Appendix 2.1 Fire Fighting Strategy

2.1 Fire Fighting

Detection and Fighting of fire for the terminal have been developed based on relevant Institute of Petroleum (IP) and National Fire Prevention Association (NFPA) Codes and Standards.

The main objectives are to ensure that the design of fire and gas detection and protection systems at the terminal reduces the risk to personnel, the environment and asset to an acceptable level.

2.2 Detection And Monitoring

Fire and gas detection equipment will be provided within the terminal to provide an early warning of hazardous or potentially hazardous situations. The fire and gas system is powered from the terminal Uninterruptible Power Supply (UPS), in the event of terminal power failure.

The terminal areas will be sub-divided into fire areas such that a clear and unambiguous indication will be given as to the location of a detected hazard. Equipment with dedicated protection such as compressor / turbines, field equipment rooms will be allocated separate fire areas. If any fire or gas detector or manual alarm push button is activated both visual and audible alarm shall be given at the fire and gas panel in the Local Equipment Room and repeated in the Main Control Room.

2.2.1 Gas Detection

Flammable gas detectors will be provided to detect the presence of flammable gas before it reaches the lower explosive limit and to take appropriate action. The terminal will be provided with two different types of flammable gas detectors. Both types will raise alarm and will initiate executive actions upon coincident operation of two detectors.

Flammable gas detectors will monitor the following areas:

- HVAC air intake;
- within gas turbine and diesel engine combustion air intakes;
- Fired Heater air intake; and
- buildings where gas may accumulate.

Hydrogen gas detectors will be used in the vicinity of battery rooms, if sealed lead acid batteries are used.

2.2.2 Fire Detection

All areas of the terminal where a significant fire may occur will be provided with appropriate fire detection equipment. The objective is to detect a fire hazard, at its early stage of development and to initiate alarms and appropriate executive actions to enable the fire situation to be brought under control.

The characteristic of a fire depends on the fuel source and as such appropriate detectors will be used. They are:

- smoke detector;
- heat detector; and
- flame detector.

The types of detectors used in different areas will vary with the hazard and environmental conditions present.

2.2.3 Alarms

Manual alarm call points will be strategically positioned around the terminal including buildings. Manual initiation of alarm will instigate audible and visible alarm within the main control room.

Site wide alarm will be initiated by:

- coincident fire detection in outside areas;
- manual alarm call points in outside areas; and
- manual activation from the main control room.

Local building alarms will be initiated by:

- coincident fire and gas detection in the building; and
- manual alarm call points associated with the building.

Visual flashing alarms will be located in noisy areas where any audible alarm may be drowned by equipment noise.

2.3 Fire Fighting

The terminal fire protection philosophy is to install fixed fire protection systems which comprise water deluge systems, foam systems, gaseous extinguishing systems, hydrants, hose reels and monitors, in areas where it is most likely for a fire to occur. These systems are supplemented by fire extinguishers. The fire protection system comprises the following:

- Firewater pumps (4 x 50%);
- Firewater Jockey pumps (2 x 100%);
- Firewater Ringmain;
- Deluge systems;
- Foam system;
- Gaseous extinguishing system shall be provided for the gas turbine enclosures;
• Hydrants;
• Hydrant hose cabinets;
• Monitors;
• Foam monitors, and
• Fire extinguishers.

2.3.1 Firewater Supply and Distribution

The capacity of the firewater system shall be 1200m³/hr. This is based on the worst-case scenario of a fire in the process area with simultaneous deluge of the area on fire and the adjacent areas. For this fire scenario, the deluge water application shall be based on the NFPA 15 application rates.

Considering the remote location of the terminal from the nearest emergency services, a total of 6 hours storage of firewater will be provided in a pond. The pond will be sized for the full design flow rate plus an allowance for evaporation, freezing conditions and firewater jockey pump supply. Make-up water is from the local fresh water supplies.

The fire mains will be arranged as a looped or grid system to supply the design flow at the minimum residual hydrant outlet pressure. The fire main will be installed with sectionalising valves capable of isolating various sections of the fire main for maintenance purposes, whilst allowing the remainder of the system to remain available for fire fighting. The sectionalising valves shall be capable of isolating, any section of pipe without inhibiting more than five protection devices (e.g. monitors and three hydrants). All sectionalising valves shall be lockable.

Spurs will be taken off the fire main to feed the deluge and foam systems. The spurs shall also feed hydrants, monitors and hose reels.

The fire main shall be sized to provide a minimum discharge pressure of 7.0 barg at the furthest monitor or hydrant and the pressure range requirements for the worst-case nozzles of individual deluge/foam systems.

2.3.2 Fixed Roof Tanks

Fixed roof tanks, containing condensate or methanol, will be provided with fixed foam chambers designed to pour foam solution onto the liquid surface. Hydrants will also be provided to deliver foam solution from mobile units to the protected tank.

2.3.3 Deluge Systems

Fixed firewater deluge system will be provided for the protection of hydrocarbon tanks, pumps, compressors, vessels and tanker loading areas.

Each deluge system will be capable of local remote manual operation at the skid and at the control room.

The firewater application rates will be based on NFPA 15.

2.3.4 Foam System

Foam is an aggregate of gas filled bubbles formed from aqueous solution. Foam forms a heat-resistant blanket, of density less than that of a flammable liquid and is able to extinguish fires by cooling, suppression of vaporisation, and by the prevention of access to oxygen.

Surface foam pourer systems will be provided for fixed roof tanks and based on NFPA 11.

Foam system will also be provided for the bunds of the odorant system, methanol tanks and condensate tanks.

In addition to the fixed foam systems, mobile foam trolley systems shall also be provided to tank areas or where there is a risk of flammable liquid release.

2.3.5 Hydrants

Hydrants shall provide a source of firewater for the fire hose, portable monitors, mobile foam units, mobile foam trailers and fire fighting vehicles.

Hydrants shall be located outside bunds and adjacent to roadways.

Pressure at hand held equipment should not exceed 7.0 barg and hose diameter shall be appropriate for hand held nozzles.

2.3.6 Firewater Monitors

Water monitors will be provided for extinguishing and cooling vulnerable parts of equipment, storage tanks and structure throughout the terminal. They will be sited around the terminal and directly connected to the fire main by valve upstands.

Monitors will deliver a stream of water for fire suppression or for cooling equipment exposed to fire.

The monitors used at the terminal will be remote operated. These will be designed to be operated by
one person with control achieved through hydraulic, electrical or pneumatic instrumentation.

Some monitors shall be fitted with foam/water nozzles, design for either Fluoroprotein Foam or Aqueous Film Forming Foam (AFFF).

2.3.7 Fire Hose Cabinets

Fire hose cabinets shall be provided for each fire hydrant. Hose lengths, coupling threads etc. will meet the requirements of NFPA 1963.

2.3.8 Gaseous Total Flood Systems

Gaseous automatic systems will be installed in the gas turbine enclosures. The gaseous system will be capable of being initiated automatically on coincident fire detection. Local discharge facilities shall be provided at entrances to the enclosure/room and a mechanical release facility shall be provided at the skid assembly. Manual release shall also be possible from the package and the Main Control Room.

The gaseous system will be provided with a backup reserve to enable a 'second shot'. Change over shall be initiated manually or automatically if pressure switch feed back signal is not received.

Status lights will be provided on each entrance to the enclosure of room to warn personnel of the status of the system.

A facility for manually inhibiting the release will be incorporated into the design to enable safe entry into the area being protected.

2.4 Miscellaneous Fire Fighting Equipment

2.4.1 Hosereels/ Hose Reel Cabinets

Hosereels shall be installed to provide fire fighting in the Control Building and workshops.

A variety of hand held and mobile fire extinguishers will be provided. Where located outside, suitable weather cabinets will be provided. The extinguishers will be positioned in areas of risk relevant to their application as follows:

- dry chemical (9kg and 12kg) suitable for liquid and electrical fires;
- dry chemical (75kg) wheeled units suitable for hydrocarbon gas and liquid fires;
- CO₂ for general use throughout electrical equipment areas; and
- extinguishers suitable for general use throughout electrical and hydrocarbon areas.

2.4.2 Mobile Foam Units

Mobile foam units will be used for rapid deployment of foam extinguishing agent on hydrocarbon spill or fires.

Foam units will be located in the vicinity of where hydrocarbon liquids are present, in large quantities i.e. tank bunded areas, lube oil storage area and slug catcher area. Each foam unit shall be housed in a weatherproof easily accessible enclosure.

2.5 Passive Fire Protection

The primary purpose of fire proofing is to minimise the possibilities of collapse in a fire of steelwork supporting equipment containing flammable or toxic materials, the release of which would add materially to the intensity of a fire and to the problems and hazards of fire fighting.

The degree and extent of fireproofing will be assessed and identified by the fire risk assessment during detail design.

2.5.1 Structural fire proofing

Fire proofing will be applied to major structural steel/pipe racks supporting air coolers where a pool fire could occur. The degree and extent of fireproofing shall be assessed and identified by the fire risk assessment.

2.5.2 Equipment fire proofing

Process pressure vessels and associated pipe work up to and including the ESD valves that contain hazardous inventories will be considered for fireproofing to minimise the pressure build up in the vessel caused by evaporating and expanding hydrocarbons. Fireproofing reduces the loading on the relief and vent system during a localised fire scenario before depressurisation has been completed. Fireproofing also protecs the integrity of the vessel by minimising the vessel wall temperature thus avoiding premature failure and escalation of the initial event.

2.5.3 Instrument fireproofing

Double acting ESD/EDP valves, which are located in a fire supporting area, will be fireproofed.

Single acting ESD/EDP valves do not need to be fireproofed as these are inherently fail-safe by design.
2.5.4 ESD & Blowdown Valves

Sensitive ESD Valves and Blowdown Valves will be considered for fire proofing where it can be demonstrated that as a result of failure of the valve due to fire damage the initial event will escalate. The results of the Fire Risk Assessment will specify the affected zones from accidental release events. Where possible, cables and tubing to critical valves will be run in trenches. Where this is not possible, alternative protection from blast will be provided.

2.5.5 Building Fire Proofing

Fire protection for buildings and specific coating systems to be employed will comply with Civil, Structural and Architectural requirements.
Three

Construction
3 Construction

3.1 Introduction

The construction of the terminal is described in this section. It includes an outline of the main activities and operations to be undertaken during the construction project and the phasing of these operations. The construction of the peat deposition site is described in the peat deposition volume of this EIS.

The potential and predicted impacts on the environment, arising from construction activities, have been assessed. The conclusions of these assessments are provided in the chapters of this EIS dedicated to each medium. The mitigation measures, which will be implemented in order to minimise the effects of the construction phase on the environment, are also addressed in this section.

3.2 Construction Management

3.2.1 Project Management and Control

Shell will appoint an earthworks contractor and a civil/mechanical contractor to undertake the activities required for the construction and commissioning of the terminal. Prior to appointment, the contractors will be required to satisfy Shell that they have the technical competence and experience to complete the work in a satisfactory manner.

The Contractors' management will comply with the Safety Health and Welfare at Work (Construction) Regulations 2001, which prescribe the details for proper safety management on site. They will also comply with Shell Group standards.

3.2.2 Environmental Monitoring Group

The Minister for (then) Marine and Natural Resources has placed conditions (Plan of Development Approval April 2002) on the Corrib Field Development as follows:

The EMG was established in July 2002, when the initial construction activities associated with the landfall at Glengad commenced. It is expected that liaison will be continued through the already existing EMG with membership expanded to include members of the community local to the development. The purpose of the Group is to ensure that interested parties, including local residents are kept informed of the activities to be carried out on site. The Group will be a forum at which environmental concerns relating to the construction project can be raised and resolved. The Group will meet on a regular basis for the duration of the construction period.

Shell also intends to establish a smaller local liaison forum with local residents around the terminal site and haul route to ensure that local residents have a way of communicating local concerns to Shell and have them addressed in a timely manner during the construction period.

3.2.3 Overview of Construction Activities

The main activities, in order of execution, will be as follows:

- site access and enabling works;
- peat excavation and transport offsite;
- earthworks (site preparation and levelling);
- ground works (piling and civil);
- structural framework (pipe racks and equipment supports);
- construction of main buildings;
- installation of major equipment items;
- piping fabrication and erection;
- testing of equipment and systems;
- installation of electrical and instrumentation systems;
- commissioning of the plant and process; and
- landscaping of the site including tree planting, compensation habitat development and environmental conservation of the surrounding areas.

The civil activities are expected to commence before the excavation and filling of the terminal platform has been completed.

A more detailed description of the construction activities is given in Section 3.3.

3.2.4 Health and Safety Management Strategy

Shell will establish a joint Health and Safety Management System with all contractors engaged in construction activities on the terminal site. Similarly for all road haulage activities the safe operation of the haulage trucks and the safety of the local...
population will be addressed in the Traffic Management Plan.

The site Health and Safety Plan will be compiled through discussions with Shell and the contractors. It will be the responsibility of the contractor to execute the planned activities safely and in accordance with national legislation, industry and Shell standards and specifications and good industry practice. Shell will manage and audit the compliance of the contractors on a regular basis to ensure that a consistent, high level of attention is given to all safety aspects on site.

Safety performance will be addressed on an ongoing basis throughout the construction phase in several forms.

Management Safety Meetings

Shell’s construction management, Health and Safety advisors and the contractor representatives will meet on a regular basis to review the site and haulage safety performance. Incident investigation and reports, and follow up of the main learning points will be discussed between those involved.

