Assessment of Geology, Flood Risk and Pollution Control

Proposed Exploratory Well Site,
Lodge Farm, Wressle, North Lincolnshire

January 2013

Reference Number : 3334/GF

EGDON RESOURCES U.K. LIMITED
PROPOSED DRILLING SITE AT
LODGE FARM
WRESSLE, NORTH LINCOLNSHIRE

ASSESSMENT OF GEOLOGY, FLOOD RISK AND POLLUTION CONTROL

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1.0 INTRODUCTION

1.1 This Assessment of the Geology, Flood Risk and pollution control has been prepared for Egdon Resources U.K. Limited in respect of their proposals to construct an Exploratory Well Site at Lodge Farm, Wressle, North Lincolnshire.

1.2 The purpose of this study is to assess the effect of this proposal on:-

- the existing hydrology of the area;
- the hydrogeology of the area;
- the flood risk potential of the site upon the surrounding land;
- the flood risk for the site;
- the control of pollution, including the types and quantities of liquids that will require control and propose methods by which the fluids can be removed with no risk to the environment.

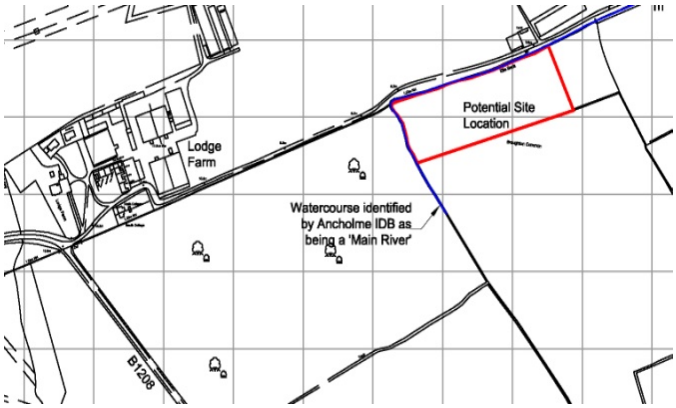
1.3 The study will assess each stage of the project and the particular issues presented by each phase. The work on the site can be broken down into four distinct phases although they may not follow on from each other in immediate succession. They are:-

- Phase 1 – Construction of the Drilling Site
- Phase 2 – Operational Phase – Drilling
- Phase 3 – Operational Phase – Testing
- Phase 4 – Site Restoration

1.4 The study will comprise a desktop study that will draw on experience of previous projects of a similar nature and information from the British Geological Society and the Environment Agency, augmented by a site inspection.

2.0 SITE LOCATION AND BASELINE DATA

2.1 The wellsite is located to the east of Lodge Farm, Wressle, within a flat field and having Ella Beck forming the west and north boundaries to the field. A large copse of trees is located to the west of the site, between the site and the B1208. Open farmland lies to the south of the site and a small copse of trees is located to the east of the site, as indicated on the extract from plan 3334 FR 01.



2.2 The Application Site covers a total area of 1.23 hectares and comprises two separate parts;

- An existing entrance off the B1208 Brigg Road and access track down to the site; and,
- A drillsite within a field to the immediate south of Ella Beck.

2.3 The well head is provisionally located at OS grid coordinates:- 496773 Eastings
411102 Northings.

2.4 Ella Beck has been identified as a 'Main River' by the Environment Agency that comes under their jurisdiction although it is within the Ancholme Land Drainage Board Area.

2.5 The land in the Lodge Farm area drops gradually from about 15m AOD at the B1208 to approximately 5m AOD at the site, with virtually no change of level across the main site area.

2.6 The west field boundary between the farmland and the copse is delineated by a leg of the Ella Beck that flows north at this point. The Beck's invert is about 1.8m below field level and the Beck was holding about 300mm depth of water when it was surveyed, see Photo 1 below:-

Photo 1 View north along Ella Dyke

2.7 The north boundary of the field has an intermittent hedge at the top of the bank, separating the field from the Ella Beck. The hedge is substantial in places but has gaps of up to 3m in its length.

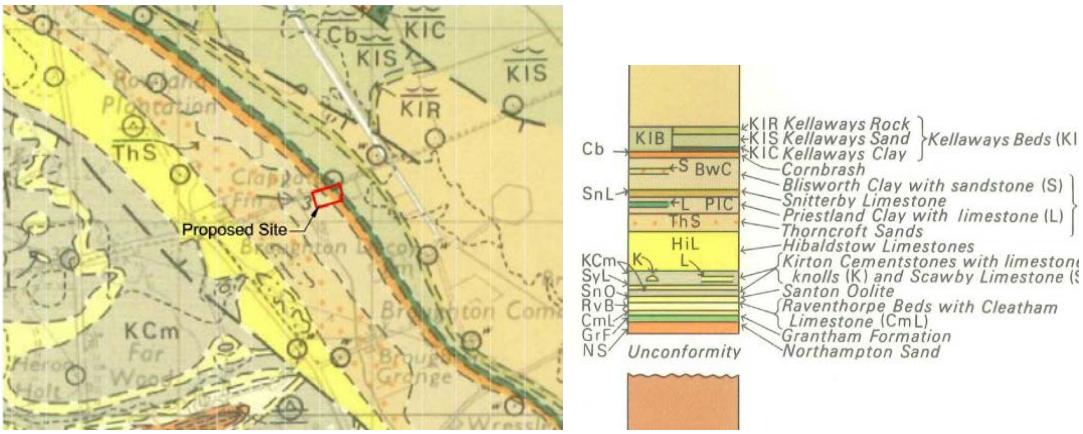
Photo 2 View west across Proposed Site Location

2.8 The application site is located immediately south of the hedge, occupying a field that is currently carrying a crop. on the lower slopes of the field, shown in Photo 2 above.

3.0 GEOLOGY AND SENSITIVITY OF WATER RECEPTORS

3.1 The 1:50,000 scale plan issued by the British Geological Society (Sheet 89) (Solid and Drift Edition) 1992, indicates that the area of the site is overlain by Blown Sand Drift deposits, covering the solid deposits of the Thorncroft Sands, Snitterby Limestone, Cornbrash and Kellaway Beds. These latter strata form part of the Ancholme Clay Group within middle Jurassic Era, as shown below and dip to the east.

Extract From BGS Geological map (Solid Deposits) (with key)



3.2 The Drift deposits are permeable and provide a source of ground water, as indicated by the numerous water wells within the vicinity of the proposed site. Most of these wells are located away from housing and they are presumed to be used for irrigation rather than domestic consumption.

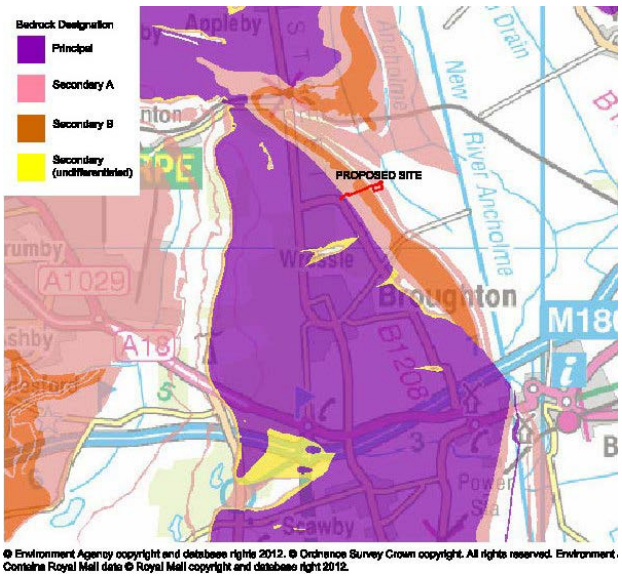
3.3 The permeable soils drain to the Ella Dyke and the level within the dyke gives a good indication of the static water table, which was about 1800mm below filed level at the time of the site visit.

3.4 The following descriptions of the different solid deposits and their aquifer potential are provided by the BGS UK Hydrogeology Viewer website.

3.5 The solid bed rock formations vary in permeability with the uppermost formation, the Kellaway Formation comprising rocks with essentially no groundwater as they are clays that confine underlying aquifers. The Kellaways Sands near the base of the sequence yields small quantities of water that is often brackish.

3.6 The Snitterby Limestone (formerly the Great Oolite Limestone) is a moderately productive aquifer that is ranks as a significant aquifer producing high yields. The lower Lincolnshire Limestones including the Hibaldstow Limestones produce significant supplies of water. The figure below shows an extract from the EA plan of the area indicating the different aquifers and the site location in relation to them where they occur immediately beneath the Superficial Deposits:-

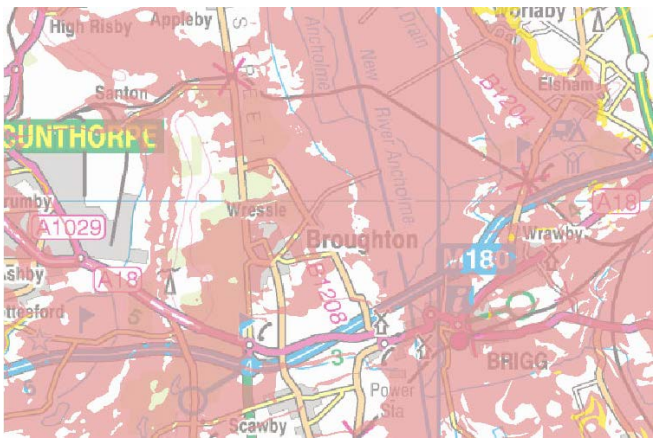
Aquifers Solid Deposit Plan



3.7 The principal Aquifer identified in the extract alongside shows a reservoir that is isolated hydraulically from the site by a fault that runs north-west to south-east.

3.8 Reference to the extract also shows that Secondary A aquifer under the site location is part of the Cornbrash Formation. The aquifers in the Hilbaldstow Limestones will be encountered at a greater depth.

Aquifers Drift Deposits Plan



3.9 The Drift Deposits (Superficial Deposits) are designated as 'Secondary A' by the EA, defining them as providing water supplies at a local scale. The site is shown in relation to the aquifer in the adjacent figure, where the pink coloured areas indicate the extent of the Aquifer in the Blown Sand deposits.

3.10 The presence of the aquifers and their importance is confirmed by the EA's designation of the area as being within a Surface Water Protection Area of Minor Aquifers of either high or intermediate importance with the area confirmed as being at risk.

3.11 The presence of these aquifers necessitates the use of particular drilling methods to avoid any contamination of the aquifers and cross contamination between aquifers at different depths and would form part of the drilling programme that would be formally submitted to DECC for approval prior to commencement of drilling. This drilling program would be submitted to the EA as part of the information provided when submitting a Notice using Form WR – 11 under the Water Resources Act 1991 (Section 199(1)).

4.0 FLOOD RISK ASSESSMENT

4.1 The Technical Guidance to the National Planning Policy Framework (NPPF) (March 2012) published by the Department for Communities and Local Government supersedes PPG25 and has been taken into account in the preparation of this section of the report, and the Sequential Test will be applied to this development.

