Appendix 17.1

Flood Risk Assessment
THE INFRASTRUCTURE PLANNING (APPLICATIONS: PRESCRIBED FORMS AND PROCEDURE) REGULATIONS 2009

Preesall Underground Gas Storage Facility, Lancashire

Flood Risk Assessment

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Preesall Underground Gas Storage Facility

Flood Risk Assessment
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Preesall Underground Gas Storage Facility

Flood Risk Assessment

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1 SUMMARY

1.1.1 Hyder Consulting (UK) Limited (Hyder) has been appointed by the Halite Energy Group to undertake a Flood Risk Assessment (FRA) to support the development of an underground Gas Storage (UGS) Facility at Preesall, Lancashire (the Project).

1.1.2 The FRA has been produced, to support the application for a Development Consent Order (DCO) to construct and operate the UGS, in accordance with Planning Policy Statement 25: Development and Flood Risk (PPS25) (Communities and Local Government, 2010) and in consultation with the Environment Agency (EA).

1.1.3 The Project comprises gas storage caverns, water washing infrastructure, gas infrastructure, power supply infrastructure and road infrastructure. The Project has an anticipated operational design life of 40 years.

1.1.4 The FRA has investigated the potential for flood risk within the application boundary to key infrastructure from tidal/coastal, fluvial, groundwater and surface water sources. In addition, the FRA has assessed the potential for impacts on third party flood risk outside the application boundary and sets out appropriate mitigation measures and further studies that may be required once the application for a DCO has been granted. The FRA has been informed by existing data and information held by the EA. The study has confirmed that coastal flooding is the main source of flooding in the study area.

1.1.5 Although there is a potential fluvial flood risk to the Project the mitigation of coastal flood risk, which represents the worst case scenario, will ensure that the Project is safe during a fluvial flood event and would not increase flood risk elsewhere. At this stage of the Project no detailed designs have been produced for the temporary works and for the temporary stockpile of excavated material. However, maintaining the temporary works at existing ground levels and stockpiling of excavated material outside Flood Zone 3 would ensure that there would be no adverse temporary impact on existing fluvial flood conditions. If significant changes in topography and the stockpiling of excavated material within Flood Zone 3 were unavoidable, further studies would be undertaken in detailed design, to ensure that the proposed temporary works would have no adverse impact on existing fluvial flood conditions.

1.1.6 All critical assets proposed as part of the DCO, which cannot tolerate flooding, are located within Flood Zone 1, classified in PPS25 as land having a low probability of flooding. Some infrastructure (such as the proposed wellheads) are located within Flood Zone 3, which is classified in PPS25 as land having a high probability of flooding. However, these facilities are able to accommodate floodwater and are also located behind existing defences.

1.1.7 In detailed design, investigations would be undertaken into the use of polystorm modular cells or other similar types of system which would allow floodwater to flow and be stored internally within the visual bunds proposed as part of the UGS. The studies will also confirm whether additional floodwater storage is required within the GCC to compensate for any potential residual displacement of floodwater as a result of the visual bunds.
1.1.8 The study has confirmed that sections of the main access road, within the application boundary, are located with Flood Zone 3. It has been confirmed that flooding of the access roads would not prevent the safe operation of the proposed infrastructure. As a result, for sections of the road located with Flood Zone 3, it is proposed to set the road surface so that it ties in with existing ground levels. As a result the proposed roads would not have an adverse impact on existing flood conditions.

1.1.9 Due to the underlying nature of the ground there is a potential risk of shallow groundwater flooding within the study area. With appropriate groundwater protection measures in place (e.g. vulnerable assets raised slightly above ground levels), the risk of groundwater flooding to key infrastructure is considered to be low.

1.1.10 With the implementation of a suitable surface water drainage strategy, there should be no significant risk to proposed infrastructure from surface water flooding. The surface water drainage strategy would ensure that surface water runoff is effectively managed within the application boundary and that there would be no increase in third party flood risk. It is envisaged that the surface water drainage strategy would be developed during the detailed design process once the application for a DCO has been granted.

1.1.11 A comprehensive re-assessment of the geological conditions has been undertaken to support the Project (Mott MacDonald, 2011). This report confirmed that to date, the precise levelling data shows no evidence of anomalous on-going local or area-wide subsidence suggesting that the existing brinefield and mine workings are at or close to equilibrated stable conditions. As a result it is understood that there is likely to be no reduction in the crest height of the existing defences due to subsidence from historical workings.

1.1.12 As a result of the construction of the new caverns a maximum future aerial subsidence rate in the order of 2mm/yr has been estimated. As the future rate at which the crest of the flood defences may reduce in height, due to subsidence caused by the new caverns, is relatively low, the crest can be closely monitored over the lifetime of the Project and beyond. If potential subsidence problems are identified, appropriate studies would be undertaken and mitigation measures identified to ensure the existing standard of protection can be maintained over the long-term.
2 INTRODUCTION

2.1.1 Halite Energy Group (the Applicant) intends to submit an application for a Development Consent Order (DCO) to the Infrastructure Planning Commission (IPC) to construct and operate an underground gas storage (UGS) facility at Preesall, Lancashire (‘the Project’). The application for the DCO will be accompanied by an Environmental Statement (ES) prepared in accordance with the Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 (‘the Regulations’) (Statutory Instrument 2009/2263) and other documents including a statement of pre-application consultation.

2.1.2 To support the ES Hyder Consulting (UK) Ltd (Hyder) has been appointed by the Applicant to undertake a Flood Risk Assessment (FRA).

2.1.3 The FRA has been produced in accordance with Planning Policy Statement 25: Development and Flood Risk (PPS25) (Communities and Local Government, 2010) and in consultation with the Environment Agency (EA).

2.1.4 The FRA has investigated the potential for flood risk to key infrastructure from tidal/coastal, fluvial, groundwater and surface water sources within the application boundary. In addition, the FRA has assessed the potential for impacts on third party flood risk outside the application boundary and sets out appropriate mitigation measures and studies, as required. The FRA has been informed by existing data and information held by the EA.
3 BACKGROUND

3.1 Description of Study Area

3.1.1 The study area comprises the application boundary (refer to Figure A17.1 in Appendix A), as well as areas outside which may be affected by flooding as a consequence of the Project. The key areas of the study area included the Fylde Peninsula, Wyre Estuary as well as land between Preesall and Nateby. The study area also includes the coastline stretching from Cleveleys to Cockerham.

3.1.2 The majority of the above ground infrastructure (Booster Pump Station, Gas Compressor Compound, Wellhead Compounds etc) associated with the Project are located on an extensive irregular shaped area of land on the Preesall Salt Field which lies to the east of the River Wyre and west of Preesall, Lancashire (NGR 335,500:446,000).

3.1.3 The Preesall Salt Field is an extensive area of predominantly low lying open agricultural land and salt marsh to the east of the Wyre Estuary. It was previously used for salt extractions, and a few structures remain. The land is currently used for a mixture of arable and pastoral farming. There are some access roads across the area and several existing farm buildings. The topography generally falls from east to west from approximately 10mAOD to 5mAOD.

3.1.4 The study area also includes a site located adjacent to Fleetwood Docks, which lies west of the River Wyre (NGR 333,515:446,830). A seawater pumping station has been proposed at this location. In addition, the study area also includes a short strip of land crossing the existing seawall between Fleetwood and Cleveleys (NGR 331,200:445,400). This strip of land is required for the installation of an outfall which will discharge brine to the Irish Sea.

3.1.5 The application boundary also includes other corridors of land required for the installation of underground transmission pipelines that will convey seawater, brine water, gas and electricity.

3.2 Hydrological Characteristics of the Study Area

3.2.1 The study area comprises generally flat low lying land, undulating in parts, on the east and west sides of the Wyre Estuary. The majority of Fleetwood, to the west of the Estuary, and farmland to the east is protected from coastal flooding by a system of flood defences.

3.2.2 As shown on Figure A17.3 in Appendix D, within the application boundary water features include reaches of Main Rivers, Ordinary Watercourses and land drainage ditches. The Main Rivers include the River Wyre, Grange Pool, Burrows Pool, Hackensall watercourse, Preesall Moss, Ridgy Pool/Hales Rushes watercourse, Pilling Water/Lee Brook and Copse Brook.

3.2.3 It is understood that the Mean High Water Spring Tide level at the mouth of the Wyre Estuary is 4.42mAOD. Due to the low lying nature of the land, flood risk within the application boundary is dominated by extreme sea levels. Although
there is potential for fluvial flooding the extent and severity is likely to be much lower than the risk from coastal flooding. On the 11 November 1977 an extreme sea level of 6.19m AOD was recorded at Fleetwood. It is understood that this event corresponds to a return period in the order of 150 years. Without the presence of the existing defences this flood level would have inundated large parts of the study area, including the Fylde Coastal Plain and the Fylde Mosslands. No evidence of historical flooding of the Preesall site has been identified.

3.3 Description of the Project

3.3.1 The proposed Project is to create underground caverns in the salt body at Preesall. When created, the caverns would be used for the storage of natural gas which can be supplied to the National Transmission System (NTS) to meet demand. In broad concept, the proposals are similar to schemes that were promoted by Canatxx Gas Storage Limited (CGS) between 2005 and 2009. The main difference between the current Project and previous schemes is that the Halite proposals are reduced in size and scale such that the amount of gas that would be stored is significantly less than that proposed in previous schemes. The Halite proposal seeks permission for up to 19 caverns with a working capacity of up to 600 million cubic metres – about half that of the previous scheme. The reduction in the gas storage capacity and the location of the proposed caverns (see below) has also condensed the surface infrastructure and, therefore, the overall site area that is required to construct and operate the proposed Facility.

3.3.2 In summary, the Project includes the following key elements:

- Gas Storage Caverns;
- Water Washing Infrastructure;
- Gas Infrastructure;
- Electrical Infrastructure; and
- Road Infrastructure.

3.3.3 These elements have been described in the following sections and are shown on Figure A17.1 in Appendix A.

3.3.4 Gas Storage Caverns

3.3.4 The proposed UGS Facility would consist of nineteen underground caverns which would be created by a solution mining (leaching) process. The caverns used in the proposed Facility would be created specifically for the project in the salt areas that have been left untouched by previous brine mining operations.

3.3.5 To access the salt, boreholes would be drilled from a number of wellheads. Initially, vertical wells would be drilled to access the land based salt body prior to directional drilling techniques to access the salt under the Wyre Estuary Site of Special Scientific Interest (SSSI). The boreholes from which the caverns would be constructed would be drilled from drilling pad sites. A steel casing would be inserted into the completed boreholes and cemented in to protect the
wells from the migration of groundwater and to provide an effective seal between the mudstone and the borehole string.

3.3.6 The drilling pad sites would be located behind the existing flood defences.

3.3.7 Initial cavern gas fill and de-brining system safety revolves around the use of both manual and emergency shutdown valves on the wellheads at the surface. Sensors on the gas injection side would close wellhead valves automatically (fail closed) if pressure on the injection side is higher than necessary to displace brine from the cavern. The shut-down would be recorded in the control room and injection to the well would cease.

Water Washing Infrastructure

3.3.8 In order to dissolve the salt and create the caverns, a supply of water is required, together with pumps and pipelines to take it to the caverns and from there to the brine disposal point. The amount of water required is very large (up to 80 mega-litres a day) such that the use of freshwater made this an environmentally unviable option. However, since seawater is only 3% sodium chloride, as compared with saturated brine at 26%, seawater is almost as effective as fresh water for this purpose and is available in much larger quantities. Fleetwood Fish Dock has, therefore, been selected as a suitable source of seawater. The fish dock, constructed in 1880, was also used to supply cooling water to an electricity generating station in the 1950’s and some of this infrastructure is still in place. The proposed construction makes maximum use of this existing infrastructure, which minimises the impact of the project.

3.3.9 The proposal is to draw water from the Fish Dock at Fleetwood, through the existing inlet and associated culvert, which is 1.22m in diameter. A Seawater Pump Station is proposed, adjacent to ABP’s Fish Dock, to pump seawater in a buried and directional drilled pipeline from the West Bank of the Wyre Estuary to the Preesall site. Filters would be incorporated into the inlet to minimise the opportunity for marine organisms to be drawn into the water washing infrastructure.

3.3.10 The river crossing would consist of four directionally drilled boreholes: one for the seawater passing from the seawater pump station; one for the returning brine; one for power, communications, controls and ancillary uses leaving one in reserve. These will be formed by directionally drilling boreholes from the West Bank, at sufficient depth to minimise the environmental impact. The pipelines will be a minimum of 8 metres below the bed of the River to ensure that the existing silt, sediments and flood defences are not disturbed.

3.3.11 The seawater would then be transmitted in a buried pipeline to the booster pump station where the pressure would be increased and the seawater pumped to the various wellhead locations. It would be fed down the well casings for the cavern washing operation at carefully controlled rates, according to industry best practices and Health and Safety Executive (HSE) requirements.

3.3.12 After the brine has been used in the washing process, it would be returned to the de-brining facility adjacent to the booster pump station to ensure the brine contains no dissolved gas or sediment from the washing stage. Dissolved gases
vent to air whilst the sediment would be collected and disposed of to an existing
cavern on the site by tanker or slurry pipeline.

3.3.13 The saturated brine would leave the Facility at a pressure of up to 5-7bar. It
would then be passed through piping, trenched in a similar manner to the inlet
seawater piping and back through the second river crossing. On the West Bank
of the river, it would then pass through similar piping, to the seawall at West
Way via a discharge monitoring facility sited adjacent to the Seawater Pumping
Station at Fleetwood Dock. In order to cross the seawall, piping would be laid
beneath the concrete access ramp from West Way, Fleetwood. The pipe would
then pass through the existing gap in the existing splash wall, trenched across
the top of the seawall, and down the face of the seawall on to the foreshore.
The passage of the pipeline from the top of the seawall would be accomplished
within a new observation platform to be built abutting the face of the seawall.
This feature would be constructed with design input from Wyre Borough
Council’s (WBC) specification and is intended to replace the existing access
ramp. All pipework would be underground with the exception of the crossing of
the old railway line adjacent to the Jameson Road bridge crossing.

3.3.14 From there the saturated brine would be conveyed through the outfall to a point
approximately 2.3 km offshore to a two port single diffuser, the design of which
is shown on the application plans, where it would be discharged into the sea in
accordance with an existing Discharge Consent. The design of the diffuser has
been carefully optimised for the marine environment, and its performance would
achieve those standards laid down by the EA in its approval.

