SSE Hornsea Aldbrough Gas Storage

Application Site Report for PPC Permit Application

April 2006

JACOBS

Scottish and Southern Energy

Document control sheet Form IP180/B

Client: SSE Hornsea Ltd
Project: Natural Gas Storage Facility, Aldbrough Job No: 60709002
Title: Site Report for PPC Application

	Prepared by	Reviewed by	Approved by
DRAFT	NAME **DJ Rowley**	NAME **G Harker**	NAME **ISC Hughes**
DATE **April 2006**	SIGNATURE	SIGNATURE	SIGNATURE

DRAFT	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

REVISION	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

REVISION	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

Executive Summary

This document represents the Site Report for SSE Hornsea's Natural Gas Storage Facility at Aldbrough and is submitted as part of an application to the Environment Agency (application number HP3336SL) for a permit to operate an installation under Regulation 10 of the Pollution Prevention and Control (England and Wales) Regulations 2000.

Records of the site and surrounding areas have been reviewed, along with proposed operational records for the site, in order to describe the condition of the site and, in particular, to identify any substance in, on or under the land that may constitute a pollution risk to the land. Pollution prevention measures have been identified and an assessment of pollution potential to land has been undertaken.

Due to the stringent engineering standards employed in the design of the facility and the control measures in place, the assessment has been made that there is little likelihood that land pollution or leaks to the land will occur during the future life of the installation.

Contents

1 Introduction

SSE Hornsea Limited, part of Scottish and Southern Energy Limited (SSE), commissioned Jacobs to prepare an Application Site Report for their new gas storage facility at Aldbrough. This report is required to establish the baseline environmental condition of the site prior to the Pollution Prevention and Control (PPC) permit being granted.

This document has been based on the Environment Agency (EA) template for an Application Site Report in Pollution Prevention and Control Applications dated August 2003.

1.1 Site Location

The installation is located off the B1242 Aldbrough / Garton Road, approximately 2km south-east of the town of Aldbrough. The centre of the site is at National Grid Reference 526000, 437000. The site covers a surface area of 20.2 hectares and can be seen in Figure A1-1.

The site comprises two distinct areas – the Central Processing Area (CPA) and the number one wellhead. The CPA is approximately square in shape and contains the processes for injection and extraction of gas from the storage caverns. The eastern third of this area is the Drilling and Leaching Platform containing Wellheads 2-9. The installation boundary of the CPA is formed generally by the site fence.

Wellhead 1 is located west of the CPA and is linked to the CPA by the gas line, around which the installation boundary runs. The Wellhead 1 installation boundary is again formed by the fenceline to create a rectangular plot containing only Wellhead 1.

Immediately outside the installation boundary fence are screening mounds, to a maximum height of 3m above the CPA. Beyond these, the area around the installation is generally flat-lying agricultural land. Bail Wood, approximately 120m west of the installation boundary, is an area of Ancient and Semi-Natural Woodland.

Springfield Farm lies approximately 375m west of the Wellhead 1 installation boundary. Buildings belonging to Bail View Farm lie approximately 440m west of the south-western corner of the installation. New Ringborough Farm lies approximately 500m east of the installation boundary, with Grange Farm approximately 900m north-east and Ringborough village approximately 1100m to the north east.

1.1.1 Topography

The installation is situated approximately 1.2 km west of the North Sea coast. The land generally falls gently to the west from the North Sea coast with the site originally lying at an elevation of between 10 and 15m AOD. The land has been regraded as part of the construction works with the Central Processing Area constructed on a plateau at 11.5m AOD with perimeter screening bunds to a maximum height of 14.5m AOD.

The Agricultural Land Classification (ALC) of soils on the site is grade 3B – moderate quality agricultural land (Reference 17).

1.2 Details of the Installation

1.2.1 Installation Activities

The Installation will comprise the following Schedule 1 activities:

- *Schedule 1, Section 1.2, Part A (1) (a) – Refining gas where this is likely to involve the use of 1,000 tonnes or more of gas in any period of 12 months.*

In addition, the storage of gas within the caverns is a directly associated activity of the installation.

1.2.2 Purpose

The purpose of the storage site is to provide storage services to the owners and users of the National Transmission System (NTS) and it is of strategic national importance.

Natural gas will be stored in nine underground caverns. The caverns are formed by drilling into the salt strata that lies approximately 1.8 km below the site and pumping seawater down the hole to dissolve the salt. Brine is extracted and pumped back out to the North Sea. Cavern formation is a construction process and is thus not an activity covered by the PPC permit.

At the date of application for the PPC permit, construction of the caverns is ongoing.

Gas will be taken from the NTS, compressed and piped into the caverns for storage. Upon withdrawal of the gas from the caverns, methanol may be added to prevent hydrate formation, and the gas will be heated and dried before being sent back to the NTS via underground pipeline. The processes within the gas plant are summarised below:

(a) Gas Injection

Gas from the NTS is compressed by 2-stage centrifugal compressors driven by variable speed electric drives with an interstage air cooler and discharge air cooler.

(b) Gas Storage

Gas is stored under pressure in nine underground caverns.

(c) Gas Withdrawal

Gas is heated by a hot water inline heater at the wellhead to keep the gas temperature sufficiently above the hydrate formation temperature. Methanol may be added to assist in preventing hydrate formation. Gas then enters the gas plant through a common injection / withdrawal manifold before passing into one of two separate production trains. The production trains consist of:

- *Pressure reduction system and liquid knock-out facilities (filter separators).*
- *Silica gel drying system in five dehydration adsorbers with a regeneration gas heater, regeneration cooler and a regeneration knock-out vessel.*

Following dehydration, the gas is metered before being supplied back to the NTS.

1.2.3 Installation Layout

The purpose of the main items of plant within the Wellhead 1 and Central Processing Areas are described in Section 3 of the associated PPC Permit Application Supporting Information document.

Apart from the natural gas stored in the caverns, the only bulk raw material to be stored and used at the site is methanol. This will be stored in the 35m^3 above ground methanol tank which is contained within a 110% bund. Other minor chemicals will be stored in drums or other containers within a chemical store, in the control building.

Processes will be controlled from a dedicated control room with the control system designed to provide automatic, semi-automatic and manual control of the CPA facilities. It is intended in future to control the site from the nearby Atwick Gas Storage Facility. Operator attendance will then be required at Aldbrough only for routine first line maintenance, start-up after emergency shutdown (ESD), follow-up of equipment trips and corrective / breakdown maintenance.

The operations at the installation will be covered by a comprehensive Environmental Management System that is accredited to ISO 14001. As such, the potential risk of pollution due to the spillage of polluting substances will be assessed and controlled.

2 Objectives

The objectives of this report are to satisfy the requirements of the PPC Regulations at the time of permitting by:

- *Identifying the environmental setting and land pollution history of the site;*
- *Identifying activities that will be conducted at the installation that may lead to land pollution;*
- *Identifying and assessing the pollution prevention measures that are in place to protect the land and:*
- *Assessing whether there is:*
  - *little likelihood that land pollution or leaks to land will occur during the future life of the installation;*

  or, there is

  - *a reasonable possibility that there is potential for current or future land pollution of the land from the installation.*

The following sections of the report present the data that has been obtained for the installation and the surrounding area.

3 Site Setting and Sources of Desk Study Research Information

3.1 Introduction

The following sections detail the sources of desk study information reviewed in order to describe the condition of the installation and, in particular, to determine the potential for substances to be present in, on or under the land associated with present and past uses of the site and its surrounding areas.