4.2 'Flood Risk' mean risk from all sources of flooding, including:-

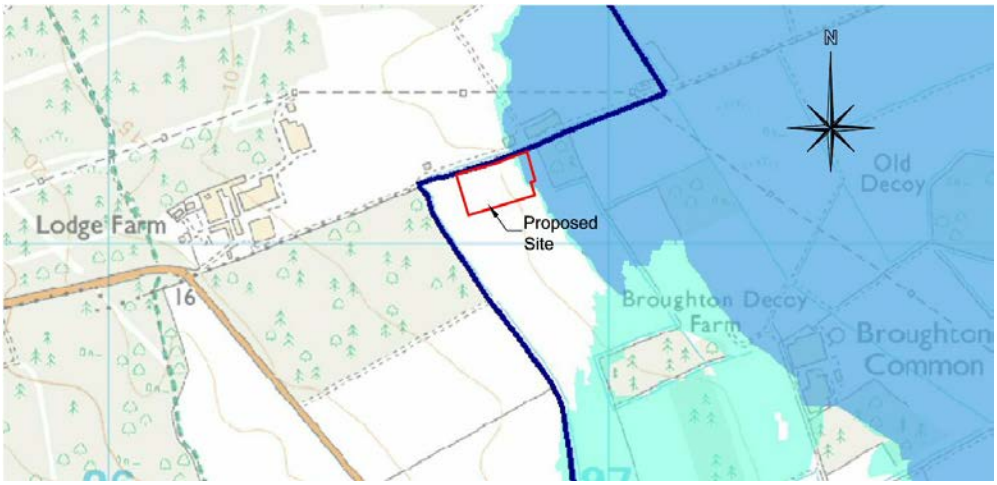
- Rivers
- Sea
- Directly from rainfall onto the ground
- Rising groundwater
- Overwhelmed sewers and drainage systems
- And from reservoirs, canals, lakes and other artificial sources.

4.3 For the purposes of this assessment the site is 5m above Ordnance Survey Datum and flooding by encroaching sea is not considered a realistic risk, although high water flows coincident with high tides could result in a flood risk. In a similar way, there are no sewers within the locality and so the risk of flooding from this source can be discounted.

4.4 The Technical Guidance (TG) to the NPPF separates areas into Flood Zones having different levels of risk, as follows:-

- Zone 1 - Little or no risk with an annual probability of flooding from rivers and sea of less than 0.1%. (Colour = White)
- Zone 2 - Low to medium risk with an annual probability of 0.1-1.0% from rivers. (Colour = Light Blue)
- Zone 3 - High risk with an annual probability of flooding of 1.0% or greater form rivers. (Colour = Dark Blue)
- Zone 3 is further sub-divided into Zones 3a and 3b, where Zone 3b is a functional flood plain.

4.5 Reference to the Environment Agency Flood Risk Map shown below confirms that the proposed site is located within Zone 1. A short section of the access road is located within Zones 2 and 3, the boundaries of which almost coincide at this point.



Plan 3: Flood Risk Map for site

4.6 The sequential test stipulated by the TG is intended to guide development towards sites within Flood Zone 1 first, and then Zone 2, before sites in Zone 3 can be considered. The appropriateness of any development within or near Flood Zones 2 and 3 is shown in Table 3 of the TG, reproduced below:-

Table 3: Flood risk vulnerability and flood zone 'compatibility'

Flood risk vulnerability classification (see table 2)		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood zone (see table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	×	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	×	×	×

Key: ✓ Development is appropriate.

- × Development should not be permitted.

4.7 The Flood Risk vulnerability of different developments is categorised in Table 2 of the TG, where mineral workings are considered to be less vulnerable.

4.8 North Lincolnshire Council's Strategic Flood Risk Assessment subdivides Flood Zone 3 into three divisions:-

- Flood risk - Zone 3 (iii) - functional floodplain
  Zone 3(iii) refers to areas within Zone 3 which have been identified as functional floodplain, which approximates to the TG Classification of Zone 3b.

- Flood risk Zone 3 (ii) - high vulnerability area
  Zone 3(ii) refers to areas within Zone 3 which have been identified as being at a greater risk of flooding compared to Zone 3(i) because:-
- They have defences that, on the basis of information supplied by the Environment Agency or others, do not currently provide the 'appropriate standard' of protection. Defences providing the 'appropriate standard' are defined as being capable of protecting against a one per cent (one in 100 year) event for flooding or a 0.5 per cent (one in 200 year) event for tidal /coastal flooding; or
- If the defences do provide the 'appropriate standard' of protection, then if they should breach during such an event the flow velocity and depth of flooding estimated will be greater than the limiting criteria (i.e. flow velocity > 1.0 m/s or depth of flooding> 0.5m).

- Flood risk Zone 3 (i) - outside high vulnerability area
  Zone 3(i) refers to areas within Zone 3 which have been identified as being at a reduced risk of flooding compared to other areas of Zone 3 because:-
- They have defences that, on the basis of information supplied by the Environment Agency or others, do currently provide the 'appropriate standard' of protection. Defences providing the 'appropriate standard' are defined as being capable of protecting against a one per cent (1 in 100 year) event for river flooding or a 0.5 per cent (1 in 200 year) event for tidal/coastal flooding; and
- If the defences should breach during such an event the flow velocity and depth of flooding estimated will be less than the limiting criteria (i.e. flow velocity <1.0m/s and depth of flooding <0.5m).

The map that accompanies these categories could not be reproduced, but shows a similar extent of the anticipated flooding near the the site ason the EA plan reproduced in Plan 3. The site was within Zones 1, 2, and 3(ii) on the SFRA plan.

4.9 Consultations have been held with the Environment Agency, who have confirmed that written permission from the EA in the form of Flood Defence Consent

'*is required before undertaking any temporary or permanent works in, under, over or within 9.0m of any main river/ sea defence*

measured from either the top of the bank or from the landward toe if the bank is raised above the natural ground level'.

The site boundary has been set back from the Ella Beck Main River by 9m, but a formal application will be made for consent in respect of the access over Ella Beck from the adjacent farm access.

4.10 Temporarily setting aside consideration of the access road, which lies partly within Zones 2 and Zone 3(ii), the remainder of the site is within Zone 1, for which the TG requires the following assessments:-

- Vulnerability to flooding from other sources as well as from rivers
- The potential to increase flood risk elsewhere through the addition of hard surfaces
- The effect of the new development of surface water run-off

4.11 The transient nature of the access track and its restricted length of about 50m means that it will have negligible effect on the Flood Zone, will not add to the Flood Risk and is not vulnerable to damage if it were to be submerged in event of a flood. It is therefore not considered further in this assessment.

4.12 It is proposed that the exploratory drilling site will have a sealed membrane passing under the site and perimeter ditches to prevent water or any other fluids from flowing out of the site.

4.13 An oil interceptor will be installed to enable discharge of surface water from the site when there are no drilling or associated activities taking place.. A cut-off valve will be located at the discharge point from the site perimeter ditch, upstream form the oil interceptor, and another isolation valve located downstream from the interceptor to provide an additional means of control. A sampling chamber between the oil interceptor and the downstream valve will allow the quality of the discharged water to be checked.

4.14 The interceptor would be isolated during the drilling phase, with the site valve closed to prevent discharge. When the drilling rig has left the site and the site cleaned of all drilling muds, and other chemicals, the water in the ditches would be

checked for contaminants and, if satisfactory, valves would be opened to allow rainwater to flow through the oil interceptor into the Beck.

4.15 Access to the interceptor will be independent form the site and will be maintained at all times to allow for water sampling.

4.16 The initial Phase of site construction will not have any effect on the flood risk as any water falling onto the site area will dissipate in the same way as prior to the construction of the site. The flood risk will **Not Increase** during this phase.

4.17 During Phase 2, when the drilling rig is operational, rainwater will be gathered in the ditches and either used on site or tankered away. The flood risk due to the presence of the site will therefore be **Reduced** from that for the undisturbed natural state.

4.18 Testing is carried out during Phase 3, without the drilling rig on site. All drilling fluids and materials associated with the drilling phase will be removed from site and the surface water discharged via a valved oil interceptor into the nearby water course. Flow would be restricted to avoid an increase in flood risk, using a nominal flow rate of about 5L/s to avoid an increase in the flood risk. This control of water discharge from the site will avoid an increase in the flood risk.

4.19 The risk of flooding due to rising groundwater is considered to be unlikely because the extent of the flooding is downslope from the site and even if the water rose above ground level to the east, the EA do not consider that the flooding will extend into the area occupied by the main site area.

4.20 If groundwater were to rise it would not be able to flood the site, because an impermeable membrane is to be laid under the site area. This membrane will be held in position by 300mm of stone as well as the drilling rig and apparatus, which will resist the uplift pressures generated by a water depth of at least 600mm.

4.21 The waterproof membrane is continuous into the ditches and up the perimeter bunds, so no water can flood into the site from any water around the site. The flood risk to the proposed site from rising groundwater is considered to be **Negligible.**

4.22 The potential to increase the flood risk elsewhere is not considered to be possible. This is because the site itself does not of itself impede or restrict any flow of flood waters and will not, by its presence, contribute to the most likely source of flooding - that due to rainwater run-off (this is discussed above). It is therefore considered that the impact of this site upon the flood risk within the area is **Negligible**.

5.0 CONSTRUCTIONAL IMPACTS

5.1 The first section of the proposed access track passes along an existing farm access from the B1208 through Lodge Farm courtyard and parallel to Ella Beck before turning across an existing field access into the field. No construction works are proposed for this section and there will be **no constructional impacts** associated with this section.

5.2 The second section of access track crosses from the established farm access over the Ella Beck using an existing field access. It may be necessary to widen this entrance to allow for the swept path of vehicles. If this is the case a formal application will be submitted to the Environment Agency for consent to lengthen the culvert in the Ella Beck by about 3 metres.

5.3 The new track into the site area will be formed by excavating the topsoil and then laying stone upon a geotextile membrane. The track will be more permeable than the topsoil so it will not impede the normal ground water flow.

5.4 The proposed site will be located away from the lower end of the field, avoiding the Zone 2 and Zone 3(ii) areas. There will be minimal earthworks, confined mainly to removal of the topsoil and storing it in bunds between the site and Ella Beck, and maintaining the 9m clearance from the top of the bank.

5.5 As the earthworks progress, there will be a tendency for water to soak into the ground and drain away, rather than remain as standing water on the site.

5.6 Rainwater falling onto the partly constructed site or track will not be confined and will not cause any contamination, so it will be allowed to discharge freely, with no change in the flood risk of the area.

5.7 The main source of contamination during construction will be from the equipment used to construct the site, such as excavators and bulldozers. Highway vehicles should not be on the site long enough to pose a threat but private vehicles used by the workforce should be checked for signs of oil drips, and all equipment stored overnight on the partly constructed site should have drip trays placed under the engine sumps to intercept any fuel or oil drips.

5.8 Any temporary fuel bowser will be contained either within a bunded area of 110% of its total capacity, or be double-skinned and with a drip tray under the hose end.

5.9 The construction process does not use liquids other than freshly batched concrete that would be placed in the bottom of the cellar and there is no significant free water associated with fresh concrete. Consequently, the risk of contaminated liquids flowing from the partly constructed site is non-existent.

5.10 A water spray may be used to inhibit dust but clean water would be used and only in sufficient quantities to dampen the dust without run-off.

6.0 OPERATIONAL IMPACTS

6.1 The operational stage will not produce any significant impact on the access road between the B1208 public highway and the site, as no vehicles are expected to be stationary for any significant time on these sections. Most of the chemicals will be transported in powder form and mixed with water on the site. The only liquids to be transported during the operations stage will be water and fuel oil for the machinery. Fuel will be transported in normal road tankers and would only discharge into the drilling rig tanks located within the confines of the site.

