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Environmental Protection Agency
Johnstown Castle
Wexford

2014-03-19

RE: P0738-03 Shell E&P Ireland Limited

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Dear Sir/Madam

The response to the request for information to The Department forEnvironment, Community and Local Government.

They responded as follows;

> *As requested, please find enclosed a copy of the Environmental Impact Assessment, carried out for the part of the construction of the Corrib Gas pipeline for which a Foreshore Licence was granted on 22 July 2011. A copy of the Foreshore Licence is also enclosed. The Environmental Impact Assessment was carried out, on behalf of the Minister, by the Marine Licence Vetting Committee.*

The MLVC report states;

> *8. Compliance with Environmental Impact Assessment (EIA) Legislation*
>
> *The MLVC reviewed both technical and scientific aspects of the EIS. Overall, the Onshore and Offshore Environmental Impact Statements and Additional Information submitted by the developer in relation to the proposed gas pipeline development covers all key parameters required to be assessed under the relevant legislation. The MLVC is satisfied that the relevant EU and National EIA legislative requirements have been met. The MLVC is also satisfied that the Onshore and Offshore Environmental Impact Statements, including the Natura Impact Statement, and Additional Information submitted by the developer provides sufficient details to allow an assessment of the impacts of the proposed works on the foreshore on Natura 2000 sites to be carried out.*

9.13. Project Splitting

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The MLVC acknowledge that multiple consents are needed for this complex project but are satisfied that project splitting has not occurred.

10. Conclusions and Recommendations

The MLVC reviewed both technical and scientific aspects of the documentation supplied by SEPIL. The Committee is satisfied that the purpose and objective of the proposed works on the foreshore are adequately explained. In addition, the committee is satisfied that the environmental information provided is sufficient to make a recommendation on the proposed development.

The MLVC is satisfied that the works on the foreshore would not have significant adverse impacts on human health and safety, the marine environment or designated Natura 2000 sites in the area and that there are no substantive grounds for a refusal, based upon environmental considerations. The MLVC recommends that the Minister issues the necessary Foreshore permit to allow the proposed works on the foreshore to proceed subject to compliance with the specific conditions below:

Article 3 of Directive 85/337 provides:

'The environmental impact assessment will identify, describe and assess in an appropriate manner, in the light of each individual case and in accordance with Articles 4 to 11, the direct and indirect effects of a project on the following factors:

– human beings, fauna and flora,
– soil, water, air, climate and the landscape,
– material assets and the cultural heritage,
– the interaction between the factors mentioned in the first, second and third indents.'

The judgement of the CJEU states;

"development consent" means:
the decision of the competent authority or authorities which entitles the developer to proceed with the project

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It also states at 27;

Thus, section 173 of the PDA, which requires planning authorities to have regard to the information contained in an environmental impact statement submitted by a developer, relates to the obligation, under Article 8 of Directive 85/337, to take into consideration the information gathered pursuant to Articles 5 to 7 thereof. By contrast, section 173 does not correspond to the wider obligation, imposed by Article 3 of Directive 85/337 on the competent authority, to ensure that there is carried out an environmental impact assessment which identifies, describes and assesses all the matters referred to in that article

It is our submission that no Environmental Impact Assessment was carried out by The Department for Environment, Community and Local Government.

The CJEU found in Case C-66/06:

75. There is consequently no guarantee that, should those projects be likely to have significant effects on the environment, the competent authority will necessarily be able to require that an environmental impact assessment as provided for by Directive 85/337 be carried out before the decision entitling the developer to proceed with the project.

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The CJEU found in Case C-215/06 at 61;

> 61. It follows from the foregoing that, by giving to retention permission, which can be issued even where no exceptional circumstances are proved, the same effects as those attached to a planning permission preceding the carrying out of works and development, when, pursuant to Articles 2(1) and
>
> 4(1) and (2) of Directive 85/337 as amended, projects for which an environmental impact assessment is required must be identified and then – before the grant of development consent and, therefore, necessarily before they are carried out – must be subject to an application for development consent and to such an assessment, Ireland has failed to comply with the requirements of that directive.

We attach the guidelines on the carrying out of Environmental Impact Assessment under Article 3.

This development has been substantially carried out without Environmental Impact Assessment makes it unauthorised.

At this time there is no evidence before the Agency that an Environmental Impact Assessment has been carried out by any of the various consent authorities.

Yours faithfully

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Peter Sweetman and on behalf of
Monica Muller

Please respond by email to sweetmanplanning@gmail.com

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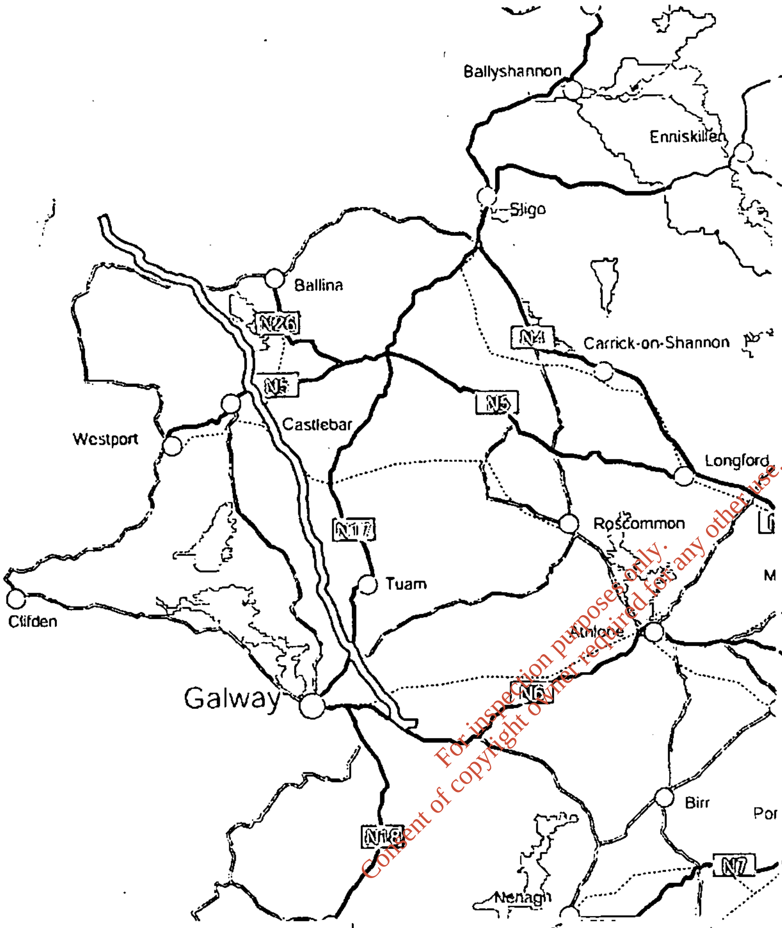
BORD GÁIS
TRANSMISSION BUSINESS UNIT

MAYO-GALWAY GAS PIPE LINE

E/S No 1633
PART 1 of 3



ENVIRONMENTAL IMPACT STATEMENT

Volume I

MAY 2001

ARUP

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Mayo - Galway Gas Pipeline

Environmental Impact Statement
Volume 1 - Main Text

May2001

Job No. C689/10

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Mayo - Galway Gas Pipeline

Environmental Impact Statement
Volume 1 - Main Text

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Prepared By: Daniel Garvey
Signed: Dan Garvey   Date: 11 05 01

Checked By: Ria Lyden
Signed: Ria Lyden   Date: 11-5-01

Passed By: Eoghan Lynch
Signed: Eoghan Lynch   Date: 11 May 2001

Revision Record

Issue No.	Date	Status	Prepared	Checked	Passed
1	1 May 2001	**Draft**	**DG**	**RL**	**EJL**
2	11 May 2001	**Final Issue**	**DG**	**RL**	**EJL**

ARUP
Consulting Engineers

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Non Technical Summary

1 Introduction

Bord Gáis Éireann intends to construct a gas pipeline with associated installations, from Bellanaboy Bridge in County Mayo to near Craughwell in County Galway. This development will form part of a series of projects to develop the Corrib natural gas field, which lies in 350m of water in the Atlantic Ocean, and bring natural gas to the west of Ireland. The Corrib field is located 70km west of the nearest coastline of County Mayo. The gas will be conveyed by subsea and landfall pipeline to the reception terminal just north of Bellanaboy Bridge.

The proposed pipeline will connect the reception terminal to the proposed Pipeline to the West, at an above ground installation (AGI) near Craughwell. This will complete the transmission of the Corrib gas to the proposed national ring main connecting Cork, Galway and Dublin.

The proposed pipeline from the Bellanaboy Bridge Terminal to Craughwell will be approximately 150km long, 660mm (26") in diameter, and buried underground throughout its length. The pipeline will be constructed in high strength steel and will operate at 85barg. Fibre optic cables in ducts will be laid beside the pipeline from Craughwell as far as Block Valve Station 2, the potential off-take point for a gas supply for Ballina. The construction contract will be into two portions, with the dividing line close to the crossing point of the N5 Dublin to Castlebar road. There may be two construction contractors. The construction period will be during 2002 and 2003.

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BGE was established under the Gas Act 1976 as the state agency responsible for the supply, transmission, distribution and sale of natural gas in Ireland. Production of natural gas commenced in Ireland in 1978, from the Kinsale Field, off the Cork coast. Since then BGE has extended the gas grid to cover a large area of the east and south of Ireland, and built an interconnector pipeline to Scotland, to connect to the European gas grid. In addition to the Mayo - Galway gas pipeline, BGE plan to construct the 'Pipeline to the West', from Dublin to Galway and onwards to Limerick, and a second interconnector to Scotland.

The Mayo - Galway gas pipeline project was initiated by Enterprise Energy Ireland Ltd as part of the Corrib field development. In late 2000 Bord Gáis Éireann (BGE) signed a contract with Enterprise Energy Ireland Ltd, whereby BGE will undertake the detailed design and construction of the pipeline.

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For the route of the pipeline refer to Plate 1.

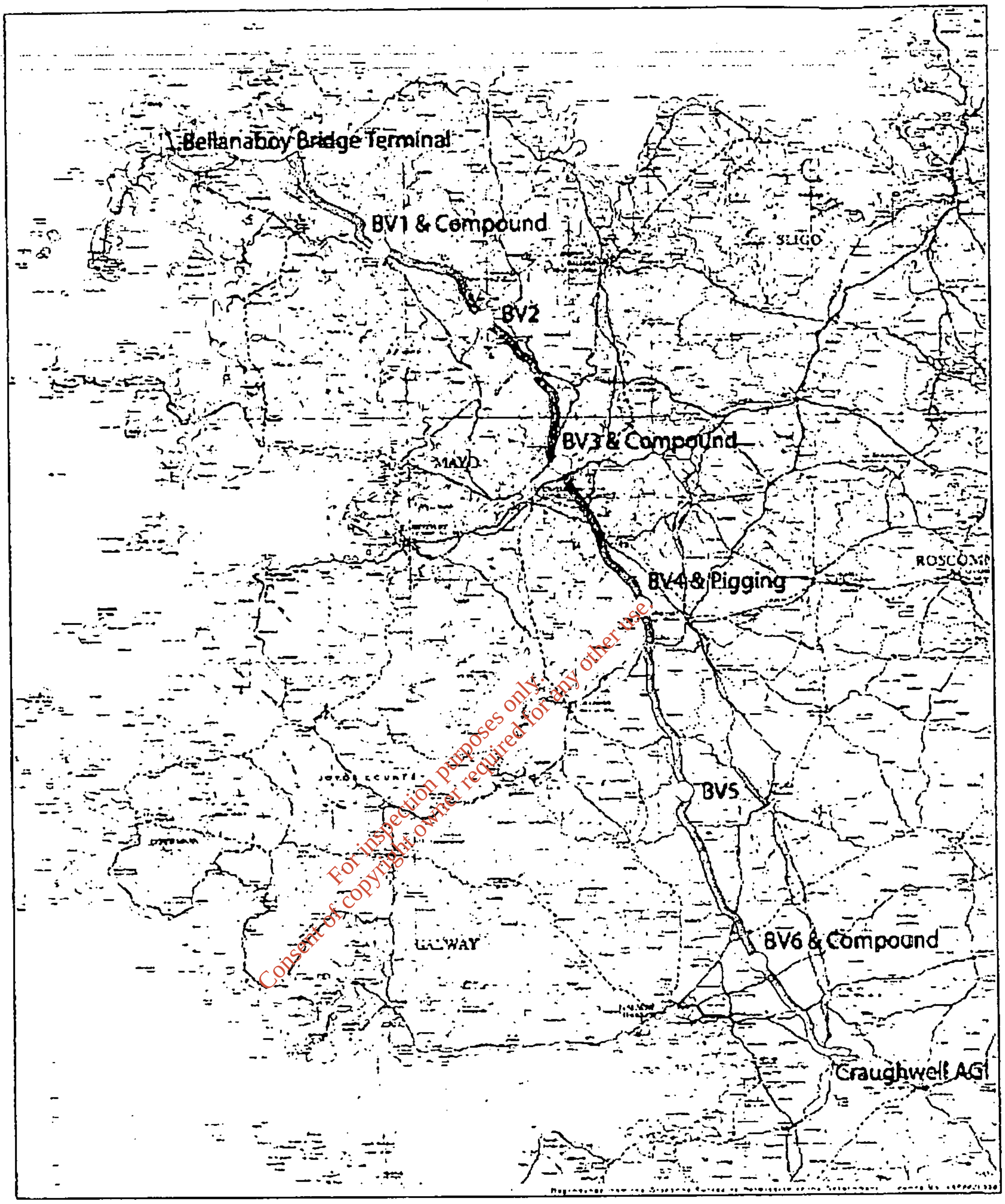

Plate 1: Pipeline Route

For more detailed information on the Environmental Impact Assessment, refer to the full EIS document, ***Mayo-Galway Gas Pipeline Environmental Impact Statement, Volumes I and II.***

The pipeline will be designed, installed, operated and maintained to meet the requirements of the latest edition of the IS 328 'Code of Practice for the Design and Installation of Gas Transmission Pipelines'.

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2 Environmental Impact Assessment

BGE must obtain the consent of the Minister for Public Enterprise to construct and operate a gas pipeline. For gas pipelines greater than a certain size and length BGE must submit an EIS to the Minister to accompany the application for consent. The Minister may attach conditions to his approval.

Gas pipelines do not require planning permission. However any above ground installations, other marker posts, such as block valve stations require planning permission from the relevant Local Authority.

The EIS has been prepared in accordance with the requirements of the European Communities Environmental Impact Assessment (Amendment) Regulations 1999, which specify the projects requiring an EIS and the information to be provided.

The principal elements of the environmental assessment process, up to submission of the EIS, which were followed during this environmental impact study, are described below:

Scoping - determining the issues to be part of the study, including further issues identified by Consultees, and the availability of data

Determination of baseline conditions - determining the criteria with reference to which the likely environmental effects of the proposed development were to be evaluated

Consultation - undertaken throughout the assessment process in order to inform interested parties and invite comment

Evaluation of significant effects/determine mitigation - an iterative process whereby the significance of potential effects is determined and design improvements or appropriate mitigation identified in order to reduce adverse effects

Determination of significant environmental effects - once mitigation/design improvements have been incorporated, the significance of residual environmental effects was determined

Reporting - the findings of the assessment are reported in an EIS, which is a public document

Consultation

Consultation is a very important part of the environmental assessment process. Consultations took place with government departments and other agencies during the environmental assessment. The main organisations contacted were:

- Dúchas (Parks and Wildlife Section)
- Birdwatch Ireland
- Irish Peatland Conservation Council
- Department of Zoology, TCD
- Dúchas (Research, Bogs and Wetlands)

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- Dúchas (Archaeological Section)
- National Museum of Ireland
- Western and Northwestern Regional Fisheries Boards
- Office of Public Works
- Bord na Móna
- Coillte
- ESB
- Eircom
- Mayo and Galway County Councils
- Geological Survey of Ireland

In addition a series of public exhibitions was held in June 2000, the feedback from which has been incorporated into this assessment.

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3 Route Selection Process

Having identified the need to construct a pipeline, the optimal route between the Bellanaboy Bridge Terminal and the gas grid near Craughwell in County Galway, was determined.

Many factors were considered during the route selection process including environmental and planning constraints, archaeology, health and safety, and socio-economic impacts. Starting at Bellanaboy Bridge in County Mayo, and ending at the proposed above ground installation (AGI) near Craughwell in County Galway, a hierarchy of constraints was drawn up to guide and inform the routeing process. These are:

a) Designated conservation areas or National Heritage Areas
b) Areas of other environmental or archaeological significance
c) Areas designated in County Development Plans as requiring special consideration
d) Areas with geology, geomorphology and topography which would present difficulties for construction and increase costs
e) Areas of potential mineral resource and/or areas of existing or future extraction
f) Densely populated areas
g) Areas of forestry
h) Crossings of motorways, roads, railways, rivers and pipelines
i) Major developments planned along the route
j) Minimising the overall length of the pipeline corridor

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Applying these criteria, a route was developed which avoids all known archaeological artefacts, and minimises impact on Special Areas of Conservation (SAC).

Features of archaeological, ecological or heritage value, lying within 1 km of the proposed route were identified. The route was carefully chosen to avoid or minimise the impact of the pipeline on these features, which include:

- three proposed Natural Heritage Areas (pNHAs) including Lough Conn which is also a Special Protection Area (SPA)
- seven Special Areas of Conservation (SACs) including Carrowmore Lake Complex, Slieve Fyagh, Bellacorick Bog Complex – passing just north of the Owenboy National Nature Reserve, and Carrowkeel Turlough
- approximately 110 archaeological sites and complexes recorded in the Sites and Monuments Record (SMR). These include an archaeological complex at Eskeragh, ringforts and enclosure sites occupying prominent positions on drumlin hillocks and ridges in townlands such as Lahardaun and Ballinvoash and an earthwork site at Annefield. In Galway there are many ringfort sites and associated souterrains as well as unclassified earthworks in the townland of Kilshanvy and Caltragh and an important battlefield as well as ringforts in the townland of Knockdoebeg West.

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4. Pipeline Construction

Timing

The main construction activities will take place during the summer seasons of 2002 and 2003. Some advance ground works may commence earlier where authorisations and conditions allow and some reinstatement works may be undertaken later.

Site Preparation

Construction activities will be undertaken within a fenced strip of land, known as the working width. This will generally be approximately 30m wide. Where prevailing conditions dictate, the working width may be reduced or widened, as appropriate. Reductions in the working width will be imposed to reduce the potential impact upon features such as hedgerows, woodlands and ecologically sensitive areas. Full use will be made of existing gaps in hedgerows and mature trees will be avoided where possible.

The working width preparation is anticipated to commence in the spring of 2002. During normal construction, the topsoil will be stripped and stored separately to one side inside of the working width in a low bund not exceeding 3m in height. It will be kept free from disturbance to reduce the risk of physical damage and compaction.

Pipe Laying

Pipe lengths will be positioned along the route and welded together. A trench will be excavated that will allow for a cover of a minimum of 1.2 m subsoil to be placed on top of the pipeline in agricultural land and 1.6 m below rivers. The welded lengths of pipe will then be carefully lowered into the trench.

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Reinstatement

The pipe trench will be backfilled with the material taken from the trench in the reverse order in which it was excavated. If necessary, subsoil forming the working width on which vehicles have run will be ripped to alleviate compaction. Field drainage will be reinstated, as necessary, at this time. The topsoil will then be spread over the working area and the land re-seeded according to the landowners/occupiers requirements.

Particular care will be paid to the reinstatement of field boundaries so as to reduce visual impact associated with construction. Hedgerow sections will be replanted in the autumn using stored material and a suitable mix of native species.

Dry-stone wall boundaries, which characterise the landscape along the route, will also have to be appropriately reinstated after the placement of the pipeline.

Testing

On completion of construction, the pipeline will be cleaned and pressure tested with water in excess of operating pressure. Each section will then be dried before being filled with gas.

Special Crossings

Railway lines and some roads may be crossed using a trenchless construction technique that minimises traffic disruption. Various other sites along the proposed route may also be crossed in this way where necessary and technically feasible. Pits will be excavated on either side of these features to accommodate the necessary machinery.

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Watercourse Crossings

The status of these watercourses with regard to fisheries will be determined in advance. The construction method and timing will be agreed with the NorthWestern Regional Fisheries Board (NWRFB) and the Western Regional Fisheries Board (WRFB) as appropriate.

