019. The Services were performed by RSK with the reasonable skill and care ordinarily exercised by an environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the Client.
2. Other than that, expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed in writing, the Services were performed by RSK exclusively for the purposes of the Client. RSK is not aware of any interest of or reliance by any party other than the Client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.**
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK 's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the Client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the Client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, invasive plants, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials, unless specifically identified in the Services.
7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a visual inspection of the site together with RSK's interpretation of information, including documentation, obtained from third parties and from the Client on the history and usage of the site, unless specifically identified in the Services or accreditation system (such as UKAS ISO 17020:2012 clause 7.1.6):

a. The Services were based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely.

b. The Services were limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the visual inspection.

c. The Services did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services.

RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the Client and RSK.

8. The intrusive environmental site investigation aspects of the Services are a limited sampling of the site at pre-determined locations based on the known historic / operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the properties of the materials adjacent and local conditions, together with the position of any current structures and underground utilities and facilities, and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters (as stipulated in the scope between the client and RSK, based on an understanding of the available operational and historical information) and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (intrusive and sample locations etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.

10. The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels and ground gas concentrations and flows, may vary from those reported due to seasonal, or other, effects and the limitations stated in the data should be recognised.

11. Asbestos is often observed to be present in soils in discrete areas. Whilst asbestos-containing materials may have been locally encountered during the fieldworks or supporting laboratory analysis, the history of brownfield and demolition sites indicates that asbestos fibres may be present more widely in soils and aggregates, which could be encountered during more extensive ground works.

12. Unless stated otherwise, only preliminary geotechnical recommendations are presented in this report and these should be verified in a Geotechnical Design Report, once proposed construction and structural design proposals are confirmed.

APPENDIX B
GEOLOGICAL INFORMATION

RECORD OF ... TQ 32 NW + "30" TQ32/32

at (house or farm) Oldland Nurseries 1" N.S. 9

Town, Village, &c. Balcombe County Sussex 1" O.S.

Six-inch map TQ 32 NW

Exact site (unless a tracing from a map is supplied, give distance and direction from parish church, cross-roads, or other object shown on maps).

Popular Edition of one-inch map (Sheet ... Square ...)

Surface level of ground ... ft. above Ordnance Datum. Well or Bore commenced at [?] 20 ft. below surface level of ground. 60

Sunk ... ft., diameter ... ft. Bored 184 ft.; diameter of boring: at top 6 in., at bottom 6 in.

Details of lining tubes (internal diameters preferred) 142 ft. of 6 in. I.D. GR 3099 2998

Water struck at depths of (feet) 152

Rest-level of water below top of well or bore 129 ft. Pumping level 150 ft. Time of recovery — hours.

Suction at 160 ft. depth. Yield: (i) on test 700 galls. per hour, (ii) normal 700 galls. per hour

Quality (attach copy of analysis if available)

Made by H. Richards & Co. for Mr. A.G. Vinten Date of boring April, 1933.