6.2 Rainwater; fuel and oils used in operating the site preparation and drilling machinery; effluent from cabins, spillages of drilling mud and possible flows from the borehole are the possible sources of contaminants arising from the site during the operational stage.

6.3 During the course of the drilling and testing, the rainwater and other fluids arising from the operations will be controlled and removed from the site in a manner that does not present a risk to the environment or to the people who live in the area.

6.4 The site will be constructed with a water-tight membrane under the stone surface, comprising a bentonite filled composite membrane that is normally used to provide containment in landfill sites. This membrane would be continued into the ditches and up over the retaining bunds that encircle the site. This system provides a complete containment for all potential contaminants and its capacity is set to contain a hypothetical situation where oil were to flow uncontrolled from the wellhead at the rate of 50 barrels/day for thirty days (57,000 gallons). Any spillages from the equipment would be contained within the site and in the unlikely event that a double-skinned fuel tank is ruptured the fuel would be contained on site prior to clean operations.

6.5 The lined ditches around the site would be designed to accommodate the rainwater runoff from the site equivalent to that from a 1:100 year storm. The water thus accumulated would be used either in the drilling process or taken off site in a sealed tanker.

6.6 A test of the well would be carried out after the drilling rig has been removed from site, during which time any fluids arising from the well would be stored in bunded tanks, with the bund having a capacity of 110% of the stored capacity.

6.7 During the testing period, rainwater falling onto the site would be contained on the site and will flow into the perimeter ditches, from which it would flow through an oil interceptor and discharge into the nearby stream, Ella Beck.

6.8 If the site were successful and commercial quantities of hydrocarbons were encountered, the site would be retained pending a planning application for consent to produce hydrocarbons from the site. In this event surface water would continue to be discharged through the oil interceptor into Ella Beck, to allow for discharge of surface water. The rate of discharge would be controlled to no more than 5L/s and the installation would be subject to an application to the Environment Agency under the Land Drainage Act.

7.0 RESTORATION IMPACTS

7.1 Removal of the drilling rig will not give rise to any particular impact as it will still be located on a sealed site, but restoration of the drilling platform has potential to give rise to short term and longer term pollution if not carefully managed.

7.2 Liquids and other contaminants left after the drilling process would be removed by suction tanker and any contaminated stone would be removed in sealed lorries prior to any dismantling of the bunds and ditches around the site. The drill pipe contained within the cellar would be cut down to at least 2m below finished ground level and a sealing cap welded on top before the walls of the cellar were broken down.

7.3 The site would then be restored to its former profile in a reverse process to the original excavation.

7.4 The restored site would then be returned to agricultural usage with an after-care period to ensure that the area returns to its former productivity.

8.0 POLLUTION CONTROL

8.1 Different pollution control measures have been referred to within the previous paragraphs but this section seeks to make reference to specific aspects of pollution control.

Drainage

8.2 All surface run-off within the site would fall to the surrounding ditch within the site and contained for removal as described in para. 6.5.

8.3 The manner of dispersal for externally sourced surface water would be unchanged, with rainwater expected to soak into the ground and disperse into Ella Beck in the same way as present.

8.4 Sand bags would be located near the site entrance to prevent any potential pollutant from flowing off the site. Spill kits designed for all materials and substances used on site would be available to deal with any emergencies that could arise. During testing any accidental spillage from the produced fluid storage tanks would be contained within purposely designed container bunds. **The natural drainage of the land would not be impeded.**

Water Resources

8.5 The conductor tube (the initial length of borehole casing) will be installed during site construction and is likely to be installed either by being driven or by use of a smaller purpose-made drill rig using air to lift material from the hole. This will ensure that the upper drift deposits are isolated hydraulically from the borehole and stability of the borehole is maintained.

8.6 The final depth of this preliminary casing will be the subject of a detailed well design submitted to DECC as part of pre-start submissions but may be extended to isolate the aquifers in the Hibaldstow Limestones.

8.7 Thereafter the borehole would be progressively lined with steel casing cemented in place to a programme previously approved by the Environment Agency under Section 30 of the Water Resources Act 1991. This would ensure that aquifers in deeper strata were suitably protected.

Air Quality

8.8 The mud logging unit used when drilling would be equipped with gas detectors and would continually monitor levels of gas components. Other potential emissions would be those from diesel exhausts from the generators powering the rig, vehicle exhausts and venting/flaring from any possible extended well testing.

8.9 Such emissions would be negligible in terms of pollution to the atmosphere in view of the exposed nature of the site. The threat of pollution to water (surface and underground) and air will be satisfactorily mitigated against by site design and adopting the tried and tested environmentally conscious operational techniques as proposed.

Waste Disposal

8.10 Four sources of waste would require to be removed from the site: -

a) drilling mud and cuttings located in the mud tanks,
b) surface water collected in the perimeter ditches around the well pad area,
c) general dry waste-paper, timber, scrap metal - collected in skips,
d) sanitary waste collected in sealed tanks located under each cabin.

8.11 Mud cuttings and produced fluids from drilling and testing operations would be removed by licensed operators and disposed of at authorised locations. Oil-based mud would be removed by its supply company for recycling.

8.12 For most of the time surface water collected in the site drainage is likely to be used in drilling-mud and make-up but otherwise, when conditions dictate, it would be collected for disposal at an authorised licensed site.

8.13 Skips for dry waste would be obtained from a local contractor and exchanged when necessary.

8.14 Foul drainage from the cabins would be collected in cess pits and emptied by a registered contractor at an approved treatment works. The use of cess pits on this site is justified by the following sequential test in accordance with PPG3.

8.15 **Development Description For Foul Drainage**

8.15.1 The application is for a temporary drilling site, with occupation during drilling of not more than six weeks. No permanent buildings will be constructed as part of this application and the temporary buildings will take the form of site accommodation cabins.

8.15.2 These cabins will be brought onto site as part of the drilling rig equipment and, after the drilling operations and testing have been completed, will be removed when the drilling rig leaves site.

8.15.3 Except during the drilling phase the site will not have any accommodation either in the form of offices or any other form that would give need for foul drainage.

8.16 **Hierarchical Assessment**

Mains Connections

8.16.1 For the present application, the nearest properties that might be connected to mains drainage are in Lodge Farm, some 450m away from the proposed site in a westerly direction. The site is separated from the Farm by Ella Beck, and so a gravity flow to the farm is not practicable.

8.16.2 There are no habitations to the east, with the flood plain and the River Ancholme separating the site from other services to the east.

8.16.3 The ground level remains almost flat towards Broughton Grange and Common Farm in the south and there is insufficient fall for foul drainage to flow by gravity to these dwellings. It is not known if these properties are connected to the mains drainage system.

8.16.4 It is concluded that connection to a mains foul drain is neither practicable nor economically realistic, particularly for a short term development.

Package sewage treatment plant

8.16.5 Installation of a package sewage treatment plant might be appropriate for a longer-term development where permanent office or residential accommodation was being created. However, the proposed development is very short term and such an installation would not be appropriate.

Septic Tanks

8.16.6 The site is located on permeable sandy soils and so water discharged from such a system would flow away freely. However, the site location is within a Groundwater Vulnerability Zone as defined by the EA and there is a water abstraction point about 80m away from the site.

8.16.7 Given the Groundwater Vulnerability, the use of septic tanks is not an appropriate arrangement for a temporary short-term development.

8.16.8 In any case, installation of a new septic tank and associated drainage to discharge into the ground is inappropriate for such a short term project particularly regarding the concerns about the risk of contamination of ground water aquifers.

Cesspool

8.16.9 The cess tanks provided and used by the drilling company have served well on numerous sites without contamination of either the site or the local area. They have an adequate capacity to avoid frequent emptying and thus avoid generation of additional highway traffic.

8.16.10 The alternatives to a cesspool have been considered and are not appropriate for a short term development which will have an active life of less than 2 months.

8.16.11 It is concluded and recommended that the cess tanks provided by the drilling contractor be used on this site to provide a secure and appropriate management of foul water.

8.16.12 **In conclusion, with the above site management procedures in place, problems regarding waste disposal will not be an issue, incorporating the cess pits.**

9.0 CONCLUSIONS AND MITIGATION MEASURES

9.1 The site is located within a sensitive area used for water abstraction from groundwater aquifers in the superficial deposits and aquifers in the bedrock. The site is also close to a Zone 3ii Flood Risk Zone, although the site and car parking are outside the extent shown on the EA interactive maps of the area.

9.2 The sandy nature of the superficial deposits allows the ground water to respond quickly to rainfall although the static water level is about 1.8m below ground level in normal conditions.

9.3 Water abstraction wells are located within 100m of the proposed site, although separated by Ella Beck, a 'Main River', which has a flow monitoring station adjacent to the proposed site.

9.4 The bedrock aquifers below the site are located down-dip from the water abstraction wells to the east of the site, so particular care will be needed whilst drilling through these aquifers to avoid contamination of the aquifer and the installation of the initial length of drilling casing will have to use a particular method to avoid contamination of the aquifers. One possible solution might be to drive a large diameter conductor tube through the sands to isolate the top groundwater, followed by installation of a smaller diameter pipe within the conductor tube through the Hibaldstow Limestones section.

9.5 The drilling process and installation of casing will be carried out in accordance with a drilling programme that is to be submitted to the Environment Agency as stated in the first paragraph of Informatives included in the EA letter of 20 June 2012. The drilling programme also has to be submitted to and approved by DECC prior to commencement of the drilling works.

9.6 Once the initial steel casings have been installed the aquifers will be isolated from any further risk of pollution.

9.7 The cellar will be constructed in such a way as to avoid leaks from the cellar into the ground, using a system developed for building cellars in other sensitive locations.

9.8 The site will be constructed as a bunded, sealed, site with sufficient containment capacity to avoid possible pollutants from discharging into the aquifer and any risk of pollution caused by water run-off can be mitigated by using standard techniques developed by exploration companies to prevent pollution.

9.9 Underlying the entire site is a Bentomat membrane that has been proved to prevent loss of liquids from similar site, even when located on permeable ground. The lining extends into the ditches and up the outer bunds to provide full containment of contaminants and surface water landing on the site.

9.10 All vehicles that are to be stationary on the partly built site or during restoration will have drip trays positioned under them to catch oil drips.

9.11 All fuel tanks would be double skinned and any refuelling of machines during the construction and restoration phases shall be carried out within a contained area to avoid spillage of fuel onto the ground.