Generally watercourses will be open-cut. The water will either be diverted through a temporary pipe to maintain its flow, or the channel will be dammed and the water pumped around the dam. The trench will then be excavated through the dry channel. After laying the pipe, the trench will be backfilled and normal water flow will be restored. The banks of all watercourses will be reinstated to their original form. Care will be taken in order to minimise siltation and strict site management will be in place with respect to spill prevention.

The proposed pipeline route will cross eight significant watercourses and thirteen medium to minor ones on its way through County Mayo and County Galway traversing two fisheries board regions. The principal catchments traversed are the Lough Carrowmore – Owenmore System of northwest Mayo, Lough Conn / River Moy Catchment, which drains northeastern and central Co. Mayo and the River Clare / Lough Corrib System which drains central and southern County Galway.

The typical sequence of construction activities is presented schematically below:

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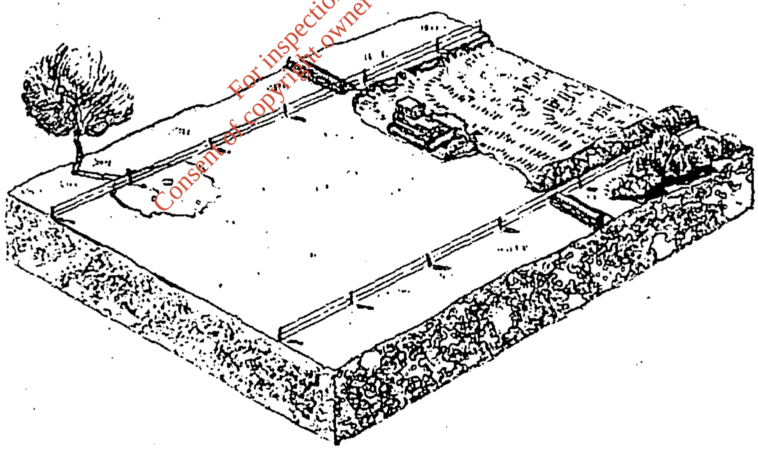

Topsoil Stripping

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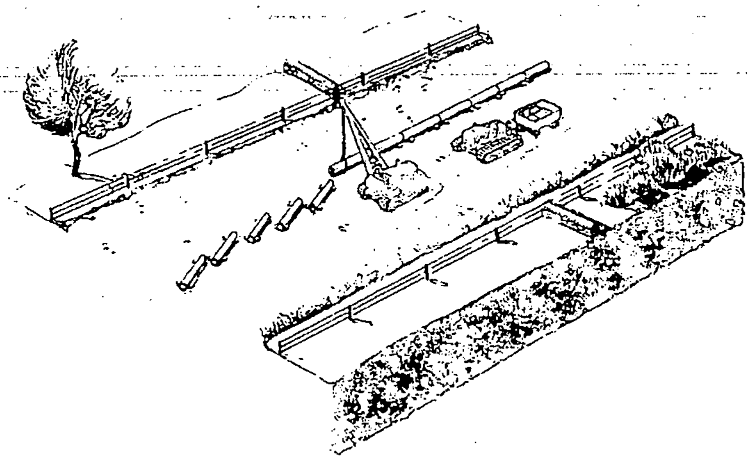
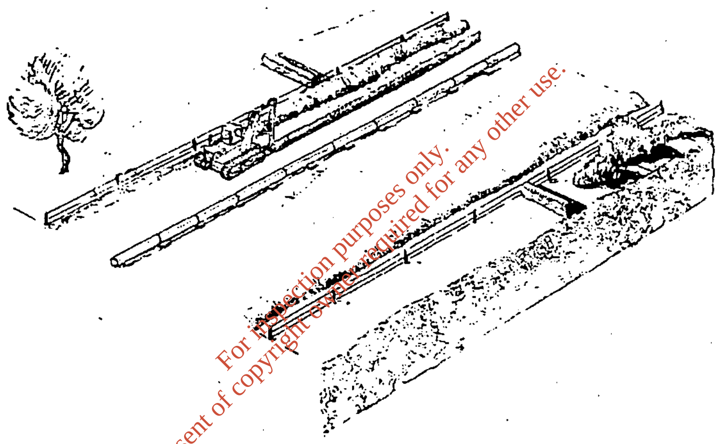


Pipe Stringing



Trench Excavation

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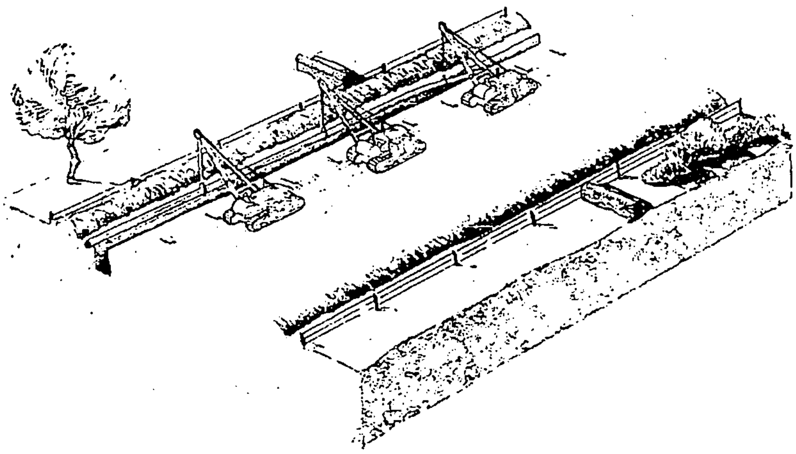

Pipelaying

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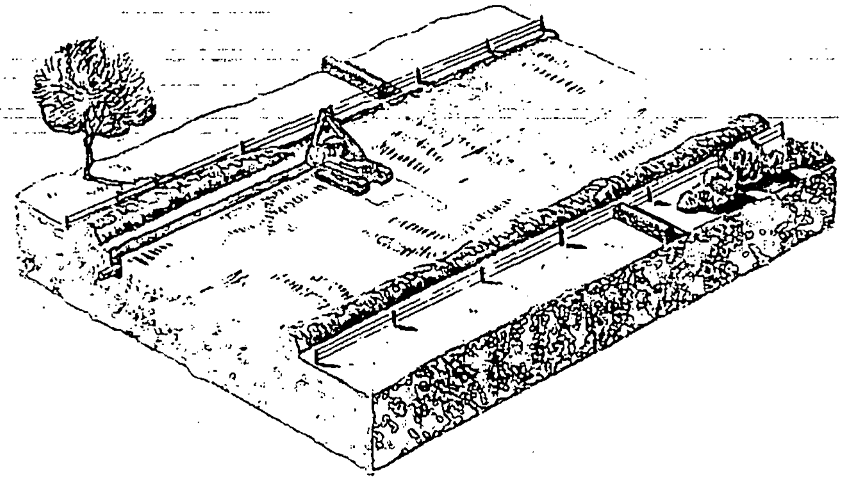

Backfilling

Above Ground Installations

There will be six above ground installations (AGI) along the pipeline route. Of these, one will be a combined block valve and pigging station and the other five will be block valve (BV) stations. BV stations will allow sections of the pipeline to be isolated, and facilitate maintenance, emergency shutdown and off-takes for spur lines. The block valve stations will also facilitate the off-take of a low-pressure gas supply to towns along the route. The pigging station will receive pigs ('pipeline integrity gauges' used for monitoring the internal condition of the pipeline) from the Bellanaboy Bridge terminal, and transmit pigs to the Craughwell installation.

The approximate pipeline distance between AGIs is as follows:

- Reception Terminal at Bellanaboy to BV1 at Bellacorick = 18.5km
- BV1 to BV2 (Ballina offtake) = 17.6km
- BV2 to BV3 (Castlebar offtake) = 22.5km
- BV3 to BV4 and pigging station (Claremorris offtake) = 21.8km
- BV4 and pigging station to BV5 (Tuam offtake) = 25.6km
- BV5 to BV6 (Galway offtake) = 25.2km
- BV6 to Craughwell AGI = 16.5km

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5 Pipeline Operation And Maintenance

Once the construction process has been completed the pipeline will be inspected, tested and commissioned, leading to full operation. BGÉ will closely monitor pressures and flow rates.

Employment of a comprehensive corrosion protection system will ensure the integrity of the pipeline and will keep maintenance requirements to a minimum. The condition of the pipe will be monitored periodically using automated internal inspections. Above ground, the pipeline will be regularly inspected by helicopter with any disturbances to the ground reported immediately and investigated.

6 Potential Impacts And Proposed Mitigation Measures

Land Use and Agriculture

The proposed pipeline route passes through mainly agricultural farmland, with the remainder being taken up by forestry, semi-natural habitats, roads, railways and watercourses.

There will be some disruption to farming activities, but this is generally confined to the construction phase. In addition, the working width will be fully reinstated after construction. In order to minimise any disruption, mitigation measures such as temporary drainage systems and access provision will be agreed with those landowners and occupiers affected.

After construction, a permanent easement of 14m will be required within which BGÉ will have the right to access, repair and inspect the pipeline, but this will not affect normal agricultural operations. The only restrictions will be to activities such as tree planting or construction.

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Planning and Policy Issues

Bord Gáis Éireann will comply with the relevant policies contained within the County Development Plans for Counties Mayo and Galway. The current pipeline project and the fibre optic cabling will be a considerable addition to the economic infrastructure of Counties Mayo and Galway and the Border, Midlands and Western Region. The availability of natural gas in the West will help to act as a catalyst to economic development, which in turn will help to redress regional economic imbalance, which is an objective of the current National Development Plan. There are considerable national economic benefits also arising from the security of gas supply to the national power-generating network.

Detailed routeing has taken account of planned developments.

Sites of Ecological Importance

The pipeline route will cross several sites, which have been identified by consultation, desktop and field survey, as being of ecological significance. These include SACs in northwest Mayo - Slieve Fyagh Bog and Carrowmore Lake Complex.

Detailed construction techniques and appropriate mitigation measures will be agreed with *Dúchas* - The Heritage Service (Department of Arts, Heritage, Gaeltacht and the Islands) to minimise environmental impact. To this end, a workshop was held with *Dúchas* to discuss these methods during the Environmental Impact Assessment (EIA) process.

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The remaining sites, although not designated, have a species and structural diversity that make them important islands of semi-natural vegetation within the predominantly agricultural landscape and act as important refuges for wildlife. These sites include small areas of blanket bog and areas of scrub and heath.

Wildlife and Protected Plant Species

BGÉ readily acknowledges its obligation to minimise the impact of the construction, operation and decommissioning activities on wildlife and in particular protected species of flora and fauna. Mitigation measures will be discussed and agreed with *Dúchas* and any necessary licences sought (note - all species of mammal amphibian are protected under the Wildlife Act 1976).

Species that may be present along the pipeline route include badgers, bats, otters, and bird species of special note such as Golden Plover. Further surveys will be undertaken if the habitats of these species are likely to be affected and any necessary mitigation measures will be discussed and agreed with *Dúchas*. In addition, BGÉ's construction contractor(s) will develop, in consultation with *Dúchas*, mitigation measures for any hedgerow or ground nesting birds that may be affected by the pipeline construction work.

Stonewall, Hedgerows and Trees

A pipeline of this length inevitably crosses numerous field boundaries. Stonewalls will be taken down, the stone stored for reuse and the walls will be reconstructed using the style and technique of the existing walls in the area, following completion of pipeline construction.

Although the pipeline will be routed to utilise existing gaps wherever possible, removal of some hedgerow sections will be inevitable. The construction contractor(s) will endeavour to fully restore all hedgerows, primarily through a scheme of replanting. In order to ensure successful restoration, a survey of all hedgerows will be undertaken and suitable native species will be used for replanting.

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Mature trees will be avoided wherever possible along the route. Where mature trees lie close to or within the working width and can be avoided during construction, a protection zone will be established around each tree to protect the roots.

Archaeology

The region crossed by the pipeline has a dense concentration of archaeological features and the avoidance of known sites has been a key factor in the routing of the pipeline. All known sites (afforded statutory protection under the National Monument Act 1930) and where possible areas identified as having a high archaeological potential, will be avoided. In order to detect the presence, and assess the extent, of both known and unknown archaeology along the proposed route, a further archaeological field walk and archaeological probing in deep bog as well as geophysical survey will be undertaken at a suitable time of year (after ploughing). This work will be accompanied by paleoenvironmental sampling in an attempt to establish the context of archaeological sites and type of environment inhabited by the people of Mayo thousands of years ago. This will be followed where appropriate by trial excavations, where necessary, prior to construction. A full archaeological presence (watching brief) will also be maintained during topsoil stripping to record any on-site finds. Contingency plans will be developed to deal with the discovery of previously unknown sites during construction.

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Hydrology

The pipeline will cross eight significant watercourses and thirteen medium to minor ones. In all cases, the necessary consents will be requested from the relevant authorities. The overall water quality ranges from unpolluted to water rich in nutrients.

Generally watercourses will be open cut. However, designated rivers and watercourses may be crossed using trenchless techniques, where suitable ground conditions prevail, thus minimising direct impacts. As stated all appropriate consents will be sought from the relevant County Councils and the Regional Fisheries Boards for all crossings, abstractions from, and discharges to, watercourses. BGÉ's pipeline construction contractor(s) will prepare an Environmental Management Plan in consultation with the relevant bodies / authorities.

In order to ensure successful restoration of major watercourses and their banks a survey of existing species has been undertaken to ensure that suitable species can be used for re-instatement. Mitigation measures will be developed and agreed with the relevant County Councils and the Regional Fisheries Boards to minimise sediment discharges to watercourses.

Hydrogeology

Groundwater and its rate, direction and pathways of flow are very important elements in the development and continuation of the blanket bog habitats in the northern portion of the pipeline route and in the karst (limestone solution weathering) habitats through which the southern portion of the route passes. In the blanket bog areas the contractor will be required to adopt specialised construction techniques to minimise the impact on the ground water regime and thus on the blanket bog ecology. In the areas with karst features underlying the route or nearby, there are ongoing geophysical studies to identify any underground features. Measure will be taken to ensure the construction impacts on the groundwater flow in these areas are minimised.

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Landscape

Pipeline construction will have a temporary impact upon the landscape, as the working width will be visible once vegetation and topsoil are removed. However, the area will be reinstated promptly after construction during suitable weather conditions. Hedgerow breaches will remain visible for a few years as the replacement plants grow to fill the gaps, though throughout the project hedgerow removal will be minimised. After this time there should be no residual impact. Dry stone walls will be carefully dismantled and replaced after the pipeline has been laid. The pipeline route through forestry will remain visible until the remaining trees are felled and, when the forest is replanted, the pipeline way leave will not be replanted. This will result in a clear line through the forest, which will be visible from a distance, similar to a firebreak. The above ground installations will each have a small building. These will have a minor impact until the screen planting matures.

Socio-Economic

Pipeline construction will provide a positive stimulation to the use of local services, such as catering and plant hire. Temporary local employment will be created, and accommodation will be required for much of the workforce locally. There are unlikely to be any significant socio-cultural impacts due to the numbers of workers involved.

The gas pipeline and fibre optic cable infrastructure provided by the project should have an

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indirect positive impact by promoting economic activity in the towns along the route.

Noise and Vibration

Before construction begins, BGE's pipeline construction contractor(s) will be required to identify expected noise levels, which will be considered in relation to the location of any noise-sensitive sites. Noise will be controlled as far as reasonably practicable, in compliance with BS 5228 (Noise Control on Construction and Open Sites). Careful siting, silencing and screening of equipment will help minimise noise during construction. All such measures will be discussed with residents likely to be affected.

Traffic

There will be significant traffic generated by the transport of line pipe and other materials and construction plant from the ports of entry, or other parts of Ireland, to the pipe storage yards and construction compounds in Mayo and Galway, prior to commencement of construction. This traffic will probably use the road network. There will also be a discernible increase in traffic levels on roads close to the pipeline route during the construction period. This increase is unavoidable but will be temporary in nature and principally attributed to the delivery of pipe, other materials and construction plant. Once on the pipeline spread, traffic movements will generally be confined within the working width. Other minor increases in traffic will be experienced as a result of the movement of the workforce to and from the working areas.

To control traffic movements and restrict impacts upon minor roads in particular, a Traffic Management Plan will be developed and agreed with the local authorities prior to construction.

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Emissions

All equipment used on site will be correctly adjusted and maintained to control air emissions. Most machinery will be powered by diesel engine. Any dust and mud generated by vehicle movements will be controlled by damping down using water spraying equipment, road brushes, wheel washes and imposing speed restrictions on vehicles.

Methods for disposing of accumulated trench water and water used during testing will be agreed with the relevant local authorities, and any necessary consent sought.

All waste and litter will be disposed of in accordance with the Waste Management Act 1996 and to the satisfaction of the relevant local authorities. Fuels and oils will be stored in an approved manner and in accordance with relevant pollution prevention Statutory Instruments. No refuelling of plant and machinery will be allowed within close proximity to a watercourse.

An Environmental Management Plan will be developed to minimise risks from spillage of oils or fuel. The construction contractor(s) will also produce a Waste Management Plan, which will identify potential wastes as well as appropriate handling and disposal methods.

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Interactions of Effects

There are some quite significant interactions of effects in different environmental media, which will result from the construction of the pipeline.

For example, construction methodology for the route in general will determine noise and vibration emissions and traffic generation, utilisation of stone for temporary roads and of sand for pipe bedding. The construction methodology adopted in the blanket bog and karst areas will determine the interaction between soils and geology, ground water movement and flora and fauna impacts and recovery over the short and long term. The method of gaining access to the soft ground areas will determine the amount of stone required for temporary roads, which will affect traffic generation on these roads and consequent noise. Road and river crossing methodology will affect the generation and impact of traffic, surface and groundwater movement and noise emissions. The construction methods chosen in forest areas will determine the visual and landscape impact in these areas and also affect generation of traffic and waste.

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7 Environmental Management

An important part of the environmental management of this project will be the ongoing liaison with both statutory and non-statutory bodies. By maintaining communications with these bodies, BGÉ intends to facilitate the smooth running of the project.

Specific issues and required working methods will be addressed in method statements prior to commencement of construction.

Residents likely to be affected by the pipeline activities will be contacted prior to the commencement of construction. This will either be by mail drop, local advertising or a personal visit. Members of the public will be able to contact Bord Gáis Éireann through the Agricultural Liaison Officers (ALO) for more information or to discuss any issues arising.

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1. INTRODUCTION

1.1 The Proposed Development

Bord Gáis Éireann (BGE) proposes to develop a gas pipeline from the northwest of County Mayo to the south of County Galway. This will form part of a series of developments, the Corrib Natural Gas Field Development and the Pipeline to the West which will provide an additional source of natural gas and connect the West of Ireland to the natural gas grid.

The Corrib Development consists of subsea wellhead production facilities at the Corrib Field, an undersea pipeline from the gas field to a landfall at Dooncarton on the coast of County Mayo, a gas reception terminal near Bellanaboy Bridge and the onshore pipeline to connect to the natural gas grid near Galway. The Pipeline to the West project is the construction of a gas pipeline from Dublin to Galway and continuing onwards to Ennis and Limerick.

The Mayo - Galway natural gas pipeline will be approximately 150km in length. It will convey natural gas from the Corrib reception terminal at Bellanaboy Bridge, near Pollathomish in County Mayo, to the connection with the Pipeline to the West at the AGI at Garracloon South, near Craughwell in County Galway. The pipeline will be underground with a minimum cover of 1.2m. It will be 660mm (26 inches) in diameter and will be constructed in high strength steel. The pipeline line will have a maximum operating pressure of 85barg.

There will be six block valve stations along the route which will allow the pipeline to be isolated into sections and will facilitate off-takes for the provision of low pressure gas supplies to towns along the route. These block valve stations will be located at an above ground installation (AGI). Other above ground features along the pipeline include pipeline marker posts and cathodic protection posts.

Fibre optic cables will be laid along the pipeline during construction. These will extend from the AGI at Craughwell to Block Valve Station 2, the potential off-take point for Ballina.

It is planned to construct the pipeline in 2002 and 2003. Construction will mainly take place in the period from April to October each year, except where there are ecological or other reasons to undertake specific activities outside this time period.