Safety Inductions

All personnel working on the site must be in possession of the FAS Safepass qualification. In addition a site specific Safety Induction will be prepared by the contractors to address all construction safety related aspects. It will be compulsory to attend this before starting any activities on the site.

Toolbox Meetings

Each contractor will organise a daily toolbox meeting to be held first thing in the morning. The planned daily activities will be discussed as well as distributing feedback and learning points from the previous day’s activities and safety reports. In addition toolbox meetings will be held when a significant change in work activities occurs.

A site permit to work system (PTW) will be in operation on the site for all activities and risk assessments will be carried out routinely. All incidents, accidents and near misses will be reported and investigated. A medical and emergency response procedure will be established in consultation with the local emergency services.

3.2.5 Environmental Management Strategy

Shell will establish a joint environmental management plan with each contractor for the construction phase. It will be the responsibility of each contractor to ensure strict compliance with all aspects of the environmental management plan. Shell will audit, on a regular basis, the environmental performance of the contractors and all corrective actions will be logged with dates for implementation. The environmental performance of the terminal construction activities will be reviewed regularly by the (already existing) EMG, and modifications will be made to the environmental management plans, if necessary to ensure their effectiveness.

A programme will be established for regular monitoring of construction noise, mud and dust, traffic movements, and water quality. Management of construction wastes will also be an important part of the environmental management plan.

Mud and Dust

Dust monitoring stations will be erected at defined points between the site and local residences. The data collected will be held on file and made available for inspection by Mayo County Council and the EMG. Any operation that generates dust will be subject to dust suppression procedures. These will include water spraying of haul roads and dapping down of open areas during dry weather.

Wheel washes will be installed near the site exit points in order to prevent mud being deposited on the local roads. This will be monitored and, if vehicles leaving the site deposit mud, a road sweeper will be deployed to clean the roads. Similarly the haul route for the peat removal operation will be monitored and any spills will be cleaned up

Plate 3.1 Wheel Wash

Noise and Vibration

Noise and vibration monitoring points will be established around the site and at local receptors, by agreement with Mayo County Council. These stations will record noise and vibration parameters to
Bellanaboy Bridge Terminal
Environmental Impact Statement

an agreed protocol. Data will be permanently stored and made available to the EMG on request and to the regulatory bodies.

All plant, equipment and vehicles will be maintained, fitted with the correct noise suppression equipment, and operated in accordance with the manufacturers recommendations, statutory requirements and in accordance with BS5228: Noise Control on Construction and Open Sites, and relevant Irish Standards for construction noise as may come into force.

Piling operations will only be permitted to take place by prior notification and within agreed site working hours.

Activities such as rock breaking and drilling will also be notified in advance and will only take place within agreed site working hours. Rippling and pre-splitting of the rock may also be required.

Protection and Compensation of Habitats

The construction phase will involve the removal of the habitats in the terminal footprint and some disturbance to the habitats in the vicinity of the footprint. These habitats have been assessed and where possible compensation will be provided by creating new wetland and bog habitats of equal value, within the land owned by Shell. This compensation plan is discussed in more detail in Section 6 Terrestrial Flora and Fauna.

Transport

All routes for vehicles to and from the site have been assessed as part of the traffic impact assessment, which is described in Section 16 of this EIS. A traffic management plan will be drawn up in conjunction with Mayo County Council, the Garda and the EMG.

All site personnel will be briefed on the driving standards that Shell will require, and on the approved routes to be used when travelling to the site. All cases of dangerous or inconsiderate driving will be reported to the Construction Manager for appropriate action.

Protection of Water Courses

Activities on site will be managed in accordance with CIRIA Guide C532 ‘Control of water pollution from construction sites, Guidance for consultants and contractors’, CIRIA, 2001. Whilst CIRIA is a UK based organisation their guidance documents are widely used in the international civil engineering industry.

Implementation of the CIRIA guide’s recommendations will ensure that the risk of pollution of groundwater, soils and surface waters, resulting from the construction activities, will be minimised.

The precautions to be put in place to control the quality of surface water run-off from the site, during the construction phase, are described in Section 3.5 below.

Refuelling

Refuelling points will be established on site. The locations will be bunded in order to contain any spills. Each refuelling point will be equipped with spill kits and all drivers and operators of plant will be trained in the use of the kits. All rubber tyred plant used on site will refuel only at these locations using funnels or refuelling nozzles as appropriate. All tracked and static equipment will be refuelled locally in their area of operation by an on site mobile double skinned fuel bowser. The fuel bowser will also carry a spill kit. All drivers and operators will be responsible for checking their vehicles on a daily basis to ensure that there are no damaged hoses, fuel lines, etc. Vehicles with such damage will not be used until they have been repaired.

Groundwater Monitoring

Additional groundwater monitoring boreholes will be installed around the site, a number of which are currently located down gradient of the site and will be used to monitor the local groundwater during construction. Refer to section 9.7 for details of the monitoring proposed.

Some of these will be permanent monitoring wells and will be left in place to act as long term monitoring points for the operational phase.

Surface Water Monitoring

A water monitoring programme will be agreed in consultation with Mayo County Council and the North Western Regional Fisheries Board. The locations will be sampled on a regular basis to monitor the effect of runoff from the site in the local watercourses. Refer to Section 7 and Section 9.7 for details of the monitoring proposed.

Waste Management

A waste management plan will form part of each contractor’s environmental management plan. The waste management plan will have three elements: waste minimisation, separation of waste at source, and appropriate storage and disposal.
Measures to ensure minimisation of waste will include:
- providing training to site staff in the requirements of the waste management plan,
- establishing a re-use and recycle culture on site,
- paying attention to site tidiness,
- ordering appropriate quantities of materials, 'just in time',
- immediate and careful storage of materials delivered to the site,
- storing materials, which are vulnerable to damage by rain, under cover and raised above the ground, and
- careful handling of materials, using appropriate equipment, to avoid undue damage.

All waste materials will be identified and segregated on site and stored in appropriately designed, secure storage containers.

The contractors' site Health, Safety and Environment advisors will monitor the implementation of the waste management plans. Waste management audits will be carried out on a weekly basis and all non-conformances reported to the Shell Health, Safety and Environment representative.

Materials, surplus to requirements, will be returned, disposed of or recovered in accordance with all relevant waste management regulations. Materials that is likely to be surplus to requirements and disposed of, off-site, will include excavated material, general demolition debris, scrap timber and steel, machinery oils and chemical cleaning solutions. These are quantified in Section 16.

3.3 Construction Activities

There will be three main phases of construction activity on the site, the enabling works, the peat excavation works and the main civil and mechanical construction works.

3.3.1 General

Before the civil and mechanical construction works can start a number of earthworks activities must be completed.

As outlined in Section 2, the site is at a gentle incline and is overlain by a layer of peat. In order to provide a level platform for the terminal, the peat will be excavated from the footprint of the terminal. In the north-eastern part of the footprint the underlying soil and rock will be removed and, in the south and west parts, fill will be placed in order to achieve the required levels. These operations will be the main activities of the enabling works stage.

The peat will be removed from site and deposited on a cutover peatland, belonging to Bord na Móna, at Srahmore. The process by which the peat will be managed is summarised in Section 3.5.

The administration building and car park, and some ancillary equipment, such as the flare stack, will be constructed in an area where the peat will remain in-situ.

3.3.2 Enabling Works Phase

The main activities for the enabling works phase will be as follows:
- erection of site fencing around whole site using a stockproof type fence as close as possible to the red line boundary;
- erection of protective fencing for the trees to be retained;
- erection of construction area safety fence;
- improvements to the main site entrance;
- construction of the main site access road;
- augmentation of the existing site drainage;
- construction of new site drainage, temporary silt ponds and installation of dewatering wells; and
- installation of wheel wash facilities.

A number of these activities will be happening in parallel. At the same time the haul road to Srahmore will be made suitable for the peat haulage operation, before the main peat removal phase commences. Mayo County Council will undertake this work. A more detailed description of the enabling works is provided in Section 3.4.

3.3.3 Peat Excavation Phase

The main activities for the peat excavation phase will be as follows:
- construction of the truck parking area and initial construction facilities,
- construction of the temporary construction facilities,
- construction of a new access road from the R314 to the settlement pond area,
- initial excavation of peat in the north-eastern area of the terminal footprint,
- excavation of the settlement ponds,
- installation of site drainage
- main peat excavation, windrowing, stockpiling and removal from site,
- installation of the southern perimeter sheet piling and terminal permanent perimeter drainage;
- excavation of the mineral soils and rock for the cut and fill of terminal footprint.

A more detailed description of the enabling works is provided in Section 3.5.
3.3.4 Civil, Mechanical, Electrical and Instrumentation Construction Phase

After removing the peat and levelling and compacting the site the following activities, will take place:

- ground works (piling and civil);
- structural framework (pipe-racks and equipment supports);
- construction of main buildings;
- installation of major equipment items;
- piping fabrication and erection;
- installation of electrical and instrumentation systems;
- testing of equipment and systems;
- commissioning of the plant and process; and
- landscaping of the site including tree planting, compensation habitat development and environmental conservation of the surrounding areas.

The civil activities are expected to commence before the excavation and filling of the terminal platform has been completed.

A more detailed description of the civil, mechanical, electrical and instrumentation construction activities is given in Sections 3.6 to 3.15.

3.3.5 Overview of Schedule and Workforce

Construction Schedule

The construction and commissioning of the terminal is expected to take 27 months. The peat removal activity is expected to take 6 months and it will be weather dependent and may be suspended occasionally due to inclement weather. Therefore depending on the start date on site, and the weather experienced, it may be necessary to undertake the peat removal activity in two phases - suspending it for the winter.

Working Hours

Typical working hours during construction will be from 0700 to 1900 Monday – Friday and from 0700 to 1600 Saturday. Certain work activities may be undertaken at night and/or at weekends. Working outside normal hours may also be necessitated through considerations of safety or weather and subcontractor availability. Exceptional construction activities will be carried out in consultation with EMG and Mayo County Council.

Construction Workforce

An estimation of the personnel profile for the construction phase of the terminal and associated upstream pipeline is shown in Table 3.2:

<table>
<thead>
<tr>
<th>Date</th>
<th>Works</th>
<th>No of Personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004 Q3</td>
<td>Road Construction</td>
<td>100</td>
</tr>
<tr>
<td>2004 Q4</td>
<td>Peat Movement</td>
<td>100</td>
</tr>
<tr>
<td>2005 Q1</td>
<td>Civil Works</td>
<td>50</td>
</tr>
<tr>
<td>2005 Q2</td>
<td>Peat Movements And Civil Works</td>
<td>200</td>
</tr>
<tr>
<td>2005 Q3</td>
<td>Civil Works And MEI Works</td>
<td>200</td>
</tr>
<tr>
<td>2005 Q4</td>
<td>MEI Works</td>
<td>300</td>
</tr>
<tr>
<td>2006 Q1</td>
<td>MEI Works</td>
<td>300</td>
</tr>
<tr>
<td>2006 Q2</td>
<td>MEI Works</td>
<td>400</td>
</tr>
<tr>
<td>2006 Q3</td>
<td>MEI Works</td>
<td>500</td>
</tr>
<tr>
<td>2006 Q4</td>
<td>MEI And Commissioning</td>
<td>250</td>
</tr>
</tbody>
</table>

3.4 Initial Site Set-up and Site Preparation

3.4.1 Site Survey

The site will be set out and surveyed to confirm all existing survey data is correct.

3.4.2 Fencing of the Site Area

The boundaries of the site will be set out, marked and a stock proof perimeter fence erected.

3.4.3 Site Clearance and Tree Protection

The existing trees and scrub in the Terminal field earthworks area will be cleared and placed in the field to the western boundary of the Terminal to form an environmental baffle to the windward side of new tree planting. In addition, certain groups of trees will be retained. These will be protected by fencing, which will be erected in the early stages of work on site.

3.4.4 Construction area safety fencing

The area to be excavated will be fenced off and appropriate signage erected in order to ensure that it is secure and to warn personnel of the presence of an open excavation and the presence of heavy plant.
3.4.5 Site Access Roads

The main entrance to the site from the R314 will be improved to make it suitable for construction traffic. The existing approach to the entrance will be widened and modified to cater for the turning of long trailer and multi axle vehicles.

Signs warning of the site entrance will be installed on the side of the R314 road, to the east and west of the site entrance.

The principal access to the site will be via the R314. Site security will control and register the movement of all vehicles and people entering and leaving the site. A secondary / emergency access to the terminal will be via the entrance on the Pollatomiish road at the north-western corner of the site. A third access point will be provided from the R314, to the west of the main entrance, to facilitate construction of the settlement ponds.

Once the entrance has been improved the permanent north-south terminal access road will be upgraded. The upgrading of this road will involve:

- the improvement of the in-situ peat (see note below) within the width of the upgraded road,
- the installation of sheet piles (see note below) along the edges of the road, and
- the importation of fill, which will be laid on a geotextile membrane on top of the improved peat.

It is envisaged that the upgrading works will start at the entrance on the R314 and work northwards. This upgrading will allow heavy traffic onto the site. The wheel wash facility will be located near the site entrance.

The secondary / emergency access road will be upgraded, by peat improvement techniques, followed by placing fill and geotextile membrane, along the line of the existing forest track, which gives access from the Pollatomiish Road.