9.12 Any bunded areas would have a retention capacity of 110% of the tanks within the bund.

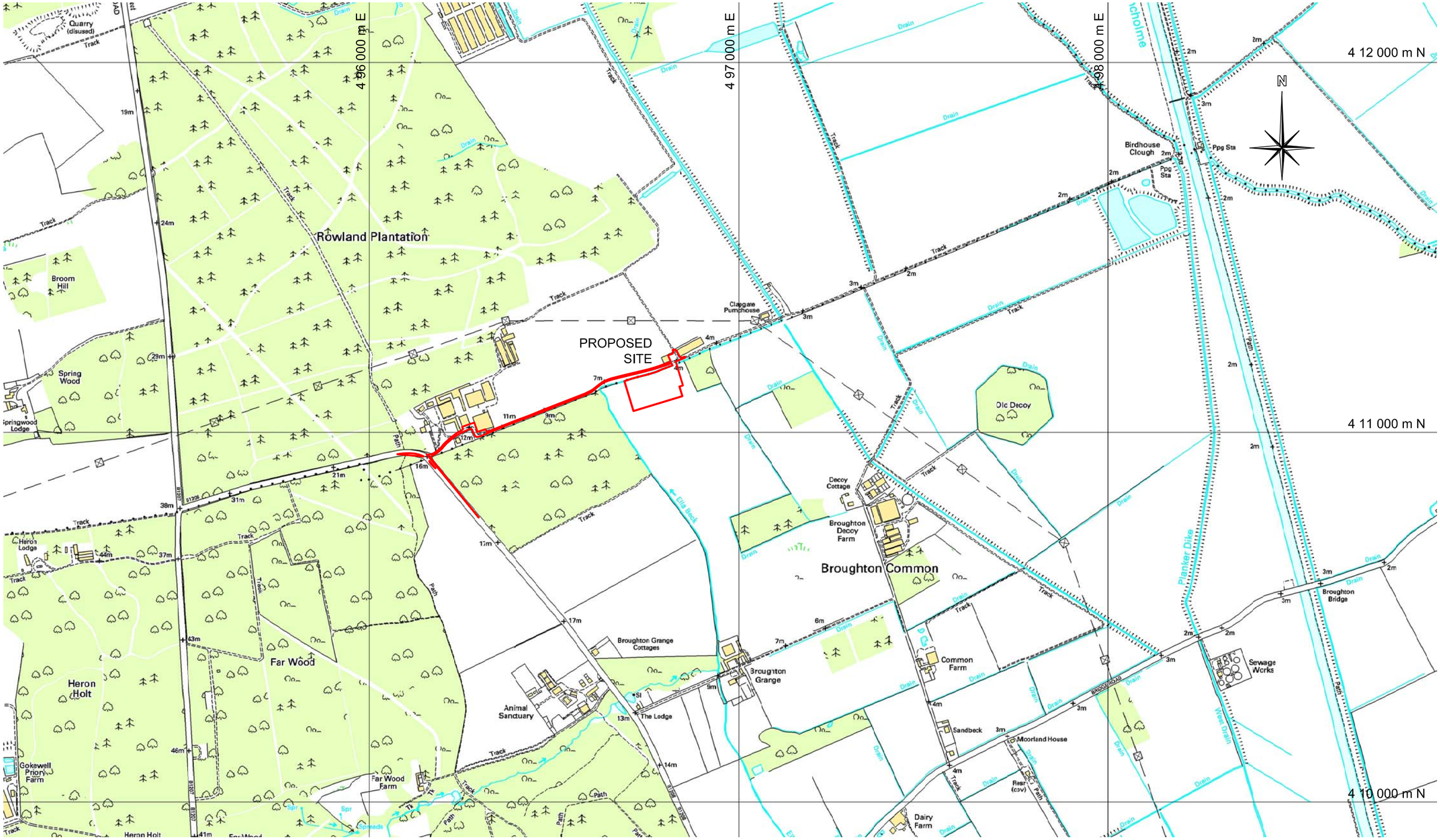
9.13 Pollution control barriers would be positioned alongside, or in the stream downstream from the proposed site to provide additional safeguards against any contaminants discharging into the environmentally sensitive areas of the Marsh.

9.14 It is concluded that if the normal industry–wide measures for control of pollution are implemented there will not be any risk of pollution to the surrounding area. The methods of containment will also prevent any risk of flooding at or around the site due to discharge of surface water.

9.15 As rainwater falling on the proposed site during its operational stage will be retained on site, there will be a decrease in discharge from the field into the drainage system. **Provided good management is maintained on the site to contain any risk of contaminants escaping from the site there should not be any increase in the risk of pollution or flood risk arising from the presence of the site.**

9.16 This development is in accordance with the Technical Guidance to the National Planning Policy Framework.

APPENDIX



Site Location Plan

Scale 1:10,000

R ELLIOTT ASSOCIATES LTD
CONSULTING STRUCTURAL & CIVIL ENGINEERS
t: (01590) 683176 f: (01590) 683533 info@rea-ltd.co.uk www.rea-ltd.co.uk

Dennett House
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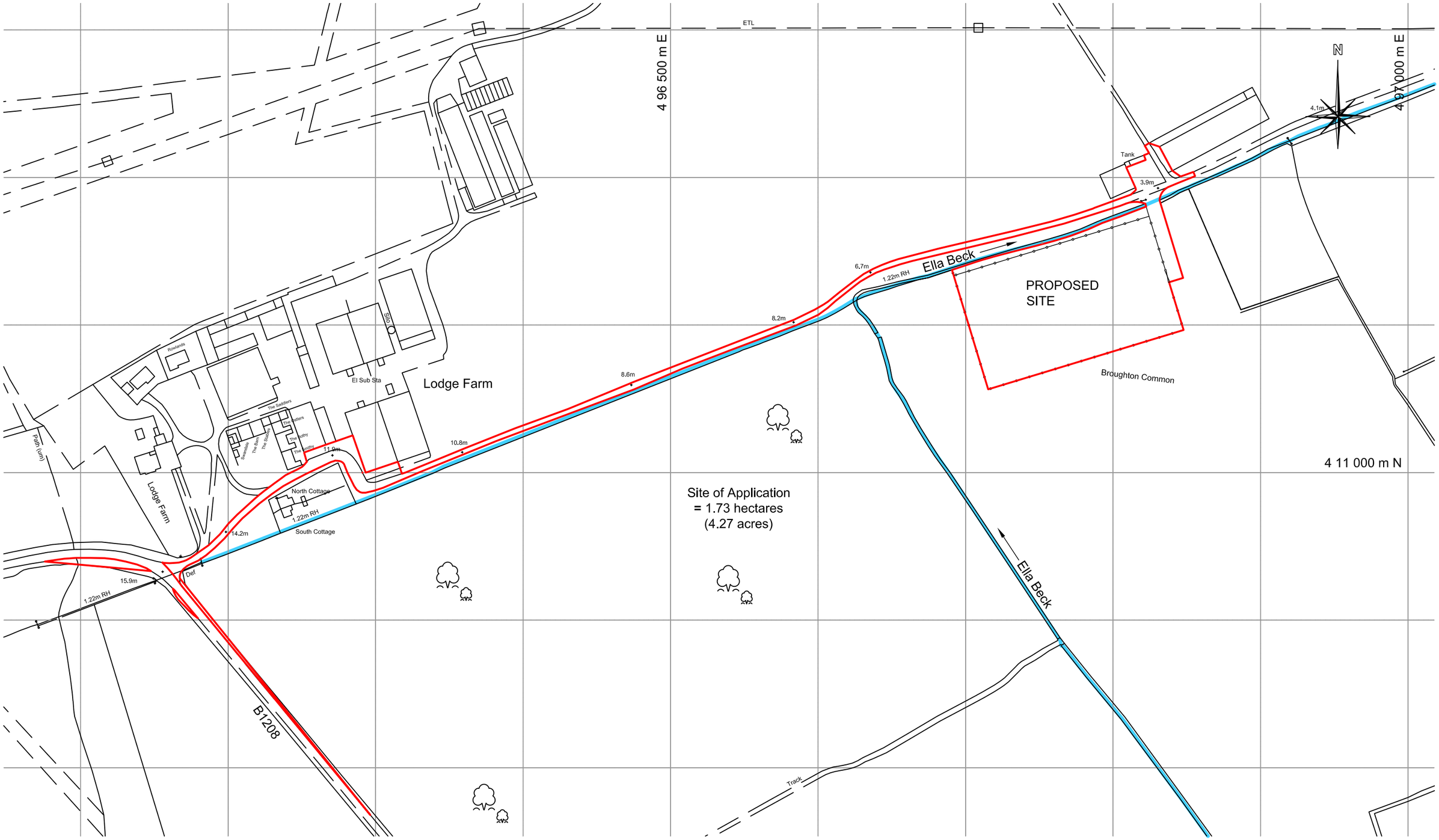
Sway
Lymington
Hampshire
SO41 6EB

Client: Egdon Resources UK Ltd Wressle Brigg Lincolnshire	Drawn By: AJNE	Date: February 2013	Sheet Size: A3
Job Title: Wressle Site	Drawing Title: Site Location Plan (1:10,000)		
	Drawing Number: 3334 GF 01		Revision

Rev | Revision note | Date



Site of Application

Scale 1:2500

0 25m 50m

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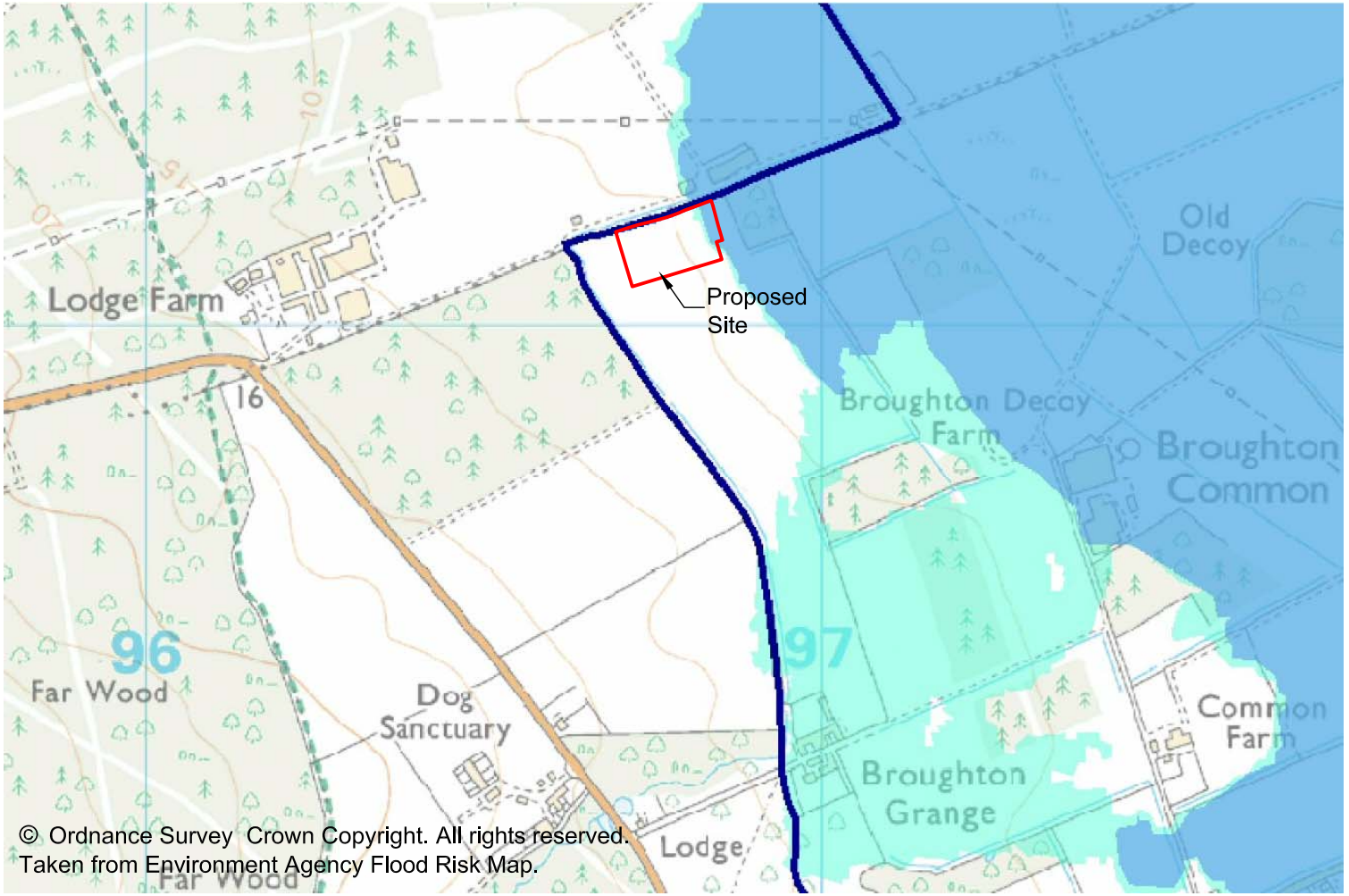
Client: Egdon Resources UK Ltd Wressle Brigg Lincolnshire	Drawn By: AJNE	Date: February 2013	Sheet Size: A3
Job Title: Wressle Site	Drawing Title: Site of Application (1:2,500)		
	Drawing Number: 3334 GF 02		Revision