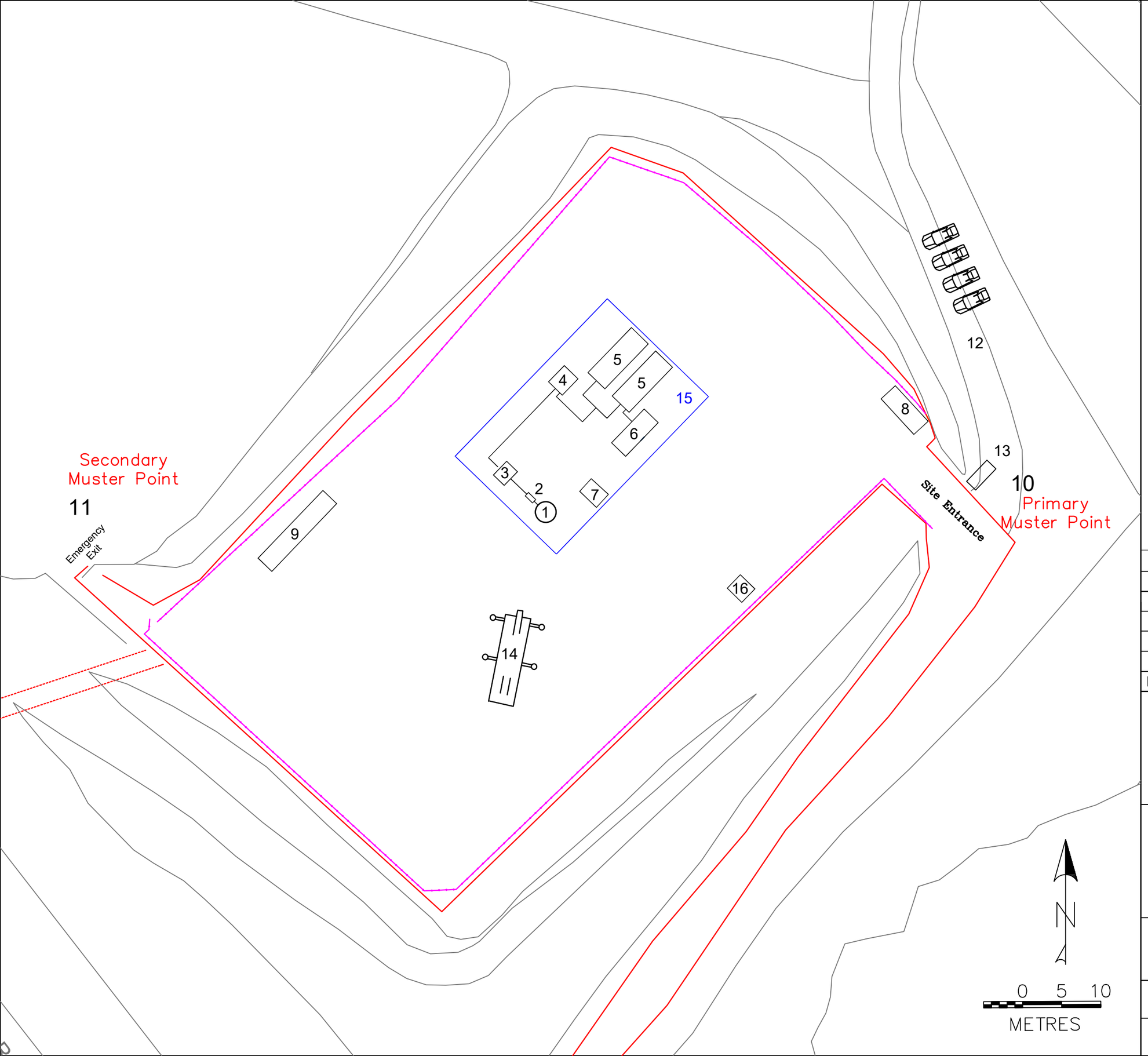
Information from do do.

(For Survey use only). GEOLOGICAL CLASSIFICATION.	NATURE OF STRATA. (and any additional remarks)	THICKNESS. Feet.	THICKNESS. Inches.	DEPTH. Feet.	DEPTH. Inches.
Tunbridge Wells Sand	Sandstone	54	.	54	.
	Sandy clay	5	.	59	.
	Sandstone	16	6	75	6
Wadhurst Clay	Clay	5	.	80	6
	Clay with layers of sandstone	20	6	101	.
	Light blue clay	6	6	107	6
	Dark blue clay	14	6	122	.
	Light brown clay	8	.	130	.
	Blue clay & sandstone in layers (signs of water)	22	.	152	.
	Dark sandy clay.	32	.	184	.

6" 15 SW. E. O.D. 350
Boring in pit 20 feet below that level
visited F. Buchan 21·2·40.