3.3.15 The principal use of the seawater and the water infrastructure is for the creation
of caverns. Once the caverns are completed, the water washing infrastructure
would only be used for the filling of caverns during periods of cavern
maintenance. Generally, the caverns would be filled with brine every 10 to 15
years to allow for the testing and inspection of the gas storage caverns.

Gas Infrastructure

3.3.16 The gas infrastructure for the project consists of a Gas Compressor Compound
(GCC), the gas distribution pipelines and manifolds connecting the wellheads to
the GCC and an interconnector pipeline which links the GCC to the NTS near
Nateby, approximately 12 km away. The interconnector pipeline is designed as
a 42 inch diameter pipe but there may be an opportunity to reduce this to a 36
inch diameter pipe. For the purposes of the Environmental Impact Assessment
the 42 inch diameter pipeline has been assessed. A connection is proposed to
National Grid Gas pipelines (No.21 and No 15 Feeder) to ensure maximum flow
rate and availability. At the connection point there would be a shut-down valve
under National Grid Gas control. An Interconnector Metering Station is
proposed, adjacent to National Grid Gas’s existing valve installation on Feeder
21.

3.3.17 Following a review of alternative sites on both banks of the River Wyre, the
GCC is proposed to be located on the northern part of the UGS site. The GCC
is the largest part of the surface infrastructure that is required to construct and
operate the UGS Facility. As such, it will be carefully designed and landscaped
in order to minimise its environmental impact.
3.3.18 The GCC would include processing equipment to condition the gas for entry to the NTS and to the caverns. The equipment would include compressors, dehydration units, air cooled heat exchangers, filters, separators, storage tanks and utility systems. There would also be additional buildings containing electrical and instrument equipment.

3.3.19 There would be a vent stack, which would be used at times of emergency and for routine maintenance. There would also be an access road, vehicle parking and a security fence.

3.3.20 From the GCC would run 3 underground gas pipeline manifolds inland of the river embankment. From these manifolds, gas distribution pipes would be connected to the individual wellheads.

3.3.21 For a strategic project such as this, it is a requirement that there is a robust high integrity electricity supply. The installation would be supplied from the connection point at the Stanah Switchyard via 100% dual circuits, so that, if one supply is not available, the load can be supplied by the other circuit. Additional switchgear would be required at Stanah and this would be included within the existing building. It is understood that the required switchgear within the Stanah Substation building would be installed, operated and maintained by Electricity North West (ENW). As a consequence the new switchgear that is required does not form part of the DCO. No changes are required to the layout and external appearance of the existing building. There would be no effect on other consumers in respect of reliability of supply or voltage control.

3.3.22 Cables would be laid underground from ENW switchgear in the Stanah Switchyard, beneath the Wyre Estuary and north through to the Sub Station at the GCC. Crossing of the Wyre Estuary would be achieved by directionally drilling two pipes for two circuits. The pipes would be a minimum of 8 metres below the bed of the River to ensure that the existing silt, sediments and flood defences are not disturbed.

3.3.23 Cables ducts and ultimately the electricity cabling would be drawn from the Preesall side across to the Stanah Switchyard. This will entail cable ducting being laid out across the field on the Preesall side so that a continuous pull can be achieved. The cables would be delivered on cable spools which would feed the cable out as the pull progresses.

3.3.24 In order to gain access for the construction and operation phases of the project, improvements would be required to the road infrastructure in the area. It is proposed to form a new road from the A588 to the site, constructed to a standard to allow for the movement of large items of equipment such as transformers, interconnector pipes and compressors. Access roads and tracks would be provided within the site linking the main permanent structures and wellheads as shown on the application drawings.
Built Development

3.3.25 The permanent above ground built development necessary for the operation of the proposed UGS Facility comprises:

- Security and Support Facility
- Seawater Pump Station
- Booster Pump Station
- Gas Compressor Compound
- Wellhead Compounds
- Interconnector Metering Station

Security and Support Facility

3.3.26 The Security and Support Facility would be located at Higher Lickow Farm. The existing farmhouse and outbuildings, which are currently vacant, provide an ideal location for this use as they are close to the route of the main access road into the site. The farmhouse would be refurbished to provide administration, training, and health and safety accommodation. The gross floorspace of the two storey building is 112 sq metres.

3.3.27 Adjacent to the farmhouse are two existing barns both of which are in a poor condition. The larger barn, which has a footprint of 250 sq metres, would be rebuilt on its existing footprint to provide staff facilities and a maintenance workshop in two storeys. The ground floor would comprise 250 sq metres and contain two offices, a locker room, toilets, a workshop and stores. The first floor comprising 100 sq metres would contain 2 meeting rooms and a canteen. The smaller barn which has a footprint of 60 sq metres would be demolished.

3.3.28 Finally, a single storey security gatehouse with a floorspace of 24 sq metres would be provided to the east of the farmhouse on the main access road. Within the complex, 17 car parking spaces would be provided for employees and visitors.

Seawater Pump Station

3.3.29 It is proposed that the Seawater Pump Station Compound would be situated adjacent to an existing seawater culvert within the Fleetwood Fish Dock, off Herring Arm Road. The Compound would contain the Pump Station itself, a transformer compound, access road and car parking area.

3.3.30 The Pump Station building would be single storey (6.5 metres to the top of the ridge) with a floorspace of approximately 430 sq metres gross. The Pump Station would contain the pump hall, electrical drive units, switchgear and control desk. It is designed to abstract seawater from the Fish Dock making use of an existing culvert originally built to supply cooling water to the former Fleetwood Power Station. The seawater would enter a sump underneath the Pump Station building prior to being filtered and pumped in an underground pipeline under the Wyre Estuary to the Booster Pump Station at the Preesall site. Abstraction of water from the Fish Dock would be controlled to ensure a viable water level is always maintained in the dock.
3.3.31 It is proposed that the external materials comprise polished metal cladding to the walls and roof; albeit that alternative designs could be considered.

3.3.32 A bunded transformer compound containing 2 transformers would be provided adjacent to the Pump Station building.

3.3.33 Access to the Compound is proposed from Herring Arm Road with 4 car parking spaces provided for staff and visitors. A 2.4 metre perimeter security fence of polyester coated mesh would be provided around the site.

**Booster Pump Station**

3.3.34 It is proposed that the Booster Pump Station Compound would be located adjacent to the Hackensall Sewage Treatment Works. Access to the Compound would be provided from the track that extends from Monks Lane. The Compound would contain the Booster Pump Station, De-brine Facility and nitrogen tank compound.

3.3.35 The Booster Pump Station would have a floorspace of 492 sq metres and would contain the Control Room, 12 high capacity pumps, electrical control equipment, switchgear and standby generator. A transformer compound would be situated adjacent to the building containing 2 transformers. The external materials are brick and tile.

3.3.36 The De-brine Facility would comprise a pond, hydro-cyclones and brine discharge pumps.

3.3.37 The Booster Pump Station would receive seawater pumped from the Seawater Pump Station at the Fleetwood Fish Dock. The booster pumps situated within the building would increase water pressure and via a number of underground pipelines deliver it to individual wellheads. Under controlled conditions, the seawater would be injected down the cased and lined boreholes to solution mine the salt. The resulting saturated brine would then be returned via underground pipes to the De-brine Facility within the Compound. Any suspended solids within the retained saturated brine would be removed by passing the brine through hydrocyclones. The ‘filtered’ saturated brine would then be pumped back across the Wyre Estuary and the Fleetwood Peninsula to the outfall off Rossall in the Irish Sea.

3.3.38 The De-brine Facility includes a reservoir tank which is required during the process of de-watering of the caverns. When gas is first introduced into the completed caverns, the residual brine would be driven out and piped to the reservoir to ensure any possibility of dissolved gas is allowed to vent. Following ‘venting’ of the gas in the reservoir, the brine would be disposed of in the normal manner as summarised above.

3.3.39 The Compound would be surrounded by a 2.4 metre security fence of polyester coated mesh (dark green). Spoil from the construction of the buildings and the De-brine Facility would be used to raise the land to the west and north of the Compound to mitigate views of the Compound when viewed from the Wyre Way.
Gas Compressor Compound

3.3.40 It is proposed that the Gas Compressor Compound would be located 500 metres to the northwest of Higher Lickow Farm. Access to the Compound would be provided from the new access road to the A588. The Compound would contain the following buildings, structures and equipment:

- Pig Launchers and Receivers;
- Slug Catchers;
- Large diameter above ground high pressure pipelines;
- Glycol Contactors to dry the gas;
- Glycol Regeneration system;
- MOPICO Compressors;
- Compressor Knock Out Separators;
- Compressor Aftercoolers;
- Gas filters;
- Gas Heaters;
- Various utility systems, plant drainage and power supply;
- Emergency/maintenance vent stack;
- Electrical/instrument and Utilities buildings; and
- Vent Stack provided within the centre of a new pond.

3.3.41 The principal buildings are the Compressor Station Building and the Electrical Equipment and Utilities Building, which are similar in design and comprise single storey buildings approximately 8.5 metres high, each with a gross floor area of approximately 360 sq metres.

3.3.42 The external plant would include:

- the glycol heaters and regeneration plant rising to a maximum height of approximately 13 metres;
- the fin fan coolers rising to a maximum of 8 metres in height;
- slug catcher and NTS Filters rising to a height of approximately 9.5 metres; and
- storage tanks of approximately 3.5 metres in height.

3.3.43 The eastern part of the Compound would provide a vent stack situated in a 50 metre radius pond. As well as ensuring that there is a sterile area around the vent stack, the pond would also act as an emergency source of fire water.

3.3.44 Most of the large diameter pipework within the Compound would be buried, with small diameter pipework and equipment outside or, where appropriate, incorporated within buildings.
3.3.45 The compound would be high security and surrounded by palisade fencing with CCTV cameras.

3.3.46 Adjacent to the Compound would be an Electrical Substation and switchyard.

**Wellhead Compounds**

3.3.47 During the drilling of the boreholes, 7 wellhead compounds are proposed to accommodate the drilling rigs. The wellhead compounds would be provided on a phased basis as the drilling of boreholes across the site progresses. The wellhead compounds would be large enough to accommodate the drilling rig, pipework and ancillary infrastructure. Following the drilling of the boreholes, the water washing infrastructure would be connected to wash the caverns and once these are created the gas manifolds would be connected to allow for the import and export of gas. Once operational the wellhead compounds would be low structures whose visual impact can be mitigated by earth screening and planting.

3.3.48 Each wellhead compound would be a high security compound surrounded by palisade fencing with CCTV cameras.

**Seawall Crossing**

3.3.49 In order to cross the seawall, it is proposed that piping would be laid beneath the concrete access ramp from West Way. The pipe would then pass through the existing gap in the existing splash wall, trenched across the top of the seawall, and down the face of the seawall on to the foreshore. The passage of the pipeline from the top of the seawall would be accomplished within a new observation platform to be built abutting the face of the seawall. This feature would be constructed with design input from WBC's specification and is intended to replace the existing access ramp. Before any construction work is undertaken an application for an EA Flood Defence Consent for the proposed works would be made. In detail, the schedule of works is as follows:

- Temporary construction compound installed landside of existing seawall, south of planned pipe crossing.
- The access ramp from West Way and Seawall will be closed to pedestrians for installation of pipe, removal of existing ramp and foundations for observation platforms for up to 12 weeks. Access will be restricted for up to an additional 12 weeks subject to control during site deliveries.
- A temporary aggregate ramp would be built up from the foreshore to the seawall to allow heavy equipment access.
- The marine contractor would install a cofferdam on the seaward side.
- The marine contractor would install HDPE pipe from inside the cofferdam to the low water mark.
- Relevant sections of the existing seawall would be removed without affecting the efficiency of the continuing sea defence.
- Installation of a steel S-bend pipe through the top section of (over the main body of) the seawall would occur with a foreshore connection made inside the cofferdam.
- Marine contractor would withdraw and continue with laying the 2.3 kms outfall pipe.
- Temporary aggregate ramp would be removed.
- Installed pipe sections would be hydro-tested.
- Re-modelling of sea defence with observation deck in keeping with Cleveleys esplanade.
- Installation of a new feature for the seawall: hinged concrete storm gates.
- Once complete, demobilization, clean up and re-instatement to the previous condition.
- The finished new seawall would remain visually in keeping with the length of the new sea defences along this part of the Lancashire coast.

3.3.50 The work would take place during the summer in the first year of construction of the UGS project and would be completed within 9 months.

**Interconnector Metering Station**

3.3.51 The interconnector metering station would consist of a single brick building of 150 sq metres floorspace in a 0.96 ha Compound. The interconnector pipeline would rise out of the ground within the Compound and re-enter the ground to connect to the NTS feeder. The above ground pipeline would have flow measurement devices, isolation and emergency shutdown valves. The building would house automatic metering and gas analysis instrumentation and is not normally manned. The Compound would be surrounded by a security fence.

3.3.52 Access to the Compound would be from the existing farmers track from Station Lane.

**Other Works**

3.3.53 In addition to the above, the following works are required:
- Temporary drilling compounds at the Fleetwood Fish Dock;
- New landscaping and mounding; and
- A number of temporary construction, drilling and storage compounds.

**3.4 Construction Programme**

3.4.1 Following the detailed engineering work, the receipt of all of the necessary consents and licences and the appointment of a contractor, construction of the development would take place in phases over an 8 year period. The main elements of the programme would be as follows:
- Mobilisation of contractors including the establishment of work compounds, the construction of the main access road and the provision of temporary footpaths as may be required.

- Construction of the Water Washing Infrastructure

- Drilling - This phase involves drilling of the wells into the salt formation, installation of leaching strings and leaching wellheads.

- Solution Mining - This phase involves solution mining of the caverns to form the underground caverns, utilising the leaching wellheads and Water Washing Infrastructure to form the caverns. This process would take several years.

- Construction of the Gas Compressor Compound for de-brining and trading of the caverns. This phase also involves installation of the gas pipelines between the GCC and the NTS, and the GCC and the caverns.

- De-brining – This phase involves installation of gas strings and gas wellheads to allow removal of the brine from the caverns. Gas would be used to displace the brine from the caverns and convert the caverns ready for gas trading.

- Gas Trading – The final phase involves fully commissioning the caverns and handover to gas trading operations.