3.2 Review of Environmental Database

Landmark Information Group was commissioned to provide an Envirocheck report for the site and surrounds. The Envirocheck report details publicly available records of Discharge Consents, Waste Management Licences, Abstraction Licences, IPC Authorisations, PPC Permits, Land Drainage Consents and Trade Effluent Consents. Landmark also provided a series of historical map sheets dating from 1855 to 1999.

A check was also made of the Environment Agency "What's In My Backyard?" (WIMBY) website (www.environment-agency.gov.uk/maps) for information on IPC Authorisations, waste management licences and flood risk in the vicinity of the installation.

A copy of the Envirocheck report is included in Appendix B1.

Details of site history are presented in Section 5.2 below, and details of geology, hydrogeology, discharge consents, trade effluent licenses, pollution incidents to controlled waters and water abstractions are presented in Section 6 below. For completeness, details of Part A and B authorised processes, waste management licenses and protected habitats are presented below.

3.2.1 Authorisations for Part A and Part B Processes

The Envirocheck report has no entries for Part A or Part B Integrated Pollution Control Authorisations (IPC) or Air Pollution Control (APC) authorisations within 1000m of the centre of the installation. The EA "What's In My Backyard?" (WIMBY) website confirms that there are no industries regulated under IPC in the vicinity of the installation.

3.2.2 Waste Management Licenses

The Envirocheck report has no entries for Licensed Waste Management facilities within 1000m of the centre of the installation. The EA WIMBY website confirms that there are no landfills or licensed waste management facilities in the vicinity of the installation.

3.2.3 Proximity of Protected/Sensitive Habitats

The government website, MAGIC (www.magic.gov.uk) was searched for details of any Nature Conservation Designations for the site and within 10 kilometres of the site boundary. The locations of Designated Sites within the vicinity of the site are shown in Figure A5-1.

No Ramsar sites, Special Areas of Conservation (SAC) or Special Protection Areas (SPA) were found to be located within 10km of the site. The closest sites of this nature are Hornsea Mere SPA, 11.5km north-west of the site, and the Humber Estuary SPA and Humber Flats, Marshes and Coast Ramsar, approximately 13.5km south-west of the site.

Three Sites of Special Scientific Interest (SSSI) are located within 10km of the site:

- *Lambwath Meadows SSSI is located approximately 5km north-west of the installation. The site is a series of low-lying seasonally flooded hayfields and is important as one of the best examples of agriculturally unimproved species-rich, damp neutral alluvial grassland in North Humberside.*
- *Roos Bog SSSI is located approximately 8km south-south-east of the installation. The site is a key Quaternary site providing a continuous record of vegetation history and environmental change in Holderness over the last 13,000 years. The site is identified as being of national importance in the Geological Conservation Review.*
- *Kelsey Hill Gravel Pits SSSI is located approximately 9.5km south-south-west of the installation. The site is of geological interest in exhibiting the representative exposure of a sequence of Ice Age (Pleistocene) deposits typical to the area. The site is identified as being of national importance in the Geological Conservation Review.*

Bail Wood is designated as a Site of Nature Conservation Importance (SNCI) for its woodland interest. The site lies within 1km of the installation and has an area of approximately 9.7ha of mixed age woodland. (Reference 17).

3.3 Geological and Hydrogeological Data

Consideration of the geology, hydrogeology and hydrology of the site is of importance since they influence the way in which any contaminants present in the soil and/or groundwater can be transported off-site, or, conversely, on-site from a nearby off-site source.

Geological and hydrogeological information for the site was obtained from the following sources.

- *British Geological Survey (BGS) Solid and Drift Map, Sheet No. 73, "Hornsea" 1;50:000;*
- *Environment Agency Groundwater Vulnerability Map Sheet 13 Humber Estuary;*
- *Envirocheck Report;*
- *Environment Agency website "What's In My Backyard?" (www.environment-agency.gov.uk) for Source Protection Zones and flood risk;*
- *British Geological Survey. GeoReports – Geological Assessment – Standard. Ref HCGOPUMEO1 (enclosed as Appendix C of Reference 13).*

Extracts of the geological and groundwater vulnerability maps are included as Figures A2-1 and A2-2 respectively.

Further detailed information was obtained from the Geological Risk Report (Reference 7), and the borehole log for the Aldbrough-1 borehole.

3.4 Site Operational Records

The installation is a new facility and thus there are no operational records to be reviewed.

3.5 Existing Site Investigation and Assessment Reports

The following investigations and assessments have been undertaken on the site. Pertinent extracts from these reports are reproduced in Appendix C5 and a summary of the geology encountered is presented in Section 6.3 below.

- *1992, East Yorkshire Salt Cavern - Provisional Soils Investigation, Aldbrough, East Yorkshire. Factual Report on Site Investigation. Foundation and Exploration Services Limited (FES).*
- *2003, Geological Assessment – Standard, British Geological Survey (BGS).*
- *2003, Report on a Ground Investigation at Aldbrough Gas Storage Facility, Norwest Holst (NH).*

FES conducted a ground investigation comprising eleven trial pits in 1992.

NH conducted a ground investigation under direction of Mott MacDonald in July 2003. This comprised sixteen cable percussive boreholes and twenty trial pits with associated sampling and testing.

A geological assessment report for the site was commissioned from BGS in 2003.

3.6 Other Information

All sources of information consulted are discussed in Section 3 above and are listed in the Reference list at the end of this document.

4 Site Layout

4.1 Storage Tanks and Associated Pipework

Table 4-A below lists the storage tanks and vessels located within the installation.

Tanks containing potentially polluting substances are located within impermeable bunds. Tank filling points and connections are located within the footprint of the bunded areas in order to contain minor spills and leaks. All tanks and bunds will be subject to an inspection and maintenance regime to be implemented once the installation is operational.

Assuming that the installation comprises the Gas Storage Caverns, these have been listed in Table 4-A for completeness. It is considered however, that by their very nature, they cannot be considered as potential sources of ground pollution.

Vessel name	Material stored	Storage Capacity	Storage method
X-1811 - X-1819 Storage Caverns	Natural Gas	Approx 300,000m^3 each	Salt strata, approximately 1.8km bgl, impermeable to gas stored
1T7025 Methanol tank	Methanol (hydrate inhibitor) Comprising 90% methanol, 10% water	35 m^3	Above ground vertical fixed roof atmospheric storage tank, contained in 110% bund.
1T7015 Water storage tank	Process waters potentially contaminated with methanol and hydrocarbons. Design case for waste waters is 20% wt methanol and 80% water plus trace HCs.	452 m^3	Above ground steel tank with a 3mm corrosion allowance.
1D7028 Closed drain drum	Condensate. Process fluids and oil skim-off from water tank and flash vessel plus fluids from anti-freeze drains from the compressor building	28 m^3	Normally kept empty. Horizontal pressure vessel located in concrete cellar with cover. Alarm at 80% and 90% full.
1T7029 / 1T7030 Catch Basin 2 / 3	Potentially contaminated waters (including fire-fighting run-off). Any oil will be separated by gravity settling.	5.75 m^3 / 64 m^3	Catch basins 2 & 3 are rectangular concrete basins. Catch basin 2 has a TOC alarm on the outlet.

Table 4-A Tanks and vessels associated with PPC Permitted activities

4.1.1 Underground Gas Storage Caverns

Cavern formation

Although construction of the caverns falls outside the remit of the PPC permit, a

brief description of the cavern forming process is included below for completeness.