N

Flood Risk Plan

Scale 1:10,000

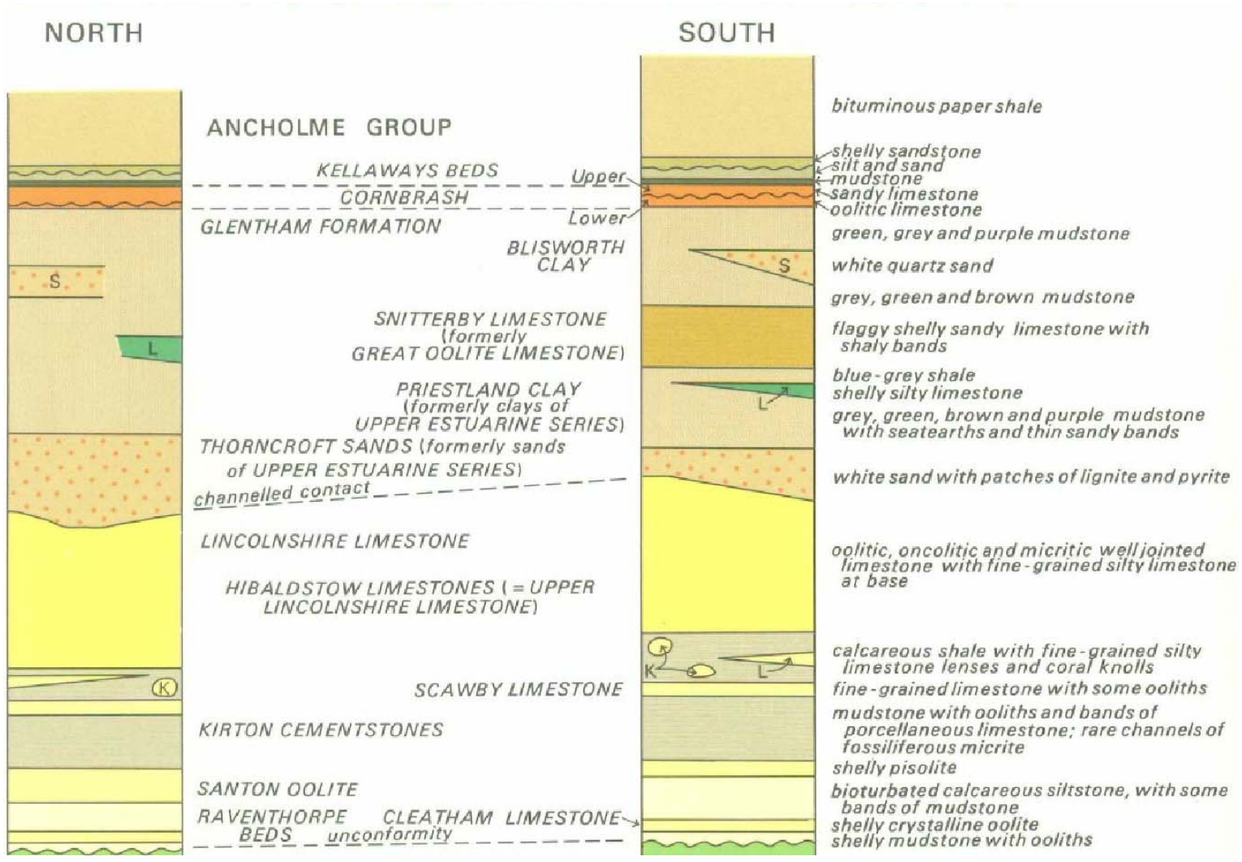
0 100m 200m

Extent of extreme flood

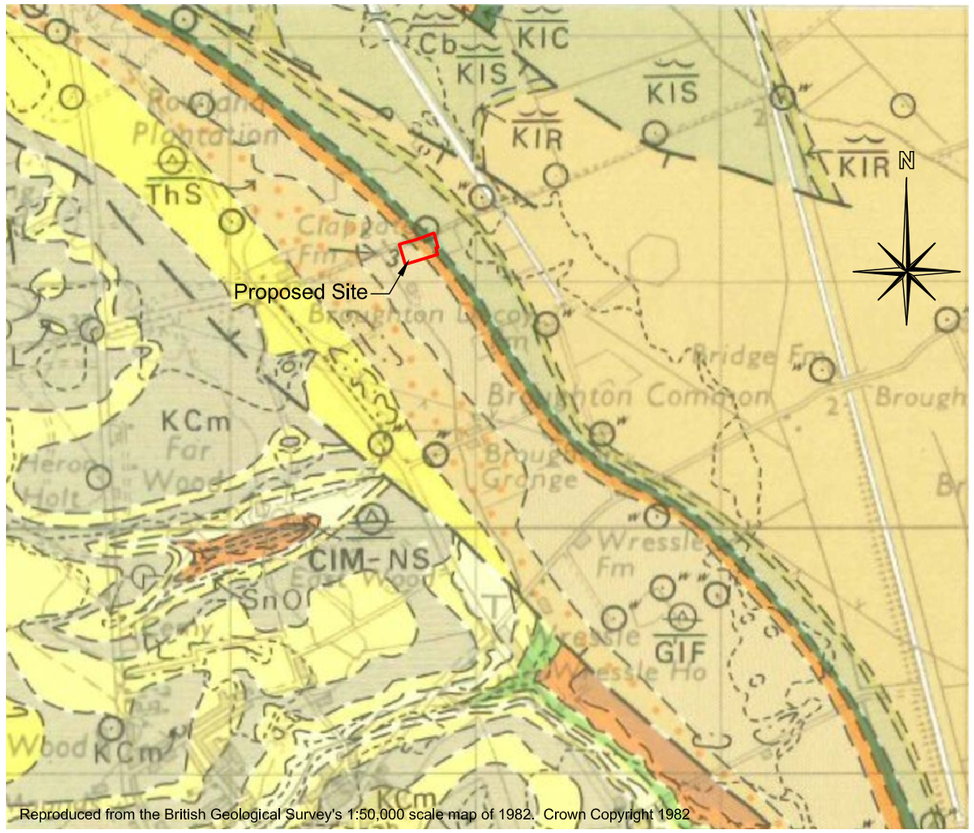
Risk of flooding from rivers or sea without defences

Dennett House
Brighton Road
Sway
Lymington
Hampshire
SO41 6EB

Client: Egdon Resources UK Ltd Wressle Brigg Lincolnshire	Drawn By: AJNE	Date: February 2013	Sheet Size: A4
	Drawing Title: Flood Risk Plan (1:10,000)		
Job Title: Wressle Site	Drawing Number: 3334 GF 03		Revision:



Generalized Vertical Section



Geological Plan

Scale 1:25,000

R ELLIOTT ASSOCIATES LTD
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Client: Egdon Resources UK Ltd	Drawn By: AJNE	Date: February 2013	Sheet Size: A3
Job Title: Wressle Site	Drawing Title: Geological Plan (1:25,000)		
	Drawing Number: 3334 GF 04		Revision:


EGDON

APPENDIX 4 – SURFACE WATER MONITORING RESULTS

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Date: 02/12/2015

Martin Brooks
Production and HSE Manager
Egdon Resources
The Wheat House
98 High Street
Odiham
Hampshire
RG29 1LP

Our Ref: MALT47072850
Your Ref: Wressle Surface Water Sampling

For the attention of: Martin Brooks

Dear Sir

Re: Wressle Surface Water Sampling Report

Please find this to be AECOM's report detailing the multiple rounds of surface water (SW) sampling undertaken at the Wressle exploration drill site during the well's testing phase, between 6th January 2015 and 30th October 2015.

Introduction

AECOM was commissioned (as URS Infrastructure and Environment UK Ltd) by Egdon Resources Plc (Egdon) to undertake sampling of the surface waters in the immediate vicinity of the Wressle exploration drill site prior to the commencement of well testing, during well testing, and following the ceasation of testing and demobilization. URS submitted the proposal[1] on 5th December 2014 and was subsequently authorized by Egdon on 8th December 2014.

Background

Egdon have undertaken the onshore exploration of potential oil resources at the Wressle site, which consisted of the drilling and installation of an operational well to date. The work was performed under a mining waste permit (MWP) as issued by the EA.

A requirement of this mining waste permit was the monitoring and sampling of the adjacent surface water feature (Ella Beck) for a number of predetermined parameters, to be collected from 3no. sampling points before, during and after the works.

URS undertook the surface water sampling on 9no. occasions (before, during and after drilling) from June to September 2014.

Further to the sampling undertaken during the drilling and installation of the well, the MWP requires that sampling continue during the testing of the well.

Site Details

Conventional exploratory onshore oil drilling has been undertaken at the site located approximately 450m east of Sadler's Lodge Farm. An area of woodland is located adjacent east whilst the agricultural

[1] P862902, Proposal for Wressle Drill Site SW Sampling, Dated 05 December 2014

land is located south. The site is bound to the north and west by Ella Brook which is not classified by the Environment Agency (EA) with regards to ecological and chemical quality.

Agricultural land exists in all directions beyond those land uses described above.

Objectives

In order to achieve the project objective, the following scope of works was undertaken:

- **Task 1 – Preliminary Works**: completion of a specific Safe Work Plan (SWP) including method statements and risk assessments for the proposed work.
- **Task 2 – Surface water monitoring**: seven monitoring visits between the 6th January 2015 and 30th October 2015. Monitoring included collection of water quality parameters and surface water samples from three sample locations (S1 to S3) for laboratory analysis.
- **Task 3 – Laboratory analysis:** all samples were transferred to the selected accredited laboratory, Jones Environmental, within secure packaging under chain of custody protocols on the day of sampling.
- **Task 4 – Reporting:** presentation of the results of the monitoring rounds, with conclusions and recommendations.

Surface Water Monitoring

Surface water monitoring was undertaken on seven (7No.) occasions between the 6th January 2015 and 30th October 2015 at three locations (S1 to S3) as follows:

ID	Location
S1	Adjacent to the site.
S2	Upstream of the site.
S3	Downstream of the site.

The sample locations are shown on Figure 1 and photographs are included as Appendix A.

Samples were collected using a bucket which was rinsed with surface water between samples. Water quality parameters, including temperature, dissolved oxygen, conductivity, pH and redox were recorded from water collected in the bucket.