The Mayo - Galway gas pipeline project was initiated by Enterprise Energy Ireland Ltd (Enterprise) as part of the Corrib Natural Gas Field Development. Initial project feasibility studies and route selection were undertaken by Enterprise. In late 2000 Enterprise signed a contract with BGE in which it was agreed that BGE would take over the project, undertake the detailed design and manage the construction of the pipeline from the Corrib reception terminal at Bellanaboy Bridge to Craughwell.

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1.2 Bord Gáis Éireann

Bord Gáis Éireann (BGE) was established under the Gas Act of 1979 as the state agency responsible for the supply, transmission, distribution and sale of natural gas in Ireland. Under Section 8 of the Gas Act 1976 BGE has a duty to develop and maintain a system for the supply of natural gas, *"being a system which is both economical and efficient and which appears to the Board to be requisite for the time being."*

Production of natural gas commenced in Ireland in 1978 with the development of the Kinsale field, off the coast of Cork. At that stage the gas transmission and distribution grids were confined to a small area close to Cork City. In 1982 work commenced on construction of the Cork to Dublin pipeline and over the years the transmission grid has been extended to parts of Counties Limerick, Tipperary, Waterford, Wicklow, Kildare, Laois, Meath, Louth and Cavan.

In 1993 BGE constructed a sub-sea interconnector pipeline, from north County Dublin to the southwest of Scotland. This pipeline connects the Irish gas grid to the international gas network.

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In addition to the Mayo - Galway pipeline, as part of its ongoing work to secure gas supplies and to extend the transmission grid further in Ireland, BGE plans to construct a second interconnector pipeline to Scotland and to construct a transmission pipeline from Dublin to Galway. This pipeline will extend, via Ennis, to connect to the existing grid at Limerick.

1.3 Legislative Requirements

1.3.1 The Gas Act

Section 8 (7) of the Gas Act states that BGE may not export gas or construct a pipeline without consent from 'the Minister'. The Minister may attach conditions to the consent. Currently the Minister with appropriate jurisdiction is the Minister for Public Enterprise.

1.3.2 EIA Regulations

Under Article 4(1) of European Council Directives 85/337/EEC and 97/11/EC environmental impact assessment statements must be prepared for certain developments. SI No. 93 of 1999 European Communities (Environmental Impact Assessment)(Amendment) Regulations, 1999, implements these directives in Ireland.

The developments listed in Part 1 of the First Schedule of Article 24 of SI 93, which require an environmental impact statement (EIS), include '*pipelines for the transport of gas, oil or chemicals with a diameter of more than 800mm (32inch) and a length of more than 40km*'. The Mayo-Galway pipeline has a diameter of 660mm (26inch) and thus does not fall within the scope of Part 1 of the first schedule. However, Part II states that an EIS is also necessary for '*gas pipelines and associated installations not included in Part 1 of this Schedule, where the design pressure would exceed 16bar and the length of new pipeline would exceed 40km*'. With an operating pressure of 85barg and a total length of 150km, the Mayo - Galway pipeline is of a class requiring an EIS under this part of the schedule.

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SI 93 0f 1999 amended the Gas Act 1976 to require BGE to submit an EIS with its application to the Minister for consent to construct a pipeline under Section 8, where the pipeline is of a class specified in Article 24. Before deciding to give consent for the pipeline, the Minister shall have regard to all submissions made on the EIS by interested parties.

This EIS will be submitted by BGE to accompany its application for Ministerial consent, under Section 8 of the Gas Act, to construct the Mayo - Galway gas pipeline.

1.3.3 Planning Permissions

The development by BGE of an underground gas pipeline, in accordance with a consent from the Minister under Section 8 of the Gas Act, is an exempted development under the Local Government (Planning and Development) Regulations. However this applies only to the pipeline and to ancillary equipment such as marker posts and cathodic protection posts. Planning permission will be required for the above ground installations (AGI) and construction compounds associated with the pipeline. BGE will be making applications to Mayo and Galway County Councils for planning permission for these installations, in due course.

1.4 The EIS

This EIS covers the development of the natural gas pipeline from the Bellanaboy Bridge Terminal in County Mayo to the AGI at Craughwell in County Galway. It documents the environmental assessment carried out over a 12-month period, which commenced in April 2000.

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The EIS is in two volumes:

Volume I: Main Report and Technical Appendices

Volume II: Figures

The scope and contents of the EIS and the methodology used in its preparation are discussed in more detail in Section 2.

Environmental assessments were undertaken for the other elements of the Corrib Natural Gas Field Development, resulting in the production by Enterprise of two EISs. These documents cover the sub-sea wellhead development, the sub-sea pipeline to the landfall and the reception terminal and connecting pipeline to it from the landfall.

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2. IMPACT ASSESSMENT METHODOLOGY

Environmental impact assessment (EIA) is an important aspect of the project, evaluating the broad range of impacts that the construction and operation of the pipeline will have on its environment. In the assessment process potential impacts are identified and appropriate mitigation, avoidance or minimising of impact is proposed. This EIS summarises the relevant environmental information associated with the EIA. The Minister for Public Enterprise will assess the document, and members of the public will be invited to comment.

2.1 The Assessment Team

The Environmental Impact Assessment (EIA) was carried out in two phases. In the first phase RSK Environment Ltd were retained by Enterprise Energy Ireland to manage the assessment process, and the assessment team comprised:

- RSK Environment Ltd (Project Management, Landscape and Visual impact, Air Quality, Waste, Hydrology, Risk, Agricultural and Physical Environment assessments);
- Alan Sanders Associates (Noise assessment);
- Brian Meehan Associates (Planning);
- Margaret Gowan Associates (Archaeological assessment);
- Parkman Ltd. (Road and Traffic assessment); and
- Ecological Advisory and Consultancy Services (Flora and Fauna assessment).

Baseline studies were undertaken and a draft document, completed to Enterprise Energy Ireland requirements, was produced.

When Bord Gáis Éireann took over the project, Arup Consulting Engineers modified and completed the draft EIS, revising it to reflect the change of developer and to incorporate the impacts of subsequent route changes, and modifications to the scheme.

Arup retained Margaret Gowan Associates and Ecological Advisory and Consultancy Services for additional baseline work, and undertook the additional work on other aspects itself. The reroutes and scheme modification and development required minor additional work to the Archaeology and Flora and Fauna baseline studies. Substantial reassessment was required for the Roads and Traffic, Soils and Geology, Hydrology and Hydrogeology, and Landscape and Visual chapters.

2.2 The Environmental Impact Study Process

The principle elements of the assessment, up to submission of the EIS are described below:

Scoping - determining the issues to be part of the study, including further issues identified by Consultees, and the availability of data;

Determination of baseline conditions - determining the criteria with reference to which the likely environmental effects of the proposed development were to be evaluated;

Consultation - undertaken throughout the assessment process in order to inform interested parties and invite comment;

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Evaluation of significant effects/determine mitigation - an iterative process whereby the significance of potential effects is determined and design improvements or appropriate mitigation identified in order to reduce adverse effects;

Determination of significant environmental effects - once mitigation/design improvements have been incorporated, the significance of residual environmental effects was determined;

Reporting - the findings of the assessment are reported in an EIS, which is a public document.

2.3 Scope of the EIS

The scope of the environmental assessment was set out in the Corrib Field Development Onshore Briefing Document. This document identified the main issues potentially associated with the proposal, as follows:

Flora and Fauna	The ecological assessment, which will include a field inspection, will establish baseline conditions, evaluate terrestrial and aquatic habitats along the route and identify measures to protect against adverse impacts on those habitats.
Soils and Geology	A geotechnical assessment will assess the soils and geology along the route to identify and mitigate against any potential impacts
Hydrology and Hydrogeology	In conjunction with the ecological assessment, a hydrological assessment of the entire route and more detailed assessments of potentially sensitive areas will be undertaken. Measures to avoid or mitigate potential impacts will be identified
Archaeological and Cultural Heritage	A study, which will include a field inspection, will identify the archaeological or cultural heritage significance of any sites along the route where possible; to reduce any predicted adverse impacts.
Landscape and Visual	A landscape and visual study of the route will include an assessment and description of the existing landscape context, features and vulnerable areas. It will evaluate the impact of the project on the landscape proposals and residual effects will also be described.
Roads and Traffic	A traffic study for the project will review the current traffic network and evaluate traffic impacts of the proposed pipeline on the network. Particular scrutiny will be made to construction impacts.
Air Quality and Noise	The potential impact of the development on air quality and potential noise emission will be reviewed.
Effluent and Solid Wastes	The characteristics, fate and potential impacts of the effluent and solid wastes from the reception terminal operations and from construction activities will be reviewed.

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Human Impact Issues The socio-economic study will review population and employment trends. The impact of the pipeline on existing and potential future commercial and recreational activities will be assessed and the potential of the pipeline to contribute to regional development along the pipeline route will be considered.

Material Assets The study will consider the implications of the pipeline and of construction, on existing and possible future development along the pipeline. It will also examine the use or sterilisation of any natural resources.

The Briefing Document was issued and a number of submissions were received from numerous statutory consultees.

This scope was further revised and updated throughout the study period to ensure that all the likely significant environmental affects were considered in line with the requirements of the relevant legislation.

2.4 Consultation

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Consultation with government departments and other agencies took place during the environmental assessment. The main organisations contacted were:

- Dúchas (Parks and Wildlife Section);
- Birdwatch Ireland;
- Irish Peatland Conservation Council;
- Department of Zoology, TCD;
- Dúchas (Research, Bogs and Wetlands)
- Dúchas (Archaeological Section);
- National Museum of Ireland;
- Western, Central and NorthWestern Regional Fisheries Boards;
- Office of Public Works;
- Bord na Mona;
- Coillte;
- ESB;
- Eircom;
- Mayo and Galway County Councils; and the
- Geological Survey of Ireland.

Ecological Consultees:

- Dr. Andrew Bleasedale, Dúchas (West Regional Ecologist)
- Dr. Alan Craig, Dúchas (Principle Officer)
- Dr. Tom Curtis, Dúchas (Rare and Protected Plant Species)
- Mr. Bob Cussen, Dúchas (Conservation Ranger, N. Mayo)

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- Ms. Caitriona Douglas, Dúchas - Research (Blanket Bogs)
- Dr. Peter Foss, Irish Peatland Conservation Council (IPCC)
- Mr Paul Galvin, Chief Planning Officer, Birdwatch Ireland
- Ms. Jackie Hunt, Birdwatch Ireland
- Dr. Noel Kirby, Dúchas (Regional Manager)
- Anne-Marie McKee (Rare Plants data Co. Mayo)
- Mr. Oscar Merne, Dúchas
- Mr Jim Moore, Dúchas (Asst. Regional Manager for Mayo)
- Mr. Tony Murray, Dúchas (Conservation Ranger, N. Mayo)
- Mr. Stephen Newton, Birdwatch Ireland
- Mr. Tim O'Connell, Dúchas (Regional Manager)
- Mr. Gerry O'Sullivan, Dúchas – Waterways Ireland
- Professor Julian Reynolds, Dept. Zoology, TCD (Crayfish information)
- Mr. Jim Ryan, Dúchas – Research (Bogs & Wetlands)
- Mr. Denis Strong, Dúchas (District Officer, N. Mayo)
- Mr. Michael Sweeney, Dúchas (Western Region)

North Western Regional Fisheries Boards

- Dr. John Conneely
- Mr. Michael Lennon & Peter Collins (Fisheries Inspectors)

Western Regional Fisheries Board

- Mr. Michael Kennedy,

Central Fisheries Board

- Dr. Martin O'Grady

Archaeological Consultees:

- Brian Duffy, Dúchas - Senior Archaeologist
- Greta Byrne - Director of the Céide Field Centre.
- Jane O'Shaugnessy, Dúchas - Archaeological Survey Unit of Co. Mayo
- Margaret Keane, Dúchas - Archaeologist
- Sue Zajac, Licensed archaeologist, Margaret Gowen & Co Ltd
- Professor Seamus Caulfield, Belderrig Research Centre

General Consultees:

- Jane Brogan - Environmental Protection Agency

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- Donal Daly - Geological Survey of Ireland
- Ray Norton - Mayo County Council
- Jo Beirn - Mayo County Council
- Siobhan Shields - North West Fisheries
- Geoff Wright - Geological Survey of Ireland (GSI) (Senior Hydrologist)
- Conner McDermott - GSI(Bedrock Geologist)
- Donal Daly - GSI (Head of Groundwater Section)
- Rebecca Kelly - GSI (Groundwater Section Assistant)
- Pat O'Connor - GSI (Principal Ecologist)
- Michael Sheeby - GSI (Quaternary Section)
- Sally Watson - University College London

Public Exhibitions

As part of the initial scoping process Public Exhibitions were held in June 2000 at the following locations:

- Pollatomish;
- Ballina;
- Castlebar; and
- Galway.

The public responses were collected, by way of questionnaires, and key issues highlighted as part of the EIA process.

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2.5 Surveys and Predictive Techniques

A combination of field surveys, desktop surveys (including consultation) and modelling techniques was used to assess the potential impacts of the proposed pipeline.

The principal surveys/predictive techniques undertaken were:

- Phase I Habitat, protected flora and fauna species and breeding/migratory bird field surveys;
- archaeological desk based assessment and field visits;
- aerial video flown along the length of the proposed route and viewed alongside digital mapping through a system known as Geofilm.

2.6 Assumptions

The initial assessment was based on detailed data provided by Enterprise Energy Ireland Ltd., their front-end engineering design contractors, and data from various feasibility studies carried out on behalf of Enterprise. Best practice techniques, using latest software programs (where applicable) have been applied in conjunction with detailed consultations with statutory and non-statutory consultees. Assessments assume that all relevant Irish and relevant European legislation will be adhered to.

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Where technical information is still under review or detailed information not available, this has been highlighted and appropriate assumptions made based on previous experience.

2.7 Difficulties Encountered in the Study

The compilation of an EIS is affected by such a diversity of factors that it is unusual to avoid some difficulty in the process. In this study the following issues had an effect on the progress of the assessment:

- *Reroutes*: The route was being refined on an on-going basis during the assessment period, which had repercussions on many of the chapters. This was often an iterative process, with the reroutes having broader impacts, resulting in further constraints.
- *Planning Applications*: There were a number of applications for planning permission along the route made during the study period, and the assessment team had to respond to these as they came to light.
- *New Road Schemes*: Preferred realignments for the N17 and the N6 emerged quite late in the pipeline routing process, but, although the routes cross close to a major road interchange near Athenry, no major rerouting was required.
- *Incomplete Aerial Photography*: The entire route was photographed early in the assessment period, and subsequent to this, there were major reroutes – particularly towards the south. A combination of poor weather conditions and the unavailability of suitable aerial photographers meant that some of the route remained unphotographed. This made some of the fieldwork planning and desktop study more difficult than would otherwise have been the case.
- *Unavailability of 1/2500 Mapping*: Towards the northern end of the pipeline route the only available Ordnance Survey mapping was quite outdated 1/10560 (6"). By the time a set of up to date 1/2500 maps had been created from the aerial photos much of the fieldwork was complete.
- *Foot and Mouth Precautions*: The national foot and mouth prevention guidelines, drawn up by the Department of Agriculture Food and Rural Development in response to the threat of infection, initially required that access the countryside and entering upon farmland was avoided unless absolutely essential. While the restrictions were relaxed somewhat, final assessment of some of the re-routed areas and AGI sites was postponed until the restrictions are fully withdrawn. In addition, in consultation with Dúchas, some more detailed studies of mammal habitats, for example, were deferred. These studies will be undertaken before construction commences.

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3. SCHEME CONTEXT

3.1 Need for the Scheme

At present Ireland is experiencing high economic growth accompanied by expectations for a higher standard of living. These factors, amongst others, drive the demand for greater use of power and energy. Gas is also predicted to become a greater provider for the power industry. This combined with the current liberalisation of the energy market will lead to increased gas consumption in Ireland. Infrastructural investments, of which this development is part, will cater for the predicted increased demand in gas, contributing to the long-term economic well being of Ireland.

With gas use increasing annually and predicted to rise in the future, demand for energy has outstripped Ireland's home production and domestic infrastructural capacity. Ireland is no longer self-sufficient and requires imports of gas from abroad.

Consultants on behalf of Bord Gáis Éireann have evaluated the required strategic investment in gas transmission throughout Ireland until the year 2025 and examined infrastructural solutions based on various gas demand scenarios.

3.2 Energy Sources in Ireland

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Ireland uses coal, oil, gas, peat, hydro and wind as sources of energy. As the demand for energy increases it is expected that gas will have increasing importance because of the efficiency of combined cycle gas turbine generators and the relatively benign environmental impact of emissions from gas combustion.

3.2.1 The National Climate Change Strategy

The energy sector is the largest producer of Ireland's CO_2 emissions from fossil fuel combustion in the production of electricity. The National Climate Change Strategy (2000) records that 24.6% of all greenhouse gases was emitted from this source in 1998, and outlines two key sector-specific domestic policy options to help meet our commitments to limit growth in greenhouse gas emissions:

- Fuel switching towards less carbon intensive fuels without affecting overall levels of electricity generation or use
- Improving the efficiency of energy transformation

In considering substituting for coal, the strategy document notes the following: *"fuel switching from coal has already contributed significantly to reduced greenhouse gas emissions in other countries and is expected also to be an important factor for many countries in meeting their Kyoto targets. Fuel switching to gas and to renewables for electricity generation will be supported by this strategy. The developments of electricity and gas interconnectors (East/West and North/South as appropriate) will assist in addressing the security of supply issue and offer opportunities to access additional energy sources with reduced greenhouse gas emissions. Continuing support will be given to the exploration for indigenous supplies of gas, and appropriate arrangements made for its early recovery and exploitation."*

Closure of the coal-fired power station at Moneypoint, with the required new capacity provided by combined cycle gas turbine plant, would make the largest single contribution to reduce greenhouse gas emissions (3.4 Mt CO_2 per annum). Dependence on gas for electricity generation would increase to around 80% in this case, and *"it would be necessary to ensure the security of energy and electricity supply in the conversion of the plant output to gas"*.

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Peat is the least carbon-efficient fossil fuel used for electricity generation in Ireland, and the strategy document refers to the progressive replacement of all remaining low-efficiency peat power stations. Bellacorick peat-fired power station (which is located on the Mayo-Galway Gas Pipeline route) is one of these older plants.

Under the heading "Gas Supply and Network Expansion" the document refers to the sourcing of additional gas supplies as *"a vital supporting element of the Strategy"*. A locally sourced gas supply such as the Corrib Field will help to meet the aims of the Strategy.

3.2.2 Sustainable Development

In "Sustainable Development, a Strategy for Ireland" (1997) an action programme is outlined towards achieving sustainable energy use. This incorporates:

- Securing energy supplies
- Making energy infrastructure efficient
- Developing indigenous resources to the maximum possible
- Using energy sources which minimise damage to the environment

To achieve these aims *"it is vital that Ireland vigorously promote its offshore oil and gas exploration programme"*. The Corrib field development and Mayo-Galway pipeline is in line with these policy objectives.

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3.3 Need for the Pipeline

In the Bord Gáis Review of Natural Gas Transmission – Capacity Requirements to Year 2025 (1999) various future gas supply options are presented:

- A new interconnector parallel to the existing Scotland-Ireland system (which might include a south-north link to provide additional gas supplies and security of supply to Northern Ireland)
- A new interconnector parallel to the existing Scotland-Northern Ireland system with implementation of a north-south link between Ireland and Northern Ireland
- An interconnector from North Wales to the Dublin area
- An interconnector from South Wales to the Wexford area
- An interconnector from Brittany (France) to the Cork area
- Construction of a liquefied natural gas terminal at Cork or Shannon estuary to import liquefied gas, by ship, from Africa
- Reinforcement of the existing interconnector with an intermediate compressor station
- Indigenous gas finds

In April 2001, Bord Gáis gave the go-ahead for the duplicate Scotland-Ireland interconnector, and as a result, implementation of the other gas supply options has become less urgent from a continuity of supply perspective. However, the report acknowledges that Corrib gas will have significant commercial and strategic benefits for the Irish gas industry.

The existing BGÉ national gas grid is concentrated in the south and east of the country. An east-west pipeline, connecting Dublin to Galway, is scheduled for construction in 2002. This 'Pipeline to the West' will combine with the Mayo-Galway pipeline to form a significant

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expansion to gas transmission infrastructure in Ireland.

The Corrib gas field will be the first gas discovery to be developed offshore from the west of Ireland. In order to facilitate gas production, onshore and offshore infrastructure is required. The proposed pipeline is required to distribute gas from the Bellanaboy Bridge Terminal in County Mayo to the national gas grid connection near Craughwell in County Galway.