3.4.2 The phases outlined above are not sequential and it is likely that a number of the construction and operational phases will be progressed in parallel. All of the built development would be achieved in the first three years of the construction programme but the washing and creation of the caverns would take place sequentially over a 4 to 6 year period as each cavern is created and tested individually. As caverns become available and subject to HSE approval, caverns may be operational whilst others are still being washed or tested. An indicative programme for the construction of the project is set out below (accurate at the time of preparation of this FRA). :-
### Table 3-1 Indicative Construction Programme

<table>
<thead>
<tr>
<th>Task</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8</td>
</tr>
<tr>
<td>Mobilisation of Contractors</td>
<td></td>
</tr>
<tr>
<td>Preliminary Earth Works</td>
<td></td>
</tr>
<tr>
<td>Haul Roads</td>
<td></td>
</tr>
<tr>
<td>Brine Discharge Pipeline</td>
<td></td>
</tr>
<tr>
<td>Seawall Crossing</td>
<td></td>
</tr>
<tr>
<td>North River Crossing</td>
<td></td>
</tr>
<tr>
<td>South River Crossing</td>
<td></td>
</tr>
<tr>
<td>Seawater Pump Station</td>
<td></td>
</tr>
<tr>
<td>Booster Pump Station</td>
<td></td>
</tr>
<tr>
<td>Gas Compressor Compound</td>
<td></td>
</tr>
<tr>
<td>Interconnector</td>
<td></td>
</tr>
<tr>
<td>Drilling Compounds</td>
<td></td>
</tr>
<tr>
<td>Wellheads &amp; Manifolds</td>
<td></td>
</tr>
</tbody>
</table>

### 3.5 Operation Life and Decommissioning

#### 3.5.1
The UGS Facility has a design life of over 40 years (2056) but its longer term operation would be dependent on the continued demand for gas, gas prices, potential new sources of gas and their reliability. In the longer term, an option under consideration is the construction of a long distance pipeline from Halite’s approved Gas Terminal at Anglesey, North Wales to the UGS Facility. This would allow re-gasified Liquefied Natural Gas (LNG) to be supplied from the Terminal at Anglesey to the Gas NTS, via the Preesall UGS Facility at periods of demand. This option, however, would require a considerable amount of further investigation and, accordingly, is not part of the current Project proposals or the application for the DCO.

#### 3.5.2
Also, in the longer term and dependent on the continued demand for gas storage, Halite may also consider proposals to extend the size of the Preesall Gas Facility. Any proposals for new pipelines or extensions to the Facility would, however, be subject to the results of further investigations and a new application at some time in the future.

#### 3.5.3
These potential longer term proposals do not form part of the current application made to the IPC.

#### 3.5.4
At the end of the life of the proposals, the caverns may have the potential for alternative uses such as ‘carbon capture’ but any alternative uses would have to be considered at that time. If there were no alternative uses for the caverns, these would be emptied of gas, filled with brine and sealed. The wellheads would be maintained and monitored in accordance with an approved Scheme.
and in a manner consistent with the ongoing maintenance and monitoring activities being conducted for the existing ICI caverns. The remaining infrastructure could remain in place if required for alternative uses. The seawater pipelines may have particular long term benefits in respect of flood control. Alternatively, the buildings and pipelines would be removed in accordance with a scheme to be agreed with the LPA.

3.5.5 A restoration and management plan would be produced to ensure the long-term maintenance and safety of the caverns and the site.

3.5.6 The restoration and management plan would also outline a regime for monitoring the condition of key sections of existing flood defence embankment within the study area. This would ensure that there would be no long-term degradation in the existing standard of flood protection provided by the defences as a result of the UGS.

3.6 Summary of Proposed Infrastructure

3.6.1 The key infrastructure proposed as part of the Project is summarised in Table 3-2. In addition a number of temporary compounds and associated access roads are proposed to facilitate the construction of the pipelines and other infrastructure.

Table 3-2 Summary of Proposed Infrastructure

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gas Storage Caverns</td>
</tr>
<tr>
<td>1.2</td>
<td>Wellheads. Manual and emergency shutdown valves</td>
</tr>
<tr>
<td>2</td>
<td>Water Washing Infrastructure</td>
</tr>
<tr>
<td>2.1</td>
<td>Seawater Pumping Station (pumps, telemetry housing)</td>
</tr>
<tr>
<td>2.2</td>
<td>Buried pipeline from the west bank of the Wyre Estuary to the Preesall site</td>
</tr>
<tr>
<td>2.3</td>
<td>Booster Pumping Station and Control Centre</td>
</tr>
<tr>
<td>2.4</td>
<td>De-brining Facility</td>
</tr>
<tr>
<td>2.5</td>
<td>Brine discharge pipeline from the west bank of the Wyre Estuary, to the seawall at West Way.</td>
</tr>
<tr>
<td>2.6</td>
<td>Brine discharge pipeline seawall crossing</td>
</tr>
<tr>
<td>2.7</td>
<td>Air vent</td>
</tr>
<tr>
<td>3</td>
<td>Gas Infrastructure</td>
</tr>
<tr>
<td>3.1</td>
<td>GCC and Substation</td>
</tr>
<tr>
<td>3.2</td>
<td>Gas distribution pipelines</td>
</tr>
<tr>
<td>3.3</td>
<td>Manifolds connecting the wellheads to the GCC</td>
</tr>
<tr>
<td>3.4</td>
<td>Gas pipeline which links the GCC to the National Grid near Nateby</td>
</tr>
<tr>
<td>3.5</td>
<td>National Grid Gas pipeline connection at feeder 15</td>
</tr>
<tr>
<td>No</td>
<td>Description</td>
</tr>
<tr>
<td>----</td>
<td>-------------</td>
</tr>
<tr>
<td>3.6</td>
<td>National Grid Gas pipeline connection at feeder 21</td>
</tr>
<tr>
<td>3.7</td>
<td>Interconnector Metering Station adjacent to National Grid Gas’s existing valve installation on Feeder 21</td>
</tr>
<tr>
<td>3.8</td>
<td>Vent Stack and Fire Water Pond</td>
</tr>
<tr>
<td>4</td>
<td>Power Supply</td>
</tr>
<tr>
<td>4.1</td>
<td>Stanah Substation*</td>
</tr>
<tr>
<td>4.2</td>
<td>132kv Dual underground circuits</td>
</tr>
<tr>
<td>5</td>
<td>Road Infrastructure</td>
</tr>
<tr>
<td>5.1</td>
<td>New road from the A588 to the site (GCC)</td>
</tr>
<tr>
<td>5.2</td>
<td>Haul roads within the site linking the access road to the main permanent structures and wellheads</td>
</tr>
<tr>
<td>6</td>
<td>Security and Support Facility</td>
</tr>
<tr>
<td>6.1</td>
<td>Security and Support Facility</td>
</tr>
</tbody>
</table>

Note* All infrastructure associated with the UGS at this location would generally be located underground and would be able to tolerate floodwater. New switchgear within the Stanah Substation building would be required. However, this would be installed, operated and maintained by ENW. Therefore, the switchgear does not form part of the DCO.
4 METHODOLOGY

4.1 Overview and Approach

4.1.1 The approach outlined below has been followed in order to assess flood risk to the Project and assess any potential impact of the Project on flooding elsewhere.

4.1.2 The FRA has been produced in accordance with PPS25 and in consultation with the EA. The aim of the FRA is to inform the decision-making process for the DCO application.

4.1.3 The FRA that has been undertaken is proportionate to the risk and appropriate to the scale, nature and location of the development. It demonstrates how flood risk from all sources of flooding to the UGS and flood risk to others would be managed now and in the future (taking climate change into account).

4.2 Data Collection

4.2.1 The FRA has been informed by existing data and information held by the EA and project parties.

Site Visit

4.2.2 In Spring 2008 a detailed inspection of the site and surrounding area was undertaken to confirm potential sources of flood risk and to investigate flood mechanisms.

Existing Topographical Data

4.2.3 Survey data was collected for key areas of the Preesall Salt Field on the east side of the Wyre Estuary. This data has been used to review the topography and characteristics of the land at this location.

Existing Flood Information

4.2.4 The following information was provided in December 2010 and July 2011 by the EA and has been used to assess the flood conditions within the study area:

- Flood Zone maps
- Historical flood map
- Extent of Main Rivers
- A list and copies of existing studies/models
- Coastal defence information
- Coastal flood levels
- National Flood and Coastal Defence Database (NFCDD) data
4.2.5 In addition the Soil Map of England and Wales (SSEW, 1983) has been reviewed in order to confirm the underlying ground conditions within the application boundary in order to appraise the risk of flooding from groundwater and surface water sources.

4.3 Environment Agency Consultations

4.3.1 As shown in Table 4-1 Detailed consultations with the EA have been undertaken throughout the study to confirm potential sources of flood risk and to agree appropriate methodologies to assess the sources of flooding. Further information on key correspondence, with the EA, is provided in Section 10 and Appendix B.

Table 4-1 EA Consultations

<table>
<thead>
<tr>
<th>Date of Consultation</th>
<th>Summary of Consultation</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 November 2010</td>
<td>Provided comments on what the EA would like to see addressed within the FRA and outline the need for Flood Defence Consent applications.</td>
</tr>
<tr>
<td>18 November 2010</td>
<td>Provided comments on what the EA would like to see addressed within the FRA.</td>
</tr>
<tr>
<td>10 December 2010</td>
<td>Hyder contacted the EA to discuss the initial flood risk findings and to agree an approach to address flood risk issues. In addition EA and PPS25 flood risk policy was discussed.</td>
</tr>
<tr>
<td>22 July 2011</td>
<td>EA confirmed that they had no objection to the FRA as submitted although comments were provided. Please see Section 10 for further information.</td>
</tr>
</tbody>
</table>

4.4 Potential Sources of Flood Risk

4.4.1 In Section 6, the FRA investigates the potential flood risk to key UGS infrastructure from coastal, fluvial, groundwater and surface water sources of flooding. This includes the following:

- The identification of potential sources of flooding to the proposed UGS
- An appraisal of the availability and adequacy of existing information on flooding
- An appraisal of the flood risk proposed to the UGS and the potential impact of the UGS on flood risk elsewhere
- If required, the identification of measures to reduce flood risk to acceptable levels
- If required, the identification of the need for further, more detailed, assessments
4.5 Detailed Assessment of Coastal Flood Risk

4.5.1 Following the assessment of potential sources of flood risk (Section 6), it was identified that coastal flooding was the dominant source of flood risk to the Project. As a consequence, a more detailed (qualitative) assessment was required to assess coastal flood risk issues.

4.5.2 Early on in the study it was identified that sufficient information (as detailed in Section 6 and 7) was already available to complete an FRA appropriate to the scale and nature of the development. The assessment, which was based on existing EA flood level and extent predictions, included the following:

- Qualitative appraisal of the potential coastal flood risk to the UGS (Section 7)
- Qualitative appraisal of the potential impact of the UGS on flood risk elsewhere (Section 7 and 8)
- Qualitative assessment to demonstration of the effectiveness of any proposed mitigation measures (Section 8)

4.5.3 For example, for the majority of the cases it was confirmed that vulnerable assets, which could not withstand flooding, were located on higher areas of land which had a low probability of tidal/fluvial flooding. As a consequence, new detailed hydrological and hydraulic modelling studies were not required to demonstrate that the UGS assets, which could not tolerate flooding would be flood free, and that the UGS would not impact on third party land.
5 PLANNING POLICY

5.1 PPS25 Development and Flood Risk

5.1.1 PPS25 sets out government policy on development in areas at risk of flooding. The principal aim of the policy is to ensure that flood risk is taken into account at all stages of the planning process, to avoid inappropriate development in areas at risk of flooding and to direct development away from those areas where risks are highest. It is also a requirement of PPS25 that new developments do not result in increased flood risk elsewhere and, where possible, act to reduce overall flood risk. Early adoption of and adherence to the principles set out in PPS25 can ensure that detailed designs and plans for developments take due account of the importance of flood risk and the need for appropriate mitigation, if required.

5.2 The Sequential and Exception Tests

The PPS25 Sequential Test classifies proposed development into one of four Flood Zones, detailed in Table 5-1.

Table 5-1 PPS25 Flood Risk Zones

<table>
<thead>
<tr>
<th>Flood Zone</th>
<th>Annual Probability of Flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Low Probability</td>
<td>This zone comprises land assessed as having a less than 1-in-1000 annual probability of river or sea flooding in any year (&lt;0.1%).</td>
</tr>
<tr>
<td>2. Medium Probability</td>
<td>This zone comprises land assessed as having between a 1-in-100 and 1-in-1000 annual probability of river flooding (1% – 0.1%) or between a 1-in-200 and 1-in-1000 annual probability of sea flooding (0.5% – 0.1%) in any year.</td>
</tr>
<tr>
<td>3a. High Probability</td>
<td>This zone comprises land assessed as having a 1–in-100 or greater annual probability of river flooding (&gt;1%) or a 1-in-200 or greater annual probability of flooding from the sea (&gt;0.5%) in any year.</td>
</tr>
<tr>
<td>3b. The Functional Floodplain</td>
<td>Land where water has to go or be stored in times of flood. Generally land which would flood with an annual probability of 1-in-20 (5%) or greater in any year or is designed to flood during an extreme 1-in-1000 (0.1%) flood, or at another probability agreed between the LPA and the EA.</td>
</tr>
</tbody>
</table>

5.2.1 PPS25 specifies that the suitability of all new development in relation to flood risk should be assessed by applying the Sequential Test to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development proposed.

5.2.2 The Sequential Test involves assessing the vulnerability of land uses in relation to flood risk and classifies new developments into one of five categories:
- Essential Infrastructure
- Water Compatible
- Less Vulnerable
- More Vulnerable
- Highly Vulnerable

5.2.3 PPS25 provides guidance on the compatibility of each land use classification in relation to each of the Flood Zones as summarised in Table 5-2.