Samples were collected into laboratory-supplied bottle ware and were submitted to Jones in pre-chilled cool-boxes under a chain of custody documentation. Surface water samples scheduled for heavy metals analyses were also filtered in the field using 0.45 micron medium capacity disposable filters to remove suspended sediments prior to storage in bottles containing preservative. All the surface water samples were analysed for the following laboratory suites:

- Metals – arsenic, water soluble boron, cadmium, calcium, chromium (total), copper, lead, mercury, nickel, selenium and zinc
- Inorganic compounds – chloride, ammoniacal nitrogen, carbonate alkalinity, pH and dissolved solids;
- PAH (Polycyclic Aromatic Hydrocarbons) – suite of 17 individual PAH compounds;
- MTBE/BTEX – Methyl tert butyl ether, benzene, toluene, ethylbenzene and xylenes;

- TPH CWG (6th January and 2nd June 2015 only) – Total Petroleum Hydrocarbons Criteria Working Group; and,
- EPH (all rounds with the exception of 30th June 2014) – Total Extractable Petroleum Hydrocarbons (C_8-C_{40}).

Fieldwork Findings

Surface Water Quality Parameters

Surface water quality parameters are presented in Table 1 and summarised below:

- Redox potential of surface water ranges from 90.2 (S3) to 462.7 (S3).
- Electrical conductivity of surface water ranges from 920mS/cm (S3) to 1018mS/cm (S1).
- Surface water pH ranges from 5.65 (S1) to 7.95 (S3).
- Surface water temperature ranges from 4.9 º C to 15.8 ºC (both S3) which indicate normal, seasonally linked variations.
- Dissolved oxygen concentrations range from 9.46mg/L (S3) to 17.78mg/L (S1) indicating well-oxygenated waters, the concentration of which varies naturally with temperature.

Laboratory Results

The results were screened against Environmental Quality Standards (EQS) for rivers and freshwater lakes provided in the Water Framework Directive (WFD), England and Wales, 2010 in order to assess potential risks to Ella Brook. Where concentrations exceed the EQS, this indicates that the brook would not be classified as 'Good' under the WFD. The surface water results indicate that the concentration of calcium carbonate was generally not reported above the method reporting limit (MRL) and therefore the EQS used in this assessment is taken from the lowest CaCO3 range (0-50mg/l).

Where EQS values were not available, concentrations were compared against criteria provided in SEPA - Supporting Guidance (WAT-SG-53) Environmental Standards for Discharges to Surface Waters. v4.0. Apr 2013.

Laboratory results are presented against screening criteria in Tables 2 to 3 and laboratory certificates are presented in Appendix B.

Metals and Inorganics

In general, concentrations of metals and inorganics did not exceed the EQS. Concentrations of ammoniacal nitrogen exceeded the EQS of 300µg/l (Good) on one occasion (07/08/15) at all three sampling locations. This concentration would classify the quality of Ella Brook as moderate. However, given the location of the site in an agricultural area, the ammoniacal nitrogen is likely to be the result of the addition of fertilisers to the soil, potentially exacerbated by the weather at the time of sampling.

The pH varied between 5.65 and 7.95 throughout the sampling events. This is considered to be within the normal range for a surface water course.

PAHs

There were no reported concentrations of PAHs in excess of the respective screening criteria for any surface water samples recovered during the sampling events.

TPH CWG / MTBE / EPH
Concentrations of TPH fractions, MTBE and total EPH were reported below the method detection limit in all the samples analysed.

Conclusion

A total of seven (7No.) surface water monitoring rounds were undertaken between January 2015 and end of October 2015 during the well testing phase of the works. Recorded concentrations of the majority of analytes at the sample locations S 1 did not exceed the EQS. Where the concentration of ammoniacal nitrogen did exceed the EQS at all sample locations on one occasion, this is considered to be an isolated occurrence and is not likely to be caused by works currently being undertaken at the site.

Therefore, the well testing works are unlikely to have had an adverse effect on the surface water quality of Ella Beck.

Table 1
Water Quality Parameters in the Surface Water Samples

Sample Location	Temp (°C) 06/01/2015	Temp (°C) 11/02/2015	Temp (°C) 12/03/2015	Temp (°C) 02/06/2015	Temp (°C) 16/07/2015	Temp (°C) 07/08/2015	Temp (°C) 30/10/2015	Max	Min
Sample point 1	7.4	5	8.4	10.1	15.4	13.3	12.6	15.4	5
Sample point 2 (upstream)	7.4	5.1	8.4	9.8	15.5	13.3	12.7	15.5	5.1
Sample point 3 (downstream)	7.4	4.9	8.6	10.4	15.8	13	12.8	15.8	4.9

Sample Location	DO (mg/L) 06/01/2015	DO (mg/L) 11/02/2015	DO (mg/L) 12/03/2015	DO (mg/L) 02/06/2015	DO (mg/L) 16/07/2015	DO (mg/L) 07/08/2015	DO (mg/L) 30/10/2015	Max	Min
Sample point 1	13.67	11.54	17.78	13.65	10.75	11.53	13.29	17.78	10.75
Sample point 2 (upstream)	13.69	11.36	16.94	13.22	10.04	11.01	11.94	16.94	10.04
Sample point 3 (downstream)	14.85	11.58	17.22	14	11.54	9.46	11.11	17.22	9.46

Sample Location	SPC (µs/cm) 06/01/2015	SPC (µs/cm) 11/02/2015	SPC (µs/cm) 12/03/2015	SPC (µs/cm) 02/06/2015	SPC (µs/cm) 16/07/2015	SPC (µs/cm) 07/08/2015	SPC (µs/cm) 30/10/2015	Max	Min
Sample point 1	988	954	955	989	931	1018	744	1018	931
Sample point 2 (upstream)	984	953	954	974	933	1013	656	1013	933
Sample point 3 (downstream)	987	955	975	985	920	1015	858	1015	920

Sample Location	pH 06/01/2015	pH 11/02/2015	pH 12/03/2015	pH 02/06/2015	pH 16/07/2015	pH 07/08/2015	pH 30/10/2015	Max	Min
Sample point 1	6.39	6.77	6.56	7.01	5.65	5.77	6.17	7.01	5.65
Sample point 2 (upstream)	7.39	7.49	7.36	7.31	6.4	6.38	6.71	7.49	6.38
Sample point 3 (downstream)	7.79	7.95	7.76	7.52	6.95	6.86	7.15	7.95	6.86

Sample Location	ORP 06/01/2015	ORP 11/02/2015	ORP 12/03/2015	ORP 02/06/2015	ORP 16/07/2015	ORP 07/08/2015	ORP 30/10/2015	Max	Min
Sample point 1	377.1	284	462.1	388.2	126.1	121.4	167.1	462.1	121.4
Sample point 2 (upstream)	361.4	221.36	455.4	399	104.2	104.8	131.2	455.4	104.2
Sample point 3 (downstream)	337.4	272.9	462.7	407.1	92.5	90.2	107.3	462.7	90.2

DO = dissolved oxygen
SPC = specific conductivity
ORP = oxygen reducing potential
ORP values corrected with SHE (Standard Hydrogen Electrode)
values for the corresponding temperature

Analyte	Controlled Waters		Sample ID	S1							S2							S3						
	GAC	Source	LOD	06/01/2015	11/02/2015	12/03/2015	02/06/2015	16/07/2015	07/08/2015	30/10/2015	06/01/2015	11/02/2015	12/03/2015	02/06/2015	16/07/2015	07/08/2015	30/10/2015	06/01/2015	11/02/2015	12/03/2015	02/06/2015	16/07/2015	07/08/2015	30/10/2015
Arsenic	50	WFD EQS 2010 Fresh (Eng/Wal)	<2.5	5.5	-	-	-	-	-	-	2.7	-	-	-	-	-	-	6.4	-	-	-	-	-	-
Boron	2000	SEPA WAT-SG-53 Fresh EQS - AA - 2013	<12	65	59	61	32	91	85	67	63	58	59	31	88	85	63	60	58	60	33	86	84	71
Cadmium	0.08	WFD EQS 2010 Fresh (Eng/Wal)	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calcium			<0.2	156100	163600	157300	N/A	144000	148800	109700	157100	159500	159100	N/A	144800	149100	99800	157900	170300	165000	N/A	147200	148100	129600
Total Chromium	3.4	WFD EQS 2010 Fresh (Eng/Wal)	<1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	1	WFD EQS 2010 Fresh (Eng/Wal)	<7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	7.2	WFD EQS 2010 Fresh (Eng/Wal)	<5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	0.05	WFD EQS 2010 Fresh (Eng/Wal)	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	20	WFD EQS 2010 Fresh (Eng/Wal)	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium			<3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	8	WFD EQS 2010 Fresh (Eng/Wal)	<3	6	-	4	-	4	3	4	4	-	-	-	3	3	5	4	-	4	4	-	-	3
Chloride	250000	SEPA WAT-SG-53 Fresh EQS - AA - 2013	<300	50800	58100	58400	46800	72900	69700	50400	50600	58300	58300	46100	73400	70600	47200	50800	58500	58500	44000	72700	70200	60100
Ammoniacal Nitrogen as N	300	WFD EQS 2010 Fresh (Eng/Wal)	<30	50	50	40	30	70	320	40	50	50	50	30	80	320	50	50	60	50	-	50	470	50
Carbonate Alkalinity as CaCO3			<1000	-	-	-	212000	12000	32000	-	-	-	-	214000	-	-	-	-	-	-	198000	-	-	-
pH			<0.01	8.15	8.13	7.41	7.93	8.47	8.33	8.03	8.08	8.09	7.34	7.97	8.18	8.13	7.87	8.10	8.12	7.41	7.97	8.23	8.04	8.04
Total Dissolved Solids			<10000	587000	611000	522000	443000	616000	647000	430000	594000	574000	590000	462000	678000	611000	488000	596000	606000	572000	461000	692000	627000	616000

All the results are in µg/L
LOD = Limit of detection
- denotes Lower than the limit of detection

xx Indicates a GAC exceedance

Analyte	Controlled Waters		Sample ID	S1							S2							S3						
	GAC	Source	LOD	06/01/2015	11/02/2015	12/03/2015	02/06/2015	16/07/2015	07/08/2015	30/10/2015	06/01/2015	11/02/2015	12/03/2015	02/06/2015	16/07/2015	07/08/2015	30/10/2015	06/01/2015	11/02/2015	12/03/2015	02/06/2015	16/07/2015	07/08/2015	30/10/2015
Acenaphthene			<0.013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acenaphthylene			<0.013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	0.1	WFD EQS 2010 Fresh (Eng/Wal)	<0.013	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)anthracene			<0.015	-	-	-	-	0.020	-	-	-	-	-	-	-	-	-	0.02	0.02	-	-	-	-	-
Benzo(a)pyrene	0.05	WFD EQS 2010 Fresh (Eng/Wal)	<0.016	-	0.02	-	-	0.030	-	-	0.02	-	-	-	0.020	-	-	0.03	0.02	-	-	-	-	-
Benzo(b)fluoranthene			<0.01	-	-	-	-	0.04	-	-	-	-	0.01	-	0.02	-	-	0.03	-	0.01	-	-	-	-
Benzo(bk)fluoranthene			<0.018	-	-	-	-	0.050	-	-	-	-	0.02	-	0.030	-	-	0.04	-	0.02	-	-	-	-
Benzo(ghi)perylene			<0.011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene			<0.01	-	-	-	-	0.01	-	-	-	-	-	-	-	-	-	0.01	-	-	-	-	-	-
Chrysene			<0.011	-	-	-	-	0.030	-	-	-	-	-	-	0.020	-	-	0.02	0.020	-	-	-	-	-
Dibenzo(ah)anthracene			<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	0.1	WFD EQS 2010 Fresh (Eng/Wal)	<0.012	0.02	0.030	0.020	-	0.050	0.02	-	0.02	0.020	0.020	-	0.040	-	-	0.03	0.050	0.020	0.030	-	-	0.02
Fluorene			<0.014	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indeno(123cd)pyrene			<0.011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	2.4	WFD EQS 2010 Fresh (Eng/Wal)	<0.014	0.07	-	-	-	0.050	0.03	-	0.17	-	0.030	-	0.050	-	-	0.28	-	-	-	0.180	-	-
PAH 16 Total			<0.195	-	-	-	-	0.290	-	-	0.26	-	-	-	0.210	-	-	0.49	-	-	-	-	-	-
Phenanthrene			<0.011	0.02	0.020	0.020	-	0.020	-	-	0.03	-	0.020	-	0.020	-	-	0.03	0.030	0.020	-	-	-	-
Pyrene			<0.013	0.02	0.030	0.020	-	0.040	0.02	-	0.02	0.020	0.020	-	0.030	-	-	0.04	0.040	0.020	-	-	-	0.02