3.4 Summary

Ireland is using increasing quantities of natural gas which, due to it low emissions, is a preferred fuel, particularly for power generation.

National policy, as stated in major policy documents, is to promote the development and use of indigenous gas sources. The construction of the Mayo-Galway natural gas pipeline is an essential component to help meet the demand for natural gas and to allow the development of the Corrib Field.

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4. BACKGROUND TO THE PROJECT

4.1 Outline of Proposed Development, Planning and Phasing

This section explains the background and origins of the Mayo - Galway gas pipeline project and the development options considered by BGE and Enterprise.

4.2 Alternatives Considered

A number of alternatives have been assessed for the project, with consideration given to the implications of:

- No pipeline development
- Use of alternative sources of energy
- Alternative gas transport options
- Various gas pipeline routes.

A do-nothing strategy would leave Ireland fully dependent on imported gas in the medium term. The only domestic sources of natural gas - the Kinsale Gas Field and the small Ballycotton field - are nearly depleted, and the Corrib Field is the only readily available replacement. Gas is currently being imported to Ireland via a subsea interconnector from Scotland, and a second interconnector will be laid in parallel to this in 2002.

Dependency on continuity of supply of gas from the international market would result in an increased exposure to fluctuations in price and availability. This would provide an economic incentive for consumers to change to alternative fossil fuels as energy sources; demand for coal, oil and peat would increase – all less desirable from an environmental perspective. Demand on the national peat reserves would increase, as would imports of oil and coal. These fuels are also greater producers of the gases which contribute to the enhanced greenhouse effect, and potentially to global warming.

The resultant decrease in domestic energy supply would also encourage exploitation of renewable sources of energy, such as wind, hydro, wave, and solar. While this would be environmentally positive, the required infrastructure and technology is at an early stage of development, and these sources will not realistically generate the amount of energy that will be required to meet demands in the immediate future.

The option of transporting the natural gas in a liquid form in road tankers from the reception terminal at Bellanaboy Bridge was found to be impractical on economic and infrastructural grounds, and would have had major environmental impacts.

A comprehensive study of the field development alternatives and pipeline routing alternatives were undertaken by Enterprise. These are summarised below.

4.3 Routing Options for the Pipeline

4.3.1 Enterprise Energy Ireland Ltd pre-feasibility and feasibility studies

A series of concept and options screening exercises were undertaken by Enterprise in order to select and define the preferred subsea development strategy. The option selected was a subsea tieback to shore, incorporating subsea well completions, infield infrastructure, a subsea control umbilical link from shore and a gas export pipeline.

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Once the decision was made to development the Corrib field by using a pipeline to bring the gas ashore and to convey it on land, a series of inter-dependent components had to be optimised. The Corrib field, the starting point for the pipeline, was reasonably well-defined. The end point, the connection point to the existing gas grid, could be in the north Dublin area or the Limerick/North Cork area. The choice of landfall, routing of the sub-sea pipeline to the landfall and routing of the pipeline from landfall to grid connection gave rise to a huge range of options.

In a pre-feasibility study undertaken in March 1999, Enterprise identified potential sub-sea pipeline routes, landfall locations, reception terminal sites and indicative pipeline route corridors, based on a combination of preliminary environmental screening, preliminary offshore sea-floor surveys, and commercial and strategic considerations.

4.3.2 Sub-sea Pipeline and Landfall Options

Results of the 1999 offshore route survey indicated significant areas of rocky seabed for all routes south of, and including, Blacksod Bay. There appeared to be no pipeline corridor through this area without the need for substantial rockdumping, rock cutting and/or blasting. This suggested that sub-sea routes south of Broadhaven Bay would not be feasible and that further studies should concentrate on the coastline from Broadhaven Bay to Killala Bay.

4.3.3 Onshore Pipeline Routes

A number of broad route corridors were identified at the pre-feasibility stage. These were:

- A route from the landfall directly to Dublin, which would give the shortest, and probably the least expensive onshore pipeline;
- A route from the landfall to Dublin via Athlone or Galway, which would be longer and more expensive than the direct route, but may be more desirable, forming part of the proposed BGÉ ring main.
- A west-coast route, from north Mayo to Galway, and then across the Shannon estuary to connect to the Cork-Dublin pipeline at Mitchelstown. This would be substantially longer and more expensive than the direct route. However, it would be of considerable strategic advantage to BGÉ in terms of security of supply. It would also form a substantial part of the Pipeline to the West.

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4.3.4 Arup onshore pipeline feasibility study

Following from the pre-feasibility study, in July 1999 Arup Consulting Engineers were appointed to carry out a detailed feasibility study to identify and select suitable landfall locations, reception terminal sites and onshore pipeline routes. The criteria for the selection of routes and landfall locations were environmental impact, safety, cost and construction schedule.

Landfall options from Broadhaven Bay to of Killala Bay were examined in detail. The locations considered were Brandy Point and Dooncartoon, at the entrance to the Sruwaddacon estuary on the east side of Broadhaven Bay, two locations at Bunatrahir Bay near Ballycastle, and four locations on the western side and two locations on the eastern side of Killala Bay. Sites for the reception terminal, close to each of the landfalls, were also identified.

The broad route corridors, identified in the pre-feasibility study and listed above, were refined and actual routes identified on 1:50,000 scale mapping. In addition, a route to Galway from a landfall near Clifden, County Galway, was also examined. It quickly became apparent that ground conditions along this route were very difficult and that there were numerous environmental constraints that could not be avoided.

A comparison of the route options was presented in the feasibility study report, together with a

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ranking based on the study criteria.

Other studies

Enterprise commissioned a series of feasibility studies on the technology for the field development, the sub-sea pipeline technology and routing, and the reception terminal. These studies were undertaken concurrently with the onshore pipeline feasibility study.

4.3.5 BGE Gas 2025 Study

The Bord Gáis Éireann commissioned a study 'Review of Natural Gas Transmission *Gas 2025*'. The study was published in August 1999. It highlighted two route schemes to connect the Corrib gas pipeline from landfall to the existing network. These were a connection directly to northwest Dublin, and one to tie in with the proposed Pipeline to the West, near Galway. The tie-in near Craughwell in County Galway was considered to be strategically more desirable and is now part of the route which was assessed for this EIS.

4.3.6 Landfall Selection

The onshore pipeline feasibility study identified a number of routes and landfalls which were practicable and had reasonably similar impacts. The route finally chosen was dictated by the requirements of the technology to be used for the wellhead development and the sub-sea pipeline.

Broadhaven Bay was selected by Enterprise as the preferred option as a result of the consideration of the following factors:

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- The export pipeline between the proposed subsea facilities and the terminal will operate in a multiphase regime (i.e. gas, water and condensate may be present in the fluid flow). Due to the separation of phases in this line and the potential for liquid slugging, the pipeline flow will have to be operated within a constrained operating envelope. The longer the offshore pipeline, the greater the operating constraints would be. Corrib to Broadhaven offers the shortest of the northern offshore routes.
- It is proposed to operate the Corrib subsea facilities remotely, from the reception terminal. The integrity of the proposed umbilical control link between the terminal and subsea facilities is crucial to maximising the operational availability of the system. The most reliable umbilical system minimises the number of in-line joints. In addition, the shorter the umbilical, the less opportunity for communication disruption. Corrib to Broadhaven offers the shortest of the northern offshore routes.
- The landfalls at Bunatrahir Bay is exposed to wind and wave action and is characterised by large areas of rock close to the shoreline, requiring considerable construction work to create a pipeline corridor. In contrast Killala and the Dooncarton landfall at Broadhaven offer the opportunity for beach landfalls with reasonable soils coverage.
- Land behind Dooncarton landfall at Broadhaven Bay provides the opportunity for a terminal location with good natural screening, thereby minimising the visual impact of this installation.
- The estimated cost of offshore pipelines to landfall and the onshore routing of pipelines in the area under consideration are very similar. The cost of an onshore terminal is not significantly impacted by the terminal location. Accordingly cost does not influence the selection of the preferred landfall location.

4.4 Routing Strategy

The strategy adopted to selecting and refine the pipeline route is described below.

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Pipeline routing is an iterative process, the route being continually refined and adjusted, taking into account various constraints, and minimising any potential negative impact on environmentally sensitive areas. Starting at Bellanaboy Bridge in County Mayo, and ending at the proposed above ground installation (AGI) near Craughwell in County Galway, a hierarchy of constraints was drawn up to guide and inform the routing process. These are:

a) Designated special area of conservation (SAC) or special protection area (SPA) or national heritage areas (NHA)

b) Areas of other environmental or archaeological significance

c) Areas designated in County Development Plans as requiring special consideration

d) Areas with geology, geomorphology and topography which would present difficulties for construction and increase costs

e) Areas of potential mineral resource and/or areas of existing or future extraction

f) Densely populated areas

g) Areas of forestry

h) Crossings of motorways, roads, railways, rivers and pipelines

i) Major developments planned along the route

j) Minimising the overall length of the pipeline corridor

Applying these criteria, a route was developed which avoids all known archaeological artefacts, and minimises impact on special areas of conservation (SAC). Dúchas (the Heritage Service) were consulted, and a number of route refinements were undertaken in response to their recommendations, these include:

- A major re-route south and west of Slieve Fyagh, towards the northern end of the route
- A further refinement of this re-route to minimise the impact on the blanket bog at Glenturk
- Avoiding some base-rich fen near Eskeragh on the Crossmolina to Bangor road
- Adjustments to the route near Caherlistrane to avoid the nearby Turlogh O'Gall SAC and Greaghan's Turlogh NHA

The route maps in Volume II, Figures 4.1 to 4.8, indicates many of the route alternatives considered for the pipeline during the route selection process. The design engineer may make further minor changes to the route during detailed design to take into account specific constraints and land owner requirements and further to minimise impacts.

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5. DESCRIPTION OF THE PROPOSED PIPELINE

5.1 Introduction

The proposed pipeline route, from Bellanaboy Bridge County Mayo to near Craughwell in County Galway is described in this section. The route is illustrated in **Volume II**, figures 4.1 to 4.8.

5.2 Main features of the Proposed Route

Upon leaving the Bellanaboy Bridge Reception Terminal (Grid Reference 0862 3329), at approximately 30 metres Above Ordnance Datum (AOD), the route runs on the western flanks of Slieve Fyagh, traverses Glenturk More and Glenturk Beg, before moving into the Glencullin River valley. The R314, two minor roads and three small watercourses that feed Carrowmore Lake are crossed.

The route runs on the north side of the valley, parallel to the Glencullin River, for approximately 6km towards Tawnaghmore, before passing through an area of coniferous forest for approximately 1.5km. Turning southwards the route crosses the Western Way walking path and into an extensive area of industrial peat workings.

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The moorland, near Tawnaghmore, is gently undulating and divided up by small streams. The route turns southeast close to Ballymonnelly Bridge and passes Bellacorick Bridge and the Bellacorick Power Station, following the course of the N59 road, for approximately 9km up to Dooleeg. A tributary of the River Owenmore - the Oweniny River, and the River Muing are all crossed by the proposed route in this section.

The route continues parallel to the N59 for 5 km, heading in an easterly direction, passing Eskeragh and remaining almost 1km north of the Owenboy nature Reserve. It crosses the N59 three times, to avoid an area of base-rich fen near Eskeragh, until, 7 km west of Crossmolina, the route bears southeasterly towards Lough Conn, crossing the Shanvolahan River in two places.

The main topographical feature visible between Eskeragh and Lough Conn is Nephin Mountain. The route passes to the north and east of Nephin. Proceeding generally southeastwards, the pipeline crosses the R316 road and several minor roads, and skirts to the south of small hills at both Knockfarnaght and Tonacrock. Lower-lying land is encountered as the proposed route moves to within 0.5 km of Lough Conn, while remaining to the west of the R315 road. The Castlehill River, the Addergoole River and three minor watercourses are traversed in this section.

To the southwest of Lough Conn, the route climbs into the foothills of Farbreiga. Over a 5km length, steeply sloping ground is present. The proposed route then departs from this hilly region into gently rolling topography from Cunnagher North to Ross West, continuing south to Tawnylaheen. Numerous minor roads and small watercourses are traversed in this region. The R310 road is also crossed and the route continues in a southeasterly direction.

Approximately 4km northwest of Castlebar, just to the north of Clogher, the pipeline route crosses the Castlebar River and the N5 road. Continuing towards Ballinvoash, rolling countryside is encountered, with a rise at Drumdoogh. Undulating countryside and a number of minor roads and farm tracks are encountered from Drumcorrabaun to Manulla. At Manulla, crossings of the Manulla River, the railway line to Ballina and the N60 road are necessary.

Continuing in a southeasterly direction from Manulla, the route crosses slightly more low-lying land, with wet and boggy areas noticeable. The route then proceeds through rolling countryside

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towards Portagh. Just to the north of Needham's Lough a small river is crossed and field ponds are in evidence in the area of Loughbunnaun. The route passes to the east of Mayo village, from where it adopts an almost southerly direction, and descends marginally from Gortaphuntaun to Barreel, travelling parallel to a minor road and crossing numerous tracks.

The route passes approximately 5km to the west of Claremorris, and after crossing the R331 road, the Robe River is crossed at Tagheen. Undulating topography is common from this area as far south as Davros. The proposed route crosses a dismantled railway at Lehinch, and climbs a gentle hill to the east of Bushfield. Several minor roads are crossed as the route continues over undulating ground past Annefield. Low-lying and occasionally waterlogged areas of ground are noted close to Carras Lough.

Passing approximately 10km to the east of Ballinrobe, adjacent to Cloonanaff, the pipeline route adopts a southeasterly orientation for approximately 3km, prior to rejoining its original southerly direction. Undulating ground is once again encountered from Ballyweela towards Nettle Hill, with several road (including the R332) and river crossings (including the Kilshanvy River twice) in this area. The pipeline crosses Togher River, followed by occasional minor roads and farm tracks. Flat to gently undulating ground is found from this area as far as Beagh More. The route follows a more southsoutheasterly direction to the north of Caherlistrane.

Tuam lies approximately 15km to the east of the route as it crosses the R333 road, succeeded by a 4-5 km section of undulating topography, as the pipeline route passes just beneath a small but steep-sided hill, Knockmaa (167 m). The route continues to Biggera Beg, returning to flatter, more gently undulating ground. Several minor roads are traversed as the route approaches Bunoghanaun. The N17 road is bisected at Racoona, from where the route continues southwards, skirting a small hill and crossing the N63 road at Knockdoemore. An area of low-lying, wet land in the flood plain of the Clare River is encountered just north of Cregmore as the route follows a southeasterly direction from the N63. The River Clare is crossed in this section.

Three kilometres after crossing the River Clare the route crosses the R339 road. The route then climbs from low land over a small rise of 73m (AOD) at Knocknabreeva. A slower descent occurs onto more gently undulating ground around Ballygarraun West, 3km southwest of Athenry where it crosses the Galway-Dublin railway line and the R348 road.

Low land is traversed in the approach to Templemartin, with many minor roads. The Eiscir River is traversed near Willmount Bridge. The proposed route then crosses the Athenry-Limerick railway line and the R347 road near Pollnabanny Bridge, 6 km south of Athenry. Finally the route runs in an eastsoutheasterly direction, crossing three minor roads and the Craughwell River before terminating at the AGI in the townland of Cappagh South, near Craughwell.

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5.3 Pipeline Description

The onshore pipeline will convey gas from the Bellanaboy Bridge Terminal in County Mayo to the gas grid connection near Craughwell in County Galway. The pipeline will be constructed of high strength carbon steel. It will also have an external corrosion protective coating and a cathodic protection system. The pipe will be 660 mm (26") in diameter and approximately 150 km long. It will be buried in the ground, to a minimum depth of 1.2m below top of subsoil. The depth of cover will be increased where the pipeline will require additional protection such as at road and river crossings.

The pipeline will be designed in accordance with IS 328 'Code of Practice for Design and Installation of Gas Transmission Pipelines' 1989. All pipelines in Ireland are built in accordance with this design standard which sets down the requirements for the design, construction and operation for steel pipelines transporting gas. This standard specifies both the minimum safety factor for the pipeline and the minimum permissible distance of the pipeline from occupied buildings.

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The proposed pipeline will be constructed of 9.52mm thick steel; rising to 19.1 mm along sections that are required to be heavy walled. Heavy walled pipe is used at locations where additional protection is required, such as at road and rail crossings, and in close proximity to dwellings. It will have a maximum operating design pressure of 85 barg.

For sections of the route, the pipeline traverses wet ground. To counteract the buoyancy pressures imposed by the water, the pipe will be coated with approximately 85mm of concrete in these areas.

In certain locations along the route, concrete slabs will be placed above the pipeline to protect it from damage. Typically this will be carried out at drainage ditches and watercourses.

Communication ducting will also be laid in parallel with the pipeline for most of the route. Three 50mm ducts will extend from Block Valve 2 (BV2) to the connection near Craughwell.

The proposed pipeline has been routed to avoid centres of population. The proposed route also minimises the number of major crossings and avoids areas liable to landslip, subsidence or other instability, as far as possible. For the whole of the pipeline, the materials used and the thickness of the pipeline walls, will be selected so as to ensure that the design factor (safety factor) specified by the design standards are not exceeded. By maintaining the building proximity distance (70 m), using appropriate materials and selecting thick walled pipe where required, the risks to any particular individual will be insignificant.

These design considerations will be further augmented by various measures, for example increased depth of cover especially at major crossings. In addition, the whole of the proposed pipeline route will be inspected (flown and/or walked), supplemented by the use of a Pipeline Integrity Monitoring System (PIMS) and a cathodic protection system.

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Natural gas is non-corrosive, so internal corrosion of the pipeline is extremely unlikely. However, the steel pipe will require external protection, which will be provided by external coating supplemented by cathodic protection.

Firstly, the pipe will be coated in the factory with a three-coat polyethylene coating system. After testing of the welds, they are field-coated to an equivalent standard by a specialist field team, using a mobile coating rig.

Cathodic protection (CP) reverses corrosion currents present in the soil by creation of a pipe to soil negative potential. This will be achieved by using an impressed current system and anode ground beds. The design of the cathodic protection system will be to IS 328 'Code of Practice for Design and Installation of Gas Transmission Pipelines' 1989.

The exact configuration of anode ground bed numbers, size and location will be determined by the results of a resistivity survey. This will be carried out prior to construction to determine the corrosiveness and conductivity of the soils along the route, and it will also record corrosion hazards from soils and other sources, and potential interference from existing power cables and other buried services. In order to monitor the system, test point connections will be mounted on CP marker posts.

A close interval electrical potential survey of the pipeline will be undertaken as soon as possible after commissioning of the cathodic protection system, in order to validate and provide a 'finger print' of the cathodic protection system. The system will be revalidated at intervals not exceeding ten years.

IS 328 requires that the pipeline *'shall be tested at least every six months and the results recorded, to ensure that pipe to soil potentials are within specified limits and to detect any significant changes.'*

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5.3.1 Control and Interface

The Corrib terminal near Bellanaboy Bridge is outside the scope of this EIS. Its function will be to regulate, condition and odorise the incoming gas from the Corrib Field, and transmit it at a maximum operating pressure of 85 barg to the Mayo-Galway pipeline. A pig trap, which will allow pipeline integrity gauges to be launched, providing feedback on various parameters in the linepipe, will form part of the main pipeline contract. At the interface between the terminal complex and the pipeline the outlet valve may be closed for emergency reasons by terminal staff. The status of the valve will be relayed by an electronic (SCADA) link to a BGÉ control room in Cork, and this valve will not be actuated without the agreement of BGÉ.

BGÉ will also maintain a control cabinet at the terminal, which will contain information gathering and transmitting equipment, such as modems, routers and computers, for interrogation of the Corrib Terminal Control System. BGÉ will have access to this equipment at all times, to ensure continuity of information and data flow. Communication between the control cabinet and BGÉ will primarily be by Eircom leased-line, but a backup radio link will also be provided.