GEOLOGICAL SURVEY AND MUSEUM, For Survey use only. ... M of U. Site marked

APPENDIX C
SITE PLANS



Legend

- Site Boundary - Above Ground
- Site Boundary - Below Ground Works
- Fence
- 1 Borehole
- 2 Surface Safety Valve
- 3 Choke Manifold
- 4 Surge Tank
- 5 StorageTank
- 6 Vapour Recovery tank
- 7 LRP Power Pack
- 8 Security Office
- 9 Welfare Cabin
- 10 Muster - Primary
- 11 Muster - Secondary
- 12 Car Parking Area
- 13 Smoking Area
- 14 Mobile Crane
- 15 Bunded Area 28m x 18m
- 16 Workshop

REV	DESCRIPTION	DATE	Checked
0	For Review	18-09-19	HSF

HSF
DELIVERING EXCELLENCE

Project:
Balcombe 2z
Pumping Operation

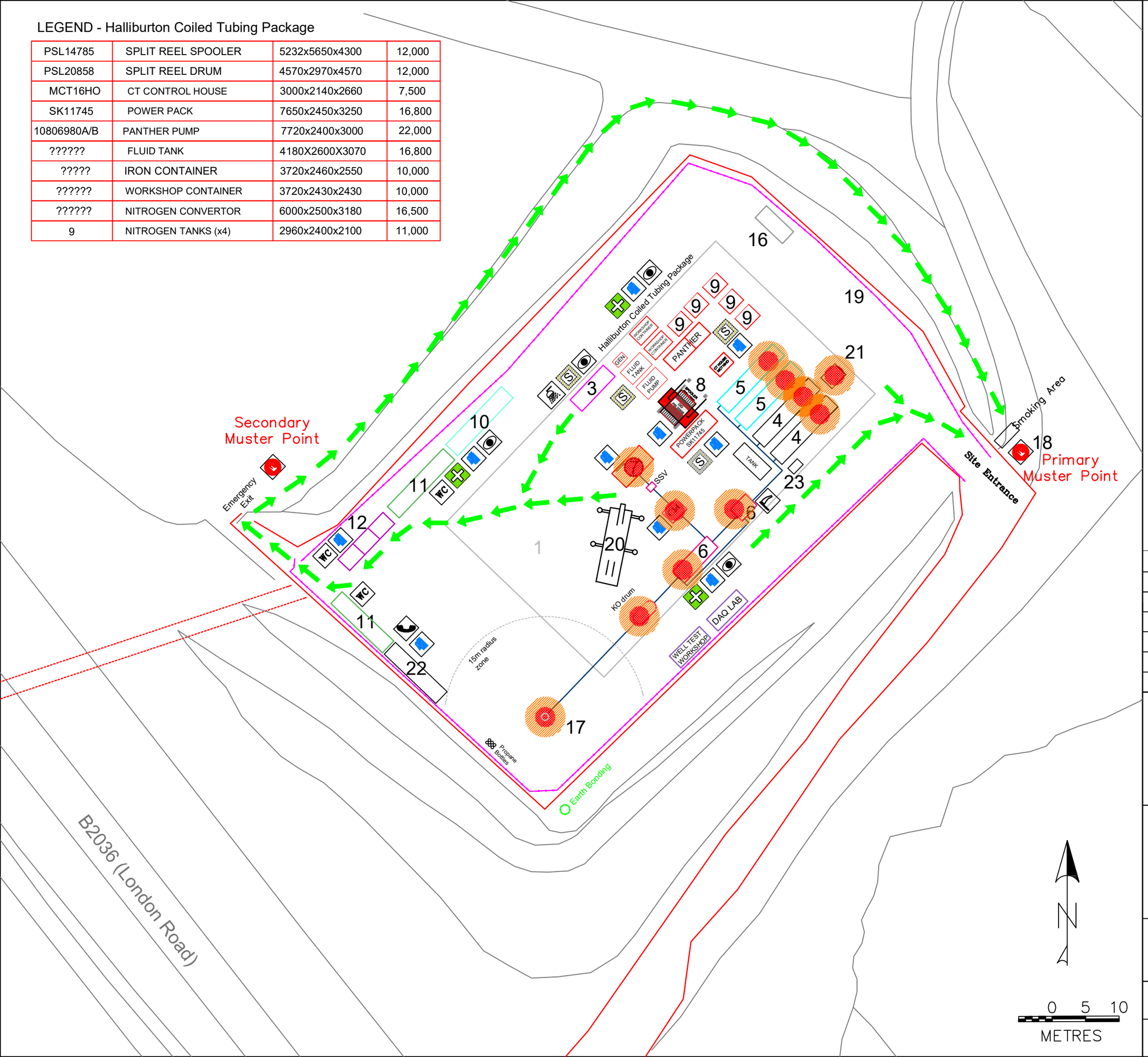
Title:
Proposed Site Plan

Drawing No: HSF-BALCOME-SL-02

Date: 18th September 2019

LEGEND - Halliburton Coiled Tubing Package

PSL14785	SPLIT REEL SPOOLER	5232x5650x4300	12,000
PSL20858	SPLIT REEL DRUM	4570x2970x4570	12,000
MCT16HO	CT CONTROL HOUSE	3000x2140x2660	7,500
SK11745	POWER PACK	7650x2450x3250	16,800
10806980A/B	PANTHER PUMP	7720x2400x3000	22,000
??????	FLUID TANK	4180X2600X3070	16,800
?????	IRON CONTAINER	3720x2460x2550	10,000
??????	WORKSHOP CONTAINER	3720x2430x2430	10,000
??????	NITROGEN CONVERTOR	6000x2500x3180	16,500
9	NITROGEN TANKS (x4)	2960x2400x2100	11,000



Legend

- Site Boundary - Above Ground
- Site Boundary - Below Ground Works
- Fence
- 1 Impermeable Membrane
- 2 Acid Pump
- 3 Acid Tank
- 4 Oil Tank
- 5 Flowback Tank
- 6 Separator/Surge tank
- 7 Borehole
- 8 Coiled tubing Unit
- 9 Nitrogen Tank
- 10 Welfare Cabin / Lockers
- 11 Toilet - Showers
- 12 Bunker Bins
- 13 MDL Canteen
- 14 Toolpusher
- 15 Potable Water
- 16 Skip
- 17 Flare
- 18 Muster Station
- 19 Car Parking
- 20 Crane
- 21 IBC (Container)
- 22 Accomodation
- 23 Oily Waste Station

- FIRST AID
- SPILL KIT
- TELEPHONE
- ASSEMBLY POINT
- FIRE EXTINGUISHER
- EYE WASH STATION
- TOILET
- WIND SOCK
- EMERGENCY SHOWER
- ESCAPE ROUTE
- ZONE 1 = 1.5m