Table 5-2 PPS25 Flood Risk Vulnerability Classification

<table>
<thead>
<tr>
<th>Flood Zone</th>
<th>Essential Infrastructure</th>
<th>Water Compatible</th>
<th>Highly Vulnerable</th>
<th>More Vulnerable</th>
<th>Less Vulnerable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Zone 2</td>
<td>✓</td>
<td>✓</td>
<td>Exception Test required</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Zone 3a</td>
<td>Exception Test required</td>
<td>✓</td>
<td>x</td>
<td>Exception Test required</td>
<td>✓</td>
</tr>
<tr>
<td>Zone 3b</td>
<td>Exception Test required</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

5.2.4 Following application of the Sequential Test, if a development that is consistent with wider sustainability objectives cannot be located in a suitably low-risk flood zone, application of the Exception Test may be required, which requires three conditions to be satisfied:

a) It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment (SFRA) where one has been prepared. If the Local Development Document (LDD) has reached the ‘submission’ stage the benefits of the development should contribute to the Core Strategy’s Sustainability Appraisal (SA);

b) The development must be on developable previously-developed land or, if it is not on previously-developed land, that there are no reasonable alternative sites on developable previously-developed land; and

c) A site-specific Flood Risk Assessment must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

5.2.5 The approach is therefore a staged one:

a) Categorisation of the site within the EA Flood Zones.

b) Application of the Sequential Test to assess if the development can be relocated to an area of lower flood risk
c) Where a particular type of development cannot be relocated to an appropriate Flood Zone (as defined in Table D.3 of PPS25), the Exception Test may be required. This involves an evaluation of the site to ensure that the initial requirements of the test are met and a detailed assessment of flood risk from all sources.

5.2.6 The relevant development tests, required to support the DCO, are addressed in Section 8.
6 SOURCES OF FLOODING

6.1 A range of potential sources of flooding to the UGS Facility at Preesall have been considered and are discussed below.

6.1.1 Coastal

6.2 Coastal

6.2.1 As confirmed by the EA, the primary source of flood risk in the study area is coastal, arising from the River Wyre Estuary and the coast off Fleetwood and the North Fylde Coastal Plain. The EA Flood Zone map showing the predicted extent of coastal flooding within the study area (excluding the protection afforded by existing flood defences) is provided on Figure A17.2 in Appendix C.

6.2.2 There is a potential coastal flood risk to the Project. This source of flood risk is assessed in detail in Section 7.

6.2 Fluvial

6.3 Fluvial

6.3.1 Due to the extensive system of Main Rivers and Ordinary Watercourses / land drainage ditches, some areas within the application boundary are likely to be at risk of fluvial flooding. However, due to the flat and relatively low lying nature of the topography in the study area, coastal sources of flooding are considered to represent the dominant risk to infrastructure associated with the Project.

6.3.2 In general, coastal flooding will represent the worst case scenario. Therefore, mitigation of the risks associated with this source would also ensure that the Project is safe from fluvial sources of flooding and would not increase flood risk elsewhere.

6.3.3 As shown on Figure A17.3 in Appendix D, the proposed alignment of the gas distribution pipelines, brine pipeline and the 132kv Dual underground circuits crosses Main Rivers and Ordinary Watercourses. However, it is proposed to lay the pipelines sufficiently deep below channel beds and general ground levels such as to have no adverse impact on existing fluvial flood conditions.

6.3.4 Through changes in the topography of the ground, the proposed construction access roads and compounds have the potential to cause temporary increased fluvial flooding elsewhere. Therefore, to prevent increases in fluvial flood risk it is recommended that these areas are maintained at existing elevations. Although some general information is available (which confirms the location of the access roads and compounds) at this stage of the Project no detailed designs have been produced for the temporary works. Therefore, an assessment to confirm the impact of the proposed temporary works, on fluvial flooding, cannot be undertaken at this stage. If significant changes in topography were required, additional studies would be undertaken as part of the detailed design to ensure the proposed temporary works would have no adverse impact on existing fluvial flood conditions.

6.3.5 In the event of a significant fluvial flood during the construction of the pipelines and wellheads, there is a risk that excavated material could displace floodwater and therefore increase flood risk elsewhere. There is also a risk that stockpiles...
of excavated material could redirect fluvial floodwater onto land that would otherwise not be flooded. To prevent potential increases in flood risk elsewhere, it is recommended that any significant stockpiles of excavated material be located on land outside Flood Zone 3. It is understood that there are currently no detailed plans for the stockpile of excavated material. Therefore, if in detailed design it is confirmed that stockpiles of excavated material within Flood Zone 3 are unavoidable, then it is recommended that further assessments be undertaken in order to ensure that the proposed construction arrangements will have no adverse impact on existing fluvial flood conditions.

6.3.6 Although there is a potential fluvial flood risk to the Project the mitigation of coastal flooding, which represents the worst case scenario, will ensure that the Project is safe from fluvial sources of flooding and would not increase flood risk elsewhere during the operational phase.

6.3.7 At this stage of the Project no detailed designs have been produced for the temporary works and for the stockpile of excavated material. However, maintaining the temporary works at existing ground levels and stockpiling of excavated material outside Flood Zone 3 would ensure that there would be no adverse temporary impact on existing fluvial flood conditions. If significant changes in topography and the stockpiling of excavated material within Flood Zone 3 were unavoidable, further studies would be undertaken in detailed design, to ensure that the proposed temporary works will have no adverse impact on existing fluvial flood conditions.

6.4 Groundwater

6.4.1 The Soil Map of England and Wales (SSEW, 1983) has been reviewed in order to confirm the underlying ground conditions within the application boundary. The ground conditions are outlined in Table 6-1. This table confirms that there is a risk of groundwater flooding within the application boundary, however flooding from this source would likely be restricted to boggy/saturated ground conditions or shallow depths of standing water.

Table 6-1 Underlying Ground Conditions within Application Boundary

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>851b - Marine alluvium</td>
<td>Deep stoneless clayey or calcareous silty soils, mainly with a humose surface. Flat land. Groundwater controlled by ditches and pumps.</td>
</tr>
<tr>
<td>22 - Marine alluvium</td>
<td>Soils of variable texture flooded by high tides. Many are soft and unripened others, often on higher sites, are of sandy texture and are firm and ripened. Frequently calcareous.</td>
</tr>
<tr>
<td>711m - Reddish till</td>
<td>Slowly permeable seasonal waterlogged reddish fine loamy over clayey, fine loamy and clayey soils associated with fine loamy clayey soils with slowly permeable sub-soils and slight seasonal waterlogging.</td>
</tr>
<tr>
<td>572l - Reddish till</td>
<td>Reddish fine loamy over clayey soils with slowly permeable sub-soils and slight seasonal waterlogging. Some similar fine loamy soils and some slowly permeable seasonal waterlogged fine loamy over clayey</td>
</tr>
<tr>
<td>Classification</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>U - Unsurveyed</td>
<td>Mainly urban and industrial areas.</td>
</tr>
</tbody>
</table>

6.4.2 The specific groundwater flood risk to critical assets and the protection measures required are outlined in Table 6-2. The majority of the Project would not be adversely affected by high groundwater levels. However, it is recommended that critical infrastructure which cannot tolerate flooding, for example some of the assets associated with the GCC and the NTS Interconnector Metering Station, should be slightly raised (e.g. in the order of 300mm) above existing ground levels to ensure that these elements are not adversely impacted upon by high groundwater levels.

6.4.3 The existing substation at Stanah is owned by ENW. It is proposed to source the electricity supply for the Project from this substation. The existing substation may be affected by shallow groundwater flooding, due to the underlying nature of the ground. It is understood that the National Grid and ENW have installed or are in the process of installing flood defences at this location to protect existing electrical equipment. All infrastructure associated with the UGS at this location would generally be located underground and would be able to tolerate floodwater. New switchgear within the Stanah Substation building would be required. However, this would be installed, operated and maintained by ENW. Therefore, the switchgear does not form part of the DCO. As a precaution, in detailed design it is recommended that consultations are undertaken with ENW to ensure that the new switchgear is slightly elevated within the existing building so that there would be no significant risk of flooding of the new switchgear from groundwater.

6.4.4 With appropriate groundwater protection measures (e.g. vulnerable assets raised slightly above ground levels) in place, the risk of groundwater flooding to key infrastructure is considered to be low.

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Underlying Ground Conditions</th>
<th>Groundwater Flood Risk</th>
<th>Flood Protection Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gas Storage Caverns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Wellheads. Manual and emergency shutdown valves.</td>
<td>Marine alluvium</td>
<td>Yes</td>
<td>Not required - wellheads can be designed to accommodate flooding.</td>
</tr>
<tr>
<td>2</td>
<td>Water Washing Infrastructure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Seawater Pumping</td>
<td>Unsurveyed</td>
<td>None – groundwater</td>
<td>Not required</td>
</tr>
<tr>
<td>No</td>
<td>Description</td>
<td>Underlying Ground Conditions</td>
<td>Groundwater Flood Risk</td>
<td>Flood Protection Measures</td>
</tr>
<tr>
<td>----</td>
<td>-------------</td>
<td>-------------------------------</td>
<td>------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td></td>
<td>Station (pumps, telemetry housing)</td>
<td></td>
<td>flood risk is likely to be low due to existing drainage infrastructure and impermeable surfaces which will act as a barrier, preventing potential groundwater from inundating the site.</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Booster Pumping Station and Control Centre</td>
<td>Marine alluvium</td>
<td>Yes – shallow flooding may occur.</td>
<td>Raise individual assets which cannot tolerate flooding slightly above existing ground levels or tank individual assets to prevent groundwater flooding.</td>
</tr>
<tr>
<td>2.4</td>
<td>De-brining Facility</td>
<td>Marine alluvium</td>
<td>Yes – shallow flooding may occur.</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>GCC and Substation</td>
<td>Reddish till</td>
<td>Yes – shallow flooding may occur.</td>
<td>Raise individual assets which cannot tolerate flooding slightly above existing ground levels or tank individual assets to prevent groundwater flooding.</td>
</tr>
<tr>
<td>3.7</td>
<td>Interconnector Metering Station adjacent to National Grid Gas’s existing valve installation on Feeder 21</td>
<td>Raised bog peat</td>
<td>Yes – shallow flooding may occur.</td>
<td></td>
</tr>
<tr>
<td>3.8</td>
<td>Vent Stack and Fire Water Pond</td>
<td>Reddish till</td>
<td>Yes – shallow flooding may occur.</td>
<td>Not required – as asset can accommodate flooding.</td>
</tr>
<tr>
<td>4.1</td>
<td>Stanah Substation</td>
<td>Marine alluvium</td>
<td>Yes – shallow flooding may occur.</td>
<td>The existing substation is owned by ENW. It is understood that the National Grid and ENW have installed or are in the process of installing flood defences at this location to protect existing electrical equipment. All infrastructure associated with the UGS at this location would generally be located underground and would be able to tolerate floodwater. New switchgear within the Stanah Substation building would be required. However, this would</td>
</tr>
<tr>
<td>No</td>
<td>Description</td>
<td>Underlying Ground Conditions</td>
<td>Groundwater Flood Risk</td>
<td>Flood Protection Measures</td>
</tr>
<tr>
<td>----</td>
<td>--------------------------------------------------</td>
<td>------------------------------</td>
<td>------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>be installed, operated and maintained by ENW. Therefore, the switchgear does not form part of the DCO. As a precaution, in detailed design it is recommended that consultations are undertaken with ENW to ensure that the new switchgear is slightly elevated within the existing building so that there would be no significant risk of flooding of the new switchgear from groundwater.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Road Infrastructure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>New road from the A588 to the site (GCC)</td>
<td>Reddish till</td>
<td>Yes – shallow flooding may occur.</td>
<td>It has been confirmed that flooding of the access road would not prevent the safe operation of the UGS. Therefore, the raising of the access road above existing ground levels, to prevent groundwater flooding, is not required.</td>
</tr>
<tr>
<td>5.2</td>
<td>Haul roads within the site linking the access road to the main permanent structures and wellheads.</td>
<td>Reddish till/Marine alluvium</td>
<td>Yes – shallow flooding may occur.</td>
<td>Not required – minor roads can accommodate shallow flooding.</td>
</tr>
</tbody>
</table>

**6.5 Surface Water**

6.5.1 Impacts on surface water flood risk are typically associated with increases in coverage by impermeable surfaces/built development. The site at Preesall is currently under agricultural use (pasture and arable crops), with some isolated farms buildings, and a golf course at the northern edge. Surface water is predominantly drained via a system of land drainage ditches and watercourses.

6.5.2 The proposed Seawater Pumping Station adjacent to Fleetwood Docks is currently classed as brownfield (previously developed) land. Table 6-3
summarises the type of ground cover observed at the proposed locations of infrastructure.

### Table 6-3 Summary of Existing Ground Cover

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Existing Ground Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gas Storage Caverns</td>
<td>Permeable agricultural land</td>
</tr>
<tr>
<td>1.1</td>
<td>Wellheads. Manual and emergency shutdown valves.</td>
<td>Permeable agricultural land</td>
</tr>
<tr>
<td>2</td>
<td>Water Washing Infrastructure</td>
<td>Made ground - mixed permeability</td>
</tr>
<tr>
<td>2.1</td>
<td>Seawater Pumping Station (pumps, telemetry housing)</td>
<td>Made ground - mixed permeability</td>
</tr>
<tr>
<td>2.3</td>
<td>Booster Pumping Station and Control Centre</td>
<td>Permeable agricultural land</td>
</tr>
<tr>
<td>2.4</td>
<td>De-brining Facility</td>
<td>Permeable agricultural land</td>
</tr>
<tr>
<td>3</td>
<td>Gas Infrastructure</td>
<td>Permeable agricultural land</td>
</tr>
<tr>
<td>3.1</td>
<td>GCC and Substation</td>
<td>Permeable agricultural land</td>
</tr>
<tr>
<td>3.7</td>
<td>Interconnector Metering Station adjacent to National Grid Gas's existing valve installation on Feeder 21</td>
<td>Permeable/impermeable</td>
</tr>
<tr>
<td>3.8</td>
<td>Vent Stack and Fire Water Pond</td>
<td>Permeable agricultural land</td>
</tr>
<tr>
<td>4</td>
<td>Power Supply</td>
<td>Caravan park/existing substation compound – mixed permeability</td>
</tr>
<tr>
<td>4.1</td>
<td>Stanah Substation</td>
<td>Caravan park/existing substation compound – mixed permeability</td>
</tr>
<tr>
<td>5</td>
<td>Road Infrastructure</td>
<td>Generally permeable agricultural land</td>
</tr>
<tr>
<td>5.1</td>
<td>New road from the A588 to the site (GCC)</td>
<td>Generally permeable agricultural land</td>
</tr>
<tr>
<td>5.2</td>
<td>Haul roads would be provided within the site linking the access road to the main permanent structures and wellheads.</td>
<td>Permeable agricultural land</td>
</tr>
<tr>
<td>6</td>
<td>Security and Support Facility</td>
<td>Semi impermeable Brownfield land</td>
</tr>
<tr>
<td>6.1</td>
<td>Security and Support Facility</td>
<td>Semi impermeable Brownfield land</td>
</tr>
</tbody>
</table>

6.5.3 The Project is expected to slightly increase the area of impermeable surface coverage within the application boundary, with the associated potential for increases in existing rainfall runoff rates and volumes. In order to help maintain or reduce existing surface water runoff rates it is proposed to use, where
possible, permeable surfaces and other Sustainable Drainage Systems (SUDS) techniques in areas where hard standing surfaces are proposed.