The following information will be transmitted:

- Outlet Valve Status
- Outlet Gas Temperature
- Outlet Gas Pressure
- Station Gas Flow Rate
- Station Energy Flow Rate (the energy flow will be a function of the calorific value of the gas, and not just its volume)
- Station Energy Accumulated Flow
- Dry Gas Calorific Value at 15°C
- Relative Density at 15°C
- Odourant Injection Flow Rate
- Moisture Content

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5.3.2 Above Ground Installations

The block valve stations along the route ensure that sections of the pipeline can be isolated for emergency containment or periodic maintenance. The number and location of these installations is influenced by the following criteria:

- Maximum allowable operating pressure
- Diameter of pipe
- The location of branches or off-takes with existing valves
- Emergency response
- The need for valves for operational purposes
- Local conditions

The site areas required vary between 3600 sq. m and 14400 sq. m; in general, if pressure

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reduction and/or pigging is to be carried out at a particular AGI, a larger site area is required. They are usually located close to roads, for ease of access. They require planning permission for construction, and generally comprise a small single-storey control building within a fenced compound.

BV1 and BV2, located near Bellacorick power station and Castlehill respectively, will provide isolation facilities for the first two sections of the linepipe. There will also be provision for future connection with another pipe at these installations.

From BV2 southwards to the AGI near Craughwell, three fibreoptic ducts will be laid in the trench in parallel with the pipeline, to provide future communications flexibility. These ducts will be 50mm in diameter, and will require access chambers at intervals of approximately 2km (generally at road crossings).

BV3 is located near Clydagh Bridge and will facilitate offtake for Castlebar, as well as isolation of this section of the pipeline.

BV4 combines with a pigging station at an AGI south of Mayo village, a location approximately halfway along the route. There will be provision for a Claremorris offtake at this installation. Pigs that have been launched at the terminal near Bellanaboy Bridge will be received here, and the southern portion of the route will be pigged by launching here and receiving near Craughwell.

BV5 and BV6, the Tuam and Galway offtakes, are located near Cloonsheen and Grange West respectively. Again, their primary role is to allow portions of the pipeline to be isolated, for routine maintenance or in the case of an emergency.

The AGI near Craughwell forms part of the Gas Pipeline to the West project, and is generally outside the scope of this EIS. However, the pig trap and associated tie-in pipework will form part of the Mayo-Galway project. This will receive pigs launched from BV4, to clean and investigate the southern portion of the pipeline.

The locations of the block valves are shown in **Volume II**, Figure 5.1. Schematic diagrams of the combined block valve station and a pig trap station, and block valve station with provision for pressure reduction are shown in Figures 5.2 and 5.3.

In order to locate the pipeline and provide adequate warning for those working overground after reinstatement, permanent marking is necessary along the route. Bord Gáis Éireann require four different marker types, details of which are contained in their standard specification and drawings. The markers are:

- Marker Posts – located at every road, rail, ditch and river, to indicate the pipeline position
- Cathodic Protection Test Posts – located at every road, to allow the cathodic protection system to be checked
- Aerial Markers – located at every third ditch, to facilitate aerial monitoring along the pipeline route
- Aerial Dish Marker – located at major changes in pipeline direction, to facilitate aerial monitoring along the pipeline route.

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6. CONSTRUCTION

Typical pipeline construction methods and sequences are outlined in this section.

6.1 Construction Strategy

The construction work is scheduled for the two-year period 2002-2003. Advanced preparatory work will be carried out first, on difficult terrain such as rock and bog. This may involve blasting and regrading rock, and constructing a road along the pipeline route in wet areas using aggregate or bog-mats. Then construction work will commence on other special locations and crossings, the full pipeline spread(s) being mobilised when the preparatory work is complete.

Prior to commencement of work, the contractor(s) will prepare method statements and works programs that will provide a more detailed breakdown of the phasing of the construction.

For the purposes of construction and supervision of construction, the pipeline will be divided into two parts with the dividing line located approximately 100m south of the N5 road near Castlebar.

The appointed construction contractor will develop a series of detailed construction method statements for the pipeline. This will incorporate the requirements of third parties; the mitigation measures outlined in this Environmental Impact Statement and the results of the site investigation surveys undertaken for the scheme. The construction methodology given in this EIS should therefore be regarded as indicative rather than absolute, unless stated otherwise.

The contractor will produce detailed method statements covering the construction of crossing of each river, stream, road and any archaeological and ecologically sensitive areas that may be identified as requiring a Method Statement. Each Method Statement will be agreed with the appropriate consenting authority. The contractor, in consultation with BGÉ, will also develop a Pollution Control Plan, a Contingency Plan and an Environmental Management Plan to control and monitor environmental performance throughout the project. A draft scope for these method statements was included in the contract document and is included in Appendix 6.1.

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A construction management team will be employed by BGÉ to monitor the construction of the pipeline and audit against the method statements and other procedures. Agricultural Liaison Officers (ALO) have been employed for the duration of the project. Their function is to liaise with the landowners along the route and to ensure that their requirements are met. The entire workforce will be briefed about relevant environmental issues, including pollution control, before work begins.

Construction of the pipeline is planned for the years 2002 and 2003. Landowners/occupiers will be consulted on all relevant land drainage matters. Some reinstatement operations (e.g. hedgerow planting) may continue beyond October 2003, depending on weather and ground conditions.

6.2 Pipeline Construction Activities

Pipeline construction is a sequential process and comprises a number of distinct operations, which are described below. The rate of progress of each operation is dependent on a number of factors, including the ground conditions, the nature of the task and the weather.

6.2.1 Pre-construction Works

Ahead of construction, the route will be surveyed and pegged out in consultation with the landowner/occupier. This will establish the precise alignment, particularly in relation to field boundaries, mature trees and environmentally sensitive sites. Wherever practical and where there are no other overriding considerations, full use will be made of existing gaps in hedgerows and mature trees. Springs and seepage lines etc. will be avoided. Water supplies fed by springs or wells used for farming processes will be surveyed and monitored.

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Where necessary, and subject to agreement with the landowner/occupier, new field drains will be installed either within the proposed working width or just outside it to:

- prevent possible waterlogging of the working width;
- enable the farmer's current drainage system to continue working throughout the period of pipeline construction;
- help prevent damage to the soil structure;
- aid recovery from construction activity.

The design of these drainage schemes will be agreed between BGÉ, the pipeline construction contractor and the land owners/occupiers. A specialist drainage contractor will carry out the work. Permanent records of the land drain locations will be made and passed to the landowner/occupier and at all times the works will be supervised by qualified, competent personnel.

6.2.2 Working Width Preparation

All construction activities will normally be undertaken within a fenced strip of land, known as the working width. This will generally be 30 m wide. The contractor may adopt a wider working width at road, rail, river, ditch, and service crossings to facilitate safe working and manoeuvring. An extended working width of 35 - 40m may also be utilised for the sections of the pipe line that cross areas of peat or moorland where this does not conflict with ecological considerations. Removal of hedges adjacent to roads will be determined by the need to gain safe access to the pipeline by vehicles carrying heavy plant, equipment and materials.

Existing third-party services will be located and marked. Warning posts will be erected for overhead cables and temporary crossing points indicated.

Drainage ditches will be flumed by the installation of temporary pipes and ramped over to create a continuous running track for construction vehicles and allow continuous flow of water within the ditch. Where necessary, a running track will be constructed of imported stone, which will be laid on geotextile sheet to facilitate its removal at the end of construction.

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6.2.3 Fencing

The temporary working width will be clearly marked and stock proof fencing will be erected in areas grazed by livestock. The type of fencing will be agreed with the landowner/occupier and special arrangements, such as for horse fencing, will be made following consultation. Stiles or gates will be incorporated into the temporary fencing to maintain access to public rights of way and farm tracks. Where necessary, additional access points will be provided to allow landowners/occupiers access across the pipeline and thereby mitigate field severance.

The standard amount of dry-stone wall or hedge that will be removed at field boundaries will be a maximum of 30m, unless agreed and authorised otherwise. At mature hedge lines a maximum of 10-15m of the hedge will be removed. At road and track crossings a maximum of 30m of hedge will be removed and the crossing will be at right angles to the pipeline, wherever possible.

Where hedge lines are removed, particularly at road crossings, temporary, secure gates will be installed to prevent unauthorised vehicle access to the working area. These gates will be maintained by the contractor throughout the construction period and will only be open for access. They will be closed when there is no activity proceeding in that section and outside the normal working hours.

Temporary water supplies will be provided for livestock as necessary.

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6.2.4 Topsoil Stripping

The topsoil will be stripped across the working width by appropriate earth moving equipment and stored carefully at one side of it (**Plate 6.1**). The topsoil stack will be typically 8m wide and up to 3m high. It will be kept free from disturbance to reduce the risk of physical damage and compaction. Generally, vehicle movements will be confined to the 'running track' on underlying subsoil.

Before topsoil stripping takes place, growing crops will normally first be removed. Following topsoil stripping, some areas of the working width may be benched or graded to enable safe working.

In areas of peat larger working widths may be required for the temporary storage of peat.

6.2.5 Temporary Access Roads

Temporary access roads between public roads and the working width may be required along the proposed pipeline route to aid the movement of machinery and materials, particularly where the ground is soft. Typically a temporary access road may consist of a thickness of crushed stone or sand overlaying a geotextile membrane.

6.2.6 Pipe Delivery, Stringing and Bending

Pipe will be shipped to Ireland, and delivered to pipeline storage depots by road. These depots will be located near Bellacorick Peat Power Station, close to Castlebar, and close to the N17 road.

The pre-coated pipe will be delivered to the working width from the depot by lorry and off-loaded with mobile cranes. Where the ground is suitable, pipe sections will be delivered to their final location along the working width to be stored on wooden skids along a line parallel to the trench line (**Plate 6.2**). If ground conditions are soft or rough the pipe will be off-loaded at designated crossings, and transported along the working width by specialised plant.

Where severe changes in direction take place, factory-manufactured bends will be installed. Wherever the bends are less severe, bending will be accomplished through the use of a pipe-bending machine at the pipe storage area or on site.

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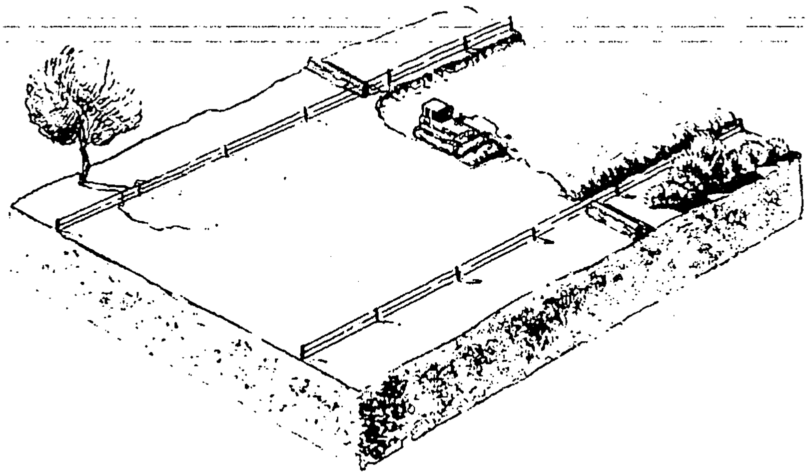

Plate 6.1: Topsoil Stripping

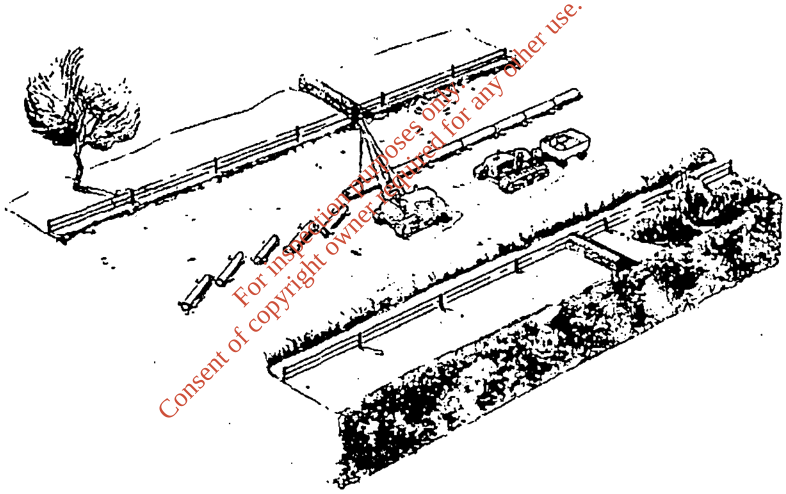

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Plate 6.2: Pipe Stringing

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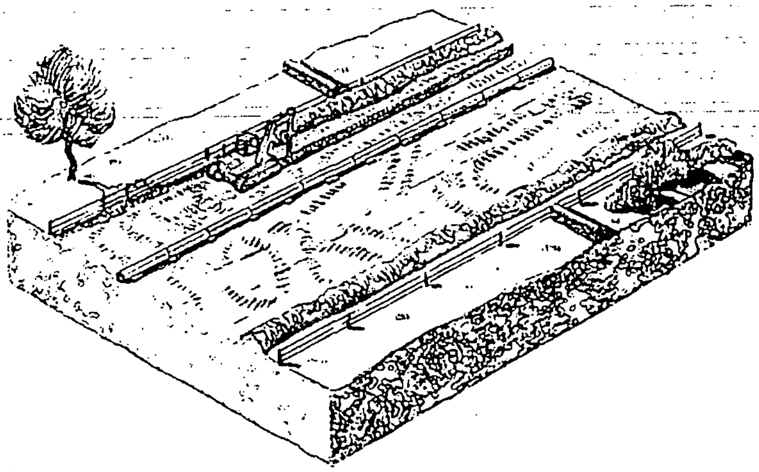

Plate 6.3: Trench Excavation

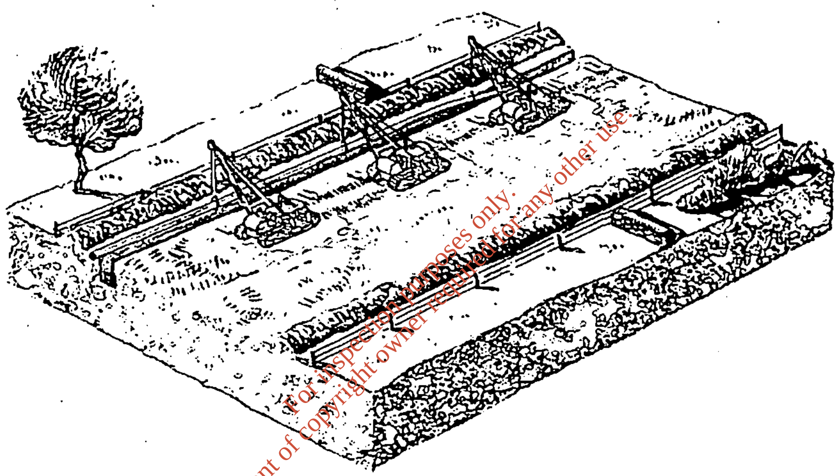

Plate 6.4: Pipelaying

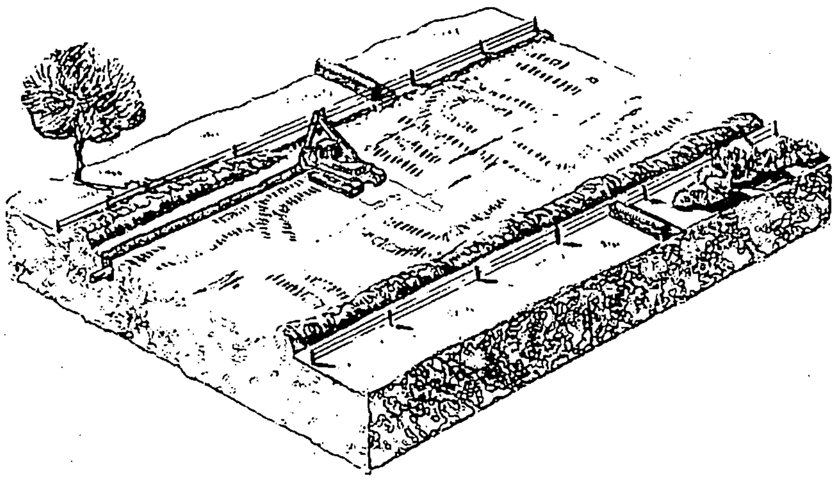

Plate 6.5: Backfilling

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6.2.7 Welding, Non-destructive Testing and Coating

The pipe lengths will be delivered pre-coated externally with a 4mm polyethylene three-layer coating system. Following stringing, the pipeline sections will be welded together. All the welds will be radiographically tested and approved before an approved coating is applied on site to the weld area.

Only qualified and approved staff will undertake welding and testing.

6.2.8 Trench Excavation

In general, the pipe trench will be dug either with mechanical excavators straddling or running alongside the pipeline trench or using a specialised trenching machine (**Plate 6.3**). The depth will be variable but will allow a minimum reinstated cover of 1.2m over the top of the pipeline in agricultural land and 1.6m below the clean bed of streams and ditches.

In areas where rock is at or close to the surface, the trench will be excavated by blasting or using mechanical rock-breaking plant.

The material excavated from the pipe trench will be stored on the opposite side of the working width from the topsoil to prevent mixing of subsoil and topsoil, which might hinder reinstatement. In any areas of rock, the pipe may be bedded on, and surrounded by sand.

6.2.8.1 Excavation in Peat

Excavation in bog and peat areas presents particular challenges, the soft ground making conventional trenching methods impractical. Contractors typically adopt one of three methods:

- Self-Weight
- Pull Section
- Drill Through

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The self-weight method would be carried out as follows: the bog is churned up and trenched along the route, and additional water pumped into the trench to stabilise the sides. The linepipe is then strung and welded over the centreline of the trench, laid on mats and skids. The skids and mats are then slowly removed, and the pipe filled with water. This will cause the pipe to sink to the bottom of the trench/churned up bog.

Pull section construction involves laying a cable along the route at the desired depth, and winching the pipe through. The first pipe length has a v-plate deflector to reduce friction, and additional sections of pipe are welded on as the pipe is winched forward. This is similar to the method used to construct a long crossing or landfall in water.

The third option, drill-through, is similar to pull-section in that a cable is laid along the route, and the pipe is winched through; but in this case, the cable route is pre-drilled.

The pipeline contractor will decide on construction methods for the wet areas, but will be required to prepare method statements for all such sections, demonstrating both the feasibility and the environmental suitability of the chosen method.

6.2.9 Pipe Lowering

Following trench excavation the welded pipe will be carefully lowered into the trench in a continuous operation (**Plate 6.4**). In rock or stony ground, the pipe will need protection from damage; either with heavy-duty polyethylene coating or sand bedding. In bog areas, a pipe-lowering method as described in 1.3.8.1 may be used.

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6.2.10 Backfilling

The pipe trench will then be backfilled, where possible with the material taken from the trench in the reverse order in which it was excavated (**Plate 6.5**). Sand padding and surround may be used to protect the pipe if the backfill material is particularly stony and in areas of rock.

The backfilled materials will be consolidated by tamping or rolling. Any surplus material from trench excavation is normally spread within the working width. Any surplus is the property of the landowner/occupier who will be consulted together with the relevant County Council as appropriate before any offsite disposal is carried out.

Land drains will be reinstalled at this stage, prior to topsoil reinstatement, permanent fencing and the removal of flume pipes and bridges. All land drainage works will conform to the relevant local authority requirements and will be installed using specialist machinery.

6.2.11 Crossing of Rivers and Streams

The trenching methodology described above will be modified for road, railway, river, ditch, and service crossings. Typical methods of construction fall into two categories, open cut and non-open cut.

The adopted methods of construction will depend on the results of the site investigation and on the requirements of the appropriate authorities. The contractor's method will be subject to BGÉ's approval. On the basis of current assessments, the preferred method is open-cut techniques subject to agreements with the relevant County Council and Fisheries Board, suitability of ground conditions, and the implementation of stringent environmental controls.

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6.2.11.1 Open Cut Crossings

One or other of the following two open-cut techniques may be employed for watercourse crossings.

Method 1

Most watercourses will be crossed using 'in river' works by means of an open cut trench, employing hydraulic excavators. Details of this method are outlined below:

- The site will be prepared by stripping the topsoil from all areas adjacent to the riverbanks and ramping the banks down to riverbed level. The stripped topsoil will be stacked separately from the subsoil within the working area.
- Excavation of the riverbed will then proceed and the excavated material stored adjacent to the trench, within the working area. The prefabricated pipeline section will then be installed in the trench and checked to ensure that a minimum cover of 1.6m exists below the clean hard bed of the river and the top of the pipe.
- Initial backfilling and final reinstatement will take place using the excavated sediment.
- The riverbanks are then reformed to their original profile to the satisfaction of the relevant County Council and Fisheries Board and the landowner/occupier. Any surplus excavated material will be removed from the site to an approved disposal facility.