- ZONE 2 = 3m

Zoned Area Calissification in accordance with API RP 500 and API RP 505

Plant Spacing based upon API RP 12R1 and CAODC IRP 20

REV	DESCRIPTION	DATE	BY
4	As installed	27-09-18	GTS CAD
3	CT Update	10-09-18	GTS CAD
2	Well Test Update	03-09-18	H2Oil
1	Increase bund area	14-05-18	GTS CAD
0	For Review	23-04-18	GTS CAD

HSF
DELIVERING EXCELLENCE

Project: Balcombe 2z Hydrocarbon Well Testing

Title: Proposed Site Plan

Drawing No: HSF-BALCOME-SL-01

Date: 18th September 2019

APPENDIX D
SUMMARY OF LEGISLATION AND POLICY RELATING TO CONTAMINATED LAND

Part IIA of the Environmental Protection Act 1990

Part IIA of the Environmental Protection Act 1990 (Part IIA) and its associated Contaminated Land Regulations 2000 (SI 2000/227), which came into force in England on 1 April 2000, formed the basis for the current regulatory framework and the statutory regime for the identification and remediation of contaminated land. Part IIA of the EPA 1990 defines contaminated land as 'any land which appears to the Local Authority in whose area it is situated to be in such a condition by reason of substances in, on or under the land, that significant harm is being caused, or that there is significant possibility of significant harm being caused, or that pollution of controlled waters is being or is likely to be caused'. Controlled waters are considered to include all groundwater, inland waters and estuaries.

In August 2006, the Contaminated Land (England) Regulations 2006 (SI 2006/1380) were implemented, which extended the statutory regime to include Part IIA of the EPA as originally introduced on 1 April 2000, together with changes intended chiefly to address land that is contaminated by virtue of radioactivity. These have been replaced subsequently by the Contaminated Land (England) (Amendment) Regulations 2012, which now exclude land that is contaminated by virtue of radioactivity.