Note: Peat/Soil improvement is a technique used to increase the strength of soft materials such as peat and silt. A binder such as lime or cement is mixed with the in-situ peat. When the binder sets, the resultant mixture has a far higher strength than the original peat. There are various techniques for introducing the binder to the peat. For the terminal, it is proposed to use ‘dry deep mixing’. In this technique an augur drills a hole, into which compressed air and dry cement is injected. Columns of strengthened material are created that overlap to form a cellular pattern. The treated area is surcharged immediately after treatment by placing of fill on it. Cement will be imported for this purpose. The impacts of this activity on the environment are considered in sections 6, 7, 8, and 11.

Sheet piles are corrugated steel plates, which are driven individually. Each pile interlocks with the pile on either side, to give a continuous steel wall in the ground. The sheet piles will extend below the peat into the firmer mineral soils and weathered rock. A pile-driving rig will install the sheet piles. It is estimated that approximately 26,000m$^2$ of sheet piles will be used.
Figure 3.2 Upgrading of Land Drains
3.4.6 Upgrading of Land Drains

The hydrology and hydrogeology of the site has been considered in some detail because it is anticipated that control of the surface and groundwater will facilitate the earthworks. Modifications will be made to the existing drainage and new drains will be installed to control rainfall runoff at each stage of the construction works.

An extensive system of forestry and agricultural drains and drainage ditches already exists in the site area. In parallel with the upgrading of the main access road, the existing drainage ditches in and adjacent to the terminal footprint area will be deepened. These drains discharge to a deep drain which runs north south to the east of the Terminal footprint. The drain will be upgraded and a series of weirs constructed in it, to control the rate of flow. An existing drainage ditch within the firebreak to the south of the terminal footprint, will also be upgraded. A silt pond will be constructed on this drain close to the south western corner of the Administration Building area. The firebreak drain discharges to the deep north south drain on the western side. Initially this drain will continue to discharge to the drainage ditch beside the R314. The deep north south drain and firebreak drains will act as catch drains for the early stages of construction. These drains are indicated on Figure 3.2. For details of the drainage proposals refer to the planning drawings.

All of the east west ditches in the terminal field will have small sediment capture ponds on the western end of the drains prior to joining the deep north south drain.

3.4.7 Settlement Ponds

A pair of settlement ponds will be constructed at an early stage in the excavation phase. The rainwater and runoff from the excavation will be collected and discharged to the settlement ponds.

The ponds will be securely fenced as a safety precaution.

Bord na Móna have been consulted on the design of the settlement ponds, which will be generally similar to the ponds at the Bord na Móna Oweninny Works.

Plate 3.2 below, shows a typical settlement pond at Bord na Móna Oweninny Works. The plate shows the outlet weir and the general design of the pond.

Drainage from the ponds will discharge, through a riprap outfall to the ground, from where it will drain to the existing drainage ditch along the R314. Refer to Sections 2, 9 and technical appendix Site Drainage Report for more detailed information on the settlement ponds.

Plate 3.2 Bord na Móna Oweninny Works showing silt pond viewed from N59 North West of the ESB Power Station. The weir is at downstream end of lagoon.

The discharge from the ponds will be monitored for suspended solids and phosphate, as described in Section 9.

The settlement ponds will be operated and maintained in accordance with procedures detailed in the Environmental Management Plan, which will be in place for the site, both during construction and operation.

During the construction period silt recovered during the maintenance of the settlement ponds, will be transported to the windrowing area of the site. It will remain there until it is in a suitable condition for transfer to the peat deposition site.

During the operation phase, it is predicted that very limited amounts of silt will be generated as there will be no un-vegetated or otherwise uncovered peat surfaces. This will be handled and disposed of in accordance with the terminal non hazardous waste management procedures.

3.4.8 Groundwater Control Wells

In order to remove water from the mineral soils and bedrock underlying the peat, as well as to promote under-drainage of the peat in the area to be excavated, it is proposed to install a series of groundwater control wells. Due to the relatively low permeability of the peat, mineral soil and bedrock vacuum assisted pumping wells, designed to suck water out of the ground, will be used.

3-8
Two lines of wells are proposed, as indicated in Figure 3.3. One line will capture the bedrock groundwater from the north eastern corner of the terminal footprint. The zone of bedrock groundwater with positive pressure will be intercepted by the second line of wells, some distance to the southwest of the first line of wells. The wells will be drilled down into the zone of more highly permeable fractured bedrock.

The volume of water from the wells will be very low and will be discharged to the upgraded land drain system.

3.5 Peat Excavation Phase

3.5.1 Truck Parking Area and Administration Building Access Road

In parallel with the latter stage of upgrading the main access road, the peat in an area to the west of the road will be strengthened. This area will be piled and then capped with a reinforced concrete slab.

During the initial site works period, before the temporary construction facilities have been prepared, this area will be used for site offices, the storage of excavation and haulage equipment and overnight parking for trucks. While basic maintenance and refuelling will also be carried out in this area, major maintenance to vehicles will be carried out at an offsite, dedicated yard.

After completing the truck parking area, the peat improvement and piling activities will continue in order to complete the full area of the permanent car park and administration buildings footprint.

A new road will be established from the main access road to this area. This road will also provide access to the south eastern corner of the terminal platform. This road will be constructed in the same way as the main access road, with peat improvement, sheet piling along both edges, geotextile membrane and fill.

3.5.2 Temporary Construction Facilities

Following on from preparation of the administration building footprint, the temporary construction facilities compound will be prepared. The peat in this area will be strengthened and sheet piles will be installed around the perimeter. Imported rock fill will be placed on a geotextile membrane on top of the improved peat.

3.5.3 Access Road to Settlement Ponds

A new entrance to the site will be opened from the R314 to gain access to the settlement pond location.

This road will be constructed using the same technique as for the main site access road. The road construction will continue around the perimeter of the settlement ponds and along the strip separating the ponds. A small laydown/turning area will also be formed adjacent to the entrance from the R314, using the previously described road construction technique.

A sheet pile wall will be installed around the perimeter of each settlement pond.

3.5.4 Drains for Access Roads, Administration Building Area and Temporary Construction Facility

New drainage ditches will be excavated on either side of the main access road and the track to the west of the terminal footprint. A new drainage ditch will be constructed on the northern, eastern and southern sides of the temporary construction facilities and on the southern and eastern sides of the Administration Building area.

The drain serving the Administration Building area will discharge to the firebreak drain. The drain serving the temporary construction facilities will discharge to the drain on the eastern side of the main access road. The drains on either side of the main access road will discharge to the firebreak drain. The drains on either side of the main access road, down slope from the connection to the firebreak drain, will discharge, via silt ponds, to the existing drain beside the R314.

When the settlement ponds have been constructed, the drains on either side of the track, to the west of the terminal footprint, will be diverted into a culvert which will discharge to the settlement ponds. The existing land drains in the part of the site between the track and the settlement ponds drain from north to south. These drains will be reinstated once the culvert construction has been completed. The drains on either side of the track, downstream of the connections to the new culvert will continue to discharge to the existing drain beside the R314.

A new ditch will be constructed to intercept the land drains in the vicinity of the settlement ponds. This ditch will discharge to the existing drain beside the R314. The existing drains on either side of the secondary/emergency access road will be upgraded.

Detailed drainage calculations and drawings are provided in Technical Appendix: Site Drainage Report.
3.5.5 Drainage of the Area of Excavation

Because of the presence of a shallow surface water table in the peat and the saturated (or near-saturated) condition of the underlying mineral soils and bedrock, groundwater can be expected to flow into any excavation that extends more than a few metres below the ground surface. Even though construction of the terminal will involve up to 10m of excavation below existing ground level, the volumes of groundwater are likely to be relatively small (given the low permeability of the materials).

Rainwater and groundwater, if it is not removed from the excavation area will tend to cause the materials to soften and consequently they will be more difficult to handle. A detailed drainage plan has been developed to deal with flows during excavation.

Most of the existing land drains drain away from the terminal footprint. When they are intercepted by the excavation of the terminal platform, they will continue to function. A number of new catch drains will be constructed to re-direct the water from the existing drains, via a silt pond, into the upgraded firebreak drain. Detailed drainage calculations and drawings are provided in Technical Appendix: Site Drainage Report.

3.5.6 Excavation of the Terminal Footprint

Peat Excavation Methodology

The peat excavation methodology has been devised in consultation with Bord na Móna.

Generally peat will be excavated by tracked excavators using large buckets to minimise the amount of cutting action on the peat fibre and existing root structures therein, it will be then loaded in to dumper trucks and transported to the windrowing area. The excavated peat will be windrowed prior to loading it into trucks for removal from the site. Windrowing consists of placing the excavated peat into linear stockpiles on a mineral soil foundation. The linear stockpiles, or windrows, will be up to 3.5m in height at the centre. When the peat has been windrowed for at least 8 days, the peat will then be transported off site. A Bord na Móna representative will monitor loading operations to ensure the suitability of the peat leaving the site.

The windrow area will have sufficient capacity to store the quantity of peat excavated over an eight day period. This is estimated to be about 28,000m³. It is expected to transport approximately 4,000m³ per day to the Bord na Móna site.

The windrows will allow the free water to be shed from the peat. They will be orientated on approximately a north-south alignment so that drainage will occur between them; additional drains will be constructed to divert the water shed from the windrow areas away from the area in which excavation is underway. Free drainage from the windrows will be maintained at all times. Sumps will be dug down-slope from the excavation face. Water from the sumps will be pumped or drained to the land drain system.

Sequence of Peat Removal

At the initial stage there will not be an area of exposed mineral soils on which to windrow the peat. However, the peat located in the north eastern quadrant of the site is thinner and drier than much of the peat over the rest of the terminal footprint. It is planned to intensively drain this area at the initial stages of construction, following that, Bord na Móna have indicated that this peat will be dry enough to be loaded directly into the trucks for transfer to the Srahmore deposition site, without windrowing. This initial activity will expose the mineral soils and gradually create space for the windrows, and the truck loading bay. Temporary access to this initial area will be via an existing track in the northeast corner of the Terminal field that will be constructed in a similar manner to the other access roads on the site.

Gabions will retain the cut edge of the peat. Gabions are rock filled steel cages. These will be placed in a trench, excavated down to the mineral soil, around the part of the terminal footprint perimeter in which a cut edge of peat will be exposed on completion of the earthworks.

In parallel with the upgrading of the main access road, a further permanent access road to the eastern boundary of the terminal footprint will be constructed, working westward from the side of the main access road. Peat excavation will progress from the northeasterm corner of the terminal platform towards the west.

As soon as the windrowing area has been established, the peat from inside the sheet-piled settlement ponds will be excavated, transported to the terminal platform, mixed with peat from within the terminal area, and windrowed. The windrowing area will gradually move across the site (as will the truck loading bay) as the peat excavation front moves west and then south.

In the areas of the terminal platform, in which the removed peat will be replaced by fill, the cut edge of the peat will be retained with sheet piles. Figures 3.4 to 3.7 indicate various stages of the peat removal operation.
Figure 3.4 Peat Removal Initial Stage
Figure 3.7 Peat Removal Completed Stage
Peat Excavation Schedule

The peat removal activities are expected to take up to six months to complete. As it will be weather dependent, it may not be possible to complete the excavation of all of the peat from the terminal footprint site in one season. This may result in a temporary suspension of the peat removal works during the wettest season, and recommencement the following spring. When the peat excavation work is suspended for a period of time due to inclement weather, sufficient perimeter drainage of the earthworks will be provided to ensure adequate removal of surface water.

3.5.7 Construction Traffic Management during Peat Removal

A road Traffic Management Plan (TMP) for the operations along the R314, L1204 and crossing at the R313 has been prepared in consultation with Mayo County Council, the Garda, and local residents. The management principles proposed are outlined below.

Section 16 of this EIS discusses in detail the impacts that might be expected from the traffic movements associated with construction activities.

Safety

Particular safety aspects have been addressed in the TMP. The measures to be implemented include:

- Road signs: New road signs will be erected on the approaches to the Haul Route from Bangor, Pollatomish, Glenamoy and from Belmullet, at locations to be agreed with Mayo County Council, but typically 2-3 km from any point of traffic control.
- Communication: Regular updates will be given to Midwest Radio and to Radio na Gaeltachta, with details of any significant activities anticipated over the coming week.
- Minibus: A minibus service will be established to transport local residents to towns in the local area;
- School bus runs: The timing and organisation of school bus runs will be discussed with the appropriate authorities in order to avoid conflict with haul route traffic.
- Driver training: All drivers will have site specific safety training.
- Speed controls: A maximum non-statutory speed limit of 40 mph will be imposed for contracted haulage vehicles on the Haul Route. A lesser maximum speed limit of 30 mph will locally apply on bends, marked by appropriate contract-specific signage, and will be implemented and enforced for all fleet vehicles.

- Tachographs: In order to ensure compliance with national regulations on maximum working hours and break intervals for drivers, vehicle tachographs and GPS position recorders will be fitted to all haulage vehicles. These will be recorded to archive and analysed for compliance with work duties, productivity limits and the like on a daily basis.
- Driver communication: Two way VHF radio communications will be provided between each vehicle and the Transport Operations Managers office. Each flagman and the weighbridge records office will also have access to this communications system, and will be trained in its use, and in the priorities and disciplined usage necessary for effective communication.