Method 2

The alternative to in-river work is 'dry' open cut trench methodology. Water flow is maintained by diverting the stream away from the proposed crossing location. Details of this method are outlined below:

- The site will be prepared by stripping the topsoil from areas adjacent to the river crossing and storing it within the working area. Suitably sized flume pipes (size to be selected by the contractor in consultation with the relevant County Council and Fisheries Board) will be

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- installed in the watercourse close to the proposed crossing, ensuring continuity of running strip.
- The temporary watercourse diversion is then excavated to the positive side of the pipeline spread, and flumed if necessary. De-watering and/or trench supports may be used to facilitate safe excavation. If pumps are used, the discharge hose will be directed through a filtering medium to limit silt carry over, before the pumped water is allowed to percolate back into the watercourse.
- The original watercourse is then dammed at both sides of the proposed crossing, creating a dry zone for trenching operations. The watercourse bed is trenched as described in section 6.3.8.
- The prefabricated pipeline section will then be installed in the trench and checked to ensure that a minimum cover of 1.6 m exists below the clean hard bed of the watercourse and the top of the pipe. The pipeline will then either be encased by a minimum of 150mm thickness of mass concrete or be protected by 150mm thick concrete protection slabs.
- Initial backfilling will take place using excavated subsoil free of large stones or other deleterious material. Final reinstatement will use the stored river bed materials.
- The riverbanks will then be reformed to their original profile to the satisfaction of both the relevant County Council and Fisheries Board and the landowner/occupier. Final riverbank reinstatement may require importation of locally sourced large stones or rocks to stabilise the banks and prevent erosion. Any surplus excavated material will be removed from the site to an approved disposal facility.

To ensure environmental protection of all the watercourses within the preferred corridor, all mechanical plant and equipment will be fuelled and serviced at locations remote from the watercourse. Pumps and other mechanical plant will be fitted with drip trays and absorbent material will be available to mop up any spillages. In the event of a spillage, all contaminated material will be removed from the site to an approved disposal facility.

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6.2.11.2 Non-open Cut Crossings -Optional

Auger boring, pipe jacks and concrete tunnels require deep excavations on either side of the crossing to aid the installation of the pipeline. De-watering, sheet piling and other techniques are generally used to enable excavations and construction techniques to be carried out in accordance with the relevant health and safety regulations.

Horizontal Directional Drilling (HDD)

With horizontal directional drilling (HDD), the pipeline is bored under the crossing (i.e. river crossings) to emerge at a target point on the opposite bank. This is a method that has been used on many pipelines to cross beneath areas where conventional construction methods may cause damage, or where access is severely restricted.

The first stage is to drill a pilot hole using drilling rods. As the drilling proceeds, a drilling fluid comprising water and bentonite (a naturally occurring clay mineral) is pumped down the centre of the hollow drill rods. This will lubricate the drilling rods, balance the groundwater and earth pressures and pick up cuttings, before returning to the surface, via the drill hole. The drill fluid is then filtered to remove the cuttings and returned to temporary mud storage tanks for reuse. The position and progress of the drill head is monitored and controlled from the surface using electromagnetic detection equipment.

Drill fluid usage will be monitored at the surface to confirm no significant losses are occurring. Bentonite mud is normally recommended for drilling through groundwater, because it is non-toxic. The composition of the bentonite, the use of any additives and its disposal, will be agreed with the relevant authorities prior to construction.

After the pilot hole is drilled, reaming devices are attached and pulled back through the borehole to enlarge it to the required diameter. Bentonite is injected around the reamer to coat the borehole. It is a thixotropic material and will support the sides of the hole ready for the pipe

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to be pulled through.

Finally sections of pipeline are laid out on the opposite bank ('strung') in a straight line, and welded together and coated before being pulled back through the borehole in one continuous length. This minimises the risk of it becoming stuck during the pull.

There is a technical requirement for the drilling mud to be returned from the stringing side to the drilling side during reaming and pullback operations for reprocessing and re-injection. The options for undertaking this operation are:

- option 1: laying a small diameter temporary pipeline (welded steel or polyethylene) across the river bed;
- option 2: using vacuum trucks, to tanker the mud from one side of the river to the other;
- option 3: drilling a second pilot hole and pulling the mud return line through it.

Provided it is technically possible, option 1 is preferred.

Microtunnelling

Microtunnelling may be required for some of the crossings. This is a method that has been used on many other pipelines to cross beneath difficult areas for construction.

Pre-cast concrete jacking pipes are placed behind a microtunnelling machine with the excavated material being removed via the tunnel entrance.

The method involves the use of a cutting head lubricated with water. Small quantities of bentonite may also be used to reduce friction. The composition of the bentonite will be agreed with the relevant authorities prior to construction. The drill fluid is returned to the surface where it will be filtered to remove the cuttings and returned to temporary mud storage tanks for re-use.

Equipment associated with microtunnelling will include a power unit, one or two storage tanks for cuttings, separation plant and an operation board.

Used drilling fluids will be sampled, analysed and disposed off-site to a licensed waste disposal facility.

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Auger Boring

This requires deep excavations on either side of the crossing to aid the installation of the pipeline where required. De-watering, sheet piling and other techniques are generally used to enable excavations and construction techniques to be carried out in accordance with Health and Safety Regulations.

A combination of rotation of the auger drill within the pipe string and a winch located on the front of the power unit installs the pipe string with the excavated material being drawn from the cutting head, down the auger drill flutes exit from the rear of the pipe string. Additional land will be required on both sides of the crossing to accommodate the additional excavated material from the pits and the auger.

However, the actual design will be submitted to the appropriate body for approval prior to construction.

Concrete Tunnel

There are two principal methods of installing a concrete tunnel:

Pre-cast concrete segments can be installed behind a protective shield, in which the tunnel is driven forward either by normal mining techniques or a tunnel boring machine, with the excavated material being removed via the tunnel entrance.

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Alternatively, pre-cast concrete rings can be installed behind a protective shield and driven forward by a combination of normal mining techniques and hydraulic jacks, with the excavated material being removed via the tunnel entrance.

Surveyors check the line and level of the tunnel to ensure correct location and depth. The concrete tunnel will be of a larger diameter than the pipe, which is welded up and then installed on supports in the tunnel either as a pipe-string or one pipe at a time. After installing the pipe the annulus between the carrier pipe and the tunnel will be filled with grout and the tunnel sealed.

Pipe Jack (carrier pipe)

This construction method is generally used on large diameter pipes and involves the carrier pipe itself being installed behind a protective shield using a combination of normal mining techniques and hydraulic jacks to drive the pipe forward, with the excavated material being removed via the exposed end of the pipe. As each pipe progresses forward then another is welded on and in this manner the pipe is installed.

It should be noted that all of the construction techniques briefly described above will be subject to suitable ground conditions, a site investigation, the requirements of the consenting authority for each crossing and the appropriate health and safety and environmental legislation.

6.3 Pipeline Way Leave Reinstatement Proposal

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The effective reinstatement of the 'way leave' following the temporary disturbance caused by the construction process will ensure that the environment will be returned to its natural state as quickly as possible.

After reinstallation of the land drains and regrading of the working width to reflect the original profile, suitable surplus subsoil will be spread on a field by field basis, ripped where necessary and stones and debris will be removed prior to topsoil replacement. After replacement, the topsoil will be stone picked and cultivated as necessary.

The working width fencing will be removed to suit the landowners/occupiers requirements. Generally on arable land the fences are taken down to allow the cultivation of the field as a whole, whereas on permanent pasture the fences are retained in order to restrict access to livestock until the reseeded sward has sufficiently recovered to withstand grazing pressures. These procedures will be agreed with the landowner/occupier before work begins.

All materials related to the construction work, including imported fill, temporary culverts and geotextile membrane will be removed on completion of the work.

Where necessary, additional or replacement land drains will be installed in the working width. In some places, this work may be carried out following topsoil replacement.

Particular attention will be paid to the careful replacement of field boundaries to reduce the visual impact (**Section 15**). Fences will be reinstated to meet the landowner/occupier's requirement using materials that match the existing fence where appropriate. Dry stone wall and earth bank field boundaries will be reinstated to match the existing boundaries. Hedgerow sections that are removed will be replanted using a suitable mix of native species. Replanting will be undertaken using either container grown stock or quality open grown stock, and followed by good maintenance and weed control. All replanted hedgerows will be protected with either rabbit-proof fencing or individual guards to protect the new growth from grazing and browsing animals. Detailed mitigation measures for hedgerows are discussed in **Section 15.5**.

River corridor vegetation will be reinstated according to the requirements of the relevant County Council and Fisheries Boards. If necessary, vegetation will be transplanted and stored prior to reinstatement (**Section 10**).

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6.4 Health and Safety Aspects

The Health and Safety Authority (HSA) is the governmental agency responsible for implementation of the Health and Safety Regulations in Ireland. These Regulations require that Project Supervisors be nominated for the Design and Construction Stages. On completion of design and construction BGE will have responsibility for implementing a strict health and safety policy for the operation of the gas transmission system.

Arup Consulting Engineers are the nominated Project Supervisor (Design Stage). This role is defined under the 1995 Safety, Health and Welfare at Work (Construction) Regulations, and requires the designer to:

- Design to avoid risks to health and safety
- Tackle the causes of risks at source, or if that is not possible
- Reduce and control the effects of risks by means aimed at protecting anyone at work and the general public who might be affected by the risks and so yielding the greatest benefit.

On award of the construction contract(s) the Project Supervisor (Construction Stage) will be nominated. The responsibilities of the Project Supervisor during construction include the co-ordination of the features listed below to ensure no compromises are made which might jeopardise the safety of employees, contractors, or the public:

- construction work on site;
- hazardous materials and chemicals;
- operating procedures;
- work permits;
- emergency response.

The health and safety performance of the contractors will be the subject of regular reviews by BGE.

The contractor will be required to ensure that the fibre optic cable is stored, handled and laid in accordance with best practice.

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6.5 Pipeline Testing

6.5.1 *Pressure Testing Procedure*

On completion of the construction of the pipeline, a 'proof test' of the pipeline will be carried out to demonstrate fitness for purpose. This will take the form of a hydrostatic test, which involves filling the pipeline completely with water and raising the pressure to 150% of its maximum operating pressure for a 24-hour period.

The pipeline may be tested in a number of separate sections, which will be determined by the topography of the pipeline route and sources of water for the hydrostatic test. The number of sections requiring testing and the source of the water will be considered further at the detailed design stage.

Before hydrostatic testing, the pipeline will be cleaned and internally checked using air or water-driven pipeline integrity gauges (PIG).

6.5.2 Solid Emissions

Typical solid wastes arising from the pigging operation will be mill scale, weld splatter, rust and other such debris. Arrangements will be made at the test locations to contain and collect this waste for subsequent disposal to an appropriately licensed facility, **(Section 18)**.

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6.5.3 Liquid Emissions

After successful cleaning, the pipeline will be filled with water and pressurised for the designated test period. The pipeline is then depressurised under controlled conditions and the water discharged. All abstractions and discharges of water will be subject to consent from the relevant authority. Prior to discharge, the water will be analysed to check quality. Filters and break tanks will be used to control the rate of discharge and remove any solids.

6.5.4 Noise

Noise from pipeline testing is mainly associated with the pumps and compressors needed to fill and pressurise the pipeline at the test ends. Typical noise values for testing equipment are given in **Section 17**. The noise from testing operations shall not exceed a limit of 70dB(A) at a distance of 1m from source.

The venting of air from the pipeline during pigging operations will also generate noise. At various stages of the testing operation it will be necessary to vent air from the pipeline. Venting will take place over relatively short periods of time, but it can give rise to high noise levels. In order to minimise disturbance, whenever possible venting will only be carried out during normal working hours or through silencers. The contractor will consult local residents prior to venting taking place.

6.6 Commissioning

On completion of hydrostatic testing and the discharge of test water, the test sections will be swabbed to remove residual water by passing through specially designed pigs propelled by compressed air. The separate test sections can then be welded together to form a complete length of pipeline.

It is important at this stage to remove all traces of water to ensure dry gas is transported on commissioning. A process called vacuum drying, which will be carried out by a specialist contractor, achieves this. It involves reducing the pressure within the pipeline by gradual removal of air using a vacuum pump. This lowers the boiling point of the residual water causing it to vaporise and hence be removed.

When this is achieved, the pressure in the pipeline can be equalised by the use of dry air or nitrogen. After drying, the pipeline will be filled with nitrogen prior to being commissioned with natural gas.

It is anticipated that testing and commissioning of the entire pipeline and facilities will be completed by late autumn 2003.

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7 PIPELINE OPERATIONAL ASPECTS

7.1 Operation Regulations

This section describes BGE's standard procedures for operating their transmission system which will be followed for operating the Mayo - Galway pipeline.

7.2 Operating Procedures

BGE's standard operating procedures comply with the requirements of IS 328 'Code of Practice for Design and Installation of Gas Transmission Pipelines' 1989. The operating procedures will include the following:

- an administrative system covering legal considerations, work control and safety;
- clear and effective emergency procedures and operating instructions;
- adequate and regular training of all personnel involved in operational and maintenance matters;
- a comprehensive system for monitoring, recording and continually updating the state of the pipeline and auxiliary equipment;
- a Permit to Work system to control all work adjacent to the pipeline or work which might interfere with gas flow;
- a schedule for the regular inspection and maintenance of pressure regulating equipment, pipework and ancillary devices to promote a high level of reliability and safety in operation;
- effective corrosion control and pipeline condition monitoring;
- a system to collect and collate information on third party activities to reduce the risk of pipeline damage;
- regular contact with owners and occupiers of the land through which the pipeline passes;
- monitoring of land restoration and crop losses, and the undertaking of remedial land drainage works where necessary.

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7.3 Condition Monitoring

7.3.1 Pipeline Integrity Monitoring System (PIMS)

BGE will also be responsible for the operation, maintenance and condition monitoring for the pipeline. The integrity monitoring system will be provided in order to minimise the consequences both to the population and the environment in the event of a pipeline failure. In the design of the system, due consideration is given to the nature of natural gas, the variability of the operating conditions and the availability and suitability of modern systems to detect pipeline problems.

The system provides a modern computer-based pipeline integrity system, which will continuously monitor the pipeline and provide an indication of a gas release based on Transient Wave Analysis or mass balance.

The computer will continuously run a dynamic mathematical model of the pipeline and compare it with the actual measurements obtained from the pipeline. The mathematical model will compute the amount of gas that is contained within the pipeline by reference to its pressures, temperatures and the gas flow into and out of the pipeline. It will be caused by changes in the operating conditions and those created by any abnormal gas release. The model will also provide validation of all instrumentation inputs to prevent mal-operation caused by erroneous information.

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Detection of a validated gas release will be indicated to the operator in the control room via an alarm. In line with written procedures, BGÉ will then isolate the pipeline at suitable locations. Once isolated the gas pressure decay checks will confirm in which section of the pipeline the leak is occurring. The pipeline will remain isolated until the cause of the gas leak is fully investigated by operational staff and the corrective action has been implemented.

7.3.2 Corrosion Protection

As described in Section 5, the pipeline will be provided with a cathodic protection system. A close interval electrical potential survey of the pipeline will be undertaken as soon as possible after commissioning of the cathodic protection system, in order to validate and provide a 'finger print' of the cathodic protection system. The system will be revalidated at intervals not exceeding ten years.

IS 328 requires that the pipeline 'shall be tested at least every six months and the results recorded, to ensure that pipe to soil potentials are within specified limits and to detect any significant changes.' BGE's standard procedure comply with this requirement.

7.3.3 On-line Inspection

On-line inspection involves passing an inspection device, known as an intelligent pig, through the length of the pipeline. This device records, describes and sizes any pipeline defects and locates them with a high and consistent degree of accuracy.

As soon as possible after commissioning, there will be a complete run through the pipeline by an intelligent pig in order to produce a 'finger print' record of the initial condition. Subsequent runs, which will take place at regular intervals, will compare the information recorded against the 'finger print' to give an indication of deterioration.

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During operation, on-line inspection will highlight deterioration in pipeline integrity, and if deterioration is observed appropriate action will be taken in order to maintain security of supply and adequate levels of safety.

7.4 Maintenance Requirements

In order to operate the pipeline with the minimum of disruption to the environment through which it passes, a BGÉ representative will act as a long-term contact with the farmers along the route. This will ensure that changes of ownership or occupancy are recorded, that the occupier is aware of the presence of the pipeline and that discussions can take place with regard to any work which might affect the pipeline. The BGE liaison officer will also consult with other contractors or utility companies working in the vicinity of the pipeline.

7.4.1 Basic Records

Work programs and maintenance schedules will be substantially completed at the time of commissioning, which will incorporate:

- production records and certification of all pipeline materials
- grade and wall thickness of linepipe, carrierpipe, sleevepipes and heavywall pipe where used
- protective materials used
- logging of soil strata
- precise line and depth at frequent intervals, particularly at road, rail, river and service crossings

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- location, type and depth of land drains
- location of underground services
- crossings of streams, ditches and any other relevant information that is not readily obtainable by surface inspection
- longitudinal profile of the pipeline
- archaeological details
- names and addresses of landowners and tenants and their easement boundaries
- details of surface installation, cathodic protection, test posts, area markers, etc.
- detailed drawings of all BVIs, AGIs, special crossings and locations of other services where required for special consideration.
- a schematic drawing showing off-takes, identification of valves and the volumetric capacity of sections between BVIs.
- a record of all air and hydrostatic tests carried out together with any certificates
- maps showing location and details of all CP installations (locations of test stations, rectifiers, ground beds, galvanic anodes, isolation joints, automatic switches, and anodes)
- design criteria
- quality assurance of materials to IS 300 or equivalent

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7.4.2 Organisation

BGÉ will expand its operations and maintenance organisation to cover the operations and maintenance of the pipeline.

Typically, BGE operate a 'Permit to Work' system for all pipeline operations that may interfere with gas flow or create hazardous conditions. The number of persons authorised is kept to a minimum. BGÉ also operates a 'Master Key' system for locking valves, gates, site buildings and instrument panels.

The pipeline will also be subject to routine surveillance. The route will be flown at regular intervals to check on any possible third party interference or for work being carried out in close proximity to the pipeline. The surveillance can also be used to check on the condition of the reinstatement of land affected by the pipeline.

The route will be walked periodically to enable close inspection of the pipeline, corrosion protectors and marker posts and to identify any problems with reinstatement such as failed hedge planting or drainage problems.

7.5 Risk Assessment/Pipeline Safety

The pipeline will be designed, constructed and operated in accordance with the IS 328 'Code of Practice for Design and Installation of Gas Transmission Pipelines' 1989. The Code defines minimum distances for the pipeline from normally occupied buildings, based on operating pressure and pipewall thickness. The proximity requirements for the Mayo-Galway pipeline are 70m for standard pipeline, and 3m for heavywall pipeline. Safety during construction of the proposed pipeline is dealt with further in Section 6.5.

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7.6 Decommissioning Methods

At the end of its useful life, the pipeline and associated facilities will be decommissioned safely, with due regard to environmental protection. The pipeline will be decommissioned, emptied of natural gas, purged (usually with nitrogen) and left capped and cathodically protected. Where the need arises, sections will be solidly grouted or removed.

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8 PLANNING, POLICY AND LAND USE

8.1 Introduction

This section considers the proposed pipeline development in the context of relevant regional and national policy guidelines and plans and the policies and objectives of the statutory development plans for Counties Mayo and Galway, through which the pipeline passes. The section also considers the likely land use impacts of the proposed pipeline.

8.2 National and Regional Planning Context

8.2.1 Government Guidelines

Current planning philosophy generally places strong emphasis on the need for 'sustainable planning and development' and in this regard, an increasing volume of Government policy directives, guidelines and European Union policy is informing planning policies.

The National Sustainable Development Strategy – 'Sustainable Development – A Strategy for Ireland' issued by the Department of the Environment and Local Government in 1997 sets out the Government policy of encouraging more sustainable development in all sectors. This document is referred to further in Section 3.

The National Climate Change Strategy was published by the Government in 2000. This strategy supports the development of indigenous gas supplies. Refer to Section 3 for a discussion of this issue.