6.5.4 The EA have confirmed (Letter dated 22 July 2011, Appendix B) that in general, any increase in impermeable surfaces would need to be mitigated by restricting the run off to the Greenfield run off rate. However, due to the close proximity to the tidal estuary the EA have confirmed that they would allow the discharge of surface water directly to the estuary at rates higher than the existing runoff rates.

6.5.5 The use of SUDS techniques both during construction and operational phases would also ensure that any contaminated surface water is prevented from entering the receiving water environment.

6.5.6 It is recommended that an adequate surface water drainage system be constructed and maintained, which ensures that surface runoff rates are appropriately managed. With the implementation of an adequate surface water drainage system, the risk of flooding from surface water is considered negligible.

6.5.7 In order to ensure that surface runoff rates are appropriately managed, it is recommended that the IPC condition the DCO on the requirement to develop a surface water drainage strategy for the Project which would need to be agreed at the detailed design stage.

6.5.8 With the implementation of a suitable surface water drainage strategy, there should be no significant risk to proposed infrastructure from surface water flooding. The surface water drainage strategy would ensure that surface water runoff is effectively managed within the application boundary and that there will be no increase in third party flood risk.
7 COASTAL FLOOD RISK ASSESSMENT

7.1 Flood Zone Maps

7.1.1 The EA Flood Zone maps (Figure A17.2), which show areas of predicted coastal and fluvial flooding ignoring the presence of existing defences, are provided in Appendix C. These Flood Zones form the basis of the sequential approach to planning the location of development and making a high level assessment of flood risk.

7.1.2 Table 7-1 outlines key infrastructure located within the three Flood Zones. The table also confirms whether the infrastructure is vulnerable to floodwater (i.e. if flooding would cause damage and failure of the asset) and if there are existing defences that would provide a degree of protection to the infrastructure.

Table 7-1 Vulnerability of Infrastructure to Coastal Flooding

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Flood Zone Category</th>
<th>Vulnerable to Floodwater</th>
<th>Defended</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gas Storage Caverns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Wellheads. Manual and emergency shutdown valves.</td>
<td>3 (High)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Water Washing Infrastructure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Seawater Pumping Station (pumps, telemetry housing)</td>
<td>1 (Low)</td>
<td>Yes</td>
<td>N/A 1</td>
</tr>
<tr>
<td>2.2</td>
<td>Buried pipeline from the west bank of the Wyre Estuary to the Preesall site</td>
<td>1/2/3 (Low, Medium, High)</td>
<td>No</td>
<td>In some places 2</td>
</tr>
<tr>
<td>2.3</td>
<td>Booster Pumping Station and Control Centre</td>
<td>1 (Low)</td>
<td>Yes</td>
<td>N/A 1</td>
</tr>
<tr>
<td>2.4</td>
<td>De-brining Facility</td>
<td>1 (Low)</td>
<td>Yes</td>
<td>N/A 1</td>
</tr>
<tr>
<td>2.5</td>
<td>Brine pipeline from the west bank of the Wyre Estuary, to the seawall at West Way</td>
<td>1/2/3 (Low, Medium, High)</td>
<td>No</td>
<td>N/A 2</td>
</tr>
<tr>
<td>2.6</td>
<td>Brine discharge pipeline seawall crossing</td>
<td>3 (High)</td>
<td>No</td>
<td>N/A 2</td>
</tr>
<tr>
<td>2.7</td>
<td>Air vent</td>
<td>2 (Medium)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Gas Infrastructure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>GCC and Substation</td>
<td>1/2/3 (Low, Medium, High)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3.2</td>
<td>Gas distribution pipelines</td>
<td>3 (High)</td>
<td>No</td>
<td>N/A 2</td>
</tr>
<tr>
<td>3.3</td>
<td>Manifolds connecting the wellheads to the GCC</td>
<td>3 (High)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>3.4</td>
<td>Gas pipeline which links the GCC to</td>
<td>1/2/3 (Low, Medium, High)</td>
<td>No</td>
<td>N/A 2</td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
<td>Flood Zone Category</td>
<td>Vulnerable to Floodwater</td>
<td>Defended</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>--------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>3.5</td>
<td>National Grid Gas pipeline connection at feeder 15</td>
<td>1 (Low)</td>
<td>No</td>
<td>N/A ¹</td>
</tr>
<tr>
<td>3.6</td>
<td>National Grid Gas pipeline connection at feeder 21</td>
<td>1/2/3 (Low, Medium, High)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>3.7</td>
<td>Interconnector Metering Station adjacent to National Grid Gas’s existing valve installation on Feeder 21</td>
<td>1/2/3 (Low, Medium, High)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3.8</td>
<td>Vent Stack and Fire Water Pond</td>
<td>3 (High)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Power Supply</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Stanah Substation</td>
<td>3 (High)</td>
<td>Yes³</td>
<td>Yes</td>
</tr>
<tr>
<td>4.2</td>
<td>132kv Dual underground circuits</td>
<td>1/2/3 (Low, Medium, High)</td>
<td>No</td>
<td>N/A²</td>
</tr>
<tr>
<td>5</td>
<td>Road Infrastructure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>New road from the A588 to the site (GCC)</td>
<td>1/2/3 (Low, Medium, High)</td>
<td>No⁴</td>
<td>Yes</td>
</tr>
<tr>
<td>5.2</td>
<td>Haul roads within the site linking the access road to the main permanent structures and wellheads</td>
<td>1/2/3 (Low, Medium, High)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>Security and Support Facility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>Security and Support Facility</td>
<td>1 (Low)</td>
<td>Yes</td>
<td>N/A ¹</td>
</tr>
</tbody>
</table>

Note.

1. Infrastructure is located in Flood Zone 1 (Low probability of flooding).

2. Infrastructure not vulnerable to floodwater. Therefore, existing defences are of no consequence to the proposed infrastructure.

3. All infrastructure associated with the UGS at this location would generally be located underground and would be able to tolerate floodwater. New switchgear within the Stanah Substation building would be required. However, this would be installed, operated and maintained by ENW. Therefore, the switchgear does not form part of the DCO.

An emergency backup power supply will be provided within the GCC in case the Stanah Substation was to fail in a flood event. Although this would not provide operational power, it would provide emergency back-up power for the safe shutdown of the facility and for use by emergency services.

As a precaution, in detailed design it is recommended that consultations are undertaken with ENW to ensure that the new switchgear and the substation...
has a highest level of flood protection to ensure that there was a robust high integrity electricity supply.

4. It has been confirmed that shallow flooding of the access roads would not prevent the safe operation of the UGS.

7.2 Development Vulnerability

7.2.1 The proposed type of development is classified as Essential Infrastructure in PPS25. However, although not classified as Water Compatible some of the infrastructure proposed, such as pipelines and the wellheads, can accommodate floodwater (i.e. floodwater would not cause damage to the infrastructure and the prevention of supplies of gas to the National Grid from the Project).

7.3 Existing Flood Defences

7.3.1 The existing formal flood defences within the study area are shown on Figure A17.2 in Appendix C. Due to the risk of regular flooding, much of the land inward of the River Wyre Estuary is defended by formal and a few informal structures.

7.3.2 It has previously been reported (Mott MacDonald, 2005) that the earth bund that provides protection to land on the eastern side of the Estuary has a crest height of between 6.6m AOD and 7.1m AOD. EA information provided for this study indicates the defence ranges in height between 6.74m AOD to 7.30m AOD. However, topographical survey information (for 2009) that has been reviewed in this study indicates that the minimum level of the crest of the earth bund may be as low as 6.3m AOD. As part of the study a site walkover was undertaken in the area of the low spot identified from the survey data. However, no clear evidence for the low spot or recent works undertaken to increase the height of the crest at this location were identified.

7.3.3 Defences are also located on the west bank of River Wyre. Although the EA has provided some information on the condition of the defences adjacent to the Fish Dock no information has been provided on the height of the defences. Once the DCO has been granted it is recommended that further data and assessment is undertaken to confirm the level of flood protection provided by the defences at this location. This would support the identification of appropriate construction arrangements in detailed design and development of a Flood Management and Evacuation Plan (FMEP) to manage the residual flood risk over the lifetime of the UGS.
7.3.4 Flood defences are also located along the coast between Fleetwood and Cleveleys. It is understood that these defences are maintained by Wyre Borough Council. Figure 7-1 shows the existing coastal defences at the proposed location of the brine discharge pipeline where it would cross the seawall. As confirmed by the EA, at this location the defences have a crest level of between 7.8m AOD and 8.3m AOD and have been assessed to be in good condition.

7.3.5 The existing defences within the study area will provide a degree of protection to assets located within Flood Zone 3 such as the Stanah Substation, eastern end of the GCC, wellheads and access roads on the Preesall site. The level of protection provided by these defences is outlined in Section 7.6.

7.4 The Impact of the Development on Existing Flood Defences

7.4.1 The Project includes the installation of pipelines beneath existing coastal flood defences on the eastern side of the River Wyre Estuary and at West Way on the coast between Fleetwood and Cleveleys.

7.4.2 The river crossing would consist of four directionally drilled boreholes: one for the seawater passing from the seawater pump station; one for the returning brine; one for power, communications, controls and ancillary uses, leaving one in reserve. These will be formed by directionally drilling boreholes from the West Bank, at sufficient depth to minimise the environmental impact. The pipelines will be a minimum of 8 metres below the bed of the river to ensure that the existing silt, sediments and flood defences are not disturbed. This would also facilitate the upgrade of the existing defences in the future. Once the DCO has been granted, and as part of the detailed design, it is proposed to undertake further studies to confirm that the integrity of existing flood defences would not be adversely impacted and full cross sectional profiles will be produced to support an EA Flood Defence Consent application.
Defences between Fleetwood and Cleveleys

7.4.3 As shown in Figure 7-2, in order to install the brine discharge pipeline, modifications to the sea wall at West Way would be required. These would include construction of a new observation platform. The existing standard of flood protection provided by the sea defences at this location would be maintained both during the construction and operational phases of the Project.

Figure 7.2 Proposed Configuration of the Seawall at the Location of the Brine Discharge Pipeline

7.4.4 Due to the proposal for the construction of an observation platform, an open cut method, rather than a directional drilling method, has been selected for the installation of the brine discharge pipeline through the existing defence at this location.

Defences on the Eastern side of the River Wyre Estuary

7.4.5 The creation of the gas storage caverns has the potential to cause subsidence. This may lead to a reduction in the existing crest height of the earth bund on the east side of the River Wyre Estuary. A reduction in the crest height could potentially increase the frequency and extent of flooding within the defended floodplain.

7.4.6 A comprehensive re-assessment of the geological conditions has been undertaken to support the UGS (Mott MacDonald, 2011). In the subsidence assessment a twofold approach to predicting subsidence was adopted, reflecting the difference between subsidence as a result of the existing brine field and subsidence from the construction of new caverns.

Existing Subsidence

7.4.7 This report confirmed that to date, the precise levelling data shows no evidence of anomalous on-going local or area-wide subsidence suggesting that the existing brinefield and mine workings are at or close to equilibrated stable conditions. As a result it is understood that there is likely to be no reduction in
the crest height of the existing defences due to subsidence from historical workings.

**Future Subsidence**

7.4.8 With the construction of the new caverns a maximum aerial subsidence rate in the order of 2mm/yr has been estimated. As the rate at which the crest of the flood defences may reduce in height, due to subsidence resulting from the creation of the new caverns, is relatively low the crest can be closely monitored over the lifetime of the Project and beyond. The monitoring would enable appropriate and timely remedial works to be undertaken in order to maintain the existing standard of protection.

7.4.9 Subsidence also has the potential to cause sections of the earth bund to fail. Failure of the earth bund would lower the performance of the defence and increase the probability of flooding of land behind the defence. Regular structural surveys of the earth bund, throughout the lifetime of the Project and beyond, would ensure that any potential loss of performance was identified early, in order to implement remedial works to maintain the existing standard of protection.

7.4.10 Further investigations to confirm the potential for subsidence, as well as its impact on crest heights and the potential to cause defence failure, are required once the DCO has been granted. In the worst case scenario a commitment from the developer may be required to ensure that the existing standard of performance of the defences (e.g. existing defence crest heights) will be maintained over the long-term. Information on the proposed defence monitoring programme is provided in Section 8.5.

7.5 **Climate Change**

7.5.1 With reference to EA guidance, climate change allowances have been calculated according to Table B.1 in Annex B in PPS25. The predicted rises in sea levels as a result of climate change are presented in Table 7-2. In the assessment of climate change, it has been assumed that the tidal flood levels provided by the EA are relevant to the year 2008.

<table>
<thead>
<tr>
<th>Period of Time</th>
<th>3 year (2016)</th>
<th>8 year (2021)</th>
<th>40 year (2056)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustment to baseline</td>
<td>20mm</td>
<td>32.5mm</td>
<td>42.5mm</td>
</tr>
<tr>
<td>date (2008-2025 at 2.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mm/yr)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025-2055 (7.0mm/yr)</td>
<td>0</td>
<td>0</td>
<td>210mm</td>
</tr>
<tr>
<td>2055-2085 (10.0mm/yr)</td>
<td></td>
<td>10.0mm</td>
<td></td>
</tr>
<tr>
<td>Cumulative increment</td>
<td>20mm</td>
<td>32.5mm</td>
<td>262.5mm</td>
</tr>
</tbody>
</table>

7.5.2 The latest climate change projections for the UK are detailed in UKCP09. These climate change predictions have recently been published (September 2011)
This report confirms that the latest advice should be applied to all future appraisals that are started (new) from August 2011 or are to be submitted for approval after 1 January 2012. However, an assessment has been undertaken, using the latest advice, which confirms the cumulative increment outline in Table 7-2 would increase by a further 12mm for 2016, 19.5mm for 2021 and 46.5mm for 2056. As these increases are relatively small they would not have a significant impact on flood risk predictions within the study area and therefore the overall findings of this study.