- Wheel washes and road sweepers: These will be used to minimise the transfer of mud onto the public roads.
- Flagmen at junctions: This activity will serve to minimise queuing at junctions and ensure safe passage for all traffic.

The cycle to be completed by each vehicle, several times per day, includes the following basic elements:

1. filling of the Payload, followed by wheel wash;
2. haulage of the Payload;
3. weighbridge and electronic recording procedures;
4. manoeuvre into tipping position, tipping, and truck deck lowering followed by wheel washing;
5. return trip unladen; and
6. manoeuvre into loading position.

Logistics of the Loading Area

Each evening, approximately half of the Truck Fleet will be parked at the Bord na Móna peat reception area (Srahmore), and approximately half will be parked at the Loading Area. This proportion may change slightly depending on operational conditions encountered. Those vehicles which are parked at the Loading Area will be preloaded for the following morning before parking, and where practicable will be wheel-washed before being parked, so that they commence their first cycle ready to depart with a loaded payload.

All vehicles will have been fuelled and safety checked during overnight downtime at either the Loading or peat reception area sites, and the Loading Area excavators will commence to fill those trucks which have travelled empty from the Srahmore peat reception site, as they commence their cycle each day.

Any queues which develop will be accommodated on the access roads to the Terminal and Deposition...
Area. The flagmen and vehicle spacing guidelines will otherwise ensure that the mean frequency of one truck passing in either direction every 90 seconds at a given point on the Haul Route is not persistently exceeded by unplanned formation of clusters of trucks in convoy.

Logistics at the Sraheen Peat Reception Area

Bord na Móna plan to operate similar working hours to the Terminal site moving material from thepeat reception area into the Peatland placement vehicles.

For more information refer to Section 2 of the peat deposition volume of this EIS which describes the operations at the peat deposition area.

3.5.8 Excavation, of Mineral, Soils Site Levelling, Cut and Fill

Once a sufficient area of the terminal platform has been stripped of peat to allow the peat removal activities to proceed unhindered, the excavation of mineral soils will commence, starting from the northeast corner of the terminal platform. The excavated mineral soil will be used for levelling the terminal footprint as well as the upgrade internal access roads. It is expected that there will be a surplus of mineral soil, which will be removed from the site, (see Section 16). The cut face of the mineral soil will be graded to a one in three slope to ensure its stability.

Plate 3.3: Peat Overlying Micaschist Bedrock in NE Corner of Site

Excavation of Rock

It will be necessary to remove rock from the north-eastern part of the terminal footprint. The geotechnical site investigation has provided a considerable amount of data on the bedrock underlying the footprint. The state of the rock varies from being completely decomposed by weathering to intact, unweathered rock. Excavators, using standard buckets, will be used to remove the more weathered rock. It may be necessary to use rock breaking chisels, attached to the excavators, and bulldozers equipped with ripping tines, to remove the intact rock. Rock blasting will not be necessary. There may be a requirement to pre-split the more intact rock to aid ripping, this will be achieved by drilling the rock at a regular intervals and using an expanding chemical crack inducer.

The exposed face of the excavation in rock will be cut to approximately a one in one slope to ensure its stability.

Processing of Rock

It may be necessary to crush/screen the excavated rock to reduce it to a size suitable for compaction. In this case, a mobile crusher/screener would be used. The potential impacts of this plant would be noise and dust. Noise suppression would be achieved by positioning the crusher/screener within a bunded area, which would also provide the facility to dampen down the area with a water spray, in order to minimise dust.

Fill Operation

The excavated rock will be used as fill material in the southern and western parts of the terminal footprint. The edge of the fill will be reinforced with geotextiles, and, where it is above the level of the surrounding ground, the face will be graded to a one in three slope. If very wet weather conditions are encountered during the filling operation the filled area may be stabilised, using soil improvement techniques as described above.

The site will be capped where appropriate, with the best quality rock. It will also be necessary to import rock fill and stone for this purpose.

Mineral Soil and Rock Excavation Schedule

Prior to the cessation of works before the first winter season, it is expected that an area of approximately two to three hectares will have been excavated to the finished terminal level of 33.4m AOD Malin. It is expected the fill operation will not be completed until the second season. A portion of the rock will be stockpiled over the first winter period.

3.5.9 Monitoring Equipment

Before any earthwork activities take place on site, piezometers, inclinometers and extensometers will be installed in the area of the works and in adjacent areas. These will be used for monitoring the levels of the water tables in the peat, mineral soils and rock, and for detection of movement in the peat.
Air, noise and vibration monitoring equipment will be deployed as and when required, which will be advised by the onsite environmental engineer and as part of the overall environmental management system.

3.5.10 Permanent Terminal Perimeter Drainage

The silt ponds for the terminal will be retained after the completion of construction. Once the site preparation phase has been completed and final site levels have been established for the terminal, the new permanent terminal perimeter drainage system will be constructed and connected to the settlement ponds. This drainage will comprise of a drain, at the toe of the slope, to intercept surface water runoff, and a deep drain, also at the toe of the slope, to intercept groundwater. Refer to the planning application drawings for details of these drains. Rainwater runoff from the clean surface water drains will also be directed to the settlement ponds.

3.5.11 Fencing

When the earthworks have been completed, a 2.4m high security fence will be erected around the terminal footprint. A 3.4m steel fence, with an intruder alert detection system, will be attached to the security fence to make a double-skin fence for the operational phase.

3.5.12 Site Landscaping

Following completion of the peat excavation operations and formation of the terminal platform, the side slopes to the terminal site will be, where appropriate, topsoiled, seeded and planted with shrubs to encourage the growth of vegetation.

3.6 Piling and Civil Works

Foundations for the support of the terminal equipment, structures and buildings will be constructed using either spread pads laid directly on the underlying bedrock or by the use of piles.

It is anticipated that up to 2000 number piles will be used.

Piling, foundation and civil works will be phased to reflect the construction schedule. The civil engineering activities, including piling, may be undertaken in parallel with the later stages of the peat excavation operations.

3.7 Structural Steelwork

All activities relating to the fabrication, preparation and coating of structural steel will be carried out ofsite. Activities on site will be limited to the erection of all steel work and any minor modifications required. Painting of the steel will also be undertaken ofsite. This will reduce the potential for some environmental impacts on site that can arise from these activities. It is anticipated that minor touch up to painting will be required on site.

3.8 Buildings

The following buildings will be constructed on site:

- control building;
- administration complex, warehouse and workshop complex;
- power generation and electrical switchgear building;
- firewater pump house;
- gas export compression building;
- water treatment building; and
- minor equipment housings.

The Control Building and the Administration, Warehouse and Workshop complex will be constructed on piles the beginning of the civil and mechanical construction period.

It is anticipated that the Switchroom, Generator Building, Administration and Control Buildings are constructed first and made weatherproof. This is due to the large amount of fitting out required in these buildings. However should the peat excavation operation be suspended due to bad weather those buildings in the areas of the site which have been levelled will be given priority. This is most likely to be in the north-eastern section of the terminal and include the compressor building. The Compressor building will be erected and substantially fitted out prior to delivery of the compressors.

3.9 Installation of Piping, Tanks and Equipment

Equipment will be prefabricated, pre-assembled and pre-finished, where possible, to minimise site work. However, the extent of this will be restricted by the limits on the size and weight of components, which can be transported to the site by road. There will be a small number of oversize loads. The transport routes for these items from the port of entry, will be under an approved permit, carefully planned, in liaison with the Local Authorities and Gardai along the route.

Tanks T4002A/B, T3001A/B, T3002 and T4001 A/B/C will be site erected from floor plates, sketch plates and shell plates prepared/rolled off-site. Erection will be by welding on site. Purpose designed scaffolding will be erected to ensure safe access.
Although the tanks are not particularly large, the amounts of water required to carry out the appropriate hydrostatic tests will be in excess of what can realistically be provided through the site potable water system. Therefore, water will be drawn from the firewater pond, the water in the firewater pond will be drawn over an agreed period of time from the newly constructed mains fed from the local authority water supply. Tank linings, where relevant, will be applied following hydrotest. Dehumidification and temperature control equipment will be utilised as necessary to dry the internal surface and prevent any weather-related delay to the lining activities.

3.10 Equipment Installation and Craneage

Equipment erection will be phased to reflect the construction schedule which will optimise the availability of heavy/specialised cranes on site and to release work faces for follow-on activities. Major equipment items will be erected directly from their transportation trailers on to their bases wherever possible. Rigging studies and method statements will be generated for major equipment items in order to ensure compliance with the site health, safety and environmental plan.

A number of equipment items, such as the air coolers that weigh approximately 65t each and sit on top of the pipe-rack, will be lifted as a complete unit using 400t capacity cranes. These cranes are needed to place the equipment at approximately 15m radius. During the visit of any heavylift crane to site, its utilisation will be maximised to give optimum benefit to the project schedule.

The building for the Sales Gas Compressors will be completed and partially fitted out prior to Compressor delivery. These units will be offloaded and then skidded into position using mechanical skates and pull lifts or similar. Final positioning will be by jacking.

The site layout permits good access for erection craneage. Careful sequential installation will be employed around the east west rack through the Process Area in order to allow craneage close enough to erect all the high level Air Coolers. For protection during the equipment, installation of scaffold shelters or tarpaulined habitats will be used to allow setting/alignment/hook-up activities to proceed through periods of inclement weather.

3.11 Pipe Fabrication and Erection

All pipe spools will wherever possible be shot blasted and primed prior to delivery to site thus reducing onsite work.

Pipe which is essentially straight run i.e. on racks or tracks will be shot blasted and primed prior to delivery to site. Any fabrication that can be carried out on these runs will wherever possible be carried out in the fabrication shop prior to delivery to site. All pipe spools will be supplied to the maximum dimension that can be readily and safely handled and transported.

Pipework erection will be phased to reflect the construction schedule.

Safe and practical access will be provided together with environmental and weather protection to allow work to proceed regardless of weather conditions.

On completion of the erection each piping system will be pressure tested to ensure its mechanical integrity. Once mechanical testing is complete any touch up painting will be carried out.

On completion of testing, pipework will be released for final painting to the required paint code on site.

3.12 Slugcatcher

The Slugcatcher will be erected using dedicated squads of specialist erectors, fitters and welders. Fingers and manifolds will be prefabricated offsite to the maximum dimension that can be readily and safely transported to site by road.

A number of options with regard to Site Assembly methodology are being investigated but the final method of erection is still to be decided.

3.13 Electrical and Instrumentation

Wherever possible work will be performed offsite by way of pre-fabrication and testing. Detailed pre-planning will clearly identify priority routings for the electrical and instrumentation cables. Ladder rack and tray installation will start on the pipe racks and in the process area with access being progressively granted across the plant, finishing in the Compressor House.

In order to obtain acceptable working conditions within the various buildings, lighting and small power systems will be installed first in order that these can be hooked up to temporary diesel generators ahead of energisation of the main power generation equipment.

Electrical equipment installation will commence with the installation of the main power transformers by crane followed by the skating/rolling in of switchgear, panels, boards, etc. progressively. A priority of the civil and structural steel sub-contractors will be to ensure that the various buildings are weatherlight,
and secure prior to installation of equipment. Electrical testing requiring equipment energisation prior to Mechanical Completion will be conducted using temporary diesel generators.

Prior to installation, instruments will be stored under conditions stipulated by the supplier in order to protect the integrity of the equipment. This will include, as appropriate, environmental protections i.e. air conditioning, heating, dehumidification, etc. Prior to installation, calibration of instrumentation will be carried out in a properly equipped and certified calibration workshop. After calibration, each instrument will be clearly labelled as having been calibrated with the date of testing.

When the control room and local equipment room are totally weatherproof, environmentally sound and physically secure, installation of the Distributed Control System (DCS) and Fire and Gas detection equipment will proceed.

3.14 Pressure Testing

To ensure the mechanical integrity of the piping systems and as part of the mechanical completion activities, all piping systems will be pressure tested prior to hand over for commissioning.

The majority of this testing will be carried out by hydrostatic tests, which requires the system to be filled with water, incrementally brought to the required pressure and held for a given time. A small number of pneumatic tests will be required where it will be essential that the piping remains completely dry. In this case air will be used rather than water.

It is anticipated that a significant quantity of water will be required to carry out this testing programme. In order to ensure that this water is available it is envisaged that use will be made of the firewater pond and storage tanks as reservoirs. The pressure test water is likely to be disposed of via the water treatment plant to the sea outfall.

Following pressure testing the system will be leak tested using an \( \text{N}_2/\text{He} \) gas mixture.

3.15 Commissioning

Commissioning of all systems will be carried out in a systematic and controlled manner to ensure that the plant is brought safely into service following completion of construction.

To ensure that the transfer from fully constructed, mechanically complete equipment to commissioning and operation, the equipment will be grouped into a number of packages called systems. Each system performs a particular function. Commissioning personnel will be involved early in the design to ensure that these systems are safely and correctly defined.

Systems will reach mechanical completion at different stages and each system will be individually commissioned following a documented commissioning procedure.

Commissioning will be carried out using a combined team of engineers from Shell, the contractor, and the equipment vendors' specialists as required. A commissioning plan will be prepared and the commissioning activities will be undertaken strictly in accordance with the defined procedures and protocols.

The transfer of systems from construction to commissioning will be controlled and documented using mechanical completion packages. These packages will contain traceable records of all material and calibration test certificates, and an agreed list of outstanding works to be completed prior to plant start-up. These documents form part of the quality control systems and will be combined with the commissioning documentation.