The caverns are being formed by drilling two vertical and seven directionally drilled boreholes. Casings for the boreholes remain in place and are cemented to prevent fluid loss into the cap rock and to provide a firm anchorage for the wellhead equipment. Borehole 1 was vertically drilled and is at the site of the initial test drilling that was previously undertaken by British Gas. The remaining boreholes are located in the drilling platform to the east of the CPA. Here, one vertical borehole will be drilled. A further seven holes will be started vertically and will then deviate towards the proposed cavern location where the drilling will then proceed vertically. The borehole is drilled through the overlying strata to the Zechstein II salt layer approximately 1800m bgl where cavern formation will commence.

Seawater is pumped from the North Sea along a pipeline to a saltwater tank on site. It is then pumped at high pressure down the borehole. This high-pressure seawater dissolves the salt and the resulting brine is pumped out of the borehole into brine storage tanks before discharge back to the North Sea.

The time to develop each cavity will be approximately 22 months. Once construction of the first five caverns and the gas processing plant is complete, the installation will become operational and construction of the final four caverns will be ongoing.

Cavern Storage

The primary containment for the storage caverns is a geological barrier of salt which is impermeable to gas. It is predicted that 10m of salt will lie beneath the design base of each cavern. The design top of each cavern will be formed about 60m below the top of the salt layer. Each cavern will be approximately 100m high with a diameter of 75 to 95 m. Spacing between caverns is to be maintained at four diameters distance, centre to centre. Each cavern is planned to have a volume of approximately 300,000 m^3, although the actual volume could be up to 400,000 m^3.

4.1.2 Pipework

For passage from the gas plant to the cavern and *vice versa* the gas will travel through 9⅝ inch carbon steel cased gas production string with premium gas tight connections as primary containment. Secondary containment will be achieved by 13⅜ inch cemented carbon steel casing with premium gas tight connections. The annular space between the production tubing and the cemented casing will be filled with corrosion inhibitor to safeguard against corrosion. The corrosion inhibitor is currently anticipated to be gas oil. Only small quantities of corrosion inhibitor are anticipated to leak out of the casing over the life of the caverns, and the inhibitor is anticipated to leak into caverns rather than out to the wider environment due to the high pore pressure of the surrounding strata.

For the surface facilities, all below ground pipes within the CPA will be laid in concrete trenches to enable them to be inspected although road crossings will be below ground. The pipeline from Wellhead 1 will be laid on sleepers above ground to facilitate heat tracing, insulation and future inspection.

Pipeline pigging on the NTS connection line will be achieved by location of a portable pig launcher / receiver on site, located to the west of the metering area (in the western part of the site).

In the Drilling and Leaching platform area (covering the eastern third of the site) surface water collection comprises open channels lined with concrete slabs laid on mortar. This will feed to a collecting sump with oil trap at the outlet pipe. This system is suitable for evacuating storm water from the platform area from a 1 in 5 year return period storm whilst maintaining a freeboard to the top of the bund of 50mm minimum. The containment volume of the drilling and leaching platform has been designed to accommodate tank failure in addition to rainfall and normal spillage volumes.

Above ground pipework will be protected against external corrosion by painting.

4.1.3 Methanol Tank (1T7025)

The methanol will be stored in an above ground vertical fixed roof atmospheric storage tank with a maximum capacity of approximately 22 tonnes. The tank vents directly to atmosphere through a flame arrestor. The tank is located within a bund capable of containing 110% of the volume of the tank. A drain collection pit is provided to contain any methanol spilt during unloading. Spills from methanol unloading will be collected, controlled and treated in the methanol recovery unit (MRU). The MRU consists of a distillation column and ancillaries such as a reboiler, condenser, pumps, drums and piping. Water from the MRU will be further treated prior to discharge to the environment.

4.1.4 Compressors

Any spill of lube oil from the compressor building is collected and controlled in a holding basin (12 m^3 capacity).

4.1.5 Transformer

Any spill of oil from the transformer is contained in a small catch basin which is large enough to contain the contents of the transformer, with an overflow to the normal sewer system for draining off rainwater.

4.1.6 Thermal and Fire Relief Valves

Relief valves provide protection against overpressure. Any liquids released by thermal and fire relief valves will be contained within paved areas of the plant and collected within the surface water drainage system and catch basins.

A fixed firewater system has not been incorporated in the installation, although the balancing lagoon could be used as an additional source of firewater by the local fire brigade. As such, the quantities of firewater that could be used on site are small. Firewater will be retained within the installation in the event of an incident.

4.1.7 Closed Drainage System (1D7028)

A closed drain system is installed to drain process fluid from the gas processing plant. It will also take skim-off from the water tank and flash vessel and antifreeze drains from the compressor house. The system drains to the closed drain drum (1D7028) which is a below grade horizontal pressure vessel within a covered concrete cellar. The drain is normally kept empty and is emptied by tanker and the contents are disposed of off-site at a suitably licensed / permitted facility.

4.1.8 Process Waste Water Storage Tank (1T7015)

The water is removed from the gas in the filter separators and by adsorption in the silica gel dehydration train. The water is potentially contaminated with methanol, aromatic hydrocarbons (Benzene, Toluene and Xylene, commonly known as BTX) and minor amounts of aliphatic hydrocarbons which are derived from gas that has been stored in the caverns. Water passes from the process water flash vessel (1D7014) on pressure difference to the waste water tank. The tank has a gross capacity of 452m^3 and is located above ground in a bund capable of containing 110% of the volume of the tank.

From the storage tank the water is sent to the methanol recovery unit (MRU) where methanol is separated from the water by distillation. The methanol is sent to the methanol storage tank and the water to the reed bed for final treatment before discharge via the surface water system.

4.1.9 External Storage Areas

External storage areas are provided for general waste.

A bunded area is also provided for storage of small quantities of miscellaneous process chemical drums.

4.2 Concrete Hardstanding and Bunds

The installation area is generally covered with concrete granulate. Roadways are constructed with an asphalt running surface. The Process Train and Regeneration areas are on concrete platforms.

Maintenance schedules will be prepared for the installation prior to its operation and in accordance with ISO14001. A Site Protection and Monitoring Programme (SPMP) will be prepared on permit issue to detail the inspection and integrity checks to be undertaken.

4.3 Vegetation

Landscape proposals for the CPA site area outside the installation boundary are an area of grass seeding with some half standard trees to the north of the installation boundary. A woodland copse mix is proposed to surround the site with some areas inside this to be a woodland edge mix. Hedgerows will be planted along the outside edge of these woodland areas. More grass seeding is proposed for land between the proposed woodland and the southern and western watercourses.

Landscape proposals for the Aldbrough 1 site area outside the installation boundary are grass seeding with some woodland edge planting along the northern site boundary and a woodland mix in the south-western corner.

4.4 Surface Water Features

Surface water features are indicated on Figure A2-2.

A surface water channel (swale) flows along the southern boundary of the CPA Installation to a surface water balancing lagoon located in the south-western corner of the CPA Installation boundary.

An unnamed drain forms the eastern boundary of the CPA site area. East Newton drain forms the southern boundary of the CPA site area. Cess Dale drain forms the

western boundary of the CPA site area. Cess Dale flows into the East Newton drain which then flows under the Aldbrough / Garton road.

4.5 Nature of the Storage and Handling of Materials

Storage of materials is discussed in Section 4.2 above.