### 7.6 EA Predicted Flood Conditions

#### 7.6.1 The EA Central Tidal Study (EA, 2008) provides flood predictions for the coast at Fleetwood and within the Wyre Estuary. These predictions, which have been used by the EA to derive the Flood Zone maps, are outlined in Table 7-3. Flood levels have been estimated for 2016, 2021 and 2056 by uplifting the predicted 2008 flood level to take into account sea level rise due to climate change. The relationship between the EA 2008 and 2115 predictions supports the method of estimation that has been adopted by Hyder.

In February 2011, the EA published a report on the Coastal Flood Boundaries for the UK Mainland and Islands (EA, 2011). In this report revised flood level estimates were provided for the coastline at Fleetwood. However, no new revised flood level estimates were provided within the Wyre Estuary. Where flood level estimates of the two studies coincide; it has been identified that the 1 in 200 year sea level has increased by approximately 100mm to 200mm.

To date the EA have not revised their Flood Zone maps to take into account the predicted increase in flood levels. The predicted increase is similar in magnitude to the difference between the EA Central Tidal Study estimated 1 in 200 year and 1 in 1000 year flood levels (i.e. in the order of 200mm to 300mm). Therefore, if the EA Central Tidal Study was to be revisited using the new flood level estimates for the coastline at Fleetwood, the revised Flood Zone 3 would be very similar in extent to the existing EA Flood Zone 2.

The increase in flood predictions is within the general limits of uncertainty and therefore supports the inclusion of a standard freeboard allowance of 330mm for all critical infrastructure/assets (which cannot tolerate flooding) proposed as part of the UGS.
Table 7-3 Predicted Floodwater Levels

<table>
<thead>
<tr>
<th>Location</th>
<th>EA Node</th>
<th>1 in 200 year (2008)</th>
<th>1 in 200 year (2016)*</th>
<th>1 in 200 year (2021)*</th>
<th>1 in 200 year (2056)*</th>
<th>1 in 200 year (2115)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coast between Fleetwood and Cleveleys</td>
<td>Tidal 01</td>
<td>6.08</td>
<td>6.10</td>
<td>6.11</td>
<td>6.34</td>
<td>6.98</td>
</tr>
<tr>
<td>Wyre Estuary to the north of the UGS</td>
<td>Tidal 05</td>
<td>6.40</td>
<td>6.42</td>
<td>6.43</td>
<td>6.66</td>
<td>7.31</td>
</tr>
<tr>
<td>Wyre Estuary to the south of the UGS</td>
<td>Tidal 06</td>
<td>6.40</td>
<td>6.42</td>
<td>6.43</td>
<td>6.66</td>
<td>7.30</td>
</tr>
<tr>
<td>Main site of the infrastructure for the UGS</td>
<td>Tidal 08</td>
<td>6.22</td>
<td>6.24</td>
<td>6.25</td>
<td>6.48</td>
<td>7.09</td>
</tr>
<tr>
<td>Wyre Estuary adjacent to Stanah Substation</td>
<td>Tidal 07</td>
<td>6.41</td>
<td>6.43</td>
<td>6.44</td>
<td>6.67</td>
<td>7.31</td>
</tr>
</tbody>
</table>

*Note - Hyder estimated flood level

7.7 Assessment Findings

7.7.1 Comparing the EA 2008 predicted flood levels and defence levels indicates that the coastal defences at Fleetwood will provide protection of the land adjacent to the seawall at West Way to 2115. Therefore, provided that adequate temporary defences are in place at the seawall crossing, there would be no significant risk of coastal flooding during the construction of the pipeline at this location.

7.7.2 For the Preesall site, the EA 2008 predicted flood levels and reported defence levels indicate that the defences on the eastern side of the Wyre Estuary will protect the land to a 1 in 200 year standard over the full lifetime of the Project (2056). However, topographical data reviewed as part of this FRA indicates that the defence crest may be as low as 6.3m AOD in a localised spot. If this level is confirmed there may be potential for overtopping of the defence during the construction and operational phase. Investigations that have been undertaken have indicated that the EA undefended flood levels within the Wyre Estuary (as reported in Table 7-3) would not be significantly higher (i.e. in the order of +3cm) with the defences in place.

7.7.3 It is proposed to generally locate key assets vulnerable to flooding at a minimum elevation of 7m AOD. As a result the proposed critical assets associated with the proposed UGS would be robust in terms of managing the inherent uncertainty in sea level predictions. Non critical assets located within Flood Zone 3 or 2, such as the wellheads, would be able to withstand inundation as a result of overtopping of the defences. As a result, apart from individual assets which cannot tolerate flooding, within the existing Stanah substation, the GCC and the Interconnector Metering Station, the potential overtopping of the defence has no major consequences for the Project although appropriate emergency plans and procedures would need to be put in place to manage this risk.

7.7.4 The GCC is proposed on land within Flood Zone 1, 2 and 3. It is currently proposed to lower the existing profile of the land within the GCC, with ground
linearly sloping up from 5.0mAOD on the east side to 6.5mAOD on the west side. Two visual bunds (ranging in height from 11mAOD to 14mAOD) are proposed on the north and south sides of the GCC to conceal the plant and equipment on the compound, when viewed from the Wyre Way and/or Cote Walls Farm. It is understood that all assets within the GCC which cannot tolerate flooding would be located on the western side of the GCC, at a minimum elevation of 7mAOD.

7.7.5 A visual bunding screen has been proposed around the wellheads. Access routes through the bunds will enable the inundation of the wellheads in significant flood events which will minimise the displacement of floodwater.

7.7.6 The visual bunding proposed around the wellheads and the GCC has the potential to displace floodwater. However, compensation floodwater storage would be provided within the GCC as a result of the proposed ground lowering. Further, information on the potential displacement of floodwater and the compensation floodwater storage that will be provided is outlined in Section 8.2.

7.7.7 As discussed in Section 7.3, as part of the detailed design further data and studies will be undertaken to confirm the level of flood protection provided by the defences located adjacent to the existing Stanah Substation. All infrastructure associated with the UGS at this location would generally be located underground and would be able to tolerate floodwater. New switchgear within the Stanah Substation building would be required. However, this would be installed, operated and maintained by ENW. Therefore, the switchgear does not form part of the DCO.

7.7.8 An emergency backup power supply will be provided within the GCC in case the Stanah Substation was to fail in a flood event. Although this would not provide operational power, it would provide emergency back-up power for the safe shutdown of the facility and for use by emergency services.

7.7.9 As a precaution, in detailed design it is recommended that consultations are undertaken with ENW to ensure that the new switchgear and the substation has a highest level of flood protection to ensure that there was a robust high integrity electricity supply.

7.7.10 Although there is a potential coastal flood risk to the Project, all key assets proposed as part of the DCO which are not able to tolerate flooding will be located outside the high flood risk zone. Assessment using currently available data indicates that there will be no increase in coastal flood risk to third parties provided appropriate compensation storage is incorporated within the Project.

7.8 Shoreline Management Plan

7.8.1 The Shoreline Management Plan for the study area (www.mycoastline.org) shows that the majority of the Project infrastructure is located in a ‘Hold the Line’ policy area. This means that in this area the EA will continue to maintain existing defences.
7.8.2 To the north of the Gas Storage Facility in the vicinity of the Knott End Golf course a ‘No Active Intervention’ policy is in place, whereby the shoreline is allowed to continue to evolve under natural processes. In terms of flood risk this ‘No Active Intervention’ policy is unlikely to have an impact on Project infrastructure as the land behind the defence is shown to be located within Flood Zone 1 (low probability of flooding).

7.8.3 As outlined in Section 7.1 no assets proposed as part of the DCO that cannot accommodate floodwater are proposed within Flood Zone 3. The existing defences are not required for the operation of the Project over its 40 year lifetime as key assets which cannot tolerate flooding would be set at a minimum elevation of 7mAOD.

7.8.4 As all above ground assets within Flood Zone 3 are located behind defences, the potential for undermining of the infrastructure through coastal erosion is not considered to be significant. However, in detailed design (once the DCO has been granted) further studies would be undertaken to confirm the potential for coastal erosion over the lifetime of the Project.

7.9 Construction Phase

7.9.1 Through changes in the topography of the ground, the proposed construction access roads and compounds have the potential to cause temporary increased coastal flooding elsewhere. Therefore, to prevent increases in coastal flood risk it is recommended that these areas are maintained at existing elevations. Although some general information is available (which confirms the location of the access roads and compounds) at this stage of the Project no detailed designs have been produced for the temporary works. Therefore, an assessment to confirm the impact of the proposed temporary works, on coastal flooding, cannot be undertaken at this stage. If significant changes in topography were required, additional studies would be undertaken as part of the detailed design to ensure the proposed temporary works will have no adverse impact on existing coastal flood conditions.

7.9.2 In the event of a significant coastal flood and overtopping of existing defences during the construction of the pipelines and wellheads, there is a risk that excavated material could displace floodwater and therefore increase flood risk elsewhere. There is also a risk that stockpiles of excavated material could redirect coastal floodwater onto land that would otherwise not be flooded. To prevent potential increases in flood risk elsewhere, it is recommended that any significant stockpiles of excavated material be located on land outside Flood Zone 3. It is understood that there are currently no detailed plans for the stockpile of excavated material. Therefore, if in detailed design it is confirmed that stockpiles of excavated material within Flood Zone 3 are unavoidable, then it is recommended that further assessments be undertaken in order to ensure that the proposed construction arrangements will have no adverse impact on existing coastal flood conditions during overtopping events.
# DEVELOPMENT IMPLICATIONS

## 8.1 Overview

8.1.1 Table 8-1 provides a detailed summary of the implications of the identified flood risk status of the study area on current development proposals.

**Table 8-1 Development Implications**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Flood Zone</th>
<th>Flood Risk Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Gas Storage Caverns</td>
<td></td>
<td>None - infrastructure can accommodate flooding. Except for the visual bunds the wellheads would be built at or below existing ground levels to ensure no increase in third party flood risk due to floodwater displacement. Further information is provided in Section 8.2 to demonstrate how additional floodwater storage would be provided within the GCC to compensate for the potential displacement of floodwater.</td>
</tr>
<tr>
<td>1.1</td>
<td>Wellheads. Manual and emergency shutdown valves.</td>
<td>3 (High)</td>
<td>None - infrastructure can accommodate flooding. Except for the visual bunds the wellheads would be built at or below existing ground levels to ensure no increase in third party flood risk due to floodwater displacement. Further information is provided in Section 8.2 to demonstrate how additional floodwater storage would be provided within the GCC to compensate for the potential displacement of floodwater.</td>
</tr>
<tr>
<td>2.</td>
<td>Water Washing Infrastructure</td>
<td></td>
<td>None - buried infrastructure</td>
</tr>
<tr>
<td>2.1</td>
<td>Seawater Pumping Station (pumps, telemetry housing)</td>
<td>1 (Low)</td>
<td>None – infrastructure located within Flood Zone 1</td>
</tr>
<tr>
<td>2.2</td>
<td>Buried pipeline from the west bank of the Wyre Estuary to the Preesall site</td>
<td>1/2/3 (Low, Medium, High)</td>
<td>None - buried infrastructure</td>
</tr>
<tr>
<td>2.3</td>
<td>Booster Pumping Station and Control Centre</td>
<td>1 (Low)</td>
<td>None – infrastructure located within Flood Zone 1</td>
</tr>
<tr>
<td>2.4</td>
<td>De-brining facility</td>
<td>1 (Low)</td>
<td>None – infrastructure located within Flood Zone 1</td>
</tr>
<tr>
<td>2.5</td>
<td>Brine discharge pipeline from the west bank of the Wyre Estuary, to the seawall at West Way</td>
<td>1/2/3 (Low, Medium, High)</td>
<td>Generally none as mainly buried infrastructure. However, the pipeline crosses a Main River at NGR 331,951: 445,501. The pipeline also crosses Ordinary Watercourses/land drainage ditches. However, it is proposed to lay the pipelines sufficiently deep below channel beds and general ground levels such as to have no adverse impact on existing flood conditions.</td>
</tr>
<tr>
<td>2.6</td>
<td>Brine discharge pipeline seawall crossing</td>
<td>3 (High)</td>
<td>The construction of the pipeline through the seawall has the potential to reduce the existing standard of protection, which could increase third party flood risk. Scheme design will maintain the existing standard of flood protection.</td>
</tr>
<tr>
<td>2.7</td>
<td>Air vent</td>
<td>2</td>
<td>None – located in Flood Zone 2. The air vent will</td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
<td>Flood Zone</td>
<td>Flood Risk Implications</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------------------------</td>
<td>--------------------</td>
<td>-------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium</td>
<td>be a small feature approximately 150mm in diameter with an automatic valve. The piped air vent will be located well above existing ground levels.</td>
</tr>
<tr>
<td>3.</td>
<td>Gas Infrastructure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 3.1 | GCC and Substation                               | 1/2/3 (Low, Medium, High) | The GCC is proposed on land within Flood Zone 1, 2 and 3. It is currently proposed to lower the existing profile of the land within the GCC, with ground linearly sloping up from 5.0mAO
d on the east side to 6.5mAO
d on the west side. Two visual bunds (ranging in height from 11mAO
d to 14mAO
d) are proposed on the north and south sides of the GCC to conceal the plant and equipment on the compound, when viewed from the Wyre Way and/or Cote Walls Farm. It is understood that all assets within the GCC, which cannot tolerate flooding, would be located on the western side of the GCC, at a minimum elevation of 7mAO
d. The visual bunds have the potential to displace floodwater. Further information is provided in Section 8.2 to demonstrate how additional floodwater storage would be provided within the GCC to compensate for the potential displacement of floodwater. |
<p>| 3.2 | Gas distribution pipelines                       | 3 (High)           | Generally none as the pipeline is mainly buried infrastructure. The gas distribution pipeline will cross a Main River at NGR 335,204: 446,643. The pipeline also crosses a large number of Ordinary Watercourses/land drainage ditches. These crossings have the potential to impact on third party flood risk. However, it is proposed to lay the pipelines sufficiently deep below channel beds and general ground levels such as to have no adverse impact on existing flood conditions. |
| 3.3 | Manifolds connecting the wellheads to the GCC    | 3 (High)           | None - infrastructure can accommodate flooding. Infrastructure should be built at existing ground level to ensure no increase in third party flood risk due to floodwater displacement. |
| 3.4 | Gas pipeline which links the GCC to the National Grid | 1/2/3 (Low, Medium, High) | The gas pipeline crosses Main Rivers at the following locations: NGR 336,832: 445,906; NGR 337,103: 446,033; NGR 337,706: 446,173; NGR 341,192:446,632; NGR 344,092: 446,543. The pipeline also crosses a large number of Ordinary Watercourses/land drainage ditches. These crossings have the potential to impact on third... |</p>
<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Flood Zone</th>
<th>Flood Risk Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 (Low)</td>
<td>party flood risk. However, it is proposed to lay the pipelines sufficiently deep below channel beds and general ground levels such as to have no adverse impact on existing flood conditions.</td>
</tr>
<tr>
<td>3.5</td>
<td>National Grid Gas pipeline connection at feeder 15</td>
<td>1 (Low)</td>
<td>None - within Flood Zone 1. At the connection point there will be a shut-down valve under National Grid Gas control.</td>
</tr>
<tr>
<td>3.6</td>
<td>National Grid Gas pipeline connection at feeder 21</td>
<td>1/2/3 (Low, Medium, High)</td>
<td>The majority of the site is positioned within Flood Zone 1. Therefore, there are no significant fluvial and coastal flood risk issues. Some of the land bordering the boundary of the compound is potentially within Flood Zone 2 and 3. It is understood that all assets that cannot tolerate flooding at this location would be located within Flood Zone 1. At the connection point there will be a shut-down valve under National Grid Gas control.</td>
</tr>
<tr>
<td>3.7</td>
<td>Interconnector Metering Station adjacent to National Grid Gas’s existing valve installation on Feeder 21</td>
<td>3 (High)</td>
<td>The site is positioned in Flood Zone 3. It is understood that the infrastructure can accommodate flooding. Therefore it is recommended that the Infrastructure should be built at or below existing ground levels to ensure no increase in third party flood risk due to floodwater displacement.</td>
</tr>
<tr>
<td>3.8</td>
<td>Vent Stack and Fire Water Pond</td>
<td>3 (High)</td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Stanah Substation</td>
<td>3 (High)</td>
<td>As part of the detailed design further data and studies will be undertaken to confirm the level of flood protection provided by the defences located adjacent to the existing Stanah Substation. All infrastructure associated with the UGS at this location would generally be located underground and would be able to tolerate floodwater. New switchgear within the Stanah Substation building would be required. However, this would be installed, operated and maintained by ENW. Therefore, the switchgear does not form part of the DCO. An emergency backup power supply will be provided within the GCC in case the Stanah Substation was to fail in a flood event. Although this would not provide operational power, it would provide emergency back-up power for the safe shutdown of the facility and for use by emergency services. As a precaution, in detailed design it is recommended that consultations are undertaken.</td>
</tr>
</tbody>
</table>
4.2 132kv Dual underground circuits