The order of commissioning systems will be detailed on the commissioning plan and this will follow the following basic categories:

- utility systems such as drains, water, instrument air etc.;
- safety systems such as emergency power, fire and gas detection, firewater, deluge etc.;
- plant control systems and main process units such as fuel gas, main power generation; and
- gas processing, compression and transport and measurement systems.

Once all systems have been commissioned, and handed over to the Terminal Manager, the plant will be prepared for the introduction of hydrocarbon gas. This activity will be co-ordinated with the offshore group. At, or just prior, to this time, the terminal will be placed under control of the "Permit to Work System”. The permit to work system is standard practice on all process plants and is designed to ensure safe and co-ordinated working at all levels. The permit to work system places an increased level of discipline, formalism and accountability on all activities to ensure safety is the first consideration. Prior to the introduction of hydrocarbon gas to the plant all required systems will be fully commissioned and handed over to the Terminal Manager. The final responsibility for introducing hydrocarbon gas to the terminal is with the Terminal Manager, who will be supported by a team of operators, the project team and by engineers and technicians from the EPC contractor.
Hydrocarbon gas will be introduced to permit post-commissioning start-up of the gas treatment and export facilities. During this time a co-ordinated series of checks will be carried out to monitor for gas leaks or any abnormal process deviations.

A performance verification run-in period will take place to verify that all systems are operating correctly and that gas of the required quality and quantity can be delivered into the gas grid.

3.16 Temporary Construction Facility

An initial temporary construction facility of approximately one hectare will be built to provide offices, car parking, canteen and washroom facilities for construction staff involved in the peat excavation phase. The temporary buildings used are expected to be of the 'Portakabin' type. This area will be to the east of the terminal footprint on the east side of the north-south access road.

For the civil, mechanical, electrical and instrumentation construction phase this initial temporary construction area as well as an area to the south of the terminal, adjacent to the administration buildings, will be used for further office and welfare facilities. Storage and lay-down areas for construction equipment, consumables and plant have been identified at various clear areas in the terminal. A dedicated area will also be set aside for the pipeline contractor to store his materials.

There will be a dedicated car parking area for up to 200 cars. At certain stages during the construction project the parking demand is expected to exceed this number. To ensure that construction workers do not cause obstruction by parking on the roads in the vicinity of the site. The contractors will be encouraged to provide transport to the site for their workforce.

3.16.1 Construction Plant

Throughout the construction of the terminal the plant to be used for the various activities is listed below:

The site preparation phase (including peat removal) will require the following plant:

- excavators of various capacities;
- loading shovels;
- rock breakers;
- peat improvement rigs,
- piling rig,
- dump trucks of various capacities;
- bulldozers;
- graders;
- road sweeping equipment;
- road spraying equipment;
- compactors; and
- mobile crushing/screening plant,
- rock drills;
- pumps and associated hoses;
- road tipper trucks; and
- generators and compressors.

For the Construction phase:

- standard construction equipment including, for example, welding equipment, generators, hand tools etc.,
- variety of cranes;
- special cranes for limited periods (as defined by lifting studies); and
- piling rigs.

A temporary ESB power supply will be installed including a sub station, transformers and switchgear to allow all temporary lighting to be installed prior to the provision of permanent power, which will be available as part of the commissioning programme. "Island mode" operation (the main operational status of the terminal where it will be self sufficient in terms of power) will not be possible until after the introduction of hydrocarbons.

Mayo County Council will install a water main from the local water treatment plant to the site entrance on the R314. A 100mm (4 inch) branch for the permanent supply will be provided to the terminal. This will be utilised during construction. A 250mm (10 inch) branch will also be provided to the fire water storage pond. In addition, water hydrants will be installed on the water main along the R314 parallel to the terminal site. Other than in emergencies this line will only be used by agreement with Mayo County Council.

3.16.2 Water Supply and Sewage Disposal from the Temporary Construction Facilities

Water will be tankered into the site to service the temporary construction facilities up until the permanent supply becomes available, the water will be sourced from the local authority water treatment facilities, which has adequate capacity.

A holding tank will be provided for the sewage from the temporary construction facilities. The tank will be emptied routinely and the contents disposed of by a licensed contractor in an appropriate manner.

3.17 Receiving Environment and Impacts

The aspects of the local environment, which may be affected during the construction phase, are described, and the impacts assessed, throughout
Most impacts during construction are temporary and are often very short term. Clearly the construction of any plant or building will change the local habitats immediately as a result of the presence of the new structure. The local area where the plant is to be built is a modified habitat as a result of forestry research operations. As described in Sections 6 and 7, there are no sensitive habitats that will be impacted by the construction process. There will be emissions to air and minor changes to the local drainage on site. There will be noise and there will be an increase in traffic especially during construction. The mitigation of these impacts is dealt with in the respective sections of this EIS. Apart from the loss of the habitat immediately beneath the terminal footprint, and the consumption of resources, there will be no long-term impacts arising from construction.

### 3.18 Mitigation Measures

During construction many of the impacts, which are not acceptable in an operation phase of a project are usually tolerated due to their short-term nature in the construction phase. However Shell is committed to ensuring that the impacts on the local environment during construction are kept as low as possible. The key impacts that will therefore be very carefully monitored and controlled are noise, dust, traffic, waste and social interactions. The environmental strategy during construction is discussed in Section 3.2.

Local liaison will ensure that the community are regularly consulted and informed of the elements of construction that will have most impact. These include the arrival of a heavy load or large piece of plant, the activities of rock breaking and piling and the occasional need to work at night, which would require light.

Shell recognises that Mayo County Council may apply conditions on the construction operation. In addition it is the wish of Shell to consult and liaise closely with the local community via the EMG in order to clearly understand their concerns and mitigate as far as possible the impacts during construction.
Four

Alternatives
4 Alternatives

4.1 Need for the Scheme

With gas consumption increasing annually and predicted to rise sharply in the future, demand for energy has outstripped Ireland's domestic production. The two small new gas fields on the South Coast, Seven Heads and Green Sands, which are expected to be on stream by late 2003, will not make up the short fall. Consequently, Ireland requires significant additional supplies of gas.

From 2001 to 2003 Bord Gáis Éireann (BGE) undertook a major upgrade of the gas pipeline infrastructure, with the construction of a second pipeline connection between Scotland and Dublin, and a transmission pipeline from Dublin to Limerick via Galway. The new infrastructure allows more gas to be imported from the UK and continental European gas networks, but it does not provide an alternative source of indigenous gas. A very significant proportion of Europe's gas comes from Algeria, Siberia and a number of the former Soviet Republics in Central Asia. As can be seen from Figure 4.1, Ireland is at the very end of the gas supply line and is vulnerable to an interruption of supply anywhere along the system.

The development of Corrib will help to provide security of supply, as Corrib will be an indigenous source of gas. It will also stimulate expansion of the onshore transmission system to the north-west of the country, which in turn will result in increased potential for growth in this region of Ireland, similar to that which occurred in the Cork region when the Kinsale Head gas field came on stream.

Ireland's recent high economic growth has driven the demand for power and energy. Gas is predicted to become a greater provider of energy in Ireland due to its reduced CO₂ emissions compared with other fossil fuels. This combined with the current liberalisation of the energy market will lead to increased gas consumption in Ireland. Infrastructure investments, of which the development of the Corrib field is a significant part, will cater for the predicted increased demand in gas, contributing to the long-term economic well-being of Ireland.

4.1.1 Energy Sources in Ireland

Ireland currently uses coal, oil, gas, wind, hydroelectric and peat as sources of energy. As the demand for energy increases, it is expected that gas will have increasing importance in power generation because of the significantly greater efficiency of combined cycle gas turbine generators, the lowest CO₂ emissions per thermal unit of fossil fuels and the resulting relatively benign environmental impact of the emissions.

Figure 4.1 European Gas Network

![European Gas Network Diagram](image-url)
Substitution of other fossil fuels by natural gas in power generation has the potential to assist in achieving Ireland's targets for reduction of greenhouse gas emissions under the Kyoto protocol.

4.1.2 Need for the Terminal

The Corrib field is located in the Atlantic Ocean, some 65km off the west coast of Ireland, shown in Figure 4.2 below. To supply consumers in Ireland the gas must be brought ashore from the offshore wells. The gas must be conditioned to meet BGE specifications before entering the national transmission system for subsequent use by domestic and industrial users. This conditioning can be carried out either offshore or onshore.

An onshore reception facility is required near the landfall regardless of whether the gas is processed offshore or onshore. However the size of the onshore terminal and activities to be undertaken in it will depend on where the gas is processed.

4.2 Development Concept Alternatives Considered

The selection of development options and technologies for the Corrib project followed the approach normally adopted for major projects. Initially a very wide range of options was considered at a high level. The range of options was narrowed and refined in a progression of engineering studies, each study going into considerably more detail than the proceeding one. The studies were:

- pre-feasibility;
- feasibility;
- front end engineering; and
- detailed engineering.

The process began in late 1998, when Enterprise Oil (now Shell E&P Ireland Limited) undertook a pre-feasibility study into the different options for the development of the Corrib field.

4.2.1 Development Concept Selection

In the pre-feasibility study a number of development concepts to exploit the gas in the Corrib Field were identified through a series of screening exercises in order to select and define the preferred development strategy.

Key considerations in the selection of the development concept were the characteristics of the Corrib field location. Compared with gas production facilities in other parts of the world, the Corrib Field lies in deep water, it has a harsh marine environment, there are no existing gas production facilities in or near Corrib, and there is an active fishery.

Conceptual assessments (of safety, operations and cost) concluded that due to these factors the most robust technical solution would be to carry out the
gas conditioning onshore. The reasons for this are discussed in Section 4.2.2.

The principal development concepts considered were:

- construction and installation of a deepwater fixed steel jacket or compliant tower with processing, drilling and accommodation facilities together with the installation of an associated gas export pipeline to shore;
- construction and installation of a "shallow" water (<100m depth) fixed steel jacket, at a location between the Corrib Field and the shore, with minimum facilities together with the installation of associated subsea infrastructure (feeding gas from Corrib) and an export pipeline transporting gas to shore;
- construction and installation of a Tension Leg Platform (TLP), a buoyant "SPAR" platform, deep draft semi-submersible floating platform, or tanker-based floating production vessel;
- subsea development with a moored control buoy and telemetry link to an onshore control station and an onshore terminal; and
- subsea development with electro-hydraulic control via an umbilical and an onshore terminal.

The three former options would be provided with processing and accommodation facilities and the two latter options would be combined with subsea completions, subsea production infrastructure, and a subsea gas pipeline transporting gas to shore. All options would require an onshore terminal for reception, methanol (Shallow water platform only) and condensate storage (for safety and environmental reasons), gas metering and odorisation facilities.

**4.2.2 Reasons Why Alternative Concepts were Eliminated**

Economic analyses determined that the very high capital and operating cost of each of the floating or fixed platform options, combined with the requirement for extensive gas transport infrastructure, could not be recovered due to the relatively moderate size of the predicted Corrib reserves and envisaged gas sale price, consequently the first four of the development options were eliminated. Safety, environmental and technical considerations supported this decision including:

- the water depth and hostile nature of the marine environment in the Corrib field area pose major engineering difficulties for a fixed steel jacket or compliant tower. The latter has only been used in the more benign environment of the Gulf of Mexico;
- the floating production concepts are similarly not suited to extended field life in the prevailing harsh environment, with large bore high pressure gas export risers presenting a particularly complex engineering problem;
- Floating production concepts are also mostly associated with oil production where storage volumes are important;
- Remote Control Buoy technology has not been developed for the extreme environmental conditions experienced in the Corrib field area. Development of an acceptable, reliable system could not be guaranteed within the proposed project time scale;
- for all of the offshore manned facilities there are significant safety implications, due to the need for regular and frequent offshore transfer of personnel by helicopter, the requirement for full time standby vessels at sea regardless of weather conditions, the very confined layout with personnel quarters in close proximity to hazardous operating equipment and the restricted escape options in the event of an emergency;
- the offshore facilities have greater environmental impacts due to increased consumption of resources and greater emissions during construction, installation and operation;
- the offshore facilities pose greater environmental risks during installation and operation as the hostile marine environment at the Corrib field would increase the risk of spills and make spill remediation more difficult;
- the offshore facilities pose greater safety risks to personnel in the decommissioning phase, due to the need to work offshore in such a harsh environment;
- the offshore facilities involve much greater environmental risks in the decommissioning phase as the hostile marine environment at the Corrib field would increase the risk of spills and make remediation more difficult; and
- the relatively dry nature of the Corrib gas (eliminating the need for processing close to the well field), the high reservoir productivity (minimising the number of wells) and high initial flowing pressures allow the use of simplified production facilities with high reliability. This permits the practical adoption of subsea production technology for Corrib.

**4.2.3 Development Concept Selected**

The development concept selected for the Corrib field is a long-range subsea tie-back to a terminal onshore with an export pipeline to connect to the gas transmission grid. Whilst during the construction phase, there will be local environmental impacts, this is the only development option which, from an economic perspective would make development
feasible. It will have the lowest risks to the safety of the workforce and in total project terms have the lowest environmental impacts and risks.