The site is not yet operational, however, the site will be designed, and procedures put in place, to prevent the loss of substances to the land.

4.6 Surface Water and Foul Drainage

An open drain collection system is installed to collect surface water run-off. Water is collected and sent to catch basins by means of sump pumps and / or via underground drain lines. Interceptors prevent potentially contaminated surface water from being discharged.

4.7 Other Observations

There are no other observations.

5 Assessment of Land Pollution Potential

5.1 Polluting Substances and Relevant Activities

A list of all substances used, stored, manufactured (or waste by-products from the manufacturing process) is contained in Appendix D1. An assessment of their pollution potential has been made based upon their properties, toxicity and volume stored, used or manufactured. Those substances that have been identified as presenting a pollution risk have been further considered as described in Section 5.2 below.

It is also necessary to identify potentially polluting substances that may already be in the land as a result of past activities or use of the site. From the desk study, it has been established that the installation area remained undeveloped until construction of the gas storage facility commenced. As such there is limited potential for pollution to have occurred due to historical activities – the only potential historical pollution would be from surface contamination arising from spillage of oil-based drilling muds used in the drilling of the wells. An impermeable geomembrane liner was placed prior to works commencing at Aldbrough 1 (see Section 5.2.1 below). Construction activities for the other Wellheads has taken place on the Drilling and Leaching Platform which is lined with an impermeable HDPE geomembrane to contain any potential spillages. Pollution resulting from the construction activities is therefore unlikely.

5.2 Historical Sources of Pollution

5.2.1 Historic Landuse

This assessment is made from a review of historical Ordnance Survey (OS) maps included within the Envirocheck report (Appendix C1), and information provided by the Operator.

The earliest available Ordnance Survey (OS) map dated 1855 shows the installation to be located within a rural area with the site of the installation and its immediate surrounds undeveloped. The nearest settlement is shown at East Newton approximately 1100m north-east of the site.

Subsequent maps (1889, 1892, 1910, 1927, 1952, 1956, 1976 and 1978) show the site and its surrounds to be undeveloped. The 1999 map shows a track from the Aldbrough / Garton Road to the area of the Aldbrough 1 borehole. Two dwellings are also shown – Springfield Farm approximately 375m west of the western installation boundary and Bail View Farm approximately 440m south-west of the installation.

5.2.2 Construction Activities

The Aldbrough 1 borehole was initially excavated in 1993. Prior to drilling this test hole a PVC liner was placed over the subgrade. This was covered with 50mm of protective sand then a 1000g Terram geotextile then 300mm of Type 1 granular material. The presence of this lining system will have prevented any spillages during drilling from penetrating into the ground.

Works for the cavern development commenced in 2004 in the main Central

Processing Area. A Drilling and Leaching platform was created at 11.5m AOD with excavated material replaced around the CPA as landscaping bunds. The Drilling and Leaching Platform was created to house wellheads 2-9 inclusive, together with the drilling equipment and plant needed for the leaching operations. To prevent land contamination the platform area was lined with a 1.5mm thick smooth HDPE geomembrane. Geomembrane panels were welded together and subsequently the geomembrane was lapped and sealed against the concrete foundations. The geomembrane was under and over-lain by 75mm of sand with the upper sand covered by a non-woven protection geotextile. A capping layer 350mm thick of 6F1 granular stone was then placed and the area surfaced with 100mm crushed stone. A drainage sump, oil trap and discharge pipe were also installed.

The brine settlement tanks have been constructed from concrete 325mm thick on the base and 300mm thick sides. Open drainage channels in the Drilling and Leaching Platform area have been lined with concrete slabs. At the drainage ditch outlet pipe a sump, oil trap and discharge pipe have been constructed, designed for a 1 in 5 year return storm.

Construction materials and activities are undertaken in accordance with an Environmental Management Plan and in accordance with appropriate regulations.

(a) Drilling

Creation of the caverns is achieved by pumping seawater into the boreholes formed by the drilling. The seawater dissolves the salt strata in a controlled manner to create caverns of the appropriate dimensions. A nitrogen gas blanket is used to control the shape of the caverns. Brine, laden with the dissolved salts, is extracted and piped to brine tanks for settlement of residues before pumping back to the North Sea.

The drilling process for caverns 2 to 9 commenced with pile driving of a 30" casing to 40m below ground level (bgl) using water-based muds. A 26" hole is drilled using water-based muds to 600m through the Chalk and a 20" casing is cemented in place. A 17.5" hole is then drilled using low toxicity oil-based muds (Carbo SEA LT) down to 1800m into the top of the Zechstein salt layer. A 13⅜" casing is cemented from ground level to the top of the salt. Finally a 12¼" hole is drilled 150m into the salt layer using a sodium chloride brine. Anticipated casing depths are as detailed below and illustrated on Figure 1:

- *55m for the 30" casing and at least 3m into the Chalk. The 30" casing will provide protection to any near-surface water-bearing strata.*
- *608m for the 20" casing and around 15m into the Lias. This casing provides protection to the Chalk aquifer.*
- *1780m for the 13⅜" casing and around 20m into the Z2 Main Salt. This casing provides a pressure tight seal between the cavity and the surface.*

Corrosion inhibitor (currently anticipated to be gas oil) is put into each annulus between the production tubing and the outer casing (approximately 40 m^3).

The creation of the caverns has been undertaken in a manner so as to prevent ground pollution. Oil based drilling muds were used during some phases of excavation of the borehole (as described above), but these were generally extracted along with the borehole arisings. These are subject to a cuttings handling system and are transferred to a skip and were transported to a suitably licensed / permitted waste management facility.

Error! Objects cannot be created from editing field codes.

Figure 1: Schematic showing Details of Sub-Surface Equipment and Well Design / Construction (not to scale, distances approximate, inhibited water no longer used)

(b) Leaching

The seawater and brine utilised in cavern creation is extracted by pumping natural gas into the cavern, leaving a void with a minor amount of residual seawater which will be removed over time as a dissolved component in the gas.

5.3 Preventative Measures

The pollution preventative measures (physical infrastructure and those relating to testing, inspection and maintenance) for each relevant activity associated with the potentially polluting substances have been identified and their extent and condition assessed. The results of this work are shown in Table D2 in Appendix D. The information provided in the table is based on the information provided in the construction drawings and specifications for the installation.

Corrosion inhibitor will be placed between the production tubing and the well outer casing. The outer casing is 13 ⅜" cemented carbon steel. From ground level, through the Chalk to around 15 m into the Lias there will be secondary containment in the form of 20" carbon steel casing, and from ground level through the shallow, potentially water-bearing, strata, tertiary containment will be provided by 30" carbon steel casing. Levels of annulus corrosion inhibitor will be monitored from the surface and topped up if necessary. It is anticipated that any drops in the annulus level are due to leakage into the production casing and ultimately into the cavern, rather than flow out into the surrounding strata.

Inspection and corrosion monitoring will be carried out at regular intervals for the high and medium pressure carbon steel lines between wellheads and separator and in the wet parts of the silica gel dehydration system. Corrosion will be monitored via corrosion coupons which will be installed at locations where high corrosion rates could be expected.

Storage tanks containing liquids that may be hazardous to the environment are installed in impervious bunds with a capacity of >110% of the largest tank or 25% of the total tankage. Tank fill points are contained within the bund wherever possible or otherwise provided with adequate containment.