with ENW to ensure that the new switchgear and the substation has a highest level of flood protection to ensure that there was a robust high integrity electricity supply.

The dual underground circuits cross Main Rivers at the following locations: NGR 335,204: 446,643; NGR 36,190: 445,708; NGR 335,616: 444,907; NGR 335,197: 443,214. The pipeline also crosses a large number of Ordinary Watercourses/land drainage ditches. These crossings have the potential to impact on third party flood risk, therefore further assessment is required.

5. Road Infrastructure

5.1 New road from the A588 to the site (GCC)

Continuous safe access to the UGS under flood conditions is not critical to the supply of gas. Therefore, access roads linking this infrastructure will be built at existing ground levels to ensure no increase in third party flood risk due to floodwater displacement.

The proposed road crosses a Main River at NGR 336,832: 445,906. This crossing has the potential to impact on third party flood risk. Currently there are no detailed designs for the proposed crossing. Therefore, further studies will be undertaken as part of the detailed design, once the DCO has been granted, to ensure the access would not impact on third party flood risk.

5.2 Haul roads within the site linking the access road to the main permanent structures and wellheads.

Apart from the GCC all other infrastructure is either able to withstand flooding or is not critical to the supply of gas during flood events. Therefore, access roads linking this infrastructure will be built at existing ground levels to ensure no increase in third party flood risk due to floodwater displacement.

6. Security and Support Facility

6.1 Security and Support Facility

None. Flood free access linking the security and support facility to Preesall will be made available via Monks Lane.

8.2 Third Party Impacts

8.2.1 Two visual bunds (ranging in height from 11mAOD to 14mAOD) are proposed on the north and south sides of the GCC to conceal the plant and equipment on
the compound. In addition isolated visual bunding screens have been proposed around the wellheads.

8.2.2 Access routes through the bunds will enable the inundation of the wellheads in significant flood events which will minimise the displacement of floodwater. The visual bunding proposed around the wellheads and the GCC has the potential to displace floodwater. However, compensation floodwater storage would be provided within the GCC as a result of the proposed ground lowering.

8.2.3 It is understood that in detailed design options would be investigated for the use of polystorm modular cells or other similar types of system which would allow floodwater to flow and be stored internally within the visual bunds. This would naturally result in a significant reduction in the volume of compensation storage required.

8.2.4 Conservative estimates of floodwater displacement (which do not take into account the storage provided internally within the bunds themselves through the use of the polystorm modular cells) and compensation, for the wellheads and GCC are provided in Table 8-2.

Table 8-2 Floodwater Displacement and Compensation Estimates

<table>
<thead>
<tr>
<th>Description</th>
<th>Flood Volume Loss (m³)</th>
<th>Flood Volume Gain (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wellhead 2 –Bund</td>
<td>920</td>
<td>-</td>
</tr>
<tr>
<td>Wellhead 3 –Bund</td>
<td>643</td>
<td>-</td>
</tr>
<tr>
<td>Wellhead 4 –Bund</td>
<td>2,059</td>
<td>-</td>
</tr>
<tr>
<td>Wellhead 5 –Bund</td>
<td>2,917</td>
<td>-</td>
</tr>
<tr>
<td>Wellhead 6 –Bund</td>
<td>472</td>
<td>-</td>
</tr>
<tr>
<td>Wellhead 7 –Bund</td>
<td>2,618</td>
<td>-</td>
</tr>
<tr>
<td>GCC - Bund</td>
<td>1,556</td>
<td>-</td>
</tr>
<tr>
<td>GCC</td>
<td>-</td>
<td>13,083</td>
</tr>
<tr>
<td><strong>Cumulative Total</strong></td>
<td><strong>11,195</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Net Gain</strong></td>
<td></td>
<td>1,888m³</td>
</tr>
</tbody>
</table>

Note: Flood volume loss and gain estimates have been derived to a maximum elevation of 6.48m AOD. This corresponds to the maximum predicted 1 in 200 year (2056) flood level within the main site of the UGS (Please see Table 7-3).

8.2.5 Even excluding the internal storage provided within the bunds, Table 8-2 confirms that there would be a net gain, of 1,888m³, in floodwater storage within the study area as a result of the proposed UGS. Due to the low lying and flat nature of the land between the existing defences on the western side of the River Wyre Estuary and the GCC the compensation storage is likely to become effective at a similar point in time as floodwater would be displaced by the visual bunds.

8.2.6 Further information on the estimated flood volumes is provided on Figure A17.2 in Appendix C.
8.2.7 Once the DCO has been granted, further studies will be undertaken in detailed design to confirm the exact configuration of visual bunds and the associated compensation storage scheme to compensate for the potential displacement of floodwater.

8.2.8 The provision of additional floodwater storage within the GCC will ensure that there would be no significant third party impacts as a result of the proposed visual bunds.

8.3 Sequential and Exception Tests

8.3.1 The Preesall site is a strategically important halite (rock) salt body in the UK due to its size and location. It is one of the few known suitable sites in the UK that can accommodate gas storage in salt caverns. Storage of gas within salt is restricted to areas like Preesall where the salt is sufficiently thick to create caverns. Further, the Preesall halite salt has been extensively investigated and geological surveys have found it to be ideally suited for storing gas. The depth of the Preesall salt bed is around 1,000 feet (300 metres), allowing gas to be stored at approximately the same pressure as the NTS, a network of gas pipelines across the UK, ensuring a fast and efficient flow of gas between the caverns and the NTS.

8.3.2 In its current proposed location and configuration critical infrastructure required for the provision of gas storage and distribution (e.g. parts of the GCC, and the Interconnector Metering Station) is located in areas with a low probability of flooding (Flood Zone 1). Other key infrastructure related to the construction of the caverns (Seawater Pumping Station, De-brining Facility, Booster Pumping Station and Control Centre) has also been located within Flood Zone 1.

8.3.3 The only critical asset located within an area with a high probability of flooding (Flood Zone 3) is the switchgear proposed within the existing Stanah Substation and parts of the GCC. However, both these areas of land are afforded flood protection by existing flood defences. Although parts of the GCC will be located within an area with a high probability of flooding (Flood Zone 3) it is understood that all vulnerable assets which could not tolerate flooding would be located on higher ground above 7mAOD.

8.3.4 A part of the detailed design further data and studies will be undertaken to confirm the level of flood protection provided by the defences located adjacent to the existing Stanah Substation. All infrastructure associated with the UGS at this location would generally be located underground and would be able to tolerate floodwater. New switchgear within the Stanah Substation building would be required. However, this would be installed, operated and maintained by ENW. Therefore, the switchgear does not form part of the DCO.

8.3.5 An emergency backup power supply will be provided within the GCC in case the Stanah Substation was to fail in a flood event. Although this would not provide operational power, it would provide emergency back-up power for the safe shutdown of the facility and for use by emergency services.

8.3.6 As a precaution, in detailed design it is recommended that consultations are undertaken with ENW to ensure that the new switchgear and the substation has
a highest level of flood protection to ensure that there was a robust high integrity electricity supply.

8.3.7 Other assets which are located within Flood Zone 3 include buried pipelines and wellheads, which can accommodate floodwater without damage to the operation of the facility. As demonstrated in Section 8.2 the only raised structures within Flood Zone 3 would be the minor visual bunds, however compensation storage would be provided within the GCC to mitigate the potential for the displacement of floodwater.

8.3.8 The study has therefore provided evidence that has demonstrated that the Project passes the Sequential Test.

8.3.9 The exception test has also been passed, for the proposed infrastructure located within Flood Zone 3, as it has been confirmed that there are no reasonable alternative sites on developable previously - developed land. In addition the UGS provides wider sustainability benefits and an FRA has been undertaken which has demonstrated that the UGS will be safe without increasing flood risk elsewhere.

8.4 Flood Management and Evacuation Plan (FMEP)

8.4.1 The FMEP will set out the flood emergency arrangements and provide information for responding to a flood during the construction and operation of the UGS. It is envisaged that the production of a site specific FMEP would form a DCO condition which would need to be discharged before the construction work takes place.

8.4.2 Whilst the potential risk of flooding to the UGS has been significantly reduced during the development process (by locating vulnerable assets within Flood Zone 1), it has not been entirely removed (e.g. the switchgear proposed within the Stanah Substation is located within Flood Zone 3). However, the switchgear would be installed, operated and maintained by ENW. Therefore, the switchgear does not form part of the DCO.

8.4.3 In order to manage the residual flood risk, a FMEP will be developed to ensure that the owners and occupiers of the UGS are prepared in the event of a flood emergency within the area.

8.4.4 The key aim of the FMEP will be to provide the operations of the UGS with clear indicators confirming when the set emergency procedures should be implemented and when the UGS should be evacuated. However, it is understood that continuous safe access to the UGS under flood conditions is not critical to the supply of gas as key parts of the UGS can be operated remotely. The FMEP will also provide key information for planning and responding to an evacuation.

8.4.5 At this stage it is envisaged that two types of trigger would be used within the FMEP to either implement a review of the FMEP procedures, place staff on a green alert (state of readiness) or issue a red alert (UGS evacuation/shutdown). The triggers are as follows:
8.5 Existing Flood Defence Monitoring Programme

8.5.1 An indicative programme for monitoring the standard of flood protection provided by key defences in the area is outlined in Table 8-3.

Table 8-3 Flood Defence Monitoring Programme

<table>
<thead>
<tr>
<th>Stage</th>
<th>Element</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Detailed Design Stage</td>
<td>In detailed design, once the DCO has been granted, additional studies will be undertaken to determine key flood defences that would need to be monitored in order to ensure that existing standard of performance of the defences will be maintained over the long-term. The studies would confirm the frequency and type of monitoring required.</td>
</tr>
<tr>
<td>2</td>
<td>Pre-Construction Stage</td>
<td>Prior to construction, the key defences would be surveyed and appropriate monitoring equipment installed.</td>
</tr>
<tr>
<td>3</td>
<td>UGS Construction and Operation</td>
<td>Throughout the construction and operation of the UGS the key defences will be monitored.</td>
</tr>
<tr>
<td>4</td>
<td>UGS Decommission</td>
<td>A restoration and management plan would be produced to ensure the long-term maintenance and safety of the caverns and the site. The restoration and management plan would outline a regime for monitoring the condition of key sections of existing flood defence embankment within the study area. This would ensure that there would be no long-term degradation in the existing standard of flood protection provided by the defences as a result of the UGS.</td>
</tr>
</tbody>
</table>

8.6 Planning Policies

8.6.1 The key planning policies relevant to the UGS in terms of development and flood risk are outlined in Table 8-4. The table also summarises how the policies have been addressed in the development of the FRA.