Oil and Gas Industry Perspective on Subsea Developments

Non oil industry observers will be familiar with large scale North sea platforms and floating production systems and may perceive these as the "right" or "normal" method for developing offshore gas fields. Sub sea developments are by their nature less visible, have less environmental impact, use fewer Inputs of materials, minimise offshore manpower and the resultant exposure to the hazards of offshore hydrocarbon production and as such represent the way forward for offshore gas production in water depths of 200 metres or greater.

The oil and gas industry has invested heavily in research and development of sub sea technology to ensure reliable long distance production of untreated gas streams tied back to either an existing platform or an onshore terminal.

Sub sea production in the North Sea commenced some 25 years ago and has now reached mature technology status. Sub sea technology development has enabled smaller gas fields such as Corrib to be developed safely and economically.

Currently there are two major gas field developments in Norway (Ormen Lange and Snovit) and one in Egypt (Scarab Saffron), which will be developed as sub sea tie backs to onshore terminals.

Thus the development concept for Corrib follows a very clear trend elsewhere in the oil and gas industry, a trend, which is driven by environmental, safety and economic factors.

4.2.4 Feasibility studies

Three feasibility studies were commenced in mid 1999 to examine and refine the main elements of the development concept. The feasibility studies considered:

- offshore field development options;
- landfall, terminal location and onshore pipeline routes; and
- layout options and terminal gas processing technology.

The feasibility studies were undertaken in parallel by independent consultants and, on completion, Shell Corrib combined the findings of the three studies to determine the best overall development concept.

4.3 Gas Field Development

4.3.1 Gas Field Development Feasibility Study

The field development feasibility study examined the development concept, identified in the pre-feasibility study, and addressed the engineering requirements and appropriate technologies. It was concluded that there should be about seven subsea wells, which would be tied back to a central, subsea collecting system known as the manifold. The manifold would be connected to a pipeline to shore. All of the subsea facilities would be operated remotely from a shore based terminal via an electro-hydraulic remote control system. Electrical power and signals, along with hydraulic control and chemical injection fluids would be carried in a composite underwater umbilical cable, laid in the seabed.

4.3.2 Constraints Imposed by the Development Concept

The field development feasibility study identified a number of constraints imposed by the characteristics and behaviour of the untreated gas flowing from the Corrib field to the terminal. These are discussed below.

Due to the pressure and temperature changes and the chemical composition of the gaseous well stream, the pipeline could be blocked by ice-like crystalline structures known as "hydrates". The length and routing of the pipeline, and the presence of water and hydrate inhibitor in the pipeline would cause slugging. These constraints require good engineering and operating practices to ensure safe and reliable operation of the offshore production system and the pipeline to shore. The distance between the wells and the terminal influences the operability of the system. This distance needs to be kept as short as possible to maximise the operability of the system and minimise the size and frequency of slugging.

The control umbilical would be a key component of the system. Construction joints in the umbilical would be a potential source of failure and should be eliminated or be kept to a minimum. Consequently the length of the umbilical should be kept as short as possible.

For these reasons the study determined that the distance between the wells and the terminal should be kept to a practical minimum.

4.3.3 Field Development Engineering Design

The engineering concepts developed in the feasibility study were further refined in the Front End
Engineering phase and the Detailed Engineering phase.

The facilities which will be incorporated into the subsea scheme can be summarised as follows:

- Subsea 'Christmas trees', a series of isolation and control valves;
- Subsea production chokes (pressure reduction and flow control);
- Pressure and temperature sensors;
- Well gas flow meters;
- Manifold isolation valves; and
- An internal pipeline integrity gauge (PIG) launching connection (for possible future use).

4.4 Examination of Alternative Landfalls, Terminal Sites and Onshore Pipeline Routes

4.4.1 Landfall Pre-Feasibility Study

The Corrib field is located in the Atlantic Ocean, some 65km off the west coast of Ireland. The natural gas transmission pipelines, are in the midlands, east and south of the county. It was apparent that whichever field development concept would be adopted, the Corrib project would require a pipeline to shore and onwards to connect to the existing gas grid.

Consequently, in 1998, in parallel with the development concept pre-feasibility study, a study was undertaken to determine suitable locations to bring a pipeline ashore.

The coastal morphology of the West Coast of Ireland from the mouth of the Shannon to Sligo Bay was reviewed. The review used published data on environmental designations, public amenity areas, aquaculture licences, aerial photography, marine and land geological information, topographical mapping and site visits.

The review concluded that, along the West Coast of Ireland, there are extensive areas of scabbed where rock outcrops occur and this severely limited the number of locations suitable for bringing a pipe ashore. Aquaculture licences are prevalent in Clew Bay and Connamara and there are extensive tracts of coast and associated hinterland that are subject to National Heritage Area, Special Area of Conservation (SAC) and Special Protection Area (SPA) environmental designations made pursuant to EU and Irish legislation on the protection of wildlife and habitats.

The review identified four main areas where a possible landfall location might be found that would not have significant environmental impact. They were as follows:

- Killala Bay area, in Counties Mayo and Sligo;
- The eastern side of Broadhaven Bay and Black sod Bay in Co. Mayo;
- The Emlagh point area, to the west of Westport In Co. Mayo; and
- Liscannor Bay and Doughmore Bay in the central part of Co. Clare.

The above locations were then subjected to a more detailed appraisal in terms of:

- Environmental constraints and potential impacts;
- Offshore pipeline routing;
- Technical feasibility and costs;
- Pipeline shore approach and landfall construction issues;
- Possible onshore terminal locations; and
- Onshore pipeline routing and construction considerations.

This appraisal refined the previous information and lead to the identification of four areas for a more detailed study. These locations were:

- North or south of the Sruwaddacon inlet, in Broadhaven Bay, Co. Mayo, with the reception terminal located inland at Bellanaboy Bridge;
- Bunatrahir Bay, Co. Mayo, with the reception terminal within 0.5km of the landfall;
- Ross Point on the south side of Killala Bay in Co. Mayo, with two possible reception terminal sites, one at the landfall and the other some distance inland adjacent to the former Asahi plant; and
- Between Lenadoon Point and Rathlee Head, on the east side of Killala Bay, Co. Sligo, with the reception terminal at the landfall.

4.4.2 Onshore Pipeline, Landfall and Reception Terminal Siting Feasibility Study

In mid 1999, coincident with the feasibility studies for the field development and the onshore terminal, a feasibility study was commissioned to identify landfall locations, terminal sites and onshore pipeline routes. The study used the findings of the landfall pre-feasibility study as its starting point.

The four potential landfall areas were examined. Landfalls in each area were identified and a suitable terminal site (or sites) was identified for each landfall.

The main criteria against which the terminal sites were judged were:
minimisation of distance from Corrib field to terminal;
sufficient area of suitable land;
sufficient distance from nearby housing;
minimisation of impact to environmentally sensitive areas; and
minimisation of visual impact and intrusion.

The conclusions of the study were as follows:

- Rathlee – primary constraint identified was the visual impact of the terminal. All locations would be highly visible and would have been difficult to screen.
- Killala – several landfall locations were considered around the bay. The most suitable landfall location was a designated Special Area of Conservation and Natural Heritage Area; another was a recreational beach area. The areas to the west of the bay, which were the best landfall locations, were designated as being of Special Scenic Importance. No suitable terminal location could be identified within a short distance of the landfall. The option of locating the terminal adjacent to the former Asahi site was considered but later discounted on the basis of its distance from the Corrib field, see Section 4.4.3.
- Bunatrahir – the beach area was designated as an area of special recreational importance. Also, it was considered that the sandstone bedrock in the area could cause problems for landfall construction. The nearby beach at Portnahealy was considered. One of the main disadvantages was the visibility of the potential terminal sites. The land is very flat and exposed and the sites were particularly visible from the R314 road into Ballycastle.
- Broadhaven Bay – The ground conditions of the foreshore and approach are predominantly sand and were considered ideal for landfall construction, allowing rapid natural regeneration. The area around the landfall was designated as an Area of Special Scenic Importance and the road along the coast and estuary was designated as a Scenic Route. The land, close to the landfall, was gently undulating with no existing screening. It was considered that any potential terminal sites within a short distance of the landfall would have a major visual impact and would not be easy to screen. A location within commercial forestry, which provided existing natural screening for visual impact, was considered. Although the bay is a candidate for SAC status, the terminal development would not be in an area covered by the proposed SAC.

The feasibility study also considered routes for a pipeline from each reception terminal to connecting points to the gas transmission grid.

4.4.3 Selection of Broadhaven Landfall

As explained in Section 4.2.4 above, on completion of the three feasibility studies, Shell combined the findings. The field development feasibility study had determined that the distance from the field to the reception terminal should be minimised. Locating the landfall and terminal in the Broadhaven area would give the shortest distance from wells to terminal. An alternative considered at this stage was to separate the umbilical from the pipeline. The umbilical would be brought ashore at Broadhaven and the pipeline would be brought ashore at one of the other landfalls. This alternative was discounted on the basis of practicality, safety, security and cost. Moreover, because the longer pipeline distances involved would result in excessive pressure loss in the pipeline and in the hydrate inhibitor line(s), the terminal would require a larger slugcatcher, additional power for gas compression and inhibitor pumping thereby increasing the size of the facilities and associated environmental emissions onshore.

The Killala and Bunatrahir options would involve considerably greater distance between field and terminal, which would require an umbilical which would be longer than current industrial experience.

Consequently the Broadhaven landfall was chosen.

4.4.4 Selection of Bellanaboy site

The feasibility study had identified a potential terminal site in an area of forestry close to Aghoos, to the north of the Bellanaboy site. When the Front End Engineering Phase and preparation of the EIS for the reception terminal commenced terminal sites were considered in detail.

A terminal location near the landfall was considered. This site was located to the south-west of Pollatomish, at the bottom of the hill inland from Brandy Point. Whilst the location cannot be seen from the south-west, it is not considered possible to screen it effectively from the road or from some residential properties. It would be completely open to views from the bay. Given the scenic nature of the area, and the conservation status of the bay, this location was discounted as it was considered that the terminal would be intrusive.

Site visits determined that the terminal at any potential location between Ross Port and the forestry near Aghoos would be very intrusive and would have a major visual impact on this scenic area. The Bellanaboy Bridge site was selected as it gave better immediate screening to the terminal than the site nearer Aghoos, identified in the feasibility study.
4.4.5 Examination of Alternative Locations Within the Bellanaboy Site

Various options were considered to minimise the overall environmental impact of the terminal. The first of these was to select a location on the Bellanaboy land where existing screening is present. The terminal layout and design were optimised to minimise visual impact. Alternatives that did not offer a reduction in visual or other impacts were discounted.

In particular a design that provided low initial visual impact was progressed on a site in the southwest corner of the Bellanaboy land. This area is the lowest lying in the land acquired by Shell and has established tree screening to the west and to a certain extent to the south. The site design was based upon three terraces in order to further minimise visual impact and permit, by cut and fill, the creation of flat site levels clear of the wet ground that characterises this location.

Further studies indicated that a better site would be on the land adjacent and to the east of the original location. A number of issues influenced this, the key ones being visual impact, peat thickness and groundwater issues.

Whilst this land is higher in elevation, detailed analysis showed that the immediate visual impact is reduced even more than that of the original site due to the presence of taller established forestry combined with cutting the terminal site into the hillside. The cut and fill levels will be designed to minimise the import and export of material to the site.

The buildings and onsite structures have been designed to be multiple low level rather than multi-story. The buildings will be designed in sympathy with the local surroundings using local materials and colour schemes.

There are seven items of equipment whose design means that from some viewpoints they will protrude higher than the tree line. Two of these are the HP and LP flare stacks, combined in a single structure. Alternatives using ground flares rather than elevated flare stacks were considered but were discounted as only suitable for use in routine maintenance flaring and not for full capacity flare use. A ground flare will be used for maintenance.

4.5 Examination of Alternative Construction Methods

The ground works will be one of the principal elements of the construction project. It is estimated that up to 450,000m³ of peat and up to 50,000m³ of mineral soils will be removed from the site to create a suitable platform for the terminal plant and equipment, at an elevation that will ensure that the existing forestry screens the site.

The main issues considered in order to determine the best solution for site preparation and the alternatives, including why they have been discounted or selected are discussed in this section. It also takes into account the grounds for refusal by An Bord Pleanala of permission for the previous scheme, which included the proposal to store the peat onsite.

4.5.1 Required Characteristics of Terminal Platform

The proposed terminal site is at a slight incline, of approximately one in forty, and is underlain by a layer of peat, of varying thickness, which in turn overlies mineral soil.

In considering the development of the site, Shell had the following options:

- build the terminal on the slight slope, or
- re-grade the site to create one or more flat terraces.

A flat site is proposed for the following reasons:

- for ease of construction and maintenance access to areas of plant should be from level roads;
- hard standings to facilitate fire fighting around storage tanks should be at the same level as the tanks being served;
- ease of operations, maintenance and emergency access and egress, stairs and access routes should be simple;
- embankments (possibly with retaining walls) would have to be introduced in a split level site, thus increasing the area required; and
- equipment design, operation and maintenance would be far more complicated if there were differences in relative elevations on a sloping or split level site.

In considering the foundations for terminal structures, and equipment, the options were:

- found the terminal on the peat and/or the mineral soils;
- treat the peat and/or the mineral soils in order to increase their strength; and
- found the terminal on bedrock.

It was concluded that minimal differential settlement of the ground in different areas of the terminal would be essential because:

- for safety and operability, particularly for equipment operating under high pressure, piping and equipment require very tight tolerances on differential settlement;
- pipersacks, piping and equipment design and installation would be very complex in a plant subject to differential settlement, as flexible connections would be required throughout, and
- excessive settlement would create operability difficulties for equipment such as pumps, turbines and compressors.