Tank bunds will be installed with manually operated pumps to remove rainwater. These pumps will be fitted with non-latchable local start buttons and will be operated weekly.

During tanker off-loading of methanol the tanker driver and a member of site staff will be in attendance and will carry out the task in accordance with written procedures.

5.4 Assessment of the Likelihood of Land Pollution

The assessment of the likelihood of land pollution from the installation is contained in Table D2 in Appendix D. The assessment has identified relevant activities where there is a reasonable possibility that there will be future pollution of the land from the

installation. The assessment is based on the information provided in the construction drawings and specifications for the installation. The methodology used to assess the likelihood of land pollution is that contained within the Application Site Report template and guidance.

It is considered very unlikely that pollution of the installation will occur over the majority of the installation due to the generally low risk of the process operations, the bunding of tanks, the comprehensive surface water management system, the extent of hardstanding that would prevent downward migration of contaminants into the ground below, and the relatively impermeable nature of the Glacial Till forming the underlying ground.

Assessment of pollution potential:

- *Do preventative measures exist for each of the relevant activities at the installation?*
  - *Yes – all tanks are bunded.*
- *Are preventative measures adequate to prevent the emission of potentially polluting substances to land?*
  - *Yes – all potentially polluting substances are stored in bunded tanks.*
- *Does the applicant have no record of pollution incidents or spills from the relevant activities to be permitted?*
  - *Yes – the site is a new installation.*
- *Are there proposals to conduct integrity testing of preventative measures?*
  - *Yes – these will be implemented in a formal maintenance and inspection strategy before operations commence at the site.*
- *Is there an adequate documented management system to demonstrate operator management and competence with the relevant activity?*
  - *Yes – documented procedures for operation and maintenance, emergency procedures and training and training records will be prepared and implemented once the site becomes operational.*

For all relevant activities at the installation there is little likelihood that land pollution or leaks to the land will occur during the future life of the installation. It is the conclusion of this report that reference data for the site does not need to be collected.

6 Conceptual Site Model

6.1 Regional Geology

6.1.1 Geological Sequence

Regionally, the installation is located in an area covered predominantly with Devensian Glacial Till, with localised alluvium along certain river and stream courses and minor pockets of Glacial sands and gravels (Devensian). The coastal area to the east of the installation is comprised of Post-Glacial (Flandrian) beach deposits of sands and gravels.

The underlying solid geology comprises relatively flat-lying Cretaceous Chalks.

6.1.2 Structural Geology

The area to the east of Aldbrough is part of the East Midlands Platform which contains major stress faults. Seismic surveys conducted in the vicinity of Aldbrough detected no faulting within the Aldbrough area (Reference 7).

6.2 Site Geology

The BGS Solid and Drift map indicates that the installation is founded on Quaternary drift deposits. These comprise alluvium in the west and south of the CPA area following the course of the Cess and East Newton Drains. The remainder of the site is underlain by Glacial Till. Underlying the drift deposits are strata of the Chalk Group overlying Jurassic, Triassic, Permian and Carboniferous strata described in more detail in Section 6.2 below.

The Aldbrough-1 borehole sunk in 1993 found the following geological sequence:

- *Boulder Clay (Glacial Till)* *0-92 feet (') below ground level (bgl)*
- *Chalk Group* *92-1682' bgl*
- *Red Chalk* *1682-1757' bgl*
- *Carstone Formation* *1757-1912' bgl*
- *Lias Group* *1912-2213' bgl*
- *Haisbrough Group* *2213-2974' bgl*
- *Bacton Group (Sherwood Sst Gp)* *2974-5186' bgl*
- *Zechstein Group* *5186-8307' bgl*

The BGS map shows the geological sequence beneath the site to be as shown in Table 6-A:

	Strata	Description	Thickness
Quaternary	Alluvium	Clay and silt with interbedded sand and peat	20-25m
	Till	Stony clay	
Cretaceous	Rowe Formation	White flinty chalk	0-80m
	Flamborough Formation	White chalk with thin marl beds	265m
	Burnham Formation	White chalk with flint bands and nodules	95
	Welton Formation	White chalk with flint nodules and with marl beds in lower part	55-60m

	Strata	Description	Thickness
	Ferriby Formation	Grey to red marly chalk	10-15m
Jurassic	Lias Group	Predominantly mudstone	c 200m
Triassic	Penarth Group	Predominantly mudstone	c 20m
	Mercia Mudstone Group	Predominantly mudstone	c 450m
	Sherwood Sandstone Group	Predominantly sandstone	c 700m
Permian	Permian mudstones and evaporites	Mudstones and evaporites	c 150m
	Brotherton Formation	Upper Magnesian Limestone	c 75m
	Permian mudstone and evaporite with dolomitic limestone	Mostly mudstone and evaporite with dolomitic limestone	c 550m
	Cadeby Formation	Lower Magnesian Limestone	c 100m
	Basal Permian sands	Sands	c 75m
Carboniferous	Coal Measures	Mudstone with beds of sandstone and coal	500+m

Table 6-A Geological Sequence Beneath the Installation (BGS, 1998)

The sequence can be seen from extracts from the BGS Geological Map in plan form and regional cross-section in Figure A2-1.

Information on strata beneath the site is provided below from the ground investigations detailed in Section 3.5 above.

6.2.1 Made Ground

Made Ground was encountered in only one trial pit in the FES investigation (see Section 6.3 below). However, this was to be expected as the trial pit was located on the site access road. The sequence of Made Ground at the Drilling and Leaching Platform area is described in Section 3.2.1 above.

6.2.2 Alluvium

The BGS Report states that alluvium is generally silty clay which may include layers of silt, sand, peat and basal gravel. It is expected that the alluvium will be less than 1m thick at the site.

Alluvium was encountered during the 2003 Norwest Holst ground investigation in Trial Pits 201, 202, 206, 216, 218-220, 232, 233 and TPE3 in the south-west and south of the CPA. Alluvium was encountered at depths up to 2.1m and described as slightly clayey sand with gravel and occasional cobbles.

Standard Penetration Tests (SPT) varied from 9 to 22 with an average of 14 classifying the material as firm. In-situ hand vane shear tests recorded results between 32 and 130kN/m^2 with a mean value of 71 kN/m^2. Particle size distribution (PSD) tests classified the material generally as gravelly sandy clay. Atterberg Limit tests found the Alluvium to have Plastic Limits between 19 and 26%, Liquid Limits between 50 and 69%, Plasticity Index of between 30 and 46 and natural moisture content of 14 to 34% resulting in a classification of intermediate to high plasticity clay.

The EA Groundwater Vulnerability map classifies the alluvium as a Minor Aquifer.

6.2.3 Glacial Till

The BGS Report states that Glacial Till is usually a variable deposit of sandy silty clay with pebbles, cobbles and boulders.

The Aldbrough 1 borehole encountered Boulder Clay (Glacial Till) as a clay with sandstone gravel of thickness 92 feet (approximately 28m).

The 2003 Norwest Holst ground investigation encountered up to 10.5m proven thickness of Glacial Till described as firm to stiff occasionally soft and very stiff brown orange slightly sandy gravelly clay.

SPT results varied from 9 to 35 with an average of 17 classifying the material as firm to stiff. In-situ hand vane shear tests recorded results between 45 and 130kN/m^2 with a mean value of 90kN/m^2. Particle size distribution (PSD) tests classified the material generally as gravelly sandy clay. Atterberg Limit tests found the Glacial Till to have Plastic Limits between 13 and 27%, Liquid Limits between 29 and 69%, Plasticity Index of between 12 and 42 and natural moisture content of 12 to 36% resulting in a general classification of intermediate plasticity clay.