The intention of Part IIA is to deal with contaminated land issues that are considered to cause significant harm on land that is not undergoing development (see Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, April 2012). This document replaces Annex III of Defra Circular 01/2006, published in September 2006 (the remainder of this document is now obsolete).

Planning Policy

Contaminated land is often dealt with through planning because of land redevelopment. This approach was documented in Planning Policy Statement: Planning and Pollution Control PPS23, which states that it remains the responsibility of the landowner and developer to identify land affected by contamination and carry out sufficient remediation to render the land suitable for use. PPS23 was withdrawn early in 2012 and has been replaced by much reduced guidance within the National Planning Policy Framework (NPPF), reference ISBN: 978-1-5286-1033-9, February 2019.

The new framework has only limited guidance on contaminated land, as follows:

Chapter 11. Making effective use of land

117 Planning policies and decisions should promote an effective use of land in meeting the need for homes and other uses, while safeguarding and improving the environment and ensuring safe and healthy living conditions. Strategic policies should set out a clear strategy for accommodating objectively assessed needs, in a way that makes as much use as possible of previously-developed or 'brownfield' land.

118. Planning policies and decisions should:

c) give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land.

Chapter 15. Conserving and enhancing the natural environment

170. Planning policies and decisions should contribute to and enhance the natural and local environment by:

e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and

f) remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.

Ground conditions and pollution

178. Planning policies and decisions should ensure that:

a) a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);

b) after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990; and

c) adequate site investigation information, prepared by a competent person, is available to inform these assessments.

179. Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.

Water Resources Act (WRA)

The Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009 updated the Water Resources Act 1991, which introduced the offence of causing or knowingly permitting pollution of controlled waters. The Act provides the Environment Agency with powers to implement remediation necessary to protect controlled waters and recover all reasonable costs of doing so.

Water Framework Directive (WFD)

The Water Framework Directive 2000/60/EC is designed to:

- enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands that depend on the aquatic ecosystems
- promote the sustainable use of water

- reduce pollution of water, especially by 'priority' and 'priority hazardous' substances
- ensure progressive reduction of groundwater pollution.

The WFD requires a management plan for each river basin be developed every six years.

Groundwater Directive (GWD)

The 1980 Groundwater Directive 80/68/EEC and the 2006 Groundwater Daughter Directive 2006/118/EC of the WFD are the main European legislation in place to protect groundwater. The 1980 Directive is due to be repealed in December 2013. The European legislation has been transposed into national legislation by regulations and directions to the Environment Agency.

Priority Substances Directive (PSD)

The Priority Substances Directive 2008/105/EC is a 'Daughter' Directive of the WFD, which sets out a priority list of substances posing a threat to or via the aquatic environment. The PSD establishes environmental quality standards for priority substances, which have been set at concentrations that are safe for the aquatic environment and for human health. In addition, there is a further aim of reducing (or eliminating) pollution of surface water (rivers, lakes, estuaries and coastal waters) by pollutants on the list. The WFD requires that countries establish a list of dangerous substances that are being discharged and EQS for them. In England and Wales, this list is provided in the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. In order to achieve the objectives of the WFD, classification schemes are used to describe where the water environment is of good quality and where it may require improvement.

Environmental Permitting Regulations (EPR)

The Environmental Permitting (England and Wales) Regulations 2016 (as amended) provide a single regulatory framework that streamlines and integrates waste management licensing, pollution prevention and control, water discharge consenting, groundwater authorisations, and radioactive substances regulation. Schedule 22, paragraph 6 of EPR 2016 states: 'the regulator must, in exercising its relevant functions, take all necessary measures - (a) to prevent the input of any hazardous substance to groundwater; and (b) to limit the input of non-hazardous pollutants to groundwater so as to ensure that such inputs do not cause pollution of groundwater.'

Notes:

1. *The above information is provided for background but does not constitute site-specific advice*
2. *The above summary applies to England only. Variations exist within other countries of the United Kingdom*