All the results are in µg/L
LOD = Limit of detection
- denotes Lower than the limit of detection

xx Indicates a GAC exceedance

Analyte	Controlled Waters		Sample ID	S1							S2							S3						
	GAC	Source	LOD	06/01/2015	11/02/2015	12/03/2015	02/06/2015	16/07/2015	07/08/2015	30/10/2015	06/01/2015	11/02/2015	12/03/2015	02/06/2015	16/07/2015	07/08/2015	30/10/2015	06/01/2015	11/02/2015	12/03/2015	02/06/2015	16/07/2015	07/08/2015	30/10/2015
Methyl Tertiary Butyl Ether	2600	PNEC	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	10	WFD EQS 2010 Fresh (Eng/Wal)	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	50	WFD EQS 2010 Fresh (Eng/Wal)	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	20	SEPA WAT-SG-53 Fresh EQS - AA - 2013	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p/m-Xylene			<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
o-Xylene	30	WFD EQS 2010 Fresh (Eng/Wal)	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatics																								
>C5-C6			<5	-	EPH<10	EPH<10	-	EPH<10	EPH<10	EPH<10	-	EPH<10	EPH<10	-	EPH<10	EPH<10	EPH<10	-	EPH<10	EPH<10	-	EPH<10	EPH<10	EPH<10
>C6-C8			<5	-			-				-			-				-			-			
>C8-C10			<5	-			-				-			-				-			-			
>C10-C12			<5	-			-				-			-				-			-			
>C12-C16			<10	-			-				-			-				-			-			
>C16-C21			<10	-			-				-			-				-			-			
>C21-C35			<10	-			-				-			-				-			-			
Total aliphatics C5-35			<10	-			-				-			-				-			-			
Aromatics																								
>C5-EC7	10	WFD EQS 2010 Fresh (Eng/Wal)	<5	-			-				-			-				-			-			
>EC7-EC8	50	WFD EQS 2010 Fresh (Eng/Wal)	<5	-			-				-			-				-			-			
>EC8-EC10			<5	-			-				-			-				-			-			
>EC10-EC12			<5	-			-				-			-				-			-			
>EC12-EC16			<10	-			-				-			-				-			-			
>EC16-EC21			<10	-			-				-			-				-			-			
>EC21-EC35			<10	-			-				-			-				-			-			
Total aromatics C5-35			<10	-			-				-			-				-			-			
Total aliphatics and aromatics(C5-35)			<10	-			-				-			-				-			-			

All the results are in µg/L
LOD = Limit of detection
- denotes Lower than the limit of detection

xx Indicates a GAC exceedance

APPENDIX 5 – RADIOLOGICAL MONITORING RESULTS

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Technical Report

Radiological Baseline Survey and Monitoring of the Egdon Resources UK Ltd's Wressle Well-site

Studsvik Contract Reference: P0753

Studsvik Report Reference: P0753/TR/001

Revision: A

Date: 19/02/2016

Prepared By: ..... Date: 19/02/16

Richard Fletcher
Waste Management Consultant

Checked By: ..... Date: 19/02/16

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Checking Level: ~~One /~~ Two ~~/ Three (see QP/04 for ref)~~

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REVISION SHEET

Rev.	Description	Revised By	Checked By	Approved By
A	First Issue	Richard Fletcher	Megan Carroll	Nick Chambers

EXECUTIVE SUMMARY

This report presents the results of a radiological baseline survey and reassurance monitoring conducted at the Egdon Resources UK Ltd Wressle well-site on 9th April 2015. The purpose was to determine whether there was significant radiological contamination arising from Naturally Occurring Radioactive Material (NORM) on the site's surface and immediate sub-surface material, and local area surrounding the site, and to produce a radiological baseline against which future sampling and monitoring could be compared. The information contained within this report can also be used as part of any future site condition report required for permit surrender.

The samples taken for the radiological baseline survey showed no significant presence of NORM and when the results were assessed against the EPR 2010 Out-of-Scope limits, all 6 samples were below the limit. Similarly, the areas that were monitored for dose-rate and surface contamination showed no significant presence of NORM.

GLOSSARY

cps	Counts per second
EPR 2010	Environmental Permitting (England and Wales) Regulations 2010, as amended
HRGS	High Resolution Gamma Spectrometry
LOD	Limit of Detection
NORM	Naturally Occurring Radioactive Material
RPA	Radiation Protection Adviser
RSR	Radioactive Substances Regulations
RWA	Radioactive Waste Adviser

CONTENTS

LIMITATIONS

This report has been prepared by Studsvik Limited in their professional capacity as Consultants, with all reasonable skill, care and diligence within the terms of the Contract with the Client. The advice and opinions in this report are based upon the information made available at the date of this report and on current UK standards, codes and legislation. The contents of this report do not, in any way, purport to include any manner of legal advice or opinion. This report has been produced in accordance with the terms and conditions associated with Egdon purchase order 1337.

Should the Client release this report to a Third Party, that Third Party does not acquire any rights, contractual or otherwise, whatsoever against Studsvik Limited and accordingly, Studsvik Limited assumes no duties, liabilities or obligations to that Third Party.

1 INTRODUCTION

This report presents the results of a radiological baseline survey and reassurance monitoring conducted at the Egdon Resources UK Ltd Wressle well-site on 9th April 2015. The purpose was to determine whether there was significant radiological contamination arising from Naturally Occurring Radioactive Material (NORM) on the site's surface and immediate sub-surface material, and the local area surrounding the site.

Egdon Resources UK Ltd are an established oil and gas exploration and production company operating onshore oil and gas production sites in the UK. Their Wressle well-site has recently been identified as requiring regulation under the Environmental Permitting (England and Wales) Regulations 2010 (EPR 2010) (as amended) Radioactive Substances Regulations (RSR). As a RSR permit is now held for the site, there is a requirement for radiological monitoring to establish a baseline of the radiological conditions. As the requirement for a permit has only recently been identified the survey only relates to site conditions at the time of the survey.

The information contained within this report can also be used as part of any future site condition report required for permit surrender.

2 SAMPLING RESULTS

A total of 10 samples were taken from accessible areas on-site and off-site adjacent to the perimeter boundary [Ref. 1]. The samples were made up of a minimum of 10 subsamples from each area. The areas the samples were taken from are shown in Appendix A.

Samples 3 to 10 were bulked together in North, East, and South and West perimeter pairs to produce 4 samples for analysis. A total of 6 samples were sent for analysis, as shown in Table 1.

Table 1 – Samples taken and sent for gamma spectrometry analysis

GAU ID	Studsvik ID	Location
GAU3310-1	EW/P1	On-site
GAU3310-2	EW/P2	On-site
GAU3310-3+4	EW/W1+EW/W2	West perimeter
GAU3310-5+6	EW/N1+EW/N2	North perimeter
GAU3310-7+8	EW/E1+EW/E2	East perimeter
GAU3310-9+10	EW/S1+EW/S2	South perimeter

The samples were analysed by High Resolution Gamma Spectrometry (HRGS) and the results assessed to determine whether the material could be considered as being Out-of-Scope of the EPR 2010. Note that this assumes the material is considered as a waste.

The results for the natural radionuclides were assessed in terms of their upper limits [i.e. uncertainties were added to the reported values] to ensure a cautious approach.

For the results reported as the Limit of Detection (LOD), the LOD was assumed to be the actual activity concentration present, in order to represent a bounding activity.

Table 2 - Results of gamma spectrometry analysis and waste category assessment

		Upper Limit (Bq/g)													
		Th-232 Chain				U-235	U-238 Chain					^{40}K	Summation Quotation for Out of Scope	NORM Waste Concentration (Bq/g)	Waste Category
GAU ID	Studsvik ID	^{228}Ac	^{212}Pb	^{212}Bi	^{208}Tl		^{234}Th	^{226}Ra	^{214}Pb	^{214}Bi	^{210}Pb				
GAU3310-1	EW/P1	0.07	0.09	0.09	0.02	0.01	0.10	0.11	0.09	0.09	0.01	0.19	0.57	0.23	Out of Scope
GAU3310-2	EW/P2	0.06	0.09	0.07	0.02	0.01	0.07	0.11	0.10	0.10	0.01	0.15	0.55	0.23	Out of Scope
GAU3310-3+4	EW/W1+EW/W2	0.01	0.01	0.01	0.00	0.00	0.02	0.01	0.01	0.01	0.02	0.26	0.07	0.04	Out of Scope
GAU3310-5+6	EW/N1+EW/N2	0.01	0.01	0.01	0.00	0.00	0.01	0.02	0.01	0.01	0.02	0.26	0.08	0.03	Out of Scope
GAU3310-7+8	EW/E1+EW/E2	0.01	0.01	0.02	0.00	0.00	0.01	0.02	0.01	0.01	0.02	0.27	0.12	0.05	Out of Scope
GAU3310-9+10	EW/S1+EW/S2	0.01	0.01	0.01	0.00	0.00	0.01	0.02	0.01	0.01	0.02	0.23	0.08	0.03	Out of Scope
	Min	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.15		0.03	
	Max	0.07	0.09	0.09	0.02	0.01	0.10	0.11	0.10	0.10	0.02	0.27		0.23	
	Average	0.03	0.04	0.04	0.01	0.00	0.04	0.05	0.04	0.04	0.02	0.23		0.10	

To assess whether the material is Out-of-Scope, should it be considered as a waste, a sum of quotients was performed on the results using the Out-of-Scope limits in Schedule 23 PART 3 Table 1 of the EPR 2010. The sum of quotients for the 6 samples was less than 1, establishing that they are Out-of-Scope of EPR 2010.

The samples were also analysed for gross alpha and gross beta emitting radionuclides. The results were in agreement with the HRGS results, and confirmed the absence of any radiologically-significant contamination.

The original results were reported in GAU3310 on 26th April 2015, this is attached in Appendix B.

3 CONTAMINATION MONITORING RESULTS

In addition to the radiological baseline sampling, reassurance monitoring was also undertaken. This included direct probe dose-rate and contamination monitoring for alpha/beta contamination. The instrumentation used for monitoring is given in Table 3 and the results by area are given in Table 4. The results presented in Table 4 are an average, the full results from monitoring are given in Appendix C.