Table 8-4 Key Planning Policies

<table>
<thead>
<tr>
<th>Planning Policy</th>
<th>Details</th>
<th>Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wyre Borough Local Plan – ENV 13</td>
<td>Development in areas at direct risk from flooding will only be permitted where:-</td>
<td>An FRA has been undertaken to assess all sources of flooding to the UGS. Where required appropriate flood mitigation</td>
</tr>
<tr>
<td></td>
<td>a) it would not cause or exacerbate flooding in other areas; and</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planning Policy</td>
<td>Details</td>
<td>Addressed</td>
</tr>
<tr>
<td>----------------</td>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td></td>
<td>measures have been proposed to ensure the UGS would not cause or exacerbate flooding in other areas.</td>
<td></td>
</tr>
<tr>
<td>b) a satisfactory standard of flood protection already exists; or</td>
<td>The FRA has confirmed that all critical assets associated with the DCO, which cannot tolerate flooding, are located within Flood Zone 1.</td>
<td></td>
</tr>
<tr>
<td>c) mitigation measures will be included in a scheme.&quot;</td>
<td>Some mitigation measures have been proposed to ensure that there would be no increase in third party flood risk.</td>
<td></td>
</tr>
<tr>
<td>Wyre Borough Local Plan – ENV14</td>
<td>Development and flood defences</td>
<td>An indicative programme for monitoring the standard of flood protection provided by key defences in the area has been developed as part of the FRA. As a result the defences will be closely monitored over the lifetime of the Project and beyond. If potential subsidence problems are identified, appropriate studies would be undertaken and mitigation measures identified to ensure the existing standard of protection can be maintained over the long-term. The UGS will not prevent or hinder the access to either watercourses or the coast.</td>
</tr>
<tr>
<td></td>
<td>“Development will not be permitted where it would adversely affect the integrity and continuity of tidal and fluvial defences, or access arrangements to either watercourses or the coast for essential maintenance, or improvement and emergency purposes.”</td>
<td></td>
</tr>
<tr>
<td>Wyre Borough Local Plan – ENV15</td>
<td>surface water run off</td>
<td>With the implementation of a suitable surface water drainage strategy, surface water runoff would be effectively managed within the application boundary and there would be no increase in third party flood risk.</td>
</tr>
<tr>
<td></td>
<td>“Development which will generate increased rates of surface water run-off will not be permitted where it would lead to adverse impacts such as an increased risk of flooding, river channel instability, or damage to habitats. Developers will be expected to cover the cost of assessing surface water drainage impacts and any appropriate mitigation works, including long-term maintenance.”</td>
<td></td>
</tr>
</tbody>
</table>
9 FLOOD DEFENCE CONSENT

9.1.1 Under the terms of the Water Resources Act 1991 and the Land Drainage Byelaws, the prior written Consent of the EA is required for any proposed works or structures, in, under, over or within 8m of the top of bank of EA designated Main Rivers. The EA has a right of access to the River Wyre by virtue of Section 172 of the Water Resources Act 1991 and a right to carry out maintenance and improvement works by virtue of Section 165 of the same Act.

9.1.2 In addition any works to watercourses within the application boundary which involve the infilling, diversion, culverting or which otherwise may restrict the flow, require the prior formal consent of the EA under Section 23 of the Land Drainage Act 1991. The EA has confirmed that culverting other than for access purposes is unlikely to receive consent, without full mitigation for loss of flood storage and habitat.

9.1.3 During detailed design of the Project the EA would be fully consulted to confirm their requirements before the submission of applications for Flood Defence Consent.

9.1.4 As confirmed by the EA (letter dated 22 July 2011), Flood Defence Consent applications would need to be submitted for the proposed River Wyre Estuary crossing and the proposed modifications to the sea wall at West Way.

9.1.5 The Flood Defence Consent applications would include up-to-date habitat and species surveys of each and every watercourse crossing, identifying key features and in particular the presence of important and protected habitats and species. A detailed construction method statement for each crossing, designed to minimise the impact of the works, will be produced for agreement with the EA before any Flood Defence Consent is submitted.
10 ENVIRONMENT AGENCY REVIEW

10.1.1 In July 2011 an FRA (Hyder, 2011), was submitted to the EA for review. The FRA was submitted in order to confirm its suitability for informing the Environmental Statement and the application for the DCO. Following the review the EA confirmed, in their letter dated 22 July 2011 (CE/2010/104161/04-L01), that they had no objection to the FRA submitted. In the letter the EA provide five comments on the FRA which are outlined and discussed in Table 10-1.

Table 10-1 EA FRA Review Comments

<table>
<thead>
<tr>
<th>No.</th>
<th>EA Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Location in Flood Zone</strong></td>
<td>All operational and critical infrastructure should be located in Flood Zone 1 where possible.</td>
</tr>
<tr>
<td></td>
<td>All operational and critical infrastructure</td>
<td>All operational and critical infrastructure proposed within the DCO, which cannot tolerate flooding will be located within Flood Zone 1 as defined by the EA Flood Maps.</td>
</tr>
<tr>
<td></td>
<td>should be located in Flood Zone 1 where possible.</td>
<td>Please see Section 8 for further information.</td>
</tr>
<tr>
<td>2</td>
<td><strong>Surface Water Run Off</strong></td>
<td>You state within the FRA “Due to the close proximity to the tidal estuary there may be potential to discharge surface water to watercourses at rates higher than the existing runoff rates. However, further consultation with the EA is required to confirm the viability of this option” In response we can confirm that only water being discharged straight into the estuary will be allowed at unrestricted rates. Any increase in hard standing within the flood plain would need to be mitigated for by restricting the run off rates from site to the Greenfield run off rate. We would request that a surface water drainage strategy is required through condition of any permission.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Please see Section 6.4 for information.</td>
</tr>
<tr>
<td>3</td>
<td><strong>Flood Defences</strong></td>
<td>All works must not reduce the existing defence height in the area and a monitoring programme must be included with the planning application for the defences over the lifetime of the project.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Please see section 8.5 for an indicative programme.</td>
</tr>
<tr>
<td>No.</td>
<td>EA Comment</td>
<td>Response</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4</td>
<td><strong>Groundwater</strong></td>
<td>Groundwater flooding is only likely to occur where there is an aquifer or permeable substrate at the surface.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In Section 6.3 it has been confirmed that there is a risk of groundwater flooding within the application boundary, however flooding from this source would likely be restricted to boggy/saturated ground conditions or shallow depths of standing water. Although the risk of groundwater flooding is considered to be low, some precautionary measures are taken forward. Please see Section 6.3 for further information.</td>
</tr>
<tr>
<td>5</td>
<td><strong>Flood Defence Consent</strong></td>
<td>You would be required to apply for consent for the new ramp adjoining the sea defence and consent required for directional drilling under river bed. To enable this process we would like to arrange a site meeting to visualise exactly where each buildings/wells are proposed to be located.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Please see Section 9 for information on Flood Defence Consents.</td>
</tr>
</tbody>
</table>
11 RECOMMENDATIONS

11.1.1 Once the DCO has been granted further studies are required/recommended (during detailed design) in order to facilitate the Project. These studies comprise:

- Investigations into the use of polystorm modular cells or other similar types of system which would allow floodwater to flow and be stored internally within the visual bunds proposed as part of the UGS. The studies will also confirm whether additional floodwater storage is required within the GCC to compensate for any potential residual displacement of floodwater as a result of the visual bunds.
- Investigations are also required to identify appropriate construction arrangements to ensure that existing fluvial and coastal flood risk in the area would not be adversely impacted upon. It has not been possible to assess the construction arrangements at this stage of the Project as detailed designs for the construction arrangements have not been produced.
- Development of a surface water drainage strategy.
- As a precaution, in detailed design it is recommended that consultations are undertaken with ENW to ensure that the new switchgear (which does not form part of the DCO) and the existing Stanah Substation has a highest level of flood protection to ensure that there was a robust high integrity electricity supply.
- Investigations into the occurrence of subsidence, as a result of the construction of the caverns, and its impact upon existing defences.
- New topographical survey or site walkover in the area of the identified potential low spot on the crest of the existing earth bund on the East side of the Wyre Estuary. This information will be used to identify if any remedial works to the existing defence are required.
12 REFERENCES


Environment Agency (2011) Coastal Flood Boundaries for the UK Mainland and Island

Environment Agency (2008) Central Area Tidal Study


Soil Map of England and Wales.1983

Appendix A

Figure A17.1: Masterplan
Appendix B

Correspondence
Dear Sir/Madam

UNDERGROUND GAS STORAGE   PREESALL SALTFIELD, SALTMINE, WYRE ESTUARY, LANCASHIRE

For any information on flood levels, defence data etc. please forward your query on to Alicia Cottam at this email address nwnorthpreston@environment-agency.gov.uk please include a location plan and grid reference so it is easier for us to find the data you request.

Please find my below my comments on what I would like to see addressed within the FRA.

As the site is located within a tidal flood zone and the proposed development is located in close proximity to flood defences, we would like to request that the applicant undertakes a Flood Risk Assessment to cover the following issues:

1. Location and level of protection offered by flood defences in this area
2. Extent of the caverns relative to the location of any flood defence embankments
3. Likelihood of subsidence in caverns and how this might affect the embankments
4. Whether or not the entire length of the defence would compromised
5. Whether or not the caverns could be located in such a manner so as not to affect the embankment
6. If the possibility of short breaches as a result of subsidence results in extensive flooding in land
7. Possible maintenance of the defences by the applicant to protect the gas storage in the future.

It must be noted that within the Shoreline Management Plan (access from www.mycoastline.org) the majority of the proposed development site sits with a no active intervention policy area, which would mean that any new or existing defences on
site must be constructed and maintained by the land owner.

Comments on the points posed within the email received on 18 November 2010:

1. The EA would want to see all services located above the Q100 flood level plus climate change, with respect to roads they need to be raised to allow for access and egress during times of flood events but following the production and implementation of an evacuation plan they may not need to raised to the Q100 level.

2. There was a revised mapping study undertaken in 2010, which may have altered the flood levels, Alicia Cottam would be able to supply this information.

3. & 4 & 6 All defence information and model data will be supplied with the data request.

5. Climate change should be calculated according to table B.1 in annex B in PPS25.

7. Any infrastructure placed under defences would need to be buried deep enough so that it would not impact on any future development or if any defences needed to be rebuilt. Full cross sectional survey of the crossing point would need to be provided.

I would suggest that the developer thinks about building new defences up to the 1 in 100yr flood level to protect the caverns/development site from any tidal erosion, these defences should be maintained by the developer for the duration/lifetime of the project.

Annex E in PPS25 give some background information as what needs to be considered within a FRA.

The above advice has been provided by Nicola Bamber.

Yours faithfully

Amy Heys
Planning Liaison Technical Specialist

Direct dial 01768 215716
Direct fax 01768 865606
Direct e-mail penrith.planning@environment-agency.gov.uk
Dear Sir/Madam

UNDERGROUND GAS STORAGE - FRA CONSULTATION
PREESALL SALTFIELD, SALTMINE, WYRE ESTUARY, LANCASHIRE

We have no objection to the FRA as submitted, however we have the following comments to make;

1. Location in Flood Zone
   All operational and critical infrastructure should be located in Flood Zone 1 where possible.

2. Surface Water Run Off
   You state within the FRA “Due to the close proximity to the tidal estuary there may be potential to discharge surface water to watercourses at rates higher than the existing runoff rates. However, further consultation with the EA is required to confirm the viability of this option” In response we can confirm that only water being discharged straight into the estuary will be allowed at unrestricted rates.

Any increase in hard standing within the flood plain would need to be mitigated for by restricting the run off rates from site to the Greenfield run off rate.

We would request that a surface water drainage strategy is required through condition of any permission.

3. Flood Defences
   All works must not reduce the existing defence height in the area and a monitoring programme must be included with the planning application for the defences over the lifetime of the project

4. Groundwater
   Groundwater flooding is only likely to occur where there is an aquifer or permeable

Environment Agency
PO Box 519, Lancashire, South Preston, PR5 8GD.
Customer services line: 03708 506 506
www.environment-agency.gov.uk
Cont/d..
Amy/Nicki

As I believe you are aware Halite Energy is seeking permission for the proposed Preesall Underground natural Gas Storage Facility through a new application to the Infrastructure Planning Commission (IPC). We are currently preparing a Environmental Statement to support the proposed scheme which will be informed by our Level 1 Flood Risk Assessment (attached).

We would be grateful if you could review the Flood Risk Assessment and provide comments to confirm its suitability for informing the Environmental Statement and the application. Our current deadline for producing the Environmental Statement is the end of July, therefore we would be extremely grateful for a quick response.

Due to the large size of the document I will be sending the Appendix in a separate email.

If you have any questions please call me or email.

Regards,

Aimee

Aimee Hart

Integrated Water Management

Unit 3 Kew Court

Pynes Hill

Rydon Lane

Exeter

EX2 5AZ

Tel: 01392 374627

www.hyderconsulting.com

Hyder is an Engineering, Environmental, Planning and Management Consultancy

Please consider the environment - do you really need to print this email?
substrate at the surface.

5. Flood Defence Consent
You would be required to apply for consent for the new ramp adjoining the sea defence and consent required for directional drilling under river bed. To enable this process we would like to arrange a site meeting to visualise exactly where each buildings/wells are proposed to be located.

Yours faithfully

Amy Heys
Planning Liaison Technical Specialist

Direct dial 01768 215716
Direct fax 01768 865606
Direct e-mail penrith.planning@environment-agency.gov.uk
Appendix C

Figure A17.2: Flood Risk Assessment
Appendix D

Figure A17.3: Surface Water Features
### Environmental Statement

**Regulation 5(2)I**

**Application Boundary**

**Surface Water**

**Sheet 2 of 3**

---

**Preesall Underground Gas Storage Facility**

**Project**

**Environment**

**Scale**

1:25000

**Sheet**

A3

**Title**

PREESALL UNDERGROUND GAS STORAGE FACILITY

**Features**

SURFACE WATER

---

**Name**

J. Norman

L. Driscoll

D. Hoare

**Issue**

NOV 11

**Plot Date**

21/Nov/2011 1:59:19 PM

**File Location**

K:\PROJECTS\WX40004-FLEETWOOD SOLUTION MINING\E-OUR-DRAWINGS\2011 ENVIRONMENTAL STATEMENT CAD DRAWINGS\A17.3-WX40004-UE31D-01-SWF.DWG

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**Notes**

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**Scales**

Size

Original

Grid

Datum

Approver

Checker

Author

Client

Project

Figure No.

Filename:

Title

Description

Date

Plot Date

File Location

---

Hyder Consulting (UK) Limited

330 Firecrest Court

PREESALL

PLUS

PREESALL UNDERGROUND GAS STORAGE FACILITY

CENTRE PARK

WX40004

WA1 1RG

UNDERGROUND GAS STORAG FACILITY

Warrington

Tel:

Fax:

+44 (0)1925 800700

+44 (0)1925 572462

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## Application Boundary

### Surface Water

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**Environmental Statement**

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**Features**

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<tbody>
<tr>
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<td></td>
</tr>
</tbody>
</table>

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**Regulation 529**

**Application Boundary**

**Surface Water**

**Sheet 3 of 3**

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**Hyder Energy Group**