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The Department of Public Enterprise published the 'Green Paper on Sustainable Energy' in September 1999. The report predicts:

'a dramatic increase in the contribution of natural gas to the electricity supply mix'

From a base of 30% in 1998, natural gas is projected by 2010 to account for 56% of the fuel mix for electricity generation. In the context of increasing dependency on natural gas in power generation, the Government's Green Paper concludes that measures such as liquid natural gas storage and pipeline construction will be required to protect the security of supply to the national gas network.

8.2.2 European NUTS II Regions - Objective 1 and Objective 2

The Republic of Ireland is divided down into two regions – the Southern and Eastern Region (S&E region) and Border, Midland and Western Region (BMW region) – NUTS (nomenclature of territorial units for statistics) II Regions, for EU structural Fund purposes. The BMW Region contains Counties Mayo, Galway, Sligo, Roscommon, Leitrim, Donegal, Monaghan, Cavan, Longford, Westmeath, Laois, Offaly and Louth and is classified as an Objective 1 region within the European Union. This means that development in the area is considered to be lagging behind in terms of social and physical infrastructure, and qualifies for the maximum allocation of Structural and Cohesion funds from the EU.

As illustrated in **Figure 8.1 (Volume II)**, the existing gas network does not extend to the midlands or the west of the country and is almost exclusively within the south and east region. Only a small part of the network, which serves Dundalk and Drogheda in County Louth with a spur to Baileborough in County Cavan, is in the BMW region.

The current proposal and other planned extensions to the national network as outlined above will provide an opportunity for many areas in the BMW region to be connected to the national gas network. In addition the installation of fibre optic cabling with the pipeline will extend the

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broadband data network to the BMW Region.

8.2.3 The National Development Plan 2000-2006

The National Development Plan 2000-2006 proposes an investment of over £40 billion in the period 2000-2006. This investment is broken down by region in line with the NUTS II Region designation of Ireland as outlined above. The National Development Plan investment strategy places a strong emphasis on underpinning the economic success of recent years and seeks to redress the regional disparities in economic wealth between and within the regions.

A total of £13.562 billion is to be spent in the BMW region through the various sectoral programmes, with almost £6 billion to be devoted to Economic and Social Infrastructure. No specific mention of natural gas infrastructure is made.

Development of advanced telecommunications is an objective of the plan, to support the accelaration of the information society and e-commerce. Provision of fibre-optic cable in the pipeline trench will help achieve this objective in the BMW region.

8.2.4 'National Investment Priorities for the period 2000-2006'(ESRI)

As part of the preparations for the National Development Plan, the Economic and Social Research Institute (ESRI) produced a report entitled: 'National Investment Priorities for the period 2000-2006'.

In general terms, the report recognises that commercial pressures, combined with the need to meet environmental standards, have raised the dependence on gas which in turn has raised issues concerning security of supply and delivery of gas and electricity in Ireland.

This report identifies that the rapid growth in the economy will require considerable investment in the electricity and gas industries over the coming decade.

The ESRI report also recognises the importance of the Corrib Gas Field and specifically in relation to the proposed new gas field states:

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'In the case of gas major investment in transmission will be needed in the next planning period. This new investment will be needed to cater for increased demand, especially from the electricity sector. However, the potential gas find off the West Coast gives rise to considerable uncertainty as to what is the best way to proceed.

While it had been proposed to possibly extend the availability of gas into the West it is clearly inappropriate to do so at present. As mentioned above, the prospect of a gas find off the West Coast leaves open the possibility that such an extension could be carried out quite cheaply. In the absence of such a find it would appear that such an extension would not be justified on cost grounds, as it would absorb scarce resources which would be better spent in promoting regional development in other ways. Certainly the prospect of a new find makes the option value of delaying any decision on a further extension very high.

Depending on the outcome of exploration off the West coast there is likely to be a need for further pipe-lines to the north and to Britain (or even the continent) to ensure adequate supplies in the future...(page 250)

The proposed Mayo-Galway pipeline will have clear benefits in terms of:

(a) meeting the national demand for gas and electricity and reducing the need to import natural gas;

(b) supplying natural gas to the west of Ireland where this would otherwise not be an economically viable option.

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8.3 Regional Planning Context

8.3.1 'The Border, Midlands and Western Region - Development Strategy 2000-2006'

'The Border, Midlands and Western Region - Development Strategy 2000-2006' Report (April 1999) was prepared for the Regional Authorities as *'a single prioritised strategic plan'* for the BMW region as an input to the proposed National Spatial Strategy.

Section 5.7.2 of this report - Regional Priorities - refers to major natural gas projects including extending the natural gas network to the Midlands and West.

The Report states:

Major Extension to the Midlands and West.

One of the key priorities for the energy sector in the Programme for Government 'Action for the Millennium' is to extend natural gas as far as practicable to major towns and cities. Bord Gáis has a statutory obligation to develop and maintain a system for the supply of natural gas on a commercial basis. Any proposals for the extension of the gas network are to be assessed by Bord Gáis in light of that obligation. The Proposed extension would provide gas to Mullingar, Athlone, Ballinasloe and Galway (and to Ennis and Shannon). Studies by Bord Gáis have indicated that the extension of the network into many towns would not provide a positive return on investment. However, the extension of the network would give residents, industry and enterprise the same choice of fuels as is now available in the areas served by the existing network.

The location of the proposed pipeline makes the introduction of gas supply to areas in the west of Ireland a more feasible proposition. It will be significant in terms of its impacts on the economic and social development of the west of Ireland and County Mayo, in particular.

The National Spatial Strategy will form the central thrust of Government policy to achieve more balanced regional development. It will highlight a number of options and choices with regard to broadband communications. The provision of fibreoptic cabling in parallel with the pipeline will help rebalance the regional disparity in this area.

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8.4 Impact of the proposed Pipeline on Strategic National Planning and Regional Development

The west of Ireland has a clear infrastructure deficit at present, in terms of energy infrastructure as well as in other areas.

As outlined in the ESRI report - '*National Investment Priorities for the period 2000-2006*' - the current proposal to construct a pipeline to bring natural gas from the landfall at Broadhaven increases the economic feasibility of extending the gas network into the west and particularly into areas such as County Mayo which are otherwise unlikely to benefit from this resource.

The introduction of natural gas may contribute to the regional development of the western region and County Mayo, in particular, by acting as a catalyst to economic development and encouraging investment in industry and commerce by providing a greater choice of fuel.

In line with the '*National Development Plan 2000-2006*', the upcoming National Spatial Plan is likely to emphasise the need for greater equality between the regions by promoting the development of strategic infrastructure in the 'Objective 1' areas.

The proposed pipeline will facilitate a natural gas connection to the 'Regional Growth Centres' of Galway and Sligo as well as the proposed 'Smaller Growth Centre' of Castlebar (in line with '*The Border, Midlands and Western Region - Development Strategy 2000-2006*' report). The economic competitiveness of these centres will be significantly improved by the provision of a natural gas supply.

Other urban centres such as Ballina, Westport, Claremorris, Ballinrobe, Tuam and Athenry could

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also benefit and there would inevitably be spin-off benefits for the associated rural hinterland areas. There would be indirect benefits to areas outside the corridor of the current pipeline, which are currently on the network or which are proposed for connection, through an increased security or supply to the national grid from the Corrib Field.

In the event of further natural gas finds off the west coast, the proposed pipeline could facilitate the connection of these supplies to the national network bringing further benefits of regional and national significance.

8.5 Local Statutory Development Plan Context

The route runs through the administrative areas of Counties Mayo and Galway.

The pipeline route has been assessed in the context of the county development plans of these counties to determine the likely impact of the development on Local Authority planning policies and development control objectives generally, on specific policies or objectives and on the proper planning and development of the area.

The assessment of the Development Plans reviews the Development Objectives outlined in the Plans and identifies where impacts on these objectives are likely or possible. Various environmental impacts (e.g. cultural heritage, flora and fauna, air, climate and the landscape) are considered elsewhere in this Environmental Impact Statement.

8.5.1 Mayo County Development Plan, 1992

The Mayo County Development Plan, 1992 is the current statutory Development Plan for County Mayo.

A series of maps contained in the 1992 Mayo County Development Plan illustrate a number of Development Objectives relating to areas to be protected, preserved, enhanced or developed for various uses.

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Table 8.1 below summarises the likely impact of the proposed pipeline on these elements of the Plan.

Table 8.1: Mayo County Development Plan 1992 - Maps 1 -12, Infrastructure, Resources and Development Control Objectives

Development Objective	Map	Impact
Physical and Administrative Boundaries	1	None
Road Classification	2A 2B	Temporary impact on use of secondary and third class roads during construction phase may occur. Not significant.
Transport Services	3	Possible impact on transport services as a result of road crossing construction may occur. Not significant.
State Forests	4	The pipeline traverses some state forests, particularly at the northern end of the route. Not significant.
Commercial Turf and Sand and Gravel	5	The pipeline crosses worked-out areas of bog at Bellacorick. No significant impacts anticipated
Minerals Prospecting	6	None
Aquaculture Areas	7	None
Forest and Wildlife Areas	8	Refer to Section 9. No significant impacts anticipated
Scenic Views	9	Impact on 'Scenic Views' is possible from some minor roads (R315, R310, R312) during construction and reinstatement phases. No impact on 'Highly Scenic Views' identified or from 'Viewing points' shown on Map 9. No long term impact.
Areas of Special Scenic Importance	10	Minor impact on views during construction and reinstatement phases is possible where the pipeline route traverses Areas of Special Scenic Importance to the west of Lough Conn. No long term impact.
Areas of Special Recreational Importance	11	No significant impacts anticipated.
Controlled Roads	12	Temporary impact on use of Controlled roads during construction of the road crossings may occur. Not significant

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As the above assessment illustrates the only potential impact in the current context relates to '*Scenic Views*' and '*Areas of Special Scenic Importance*' and impacts associated with road crossings.

These are moderate temporary impacts, confined to the construction and reinstatement phases and will cease once reinstatement is complete.

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8.5.2 *Galway County Development Plan*

The Galway County Development Plan, 1997-2002 is the current statutory Development Plan for County Galway. **Table 8.2** below summarises the likely impact of the proposed pipeline on elements of the Plan outlined in the 'Extract of Maps' Volume of the Galway County Development Plan.

Table 8.2: Galway County Development Plan 1997 - Impact on Development Objectives as outlined in 'Extract of Maps'

Description	Maps	Impact
Land Use and Development Control Objectives for: Oughterard, Spiddal, Moycullen, Barna, Oranmore, Claregalway, eastern Environs and Portumna	1-9	Pipeline Route not affected
Specific Roads Objectives	10	Pipeline Route not affected
Village Plan Boundaries	11	Pipeline Route not affected
Areas of Recreational Amenity - Galway West	11a	Pipeline Route not affected
Areas of Recreational Amenity - Galway South	11b	Pipeline Route not affected
Galway City Environs	12	Pipeline Route not affected
Gaeltacht Areas	13	Pipeline Route not affected
Areas with vulnerable aquifers	14	Pipeline Route not affected
Natural Heritage Areas Proposed and Candidate Special Areas of Conservation - an Overview	15a	Pipeline Route not affected
Natural Heritage Areas Proposed - Detailed Map	15b	Pipeline Route not affected
Areas of Scenic Amenity - Galway West (Part 1)	16a	Pipeline Route not affected
Areas of Scenic Amenity - Galway West (Part II)	16b	Pipeline Route not affected
Areas of Scenic Amenity - Galway South (Landscape Classifications) - Outstanding Scenic Amenity Areas (OSAA) - High Scenic Amenity Areas (HSAA)	16c	Pipeline Route not affected

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As **Table 8.2** illustrates, there will be no significant impact on any of the above objectives of the Galway County Development Plan.

8.6 Summary

The existing Bord Gáis Éireann network is confined to the more urbanised and industrialised areas in the south and east of the country; however there are proposals to extend the existing network to Galway, Ennis and Limerick. The less developed urban / industrial base in the west, however, means that in the absence of the Corrib reserves coming ashore at Broadhaven, it is unlikely that there would be sufficient demand to justify an extension to serve County Mayo.

The current pipeline proposal will be a considerable addition to the economic infrastructure of Counties Mayo and Galway and the Border, Midlands and Western Region. The availability of natural gas and fibre optic broadband data links in the West will help to act as a catalyst to economic development, which in turn will help to redress regional economic imbalance, which is an objective of the current National Development Plan. There are considerable national economic benefits also arising from the security of gas supply to the national power-generating network.

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The pipeline has been routed so as to avoid built-up areas and features of amenity, ecological, scientific or archaeological interest and is consistent with the policies and objectives set out in the statutory Development Plans for County Galway and County Mayo.

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9 TERRESTRIAL HABITATS & SPECIES

9.1 Introduction

This section presents the results of a desk study and field surveys of the route of the proposed pipeline from the Bellanaboy Bridge reception facility in north Co. Mayo to Craughwell, Co Galway. The aim of the study and surveys was to assess the likely potential impact of the proposed pipeline development on habitats and species. The study identified sites or features close to the proposed pipeline route, which are likely to be of scientific interest and/or conservation value, and investigates the presence of protected species of plants and animals along the route. These findings have been used to identify mitigating measures to reduce the impacts of pipeline installation.

During the pipeline routing process, (**Section 4.2**) emphasis was placed on avoiding designated nature conservation sites and areas of semi-natural habitat wherever possible. As a consequence of this, 70% of the land crossed by the proposed route is agricultural and less than 12% comprises semi-natural habitats. Modified habitats, including agricultural lands, cutover bog, conifer plantations etc., account for over 88% of the habitats encountered on the route.

During the detailed routing of the pipeline, minor re-alignment may be necessary. Where this is the case, further surveys will be carried out to ensure that all ecological constraints are taken into account as part of the ongoing environmental impact assessment process.

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9.2 Methodology

A method statement for the study was prepared at the outset, (**Appendix 9.1**). This was circulated in Dúchas for comment and approval. As a whole the level of survey achieved was more than that originally planned.

Field surveys were carried out where the route is on, adjacent to or within one kilometre of a designated conservation area. An example of a route survey card is provided in **Appendix 9.6**.

In addition, field surveys were also carried out on those sections of the route which were identified as being potentially sensitive and/or of ecological value/interest from aerial video footage (Geofilm[1]), desk study and consultations. For example the proposed pipeline route from Bellanaboy Bridge to just east of Owenboy was surveyed in the field - including the non-designated conservation areas - with the exception of short sections of impenetrable coniferous plantation.

Field surveys were carried out between June and October 2000.

The assessment of habitats occurring along the pipeline route was conducted for 50 m. on either side of the proposed centreline using aerial video (Geofilm) and, in the case of some re-routes, from high resolution vertical colour aerial photographs. The remainder of the route was subject to field checks via agreed access or key vantage points. Those sections of the route not surveyed in the field to date will require field survey prior to construction.

The fauna survey was limited to vertebrate fauna, with comment provided on the potential for invertebrates. Evaluation has been based on either Geofilm or field survey, with the habitats present providing the principal guide.

Field survey results are presented in **Appendices: 9.2 and 9.3.**

Information has been collated from statutory and non-statutory sources relating to nature conservation issues within the route corridor. This has been used to help define the route and

[1] *Geofilm* is a registered trademark. The video is filmed by a forward-facing camera, which is mounted below a helicopter, flying at an altitude of approximately 800 feet, into the navigation system of which the co-ordinates of the route have been pre-programmed.

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ensure that the design and construction of the pipeline avoids or minimises adverse impacts. This has included the assimilation of information on designated wildlife sites, watercourses and protected species from statutory (Dúchas) and non-statutory bodies (e.g. BirdWatch Ireland and the Irish Peatland Conservation Council).

In addition to the above desk study, the following was also undertaken:

- detailed Phase I (JNCC 1990) equivalent habitat mapping at 1:10,000 from field survey and Geofilm - habitat types are described in Appendix 9.3;
- collation of data on presence of and/or potential habitats for protected plants species;
- collation of data on the presence of, and/or potential habitats for, protected species of fauna;
- information on the presence of birds, particularly breeding and migratory species.

Phase 1 habitat mapping for the entire length of the proposed pipeline is provided in **Maps 9 to 16 (Volume II)**.

9.3 Existing Ecology – An Overview

Principal habitats of the northwest Mayo section of the route are low-level blanket peat, coniferous plantation on blanket peat, wet rushy grassland, semi-improved and improved grasslands, and areas of scrub.

The east Mayo landscape is predominantly a wet one, dominated by bogs (blanket, raised and transitional), wet heath, lakes and rivers. The topography is that of gently rolling hills, drumlins being an obvious feature of the landscape.

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Interspersed with the reclaimed agricultural fields, the prevailing landscape of east Galway is that of marshy pasture (including turloughs), vast expanses of bog, shallow lakes (on marl or peat) and areas of bare or scrub-covered limestone. In a number of areas the limestone is exposed at the surface, usually in the form of limestone pavement, although a number of limestone knolls, such as that of Knockmaa Hill occur along the route. In other areas, scrub vegetation has developed on a thin layer of soil. This is usually dominated by hazel. Another characteristic feature of these grazier-dominated limestone lowlands of east Galway is dry stone walls.

The main habitat types encountered along the proposed route are described in **Appendix 9.4.** The habitat types encountered along the proposed route are shown in **Table 9.1** where they are listed in order of their percentage occurrence along the route. **Table 9.2** compares the occurrence of semi-natural habitats with those that have been modified as a result of agricultural, forestry, and turbary practices.

TABLE 9.1: Habitat types - summary of the frequency of occurrence – shown as percentages of the total route.

Habitat Type	%
Improved/Semi improved grassland	70.02
Conifer plantation	8.44
Wet modified blanket bog (includes: cutover/overgrazed/eroded)	7.16
Intact blanket bog	3.95
Wet rushy (*Juncus*) grassland	3.31
Raised Bog (incl. transitional *Sphagnum* Bog- see text)	2.88
Industrial cutaway bog	2.73
Scrub (all types)	1.24
Fen (all types)	0.25
Broad – leaved plantation	0.018
	100%

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Table 9.2: Comparison of modified and semi-natural habitats on the route

Type	Percentage of total route
Modified habitats (including improved/semi-improved grassland, conifer plantation cutover bog etc.)	88.36
Semi-natural habitats	11.63

9.4 Existing Terrestrial Habitats

9.4.1 Habitats and Flora

The following sections describe the route in terms of habitat. An account of the composition and ecology of the main habitats/vegetation types encountered along the proposed route is outlined in **Appendix 9.4**. The equivalent habitat for Phase 1 (JNCC, 1990) is given where possible, as is the international plant community classification system (phytosociological affinities) of the vegetation and the recently devised Irish habitat classification according to Fossitt (2000).

All mention of river crossings in this section should be read in conjunction with **Section 10.**

9.4.1.1 *From the Terminal site to just east of Owenboy*

A summary of sections of the route from Bellanaboy (F8634 3254) to just east of Owenboy (G 0730 1710) in habitat terms is given in **Table 9.3.** Detailed results of the habitat surveys including sections of the proposed route - and sensitive areas adjacent or near to the route – from Bellanaboy (F 8634 3254) to east of (G 0730 1710) are given in **Appendix 9.2.** Impenetrable sections of the route with dense vegetation, such as mature coniferous plantations, were not walked.

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Table 9.3: Summary of habitats surveyed on the north Mayo section of the route.