Table 3 – Instrumentation used for dose-rate and contamination monitoring

Instrument	Serial Number	Readings taken
Thermo Scientific RadEye B20-ER	0699	µSv/h
Tracerco T401	112086	cps

Table 4 – Average results of direct probe monitoring in gross dose-rate and gross counts per second (cps)

Area/item monitored	Studsvik ID	Average Dose-rate (µSv/h)	Average counts per second (cps)
Off-site North perimeter	EW/N1+EW/N2	0.14	1.2
Off-site East perimeter	EW/E1+EW/E2	0.10	1.2
Off-site South perimeter	EW/S1+EW/S2	0.14	1.2
Off-site West perimeter	EW/W1+EW/W2	0.19	1.2
On-site surface	P1a	0.29	1.8
On-site surface	P1b	0.21	1.8
On-site surface	P2a	0.28	1.9
On-site surface	P2b	0.30	1.8
Site surface - Area adjacent to well pad	N/A	-	1.8
Site surface - Area of apparent drill cuttings	N/A	-	1.3
Tubular (external only)	N/A	-	0.8
Well pad	N/A	-	1.0
Christmas Tree	N/A	-	1.2
Background	N/A	0.26	1.5

In order to demonstrate that the instruments were functioning correctly during the survey, the instruments were calibrated and function checks were performed on the instruments prior to the commencement of monitoring (pre-use function check) and after the conclusion of monitoring (post-use function check), as per Studsvik Working Practice WP/RP/060.

4 SUMMARY AND CONCLUSIONS

In April 2015, a radiological baseline survey and reassurance monitoring was undertaken on the Egdon Resources UK Ltd Wressle well-site and immediate surrounding area. The purpose was to determine the presence, or otherwise, of radiologically significant contamination related to NORM.

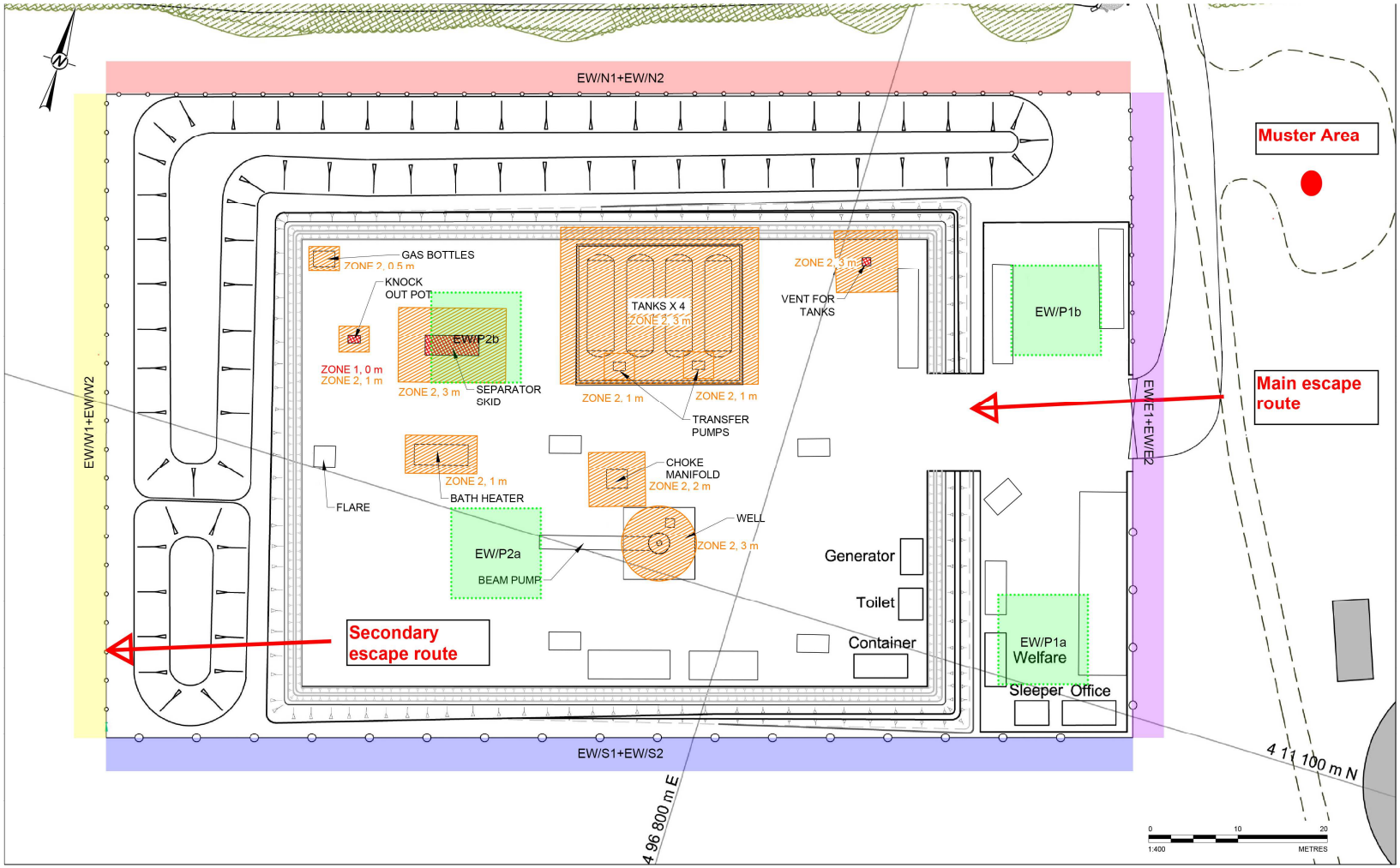
The samples taken for the radiological baseline survey showed no significant presence of NORM or any other radiologically-significant contamination and when the results were assessed against the EPR 2010 Out-of-Scope limits, all 6 samples were below the limit. Similarly, the areas that were monitored for dose-rate and surface contamination showed no significant presence of NORM.

The HRGS results from two samples taken on-site (EW/P1 and EW/P2) did show slightly elevated levels of radionuclides in the natural decay series (Th-232 and U-238) when compared to samples taken off-site. It is a reasonable assumption that the elevated levels are due to the use of foundry slag to cover made ground. This by-product can contain elevated concentrations of naturally occurring radionuclides as a result of the smelting process.

5 REFERENCES

1. P0753/SP/001 – Rev. B – Egdon Wressle 1 well-site baseline sampling plan

APPENDIX A – SAMPLE LOCATION MAP



APPENDIX B – SAMPLE RESULTS

GAU Radioanalytical Laboratories

UKAS TESTING 2758

Report **Gamma and gross alpha beta analysis of 10 sediment samples**

(Sample IDs: EW/P1, EW/P2, EW/W1, EW/W2, EW/N1, EW/N2, EW/E1, EW/E2, EW/S1, EW/S2.)

Studsvik UK Ltd

Customer	Studsvik UK Ltd, Ribble House Meanygate Bamber Bridge Lancashire PR5 6UP
Customer purchase number	8305
GAU job number	GAU3310
Date samples received	24th April 2015
Report date	26th May 2015
Report produced by	Madeleine Cobbold (Technical Support, GAU-Radioanalytical)
Signed	
Report authorised by	Prof P. E. Warwick (Deputy Director, GAU-Radioanalytical)
Signed	

Job reference number
GAU3310

Methodology
The samples were received in good condition by GAU-Radioanalytical on **24th April 2015**.

Sample Preparation
10 sediment samples were received with the request that the samples labelled 1 + 2 for letters W, N, E and S be bulked together to form a total of 6 samples for analysis (see Sample Summary table below).
A sub-sample was taken from each pot and dried at 100°C over the weekend. 20g of each sample to be bulked was taken and combined to form 4 bulk samples of 40g each. These bulk samples were homogenised and a sub-sample was taken for gamma analysis from all 6 samples. After counting, a sub-sample of the gamma spectrometry fraction was ground and sieved prior to gross alpha beta analysis.

Gamma spectrometry (GAU/RC/2032: Accredited to ISO/IEC 17025:2005)
High resolution gamma spectrometric analysis was performed using HPGe detectors. Detectors were calibrated against a mixed radionuclide standard solution. The standard was used to prepare a source of identical geometry to that of the samples. Gamma spectra were analysed and individual radionuclides quantified using Fitzpeaks spectral deconvolution software (JF Computing Services). All anthropogenic gamma emitting radionuclides detected were reported.

Gross alpha and beta in solid samples using GFPC (GAU/RC/2028)
The samples were dried, ground and sieved through a 125µm sieve, approximately 125mg of the sieved material was mounted on a filter paper. The samples were counted by gas flow proportional counting. Gross alpha and beta activities were determined relative to ^{241}Am (alpha) and ^{137}Cs (beta).

Limits of detection / quantification

For gamma data, limits of quantification, LQ, is calculated as defined by Currie (1968) and Gilmore & Hemingway (2000)

Limits of detection for other radiochemical analyses are quoted as L_D as defined by Currie, 1968.

References

Currie L.A. (1968). Limits of qualitative detection and quantitative determination. *Analytical Chemistry*, ***40 (3),*** *586-593.*

Gilmore G. and Hemingway J. (2000). Practical gamma-ray spectrometry. John Wiley, Chichester, UK

Job reference number
GAU3310

Summary of samples and Results

GAU ID	Customer ID	Sample type	Wet dry ratio	Comments
GAU3310-1	EW/P1	Sediment	1.04	-
GAU3310-2	EW/P2	Sediment	1.08	-
GAU3310-3	EW/W1	Sediment	1.11	Bulked together
GAU3310-4	EW/W2	Sediment	1.09	
GAU3310-5	EW/N1	Sediment	1.11	Bulked together
GAU3310-6	EW/N2	Sediment	1.10	
GAU3310-7	EW/E1	Sediment	1.12	Bulked together
GAU3310-8	EW/E2	Sediment	1.16	
GAU3310-9	EW/S1	Sediment	1.08	Bulked together
GAU3310-10	EW/S2	Sediment	1.09	

Gross alpha and gross beta results

GAU ID	Gross alpha	+/-	Gross beta	+/-
GAU3310-1	1.7	0.3	0.9	0.2
GAU3310-2	1.3	0.3	1.0	0.2
GAU3310-3+4	<0.2	-	<0.4	-
GAU3310-5+6	<0.2	-	0.5	0.2
GAU3310-7+8	<0.2	-	0.4	0.2
GAU3310-9+10	<0.2	-	0.4	0.2

Results are quoted in Bq/g of dry sample.
Uncertainties are based on combined standard uncertainties.
Coverage factor k = 2 S.D.

Job reference number
GAU3310

Gamma spectrometry*

Artificial Radionuclides*

GAU ID	^{60}Co	+/-	^{137}Cs	+/-	^{241}Am	+/-
GAU3310-1	<0.002	-	<0.001	-	<0.001	-
GAU3310-2	<0.001	-	<0.0006	-	<0.001	-
GAU3310-3+4	<0.002	-	0.0022	0.0007	<0.0009	-
GAU3310-5+6	<0.0009	-	0.0015	0.0004	<0.0007	-
GAU3310-7+8	<0.001	-	0.0018	0.0006	<0.0009	-
GAU3310-9+10	<0.0009	-	0.0022	0.0004	<0.0008	-

*Indicates results obtained using an accredited method.
Results are quoted in Bq/g of sample dried.
All anthropogenic radionuclides detected were reported.
Uncertainties are based on combined standard uncertainties.
Coverage factor k=2 S.D.
Reference date: 24/04/2015