The EA Groundwater Vulnerability map classifies the Glacial Till as a Non-Aquifer.

6.2.4 Cretaceous Strata

The solid geology underlying the drift deposits are Chalk strata of the Cretaceous. These are the Rowe, Flamborough, Burnham, Welton and Ferriby Formations. The Ferriby Formation unconformably overlies the Lias Group of the Jurassic.

The BGS Report describes the Rowe Chalk Formation as a white flint-bearing chalk with sporadic marl bands which is interpreted to dip gently to the north-east by approximately 2 degrees and is underlain by the Flamborough Chalk Formation.

The Aldbrough 1 borehole encountered the Upper Cretaceous Chalk Group as a soft to firm, locally argillaceous limestone with frequent interbeds of chert of thickness 1590 feet (approximately 485m). This overlay the 75 foot (approximately 23m) thick Red Chalk of the Lower Cretaceous. This was underlain by a fine to coarse grained calcareous sandstone of the Carstone Formation of the Lower Cretaceous of thickness 155 feet (approximately 47m).

6.2.5 Jurassic Strata

The Lias Group is unconformably overlain by the Ferriby Formation chalk.

The Aldbrough 1 borehole encountered the Lias Group as a firm to hard clay to siltstone of thickness 301 feet (92m).

6.2.6 Triassic Strata

Underlying the Lias Group are strata of the Triassic. These are the mudstones of the Penarth and Mercia Mudstone Groups and sandstones of the Sherwood Sandstone Group.

The Aldbrough 1 encountered the Haisbrough Group of the Rhaetic (now known as the Penarth Group), Keuper (Mercia Mudstone Group) and Muschelkalk Formations of siltstones. These overlie the Bacton Group (now known as the Sherwood Sandstone Group) of Bunter Sandstones (Sherwood Sandstones) – medium grained sandstones becoming finer with depth to the siltstones of the Lower Bunter. The

borehole encountered Triassic strata of thickness 2973 feet (approximately 906m).

6.2.7 Permian Strata

The Aldbrough 1 borehole encountered the Zechstein of the Permian as a sequence of salts comprises Z4 overlying Cahn Marl over Z3 over the Platten Dolomite over Grauer Salzton over the Z2 Lower Evaporites. The penetrated thickness of Permian strata was 3121 feet (approximately 951m).

6.3 Hydrogeology

The Groundwater Vulnerability Map (extract reproduced on Figure A2-2) indicates that the Central Processing Area of the site is located on a Minor Aquifer. The remainder of the site is located on a Non-Aquifer.

Minor Aquifers are “fractured or potentially fractured rocks, which do not have a high primary permeability or other formations of variable permeability including unconsolidated deposits”. These aquifers are important both for local supplies and in supplying base flow to rivers. Minor aquifers in the site vicinity comprise Carstone, Elsham Sandstone, Tealby Limestone, Claxby Limestone, Spilsby Sandstone, Kellaways Rock and Kellaways Sand. They also comprise drift deposits such as blown sand, dry valley deposits, alluvium, river terrace deposits, marine and estuarine alluvium (sand and gravel), storm beach deposits and glaciofluvial sand and gravel deposits. The Minor Aquifer at the site is therefore interpreted to be the alluvial deposits around the Drains of maximum thickness 1m.

Non-aquifers are “generally regarded as containing insignificant quantities of groundwater”. Non-aquifers in the site vicinity comprise the Upper Tealby Clay, Lower Tealby Clay and Ancholme Clay Group. The map also states “north of the Humber Estuary wherever the Chalk is overlain by more than 5 metres of clay within the drift sequence, permeable drift deposits at the surface are shown as Minor Aquifers and where impermeable drift is present at the surface this is shown as Non-Aquifer”. Therefore it is interpreted that the Glacial Till at the site is classified as a Non-Aquifer.

One discharge consent is listed within a 1000m radius of the centre of the installation. This is for the construction of the caverns for trade effluent to the North Sea, issued 3 December 1997. The Envirocheck report has no entries for Trade Effluent Licences.

The Envirocheck report shows no records for pollution incidents to controlled waters within 1000m of the centre of the installation.

The Envirocheck report shows one water abstraction within 2000m of the centre of the installation. This is abstraction of groundwater from Chalk at Ringborough Farm for general farming and domestic, located 1165m to the east of the installation.

A ground investigation by Norwest Holst in July 2003 found groundwater strikes to vary from 8.6m below ground level (bgl) to 2.0m bgl. Groundwater levels measured in three boreholes on 31 July 2003 found groundwater levels at 0.83, 3.1 and 3.2m bgl.

6.4 Surface Water Features

The surface water features in the vicinity of the site that could be potentially

impacted by the Installation are shown on Figure A2-2 and are as follows:

- *Unnamed drain flowing north to south to the east of the Central Processing Area (CPA).*
- *East Newton Drain to the south of the CPA. This drain flows generally east to west.*
- *Cess Dale Drain to the west of the CPA and to the east of the Aldbrough 1 installation area (the gas pipeline within the installation boundary crosses the Drain). This drain generally flows from north to south and converges with the East Newton Drain at the south-west corner of the CPA.*
- *The man-made swale and balancing pond within and adjacent to the southern boundary of the installation which discharges to the Cess Dale Drain.*
- *Unnamed drains. The land surrounding the site is crossed by a series of unnamed drains.*
- *The North Sea lies approximately 1200m east of the CPA.*

6.4.1 Hydrology and Water Quality

The installation is situated approximately 1.2 km west of the North Sea. Field drains form the eastern, southern (East Newton Drain) and part of the western (Cess Dale Drain) boundaries of the wider site area (although do not form part of the installation boundary). The East Newton Drain joins with Bail Drain approximately 300 m west of the site. At Humbleton the drain becomes Humbleton Beck where it flows southwards toward Burstwick (Burstwick Drain) then on to Hedon (Hedon Haven) and eventually into the Humber Estuary.

The Norwest Holst ground investigation in July 2003 found water levels in the East Newton and Cess Dale Drains to be approximately 3 m bgl. The location of these surface water features are shown on Figure A2-2. The gas pipeline from Aldbrough 1 to the CPA crosses the Cess Dale Drain, but there are no further natural surface water features within the installation boundary.

A surface water channel and balancing pond are located to the south of the installation boundary. These take surface water run-off from drainage on site which passes through a catch basin before discharge into the channel (swale) and pond. The pond discharges via a pipe into the Cess Dale Drain. The pond base is set at 9 m AOD.

The Environment Agency “What’s In My Backyard?” website shows that the site is not within a zone of flood risk; however these maps are indicative only. The map indicates that the Bail Drain (into which the East Newton Drain flows) to the west of the site, south-west of Bail Wood (approximately 900m west of the installation boundary), has a 1 in 1000 chance per year of flooding.

The EA website shows no river quality information for waters in the vicinity of the installation. Section 16.2 of the Supporting Information contains data supplied by the Environment Agency for the Burstwick Drain at Hedon (approximately 15km from the installation). For the year 2000 to 2002 for a 8.4km stretch of the Drain from Burton West Drain to Hedon Haven, the data shows biological oxygen demand (BOD) grade D, ammonia grade C and dissolved oxygen grade E.

Information regarding discharge consents in the vicinity of the installation is included in Section 3.3.3.