4.5.2 Foundation Options in Peat and Mineral Soil

In determining how a flat site, with minimal differential settlement could be achieved, consideration was given to the question: Can the peat and mineral soil be utilised to support foundations?

The geotechnical site investigation work concluded that the peat would have very low load bearing capacities and would give rise to excessive, variable and difficult to predict settlements, if subject to foundation loads. It was determined that it would not be feasible to achieve the necessary foundation criteria in the peat, without improving its engineering properties.

Of equal importance was the suitability of the peat as a platform from which to construct the terminal buildings and erect the terminal structures. It was concluded that the peat, without improving its engineering properties, would not provide a suitable surface, and would not be a stable platform from which to undertake construction works.

The engineering properties of the mineral soils vary. However, most of it has sufficient strength to provide suitable foundations for terminal structures and equipment. The mineral soil would also provide a stable construction platform, provided rainfall runoff was carefully controlled to avoid water collecting, as ponding would soften the mineral soil.

4.5.3 Peat Improvement Techniques

Various methods were considered for improving the engineering properties of the peat and mineral soil. The techniques and the advantages and disadvantages associated with each are outlined below.

Ground Improvement by Either Vibro Stone Columns or Vibro Concrete Columns

This technique would require the placement of columns on a regular grid covering the complete area of the proposed works followed by a geogrid reinforced granular mattress. This would create a sound-working platform for the construction of the works.

This method was discounted due to the need for in excess of 10,000 columns. The equipment to install the columns would also require stable working platforms, necessitating the import of additional fill because the peat would not provide a stable platform. This method would result in the terminal being built at a higher elevation creating a more significant visual impact and the traffic movements related to material import would also be high.

Surcharging the Peat

This option was reviewed but was discounted. If the peat and mineral soil were surcharged with sufficient load, for a sufficient duration, they would be consolidated and compacted. This would increase their strength and, by causing settlement to occur in advance, would result in reduced settlement when loaded by the terminal equipment and structures.

Surcharging of the peat and mineral soil would require a considerable thickness of fill to be laid on the peat. The thickness could then be reduced after design settlement had been achieved. This solution would result in the terminal being built at a higher elevation creating a significant visual impact. The long-term settlement would be an issue over the life of the plant because, although the peat would have been compressed, its engineering characteristics would continue to be uncertain and hence lead to uncertainty in determining future differential settlement. The surcharge would have to be left in place for a significant length of time to maximise the strength gain and the consolidation of the peat. This would delay the overall schedule. This Option also had high associated traffic volumes.

Treatment of the Peat

There are methods by which soft soils such as peat can be treated. The addition of either lime or cement can greatly improve the strength properties. In recent years peat improvement techniques have proved successful for road and rail construction and for enabling works but have yet to be proven for building and equipment foundations.
4.5.4 Foundations on Bedrock with Peat Retained

It was considered that the peat could not be improved sufficiently to provide an adequate founding medium for the terminal buildings and structures. Consideration was then given to the following techniques, which would allow the peat to remain in place, yet provide a stable construction platform, with foundations supported on piles on the bedrock.

Creation of Fully Piled Concrete Raft

A piled concrete raft would be constructed on top of the peat over the terminal footprint area, on which to support the equipment, structures and/or buildings. The raft would offer the advantage that it would act as a single foundation for all the works both temporary and permanent. However, it would require a significant volume of imported fill to create a level platform. Furthermore, the raft itself would be a major construction project. It would require a considerable number of piles and a considerable volume of reinforced concrete. This option would result in a much higher terminal elevation creating a significant visual impact. There would also be schedule implications as the raft would have to be constructed before the main terminal works could commence. The import of this fill and ready mixed concrete would generate significant environmental impacts related to vehicle movements.

Addition of a Graded Fill Blanket

The principle of this alternative is to leave the peat in place and to introduce a complete blanket coverage of a graded rock fill over the entire area of the site. The rock fill blanket would provide a construction platform. The main structures and equipment would be supported on piles on the bedrock, through the rock blanket. Site roads and hard standings would be support on the rock fill blanket.

Settlement of the peat would generate maintenance issues during the life of the terminal because all the unpiled areas would consolidate over time. This alternative would also result in a much higher terminal elevation creating a significant visual impact. This option would require an enormous volume of rock fill, which would be difficult to source locally and would have major traffic implications.

As all of the techniques for improving the strength characteristics of the peat and retaining the peat on site had considerable disadvantages, the assessment then considered firstly partial and then total removal of the peat.

4.5.5 Partial Peat Removal

In this option the peat would be removed from the parts of terminal footprint in which the main structures and equipment would be located. The main issues arising from this option can be summarised as follows.

A significant volume of imported fill would still be required to provide a construction blanket and pile head restraint. A significant volume of peat would have to be removed which would also require the initial construction of temporary haul roads. This option would result in the terminal being built at a higher elevation, causing greater visibility and therefore a more significant visual impact. The import of fill would also generate a significant amount of vehicle movements. Settlement of the remaining peat would generate maintenance issues during the life of the terminal because all the unpiled areas would consolidate over time. Measures to minimise the effects of settlement on underground drainage systems would also have to be implemented.

4.5.6 Total Peat Removal

Total peat removal was considered. The plan would involve the excavation of the peat and underlying soil and rock to create a level platform. This would ensure a stable working platform for the construction of the terminal and eliminate the maintenance and operability problems associated with differential settlement. The terminal elevation could be chosen to ensure that the visual impact was minimised.

However, very large quantities of peat and some mineral soils would be generated for which a use or disposal site would be required.

It was concluded that if an environmentally appropriate reuse or disposal option could be identified for the excess peat and mineral soils, total peat removal would present the best practical option for the terminal, both for its construction and operation.

4.5.7 Peat and Mineral Soil Re-use

The reuse of the peat and mineral soil was considered.

The excavated peat would not be suitable as an engineering fill material. It cannot be laid down and compacted to meet engineering criteria. The characteristics of the mineral soils are quite variable. Some of this material would be reusable as fill but not all of it.
4.5.8 Alternative Uses of Peat

Investigations were undertaken to identify and assess alternative means of utilising the excavated peat. These are described below:

Fuel In Power Stations

The use of the excavated peat as a fuel in power stations has been investigated in discussions with Bord na Móna. It was determined that the peat would be too wet to be used directly as fuel and a complex and time consuming procedure of drying the large volumes would be required. In addition, there would be the issue of haulage from the site to the power stations (it is understood that the local peat burning power station at Bellacorrick will cease operation by the end of 2004). These issues determined that it would not be feasible to use the peat as a fuel.

Gardens / Horticulture

The type of peat used for horticultural purposes is termed Younger Sphagnum Moss Peat. The peat present on the terminal site is Blanket Bog Peat, which has been humified too much and its structure broken down. It is therefore not suitable as a horticultural material.

There is the possibility that the peat could be used to improve soil texture in agricultural land. However, the very large quantities of peat to be excavated make this alternative impracticable due to the infinite variety of potential locations and the uncertainty over the timescales in which the peat could be removed.

Fuel for Domestic Use

Market demand was deemed too small relative to the quantities of peat involved. Use as domestic fuel would also entail a lengthy process of drying, need land to dry out material to a depth of 0.1m as well as the difficulty of distributing the peat as discussed above.

4.5.9 Peat Storage Proposal

Since any offsite reuse or disposal option would involve significant traffic movements and consequent impact, on-site peat storage was investigated.

A method was identified to store this peat on a site adjacent to the terminal in an engineered repository. This solution had the advantage of a short haul distance within the construction site, thus avoiding the use of public roads. It also offered the possibility of utilising the storage area for future planting or forestry. To avoid importing substantial quantities of fill, and thereby minimise the traffic impacts, the repository would have been founded on the in-situ peat.

Shell’s previous Planning Application to Mayo County Council incorporated the peat repository. While Mayo County Council granted permission, the repository was the reason for refusal of planning permission by An Bord Pleanála, which had concerns over the drainage and the long-term stability of the stored peat.

Offsite Removal

Transportation of the peat offsite by various means was considered depending upon the location of the deposition site or end use. Export of the peat away from the area by barge was considered but discounted for the following reasons:

- the Sruwaddacon Estuary would have to be crossed. This would increase the time and costs for installing the pipeline;
- building a new pipeline in a short timeframe may not be possible;
- there is no adequate mooring point for a barge. Therefore barges would have to be moored more than 2km offshore from Glengad and a pipeline laid out to the barge;
- the distance to pump would be almost the same as to Srahmore area, 9km pipeline length and 1.2km offshore;
- this would be a large volume for any barge system to collect and then deposit in another place; and
- acquisition of the necessary wayleaves would potentially impact on the project schedule.

4.6 Current Proposal – Peat Removal

Following the An Bord Pleanála refusal, all options were reviewed, including the alternatives for retaining the peat in situ and treating it, which had been investigated prior to the previous Planning Application.

The review determined that total peat removal was the preferred method of dealing with the peat on the footprint.

Given that the option to retain the peat in a repository on site was rejected by An Bord Pleanála, and the difficulties with other options referred to above it was necessary to consider the potential for depositing the peat off site.

A number of sites were considered and the methods whereby the peat would be removed and subsequently deposited were also assessed.
4.6.1 Peat Removal Options and Sites Considered

An assessment was made of potential deposition locations, in the Erris area which would be acceptable from a planning and environmental point of view. The criteria used to identify potential sites were:

- Landownership: ease with which site could be made available for development;
- Gradient; a flat site with no evidence of stability problems;
- Drainage: well drained site that would not have any potential impacts on adjacent water courses;
- Access by road: good road access from Bellanaboy site to minimise impacts on local road users;
- Worked bog: preference for an already worked bog to avoid sterilisation of peat reserves; and
- South of Carrowmore lake or in Glenamoy catchment to avoid any potential risks to Carrowmore lake.

The various sites considered are presented in Table 4.1.

Table 4.1 Potential Sites for Peat deposition

<table>
<thead>
<tr>
<th>Potential Site Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collett land to south of R314</td>
</tr>
<tr>
<td>Site north and east of terminal site</td>
</tr>
<tr>
<td>Site at Bamatra</td>
</tr>
<tr>
<td>Site at Glenturk</td>
</tr>
<tr>
<td>Eight sites belonging to Bord na Mona</td>
</tr>
<tr>
<td>Local landfills</td>
</tr>
<tr>
<td>Retain 50% on site in old peat repository</td>
</tr>
</tbody>
</table>

On the basis of the assessment the favoured site is a Bord na Móna cut over peatland, at Srahmore, to the north west of Bangor Erris.

This site, approximately 11km away from the proposed terminal site, is one from which the peat has been harvested for a local power station. The peat from the terminal could be deposited at this site, which is nearly flat (basin shaped) and has been drained.

Having identified a deposition location, consideration was given to the method of transporting the peat from the terminal site.

4.6.2 Assessment of Transport Methods

A number of possible peat transport methods were considered by Shell and its consultants, including, experienced earthworks contractors. The methods are summarised below:

4.6.3 Alternative Peat Transport Options

The possibility of transporting the peat from the Bellanaboy Bridge Site by rail was considered. Issues which were identified included:

Transport the Peat by Rail

- installing a temporary rail link would take a considerable amount of time given the many stream and small river crossings required. It would be a major construction project in itself;
- wayleave agreements with landholders would be required;
- there would be severance of farms;
- train drivers may require special licences as there would be several roads to cross as well as many private driveways;
- loading and unloading facilities would be considerably more complicated for trains than for trucks or for a pipeline; and
- there would be no residual benefit to the community of either a train system which would have to be removed after use.

Pump the Peat

Pumping the peat in a pipeline to Srahmore was considered.

Following are some characteristics and problems associated with pumping, in general:

- two types of pumping are possible, either as a paste with 0-1 times water added or as a more liquid waste with 5-6 times water added. As liquid waste, the volume would be 6-10 times as large as a paste (2-4 million cubic metres);
- it is possible to pump the peat;
- this quantity, distance and timeframe has never been done before;
- to progress the proposal some investigation and sampling of the peat would be required to determine rheology and settlement patterns;
- to ensure a reliable, working system, extensive testing and trials would be required. There are also potential environmental problems with the risk of run-off of the liquid waste into rivers.
- pumping paste would require a much higher pressure than pumping as a liquid and therefore would require a steel pipe;
- pumping paste may require intervention during operation to clean the system or provide additional pumping. This may pose a serious risk for a pipeline crossing watercourses.
• pumping liquid waste would require large amounts of water for mixing; and
• wayleave agreements may also be required for a temporary pipeline but it might be possible to lay the pipeline along the road with minimum disruption.

Pumping to Srahmore raised a number of issues:

• a temporary pipeline should be buried alongside road to avoid disruption to road users;
• there would be concern at the receiving end with handling liquid peat. Bord na Móna would consider taking and depositing peat delivered by truck as they consider that receiving the peat in solid form is the most feasible and environmentally the safest option; and
• there is uncertainty about the characteristics of the peat in 5 or 10 years time, if the peat would be stable and if vegetation would colonise the deposit.

During consideration of these factors it was concluded that there were constraints on the pumping option based upon:

• uncertainty about pumping a paste type substance over 10km distance (several intermediate pumps may be required, additional water injection, etc.);
• the handling difficulties to be dealt with at the deposition location if the peat is pumped in liquid waste form (containment, bunds, drainage, etc.);
• the pipeline difficulties to be resolved including temporary wayleaves;
• the extensive testing regime, which would be required to prove the feasibility of pumping and the time required to undertake this (characteristics of the peat, preliminary pump trials, more extensive scale trials, etc.); and
• environmental risks to watercourses caused by the disaggregated nature of pumped peat.

It was therefore decided on environmental and logistical grounds that further study of this option would not be beneficial.

Peat Transport by Truck

The use of trucks travelling on the public roads to transport the peat would be simple, practical and a proven method. The roads are already there. There would be no new severance and new wayleaves would not be required. The transport operation would be expected to take up to six months. It would be necessary to upgrade the roads between the terminal site and Srahmore and to take other measures to minimise disruption to other road users.

The upgraded road network would be a residual benefit to the local community.

Bord na Mona have for many years transported significant quantities of peat in the Bangor Erris region by truck.

Having considered alternative peat transport methods, it was decided that the peat would be transported by truck on the public road.

4.6.4 Modification to Total Peat Removal Option

Following the decision to remove the peat from the site and to transport it using the public road network, construction methods were reviewed in order to reduce, to the practical minimum, the quantities of peat and mineral soil which would have to be removed from the terminal footprint.

Thus, as described in Section 4.5, a combination of different techniques are proposed to create stable construction platforms. In the process area of the terminal footprint the peat will be removed. The peat will be left in place in the access roads, the administration building area and the temporary construction facilities. Peat stabilisation will be used in these areas to increase the strength of the peat, in order to create a working platform. In the truck parking area, part of which will be used in the long term, as the terminal car park, a piled concrete raft will be constructed on top of the peat, the foundation loads being transferred to the underlying mineral soil and rock.

4.6.5 Peat Deposition Methods

Alternative methods of deposition of the peat are covered in the volume of this EIS dealing with the peat deposition site.

4.7 Terminal Technology Options

4.7.1 Introduction

The terminal feasibility study considered a range of technology options for the terminal. These technologies were refined in the subsequent Front End Engineering and Detailed Engineering Design phases.

The terminal will comprise:

• slug catching and separation facilities;
• gas conditioning facilities;
• sales gas compression;
• fiscal metering and odorising;
• condensate stabilisation and storage;
The main technological options considered for the terminal are outlined below. The various options were evaluated in terms of technical feasibility. The reasons for choosing the selected option are given.

The options for the following materials/processes are described:

- Gas Conditioning;
- Hydrate Inhibitor;
- Produced Water Treatment; and
- Mercury removal.

4.7.2 Gas Conditioning

When a wellhead gas is treated to meet a sales gas quality specification such as heating value (calorific value) and water and hydrocarbon dewpoints, the treatment is referred to as gas conditioning. This conditioning enables condensate and water present to be separated out. As the gas is produced, the reservoir pressure falls and as a consequence the inlet pressure to the terminal falls. Gas compression will be required for all gas conditioning alternatives.

Initially, the following gas conditioning technologies were studied for their suitability for use at the Bellanaboy Bridge Terminal:

- Joule-Thompson (J-T);
- silica gel adsorption;
- activated carbon;
- molecular sieve;
- mechanical refrigeration;
- turbo-expansion; and
- lean oil adsorption.

Preliminary evaluation concluded that all but the Joule-Thompson and the silica gel adsorption schemes were technically, environmentally and economically less attractive.

Activated carbon and molecular sieves are solid desiccants, which remove mainly water and condensate by adsorption. The molecular sieve method was rejected because its condensate adsorption rate is too low for the composition of the gas. Activated carbon was rejected because its water adsorption rate is very low. Compared to the Joule-Thompson alternatives, turbo-expansion requires an increased amount of rotating equipment and hence, results in reduced reliability. The turbo-

expansion option is also economically less attractive than the other alternatives.

Lean oil adsorption will not be effective at the higher operating pressures envisaged for Corrib and hence has been discounted. As sufficient pressure will be available for utilising the J-T option, mechanical refrigeration is not required in the early years of operation. Mechanical refrigeration for cooling the gas will be used when the terminal inlet pressure decreases around year 9.

Silica Gel Adsorption

Silica gel is used to remove water and condensate from the gas stream to meet the prescribed dewpoint specifications. The gas is passed through silica gel desiccant beds, which are contained in vertical vessels, where the water and condensate are adsorbed. The adsorbed components are removed from the bed by recycling hot gas through the adsorbent bed. The adsorbed components are then cooled and separated in a vessel, and the water and condensate are routed to the produced water and condensate stabilisation systems respectively.

Joule-Thompson Expansion (J-T valve)

The gas pressure is let down to a level sufficient to enable water and condensate liquids to condense out of the gas phase from where they would be separated in a downstream cold separator. As the inlet pressure to the J-T valve falls, a gas/gas exchanger would be used to pre-cool the gas, thus helping the J-T effect and improving separation. As the inlet pressure drops further (around year 9), a mechanical refrigeration based gas chiller is introduced between the gas/gas exchanger and the J-T valve to achieve the required water and hydrocarbon dewpoints.

Comparison of Silica Gel Adsorption and J-T Valve

Further studies were then conducted on J-T and silica gel technologies using a predicted set of criteria for the gas and dewpoint requirements.

The J-T option has been chosen over the silica gel option as no guarantee of operational performance could be obtained from the silica gel manufacturers with the predicted pressures and possible variations in the composition of the gas. The silica gel option would also have resulted in the periodic replacement of the silica gel beds due to reduced efficiency. The silica gel would have been classed as hazardous waste. The silica gel option would also require a regeneration compressor.

The J-T option requires gas compression from start-up, resulting in an installed thermal input of
approximately 50 MW. This installed energy requirement would necessitate an IPPC Licence from the EPA.

4.7.3 Hydrate Inhibitor

Hydrate is a solid ice-like material formed from gas and water at specific temperatures and pressures. Hydrate inhibition options were assessed to identify the best inhibitor to protect the subsea facilities and the terminal from hydrates formation during normal operation, shutdown and start up conditions. The selected inhibitor will not adversely affect water quality, or significantly increase atmospheric emissions, at the terminal and it allows for the minimisation of the environmental impact of the terminal in areas of waste generation and toxicity of the process systems.

The hydrate inhibitors investigated were:

- methanol;
- Mono Ethylene Glycol (MEG); and
- Threshold Hydrate Inhibitors (THIs).

### Methanol

Methanol is a very effective and commonly used hydrate inhibitor requiring relatively low concentrations in the gas stream. In addition to its ability to inhibit the formation of hydrates, it can also dissolve hydrates which have already formed. Methanol vaporises along with other low volatility components leaving the waste water relatively free of hydrocarbons, thereby reducing the impact on the water treatment plant. In environmental terms this is important. The cost of methanol and methanol regeneration facilities is significantly lower than that of glycol.

### Glycol

Glycol is another commonly used inhibitor. The use of glycol was rejected for a number of reasons. Glycol cannot dissolve hydrates, once they have formed. Glycol is required in higher concentrations than methanol to achieve the same degree of hydrate suppression. The glycol option would require a 3" pipeline in parallel to the subsea pipeline due to the higher volumes required and higher fluid viscosity. This would result in significant additional investment and also cause the release of aromatic volatile organic compounds known as BTEXs (Benzene, Toluene, Ethylene and Xylene) to the waste phase. Due to the environmental and occupational health risks associated with RTFX, equipment would be required to remove them from the waste water.

A glycol recovery system produces high volumes of solids that require disposal offsite as a waste, thus increasing the environmental impact. The predicted extent and cost of this disposal will make any glycol scheme less attractive. Furthermore, at current prices, fresh glycol costs are 2.5 times higher than methanol.

### Threshold Hydrate Inhibitor

Of the two types of Threshold Hydrate Inhibitors (THIs) available, the Anti Agglomerate (AA) inhibitors were ruled out due to the Comb Field's very low condensate volumes which preclude the formation of a stable water and condensate emulsion.

The other type of THIs, Kinetic Hydrate Inhibitors (KHI's), could not be used on their own for the first 8 years of the project due to their poor effectiveness in higher (above 70 barg) operating pressures. KHI's also have to be used in conjunction with a carrier fluid such as methanol. There is also a general lack of experience of working facilities using KHI's. The environmental effects of KHI use were also uncertain, especially regarding the water treatment aspects.

### Conclusion

The use of methanol was therefore selected as the hydrate inhibitor of choice, as methanol provides the most cost effective method of preventing hydrates over the life of the field. It also provides significant environmental benefits in minimising effluent production volumes and does not produce significant levels of solids.

4.7.4 Mercury Removal

Gas

Well tests in the Corrib Field have shown the presence of trace amounts of mercury in the wellstream, which is not unusual for natural gas fields.

In order to establish whether the associated emissions from using the Corrib gas as fuel within the terminal would fall within acceptable limits, exhaust concentrations of mercury were calculated for normal terminal fuel gas usage of 3 mmscfd. The calculations indicated that mercury levels were well within recognised limits. The range of concentrations measured was found to be below 10 micrograms/(mg/m³), an order of magnitude below the level recommended by EPA in the IPC BATNEEC 'Guidance Notes for the Chemical Sector'. However, in line with industry practice the gas will be passed through a mercury removal bed which will remove the mercury to below measurable levels.
Condensate

Mercury levels in the condensate are predicted to be in the range of 1ppm or less. On this basis the mercury concentrations in the heating medium heaters, where the condensate will be used as fuel, were calculated and shown to exceed current EPA guidance level. To ensure that mercury levels within the condensate will be within EPA guidance levels, mercury removal equipment will be installed. This equipment will be detailed in Shell’s application for an IPPC Licence.

4.7.5 Produced Water Treatment and Disposal

Produced water treatment is discussed in detail in Section 2 and its disposal in Section 10. Disposal options considered for the treated waste water were:

- onshore injection;
- local drainage;
- coastal discharge, no mixing;
- estuarine discharge, no mixing;
- coastal discharge, limited heavy metal removal;
- water treatment and coastal discharge mixing;
- estuarine mixing; and
- reinjection into the Corrib reservoir

The onshore injection and local drainage options were ruled out due to the possible salty nature of the waste water. Local drainage discharge to Sruwaddacon Bay was ruled out due to the shallow and tidal nature of the bay.

To re-inject water into the reservoir, it would require much larger onshore facilities for pumping, creating associated environmental emissions onshore. The laying of a second high pressure pipeline back to the field to re-inject the produced water into the reservoir would also have required a trench in the seabed. A water disposal well would be required with the consequent additional offshore environmental impacts of drilling a well to a depth of approximately 4,000m.

The chosen disposal option is water treatment, to environmental quality standard levels and coastal mixing. Discharge and dispersion modelling studies have been carried out, and are discussed further in Section 10.0.

Waste Water Treatments Considered

With the decision to treat the water to EQS discharge levels, a number of the technical options were discounted during early design phase.

Evaporation

Evaporative treatment of effluent can apply to effluents from a methanol or KHI based inhibitor system. A glycol based system effectively includes total evaporation in regenerating the glycol.

Evaporative treatment systems were discounted as they generate very significant quantities of salts for disposal.

Primary Treatment

The separation of insoluble gross oil and settleable solids content using API separators and plate interceptors (tilled or corrugated) were considered to reduce waste mass loading and protect downstream equipment.

Separate API separators would be required for the surface water runoff from the process and utility areas of the facilities. It is proposed to use corrugated plate interceptors as primary treatment.

Secondary Treatments

Flocculation, air flotation (dissolved or induced), sedimentation and filtration (gravity or pressure), hydrocyclones and absorption were considered to further lower oil in water concentrations and particulates. They are also used to enhance metals precipitation / separation.

Flocculation and precipitation by pH adjustment and sedimentation were also considered for heavy metals removal.

Pressure filtration systems were considered to reduce the volume of solids. This was selected as the preferred method of secondary treatment due to the performance characteristics.

Tertiary Treatment

Residual treatment of dissolved pollutants and metal ions using biological processes, aeration, micro, ultra or nano filtration, final polishing by ion oxohanko / granulated activated carbon [GAC] or a combination were considered.

Biological processes were discounted due to the high dissolved solids feeds, particularly the brine type fluids that will come from a methanol based hydrate inhibitor system. The effluent would require dilution to approximately 1/3 of seawater chloride concentrations for biotreatment to work. The only source of such water would be from potable water.

High pressure membrane filtration, is preferable in these circumstances and was selected.
Selected Waste Water Treatment Methods

The following has been adopted as the most effective method of achieving the required discharge limits. This philosophy has been determined as Best Available Techniques (BAT).

The two streams identified for treatment are:

- Surface water
- Produced Water

**Surface Water Treatment Package**

The process comprises of:

- Corrugated Plate Interceptor (CPI) for removing the bulk of separable oil.
- Multimedia Filters for the removal of particulate suspended solids
- Ultra Filtration (UF) for the removal of residual free and emulsified oil

The proposed treatment route will comprise the following:

- Corrugated Plate Interceptor (CPI) for the removal of suspended solids and free oil.
- Ultra filtration (UF) for the removal of emulsified oil and certain organics
- Nano filtration (NF) for the removal of the majority of heavy metals.
- Ion exchange to remove remaining traces of metal.
- Activated Carbon (GAC) for removal of trace residual hydrocarbons.

As discussed above a detailed description of the selected option is given in Section 2.