The Envirocheck report has no details of licensed surface water abstractions within 1km of the site.

6.5 Results of Previous Investigations / Assessments

The installation has been subject to two previous ground investigations, an exploratory borehole at the location of Wellhead 1, and is the subject of a British Geological Survey (BGS) Geological Assessment Report. Details of the strata encountered in these investigations is presented in Section 6.2 above, and a brief summary of the extent of the investigations is presented below.

A ground investigation conducted by Foundation and Exploration Services Limited in August 1992 comprised eleven trial pits which encountered 0.2 – 0.35 m of topsoil over Glacial Till proved to a maximum of 3.4m below ground level. One trial pit excavated within the access track encountered 0.5 m of Made Ground over Glacial Till. The exploratory hole location plan provided in the interpretive report (Mott MacDonald 2003 in Jacobs 2004f) only shows the positions of FES trail pits 6 to 10 inclusive. The locations of trial pits 1 to 5 and 11 are unknown.

In July 2003 Norwest Holst undertook a ground investigation for Mott MacDonald at the site comprising 16 cable percussive boreholes, 29 trial pits and 3 trial trenches. The investigation encountered alluvium in eleven exploratory holes and Glacial Till in all exploratory holes to a maximum depth of 10.5m bgl. Groundwater strikes were encountered in nineteen of the exploratory holes at depths between 2.0 and 8.6m bgl.

A Geological Assessment Report for the site was produced by the British Geological Survey in June 2003. This reported that there was likely to be high susceptibility of compressible ground and moderate susceptibility of running sand and artificial ground at the site. Also shallow groundwater may be encountered in any Made Ground and within coarser horizons within the Alluvium. The Chalk is classified as a Major Aquifer although the overlying Alluvium is classed as a Minor Aquifer and the Glacial Till as a non-aquifer.

The report suggests that the Alluvium may be a compressible silty clay overlying the variable sandy silty clay of the Glacial Till. The depth to rockhead is estimated to be 41m with the solid geology comprising the Rowe Chalk Formation of white, flint-bearing chalk with sporadic marl bands of thickness around 50m. It is interpreted that the Rowe Chalk may dip gently to the north-east by approximately 2 degrees.

6.6 Other Receptors

This report is assessing the implications of land pollution and therefore the receptors considered are the underlying strata, surface waters and groundwaters.

6.7 Land Pollution History

There are no records of substantial land pollution incidents at the site.

6.8 Site Zoning

Due to the design of the facility and the small quantities of chemicals that are to be stored and used at the site, the pollution potential of activities at the installation, as assessed in Table D2, is assessed to be low. Therefore the installation has not been divided up into zones.

6.9 Summary of Conceptual Site Model

6.9.1 Introduction

The findings of the desk study and site reconnaissance (detailed above) have been used to develop the conceptual site model (CSM) for the site. Uncertainties in the CSM are identified and their significance discussed.

Although there will be some storage and use of chemicals at the installation, the design of the facility means that leakage from storage is unlikely and spillages will be contained within the site drainage system. Therefore it has been assessed that there are no potential contaminant sources at the site.

The corrosion inhibitor emplaced between the production tubing and the well casing is a potential contaminant, but as can be seen from Table D2, the likelihood of any leakage through the well casing to surrounding strata is low. Any leakage that may occur is likely to be internal into the production pipework, from where the inhibitor will flow into the cavern and be contained by the impermeable salt strata, or be removed along with the gas.

For completeness, a list of potential contaminant pathways and potential receptors are included below.

Potential contaminant pathways are:

- *Shallow groundwater in the alluvium. There may be limited quantities of perched groundwater in the alluvium. This will be contained but may enable any contaminants present in the water to reach local drains.*
- *Surface Waters. Surface water drains are located to the east, south and west of the site.*

Potential receptors are:

- *Underlying strata;*
- *Groundwater (perched in the Alluvium);*
- *Groundwater (in the Chalk aquifer);*
- *Surface Waters.*

The Aldbrough site will seek to gain accreditation under ISO14001 environmental management systems, and thus will have procedures in place to prevent environmental degradation, as is the case at the similar, currently operating, site at Atwick. The installation has been designed to minimise environmental and safety risks, operational procedures will be adhered to and a maintenance schedule will ensure items of plant and infrastructure are regularly inspected and maintained.

Tanks will be contained within bunds and much of the site is covered in hardstanding. Site drainage will be diverted to the water treatment unit if contaminated. Typically, the drainage will be contained by interceptors prior to entering the balancing lagoon prior to discharge to the Cess Dale Drain.

As such, the risk to the underlying ground and groundwater from operations at the installation is minimal.

6.9.2 Graphical Representation of the Site

A graphical representation of the CSM is shown in Figure E2.

6.9.3 Uncertainties in the CSM

There are a number of uncertainties in the preliminary conceptual model that could affect the distribution of pollutants in the subsurface. These uncertainties include the following parameters:

- *Several hydrogeological features are uncertain in the model:*
  - *The hydraulic gradient of groundwater is not confirmed.*
  - *The depth to groundwater has not been confirmed.*
  - *The presence of perched groundwater in the Alluvium has not been confirmed.*
  - *The permeability of the underlying strata has not been confirmed.*
- *There is uncertainty as to the attenuation properties of the underlying strata due to the potentially variable nature of the deposits.*

However, due to the containment features and good management practices that will be implemented at the site, there will be minimal risk of pollutant spillage and thus, as the CSM identified no potential pollutant sources, the uncertainties relating to underlying ground conditions do not affect the minimal risk to the ground identified in Section 6.9.1 above.

7 References

1. Guidance note for the Control of Pollution (Oil Storage) (England) Regulations 2001. DEFRA, 2001.

2. Pollution Prevention Guidelines PPG 2: Above Ground Oil Storage Tanks. Environment Agency, February 2004. (Used for general Best Practice guidance).

3. Pollution Prevention Guidelines PPG26: Storage and Handling of Drums and Intermediate Bulk Containers. Environment Agency, February 2004.

4. British Geological Survey (1998). Hornsea. England & Wales Sheet 73. Solid and Drift Geology. 1:50,000 Provisional Series. NERC.

5. IPPC Guidance on the Protection of Land under the PPC Regime: Application Site Report and Site Protection and Monitoring Programme. IPPC H7. Environment Agency, August 2003.

6. IPPC Template for an Application Site Report in PPC Applications IPPC H7 (Reporting Template 1). Environment Agency, August 2003.

7. Jacobs (2004). SSE Hornsea Ltd. Aldbrough Gas Storage Facility, Geological Risk Report. 60-7090-04/C.06f/0022. June 2004.

8. Jacobs (2004). SSE Hornsea Ltd. Dehydration System Selection Study. Report 60-7090-01/P.06g/0001 issue B.

9. Jacobs (2004). SSE Hornsea Ltd. Waste Water Handling Study Report. Report 329-1405-0003 issue B.

10. Jacobs (2004). SSE Hornsea Ltd. Process Control Philosophy. Report 329-1405-007 issue C.

11. Jacobs (2004). SSE Hornsea Ltd. Leaching Plant Process Control and Operating Guide. Report 60-7090-06/P.07d/1001 issue B.

12. Jacobs (2005). SSE Hornsea Ltd. Central Processing Area – Technical Specification. Report 60-7090-01/N.02a/0001/D.

13. Jacobs (2004). SSE Hornsea Ltd. Underground Gas Storage Project. Central Processing Area – Site Information. Containing:
Mott MacDonald (2003). Aldbrough Gas Storage Facility. Ground Investigation – Interpretative Report. Containing:
    - Landmark Information Group. (2003). Envirocheck Report – Aldbrough Gas Storage Facility. Reference 300103-1-1.
    - British Geological Survey (2003). Geological Assessment – Standard. Reference HCGOPUME01.
    - Foundation & Exploration Services Limited (1992). British Gas Plc, East Yorkshire Salt Cavern. Provisional Soils Investigation, Aldbrough, East Yorkshire. Factual Report on Site Investigation.

    Norwest Holst Soil Engineering Limited (2003). Report on a Ground

Investigation at Aldbrough Gas Storage Facility. F12963.

14. Jacobs. Underground Gas Storage Project. Central Processing Area – Engineering Procurement & Construction Package.

15. Jacobs (2004). Aldbrough Gas Storage Facility: Leaching Plant Civil and Structural (Reference 03.147.20). Technical Specification. 4 April 2004.

16. Jacobs (2004). Aldbrough Gas Storage Facility Site Facilitating Works. Drilling and Leaching Platforms (Reference 03.147.15). Technical Specification. April 2004.

17. Jacobs (2004). Aldbrough Gas Storage Project. COMAH Pre-Construction Safety Report (Phase 2 Submission – Central Processing Area). December 2004.

18. National Rivers Authority (1994). Groundwater Vulnerability of Humber Estuary. Sheet 13.

19. Jacobs (2004). Aldbrough Gas Storage Facility. Conceptual Design Report – Well Construction. Reference 60-7090-04/c.06f/0023. August 2004.

20. Edeco (2004). Aldbrough Gas Storage Facility. Well Design Report and Drilling Programmes.

Appendix A - Drawings

Drawings relating to the Site Report are contained within Section 5 of the PPC application pack for the installation.

Appendix B - Site Reconnaisance

B1 **Figures** (Not Applicable)

B2 **Photographs** (Not Applicable)

B3 **Relevant Test Certificates** (Not Applicable)

Appendix C - Desk Study Information

C1 **Environmental Consents, Licences, Authorisations and Permits for Site and Surrounding Area** (Envirocheck Report)

C2 **Geological and Hydrogeological Data** (Not Applicable)

C3 **Hydrological Data** (Not Applicable)

C4 **Site Operational Records, Records of any Land Pollution on Site** (Not Applicable)

C5 **Existing Site Investigation, Assessment and Remediation Records**

Extracts of Foundation and Exploration Services Limited 1992 Ground Investigation.

Extracts of Norwest Holst Soil Engineering Limited 2003 Ground Investigation.

C6 **Other Information** (Not Applicable)

Appendix D - Data Assessment

D1 Potentially Polluting Substances

D2 Assessment of Land Pollution Potential

Material	Potentially Polluting Substance	Justification for Designation as Potentially Polluting Substance
Methanol CAS no. 67-56-1	Yes	Approx 22 tonnes. When exposed to air, methanol evaporates to atmosphere where, if it reacts with other VOCs it can contribute to the formation of photochemical smogs. Methanol entering soil would be rapidly biodegraded though some may enter groundwater. In soils exposed to air, methanol would evaporate rapidly. Methanol dissolves in water and will evaporate from water exposed to air. Methanol in water would be biodegraded and is considered to pose a low acute toxicity to aquatic organisms.
Process waste water	Yes	Water may be contaminated with methanol, aromatic hydrocarbons and aliphatic hydrocarbons. 300,000 litres
Fluids in closed drain	Yes	Closed drain collects fluids from the site and may be contaminated with oils, anti-freeze etc
Antifreeze (ethylene glycol)	No	Only small quantities used in hot water system (33% of hot water system).
Corrosion Inhibitor	Yes	Approximately 40 m^3 contained in annulus between production casing and 13 $^3/_8$" casing. Small possibility of leakage to external environment, but most likely will leak internally to well.

Table D1 Potentially Polluting Substances associated with PPC Permitted Activities

Table D2 Assessment of the Likelihood of Pollution

Note: This table is based on the EA Template but has been adapted to reduce the number of columns. The 'records of pollution' column is not applicable as the site is not yet operational and thus no pollution will have been caused by PPC activities.

Site Operation & Substance	Relevant Activity	Pollution Potential	Pollution Prevention Measures	Inspection / testing of containment	Are measures adequate?	Little likelihood of pollution?	Reasonable possibility of pollution?
Methanol	Delivery by road tanker to installation	Spillage from tanker on installation roads entering road drainage	Primary containment – road tanker. Any spillage will enter the site drainage which discharges to an interceptor.	Integrity testing & inspection in accordance with ISO14001 requirements	✓	✓	-
	Road tanker off-loading	Spillage from road tanker or delivery pipework to hardstanding	Any spillage will enter the site drainage system which discharges to an interceptor.		✓	✓	-
		Overflow	Tank will have contents gauges & high level alarms in control room. Unloading subject to Site Operating Instruction. Local level indicator visible from truck unloading area.		✓	✓	-
Storage	Storage in 1T7025	Failure of containment leading to spillage to land	Primary containment – above ground tank with 110% bund. If the bund failed fluids would flow to the site drainage system and then to the interceptor.		✓	✓	-
Use	Feed supply	Leakage/ seepage from pipework conveying methanol from storage to wellheads	Primary containment – pipes. Any leaks will flow to site drainage and on-site interceptors.		✓	✓	-
Contaminated waters	Emptying	Spills during emptying of catch basins	Any spills would drain back into the catch basins.		✓	✓	-
Waters with oil, methanol etc	Fire Fighting	Water used to fight a fire becoming contaminated & entering site drainage	Any fire fighting fluids will enter the site drainage & flow to the site interceptor. If uncontaminated, the fluids will be discharged to the balancing lagoon.		✓	✓	-
Process waters	Transfer	Leakage of pipes from processes to storage tank & tank to MRU	Primary containment – pipes. Any leaks will flow to the site drainage system and then to the interceptor.		✓	✓	-
Waters with methanol & trace hydrocarbons	Storage	Failure of containment – Process Water Tank (1T7015)	Primary containment – tank is above ground tank within 110% bund. If the bund failed fluids would flow to the site drainage system and then to the interceptor.		✓	✓	-
	Emptying	Spills during emptying of the closed drain drum (1D7028)	Any spills would enter the site drainage system and flow to the on-site interceptors.		✓	✓	-
Corrosion Inhibitor	In-situ in annulus between production and well casings	Leakage through pipework – into the production pipe	Primary containment – carbon steel production tubing Secondary containment – in the event of a leak through the production tubing the inhibitor would sink into the cavern or be removed along with gas	Yes – annulus levels will be checked	✓	✓	-
Use		Leakage through pipework – out of well casing. This is considered unlikely as external bearing pressure is likely to keep the fluid within the well	Primary containment - 13⅜" cemented carbon steel casing with premium gas-tight connections. Secondary containment – 20" carbon steel casing to 608 m bgl (through the Chalk aquifer). Below 608 m bgl the secondary containment is natural strata (predominantly mudstones). Tertiary containment – 30" carbon steel casing to 55 m bgl (through shallow, potentially water-bearing, strata)	Yes – annulus levels will be checked	✓	✓	-

Appendix E - Conceptual Site Model

Drawings relating to the Site Report are contained within Section 5 of the PPC application pack for the installation.