From	To	Dist. (km)	Dominant habitat
F 8634 3254	F 8640 3245	0.12	Modified wet blanket bog
F 8640 3245	F 8657 3210	0.37	Improved/semi-improved grassland
F 8657 3210	F 8700 3144	1.02	Coniferous plantation
F 8700 3144	F 8704 3126	0.13	Overgrazed/eroded blanket bog and wet rushy fields by river
F 8704 3126	F 8706 3077	0.42	Blanket bog short intact and modified
F 8706 3077	F 8693 3047	0.31	Degraded blanket bog
F 8693 3047	F 8690 3007	0.40	Coniferous plantation
F 8690 3007	F 8691 2954	0.55	Wet modified blanket bog and marshy grassland
F 8691 2954	F 8698 2902	0.56	Improved/semi-improved grassland
F 8698 2902	F 8699 2892	0.10	Recently felled forestry
F 8699 2892	F 8745 2831	0.78	Coniferous plantation
F 8745 2831	F 8971 2664	2.80	Coniferous plantation and cutaway
F 8971 2664	F 9014 2641	0.48	Marshy grassland with *Juncus effusus*
F 9014 2641	F 9052 2624	0.44	Coniferous plantation
F 9052 2624	F 9074 2617	0.22	Marshy grassland with *Juncus effusus*
F 9070 2617	F 9104 2603	0.37	Coniferous plantation
F 9104 2603	F 9160 2570	0.61	Marshy grassland with *Juncus effusus*
F 9160 2570	F 9296 2464	1.70	Intact blanket bog
F 9296 2464	F 9419 2405	1.35	Coniferous plantation
F 9419 2405	F 9418 2275	1.25	Industrial cutaway blanket bog
F 9418 2275	F 9470 2175	1.05	Intact blanket bog
F 9470 2175	F 9713 2045	2.75	Industrial cutaway blanket bog
F 9713 2045	F 9721 2040	0.09	Improved/semi-improved grassland

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F 9721 2040	F 9724 2039	0.03	River
F 9724 2039	F 9760 2019	0.40	Marshy grassland with *Juncus effusus*
F 9760 2019	F 9805 1995	0.45	Industrial cutaway blanket bog
F 9805 1995	F 9889 1956	0.91	Coniferous plantation
F 9889 1956	F 9897 1951	0.12	Improved/semi-improved grassland
F 9897 1951	F 9952 1934	0.58	Coniferous plantation
F 9952 1934	G 0010 1898	1.55	Cutaway blanket bog
G 0010 1898	G 0148 1880	0.50	Improved/semi-improved grassland
G 0148 1880	G 0189 1873	0.41	Cutaway blanket bog
G 0189 1873	G 0219 1865	0.30	Coniferous plantation
G 0219 1865	G 0235 1857	0.18	Intact blanket bog
G 0235 1857	G 0261 1843	0.28	Marshy grassland with *Juncus effusus*
G 0261 1843	G 0274 1850	0.14	Improved/semi-improved grassland
G 0274 1850	G 0322 1861	0.47	Overgrazed/eroded blanket bog
G 0322 1861	G 0362 1872	0.52	Coniferous plantation
G 0362 1872	G 0386 1880	0.21	Improved/semi-improved grassland
G 0386 1880	G 0404 1880	0.17	Overgrazed/eroded blanket bog
G 0404 1880	G 0436 1877	0.30	Improved/semi-improved grassland
G 0436 1877	G 0515 1862	0.83	Improved/semi-improved grassland
G 0515 1862	G 0591 1822	0.99	Improved/semi-improved grassland
G 0591 1822	G 0616 1801	0.31	Coniferous plantation
G 0616 1801	G 0662 1768	0.54	Marshy grassland with *Juncus effusus*

9.4.1.2 *East of Owenboy to Massbrook Lower*

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Table 9.4: Summary of habitats surveyed on the section of the route from east of Owenboy to Massbrook Lower.

From	To	Dist. (km)	Dominant habitat(s)
G 0662 1768	G 0696 1715	0.64	Improved/semi-improved grassland
G 0696 1715	G0718 1588	1.36	Conifer plantation
G 0718 1588	G 0738 1547	0.46	Blanket bog
G 0738 1547	G 0874 1281	3.16	Mix of improved and wet grassland
G 0874 1281	G 0889 1277	0.17	Conifer plantation
G 0889 1277	G 0909 1261	0.26	Wet modified /cutover blanket bog
G 0909 1261	G 0913 1254	0.09	Improved grassland
G 0913 1254	G 0944 1206	0.54	Wet modified /cutover blanket bog
G 0944 1206	G 0960 1184	0.29	Improved/semi-improved grassland
G 0960 1184	G 0996 1164	0.41	Cutover blanket bog and conifer plantation
G 0996 1164	G 1463 0829	6.49	Mostly improved/semi-improved grassland and low hedges with Ulex, with low hedges and small trees
G 1463 0829	G 1502 0813	0.42	Modified/cutover blanket bog either side of the Addergoole River
G 1502 0813	G 1551 0706	1.25	Mostly improved/semi-improved grassland with some unimproved marshy grassland, small areas of Ulex heath and a very small conifer plantation
G 1551 0706	G 1608 0535	1.76	Mix of: Cut-over blanket bog; Ulex scrub; some reclaimed fields with improved grassland; wet rushy grassland, scattered willow scrub and some conifer plantation.

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9.4.1.3 *Massbrook Lower to south of Gort townland*

Along this section of the proposed route the pipeline is routed through areas of agricultural pasture, blanket bog, and young coniferous plantations on blanket bog. From an ecological point of view, the blanket bog habitats are the most interesting and these pre-dominate in areas above an altitude of 100m. The blanket bog, though cutaway in places, is relatively intact and is dominated by *Molinia caerulea, Myrica gale* and *Erica tetralix*. On the shallower peat, which covers more the steeply sloping terrain, dry heath vegetation dominated by *Calluna vulgaris* is well developed. Although these blanket bog/dry heath areas do not lie within a protected area such as a National Heritage Areas (NHA) or Special Areas of Conservation (SAC) the habitats are of relatively high ecological interest and thus it is essential that damage is minimised during pipeline construction (**Table 9.5**).

Table 9.5: Details of sections the route from road at Massbrook Lower to south of Gort townland.

From	To	Dist. (km)	Main habitat
G 1608 0535	G 1620 0520	0.20	Marshy grassland with *Juncus effusus*
G 1620 0520	G 1632 0502	0.22	Cutaway blanket bog
G 1632 0502	G 1704 0433	0.82	Improved/semi-improved grassland
G 1704 0433	G 1728 0404	0.38	Overgrazed/eroded blanket bog
G 1728 0404	G 1752 0375	0.40	Marshy grassland with *Juncus effusus*
G 1752 0375	G 1795 0271	1.44	Intact blanket bog
G 1795 0271	G 1800 0223	0.50	Coniferous forestry
G 1800 0223	G 1796 0212	0.14	Marshy grassland with *Juncus effusus*
G 1796 0212	G 1807 0092	1.18	Eroded blanket bog with improved/semi-improved grassland

9.4.1.4 *South of Gort townland via Cunnagher North to Sranalee*

This section of the route (**Table 9.6**) contains a varied range of habitats including cutaway blanket bog, conifer plantation, wet *Juncus* pasture, and improved grassland. It avoids a small area of raised bog, which is included in the field survey results, the details of which are given in **Appendix 9.2**.

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Table 9.6: Details of sections from south of Gort townland via Cunnagher north to Sranalee

From	To	Distance (km)	Main habitat
G 1807 0092	G 1799 0053	0.41	Conifer plantation
G 1799 0053	M 1792 9795	2.85	Eroded and cutover blanket bog with some semi-improved and marshy grassland.
M 1792 9795	M 1789 9475	0.56	Improved grassland
M 1789 9745	M 1779 9725	0.21	Wet *Juncus effusus* grassland
M 1779 9725	M 1762 9698	0.31	Improved grassland
M 1762 9698	M 1715 9591	1.16	Cutaway blanket bog

9.4.1.5 *Sranalee to NW of Rockfield*

Wet marshy grassland and forestry, with some improved fields dominate the section of the route (Table 9.7) which runs parallel to the Clydagh River. The southern part of this section runs through forestry and across cutover blanket bog. Both sides of the river crossing are dominated by improved grassland.

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Table 9.7: Summary of habitats from Sranalee to NW of Rockfield

From	To	Dist. (km)	Main habitat
M 1715 9591	M 1717 9572	0.31	Improved grassland
M 1717 9572	M 1719 9540	0.32	Improved/ Semi-improved grassland
M 1719 9540	M 1725 9509	0.30	Conifer plantation
M 1725 9509	M 1747 9482	0.37	Wet rushy grassland
M 1747 9482	M 1767 9466	0.26	Conifer plantation
M 1767 9466	M 1803 9432	0.63	Cut-over blanket bog
M 1803 9432	M 1813 9409	0.24	Improved grassland
M 1813 9409			River
M 1813 9407	M 1855 9358	0.66	Improved grassland
M 1855 9358	M 1877 9332	0.33	Forestry – some felled

9.4.1.6 *Rockfield to southeast of Manulla Junction*

This length of pipeline extends from Rockfield (M 1877 9332), west of the village of Turlough, to southeast of Manulla Junction (M 2207 8673). The general landscape of this part of the country is very wet, as evidenced by the abundance of bog, rivers and small lakes and the topography is gently undulating, due to the presence of drumlins. Most of the land traversed, however, is comprised of reclaimed agricultural fields, which are of low conservation value (**Table 9.8**). Most of these are small and many support well developed hedgerows. Other habitats crossed include wet, marshy grassland, small stretches of coniferous forestry blanket bog and fen. The pipeline route generally keeps to the low-lying areas. There are two main river crossings, the Castlebar and the Manulla Rivers, along with several minor watercourses. The detailed results of the habitat surveys for this section of the proposed route are given in **Appendix 9.2**.

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Table 9.8: Summary of habitats from Rockfield to S.E. of Manulla Junction

From	To	Dist. (km)	Main habitat
M 1877 9332	M 1907 9279	0.62	Improved/semi-improved grassland and marshy grassland
M1907 9279			River
M1907 9279	M 1904 9200	0.81	Improved/semi-improved grassland
M 1904 9200	M 1904 9196	0.04	Wet/marshy grassland
M 1904 9196	M 1904 9191	0.04	Improved/semi-improved grassland
M 1904 9191	M 1904 9177	0.14	Wet/marshy grassland
M 1904 9177	M 1912 9154	0.23	Improved/semi-improved grassland
M 1912 9154	M 1915 9150	0.65	Blanket bog
M 1915 9150	M 1924 9137	0.15	Improved/semi-improved grassland
M 1924 9137	M 1940 9110	0.32	Blanket bog
M 1940 9110	M 1943 9097	0.13	Improved/semi-improved grassland
M1943 9097	M 1942 9074	0.24	Fen
M 1942 9074	M 1942 9067	0.07	Wet/marshy grassland
M 1942 9067	M 1964 9017	0.59	Improved/semi-improved grassland
M 1964 9017	M 1975 9005	0.17	Fen
M 1975 9005	M 2007 8983	0.40	Improved/semi-improved grassland
M 2007 8983	M 2017 8976	0.12	Wet/marshy grassland
M 2017 8976	M 2072 8875	1.18	Improved/semi-improved grassland
M 2072 8875	M 2088 8859	0.23	Wet modified bog
M 2088 8859	M 2147 8805	0.82	Improved/semi-improved grassland and river crossing
M 2147 8805	M 2177 8780	0.40	Blanket bog
M 2177 8780	M 2207 8673	1.14	Improved/semi-improved grassland

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9.4.1.7 *Manulla Junction to Shinganagh, on the Plains of Mayo*

This length of pipeline extends from southeast of Manulla Junction (M22078673) to Shinganagh, on the Plains of Mayo (M26808040). The general landscape remains wet in character, with plenty of rivers and lakes. A landscape of low rolling hills is caused by the presence of drumlins. Land traversed is predominantly covered in agriculturally improved fields, which is of low conservation value, with some small areas of bog and wet, marshy grassland (**Table 9.9**). Many of these wet areas are associated with nearby lakes. There are several minor water crossings to be negotiated. There are some good examples of hedgerow communities present, although this habitat has been significantly reduced by the removal of field boundaries to create larger fields.

Table 9.9: Summary of habitats from Manulla Junction to Shinganagh, on the Plains of Mayo

From	To	Dist. (km)	Main habitat
M 2207 8673	M 2221 8658	2.7	*Sphagnum* bog
M 2221 8658	M 2328 8445	2.47	Improved/semi-improved grassland
M 2328 8445	M 2336 8427	0.18	Wet modified bog
M 2336 8427	M 2341 8414	0.15	*Sphagnum* bog
M 2341 8414	M 2430 8244	1.90	Improved/semi-improved grassland
M 2430 8244	M 2450 8232	0.22	Wet/marshy grassland
M 2450 8232	M 2680 8040	3.04	Improved/semi-improved grassland

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9.4.1.8 *Shinganagh to the townland of Carrowkeel*

This length of pipeline extends from Shinganagh, on the Plains of Mayo (M26808040) to the townland of Carrowkeel, north of the Robe River (M28897241). The general landscape remains highly wet in character, although there is a reduction in the number of rivers and lakes present. The general topography is more even and drumlins are no longer an obvious feature. The land traversed is predominantly covered in agriculturally improved fields, which are of low conservation value, with some small areas of bog and wet, marshy grassland. Much of these wet areas are associated with nearby lakes. There are several minor water crossings to consider along this section of pipeline. There are some good examples of hedgerow communities present. Many of the fields have been further subdivided to create a greater number of smaller fields, (**Table 9.10**).

Table 9.10: Summary of habitats from Shinganagh to the townland of Carrowkeel

From	To	Dist. (km)	Main habitat
M 2680 8040	M 2777 7850	2.14	Improved/semi-improved grassland
M27777850	M27802835	0.16	*Sphagnum* bog
M 2780 2835	M 2808 7703	1.35	Improved/semi-improved grassland
M 2808 7703	M 2809 2698	0.06	Wet/marshy grassland
M 2809 2698	M 2853 7597	1.12	Improved/semi-improved grassland
M 2853 7597	M 2855 7594	0.03	*Sphagnum* bog
M 2855 7594	M 2861 7526	0.70	Improved/semi-improved grassland
M 2861 7526	M 2864 7499	0.27	Wet modified bog
M 2864 7499	M 2889 7241	2.65	Improved/semi-improved grassland

9.4.1.9 *Carrowkeel to Roos*

This length of pipeline extends from the townland of Carrowkeel, north of the Robe

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River (M28897241) to the townland of Roos (M 2985 6453). Despite the presence of large areas of peat (most of which has been extensively modified) in the area, the pipeline route avoids these and is confined to agricultural land for its entire length, with the exception of where it crosses the Robe River (M28997136). There is some wet, marshy grassland associated with the floodplain of the river. The topography of the area is gently undulating, with very little variation in altitude. Hedgerows are not well represented and the field boundaries are generally marked with stone walls and fences (**Table 9.11**).

Table 9.11: Summary of habitats from Carrowkeel to Roos

From	To	Dist. (km)	Main habitat
M 2889 7241	M 2900 7141	1.02	Improved/semi-improved grassland
M 2900 7141	M 2896 7126	0.16	Wet/marshy grassland
M 2899 7136			River
M 2896 7126	M 2985 6453	11.00	Improved/semi-improved grassland

9.4.1.10 *Roos to northeast of Cloonsheen*

This length of pipeline extends from the townland of Roos (M29856453) to northeast of the townland of Cloonsheen (M32305653). There are a number of minor water crossings to negotiate, including two crossings of the Kilshanvy River. The topography of the area is gently undulating, with very little variation in altitude. The general topography is that of gently rolling hills, covered by a patchwork of agriculturally improved fields. Most of the land traversed is agricultural, with the exception of a few wet and peaty areas. Hedgerows are not well represented and the field boundaries are generally marked with fences and some stone walls (**Table 9.12**).

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Table 9.12: Summary of habitats from Roos to Cloonsheen

From	To	Dist. (km)	Main habitat
M 2985 6453	M 1357 6228	2.62	Improved/semi-improved grassland
M 13576228	M 3130 6170	0.93	*Sphagnum* bog
M 3130 6170	M 3150 6160	0.21	Wet modified bog
M 3150 6160	M 3203 5882	3.12	Improved/semi-improved grassland
M 3203 5882	M 3199 5876	0.06	Wet/marshy grassland
M 3199 5876	M 3245 5726	1.66	Improved/semi-improved grassland
M 3245 5726	M 3244 5710	0.14	*Sphagnum* bog
M 3244 5710	M 3232 6577	0.47	Improved/semi-improved grassland
M 3232 6577	M 3230 5653	0.12	Wet/marshy grassland

9.4.1.11 *North east of Cloonsheen to west of Knockmaa Hill*

This length of pipeline extends from north east of the townland of Cloonsheen (M32305653) to west of Knockmaa Hill (M34484855). There is one main river crossing, the Togher River. The general landscape is low-lying and gently undulating. The underlying rock is limestone, which can be seen outcropping in a number of fields. The 6" O.S. Map highlights the occurrence of a number of turloughs in the area. Large areas of land are prone to flooding. The route passes through an extensive network of reclaimed and improved agricultural fields. The only other obvious habitat is an area of peat that has developed along the Togher River. There are some well-developed hedgerows present along the route (**Table 9.13**).

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Table 9.13: Summary of habitats from NE of Cloonsheen to west of Knockmaa Hill

From	To	Dist. (km)	Main habitat
M 3230 5653	M 3275 5471	1.97	Improved/semi-improved grassland
M 3274 5471	M 3276 5423	0.39	*Sphagnum* bog (Raised bog)
M 3276 5423	M 3276 5425	0.11	Improved grassland
M 3276 5425	M 3276 5406	0.20	*Sphagnum* bog (Raised bog)
M 3273 5425			River
M 3276 5406	M 3448 4855	6.42	Improved/semi-improved grassland

9.4.1.12 *West of Knockmaa Hill to the townland of Bunoghanaun*

This length of pipeline extends from west of Knockmaa Hill (M34484855) to the townland of Bunoghanaun (M 3740 4122). The general landscape is of limestone bedrock covered in till of varying depths. The route passes through an extensive stretch of small agricultural fields. Hedgerow development is extremely poor or absent. Most of the surrounding area consists of bare limestone. Limestone boulders occur as surface outcrops in a number of fields (**Table 9.14**).

Table 9.14: Summary of habitats from west of Knockmaa Hill to Bunoghanaun

From	To	Dist. (km)	Main habitat
M 3448 4855	M 3740 4122	8.08	Improved/semi-improved grassland

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9.4.1.13 *Bunoghanaun to the townland of Cahernashilleeny, north of the Clare River*

This length of pipeline extends from the townland of Bunoghanaun (M 3740 4122) to the townland of Cahernashilleeny, north of the Clare River (M 4128 3412). Hedgerow development is extremely poor or absent. Most of the surrounding area consists of bare limestone. There is a large quarry to the east of the pipeline route. The route passes through an extensive stretch of small agricultural fields. Limestone boulders occur as surface outcrops in a number of fields (**Table 9.15**).

Table 9.15: Summary of habitats from Bunoghanaun to the townland of Cahernashilleeny, north of the Clare River

From	To	Dist. (km)	Main habitat
M 3740 4122	M 4000 3702	5.37	Improved/semi-improved grassland
M 4000 3702	M 4006 3670	0.34	Scattered scrub
M 4006 3670	M 4128 3412	2.92	Improved/semi-improved grassland

9.4.1.14 *Cahernashilleeny just north of the River Clare, to Carraunduff*

This length of pipeline extends from Cahernashilleeny (M 4128 3412), just north of the River Clare, to Carraunduff (M 4608 2798). The proposed route moves in a southeasterly direction, through predominantly agricultural land (**Table 9.16**). Other habitats traversed include wet, marshy grassland associated with the River Clare and patches of hazel scrub over limestone pavement. Dry stone walls increasingly mark field boundaries, typical of East Galway.

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Table 9.16: Summary of habitats from Cahernashilleeny, just north of the River Clare, to Carraunduff

From	To	Dist. (km)	Main habitat
M 4128 3412	M 4166 3375	0.5	Improved/semi-improved grassland
M 4167 3374			River
M 4166 3373	M 4173 3364	0.12	Wet lowland/marshy grassland
M 4173 3364	M 4472 2937	5.21	Improved/semi-improved grassland
M 4472 2937	M 4476 2930	0.10	Dense scrub
M 4476 2930	M 4575 2812	1.53	Improved/semi-improved grassland
M 4575 2812	M 4608 2798	0.36	Dense scrub

9.4.1.15 *Carraunduff to Templemartin*

This length of pipeline extends from Carraunduff (M 4608 2798) to Templemartin (M 5037 2222). The proposed route traverses gently rolling countryside, predominantly consisting of a patchwork of small, irregularly shaped, agriculturally improved fields. There is some evidence that many of these fields have decreased in size through the erection of fences within some of the larger fields to subdivide the field into a number of subsections. Where hedgerows are found, they are not as well developed as those further south, although there are some exceptions. The 6" O.S. map and the Geofilm suggest that the soil depth is relatively shallow over much of this section of the route. This is evidenced by the frequent occurrence of rock outcrops within many of the fields. Areas of patchy scrub, dominated by *Corylus avellana*, *Ulex europaeus* and/or *Crataegus monogyna*, are found in this situation. There is some low-lying land that is liable to flooding, some of which may represent turlough habitat. The pipeline passes close to Turloughakin (M48502340). The pipeline also crosses two rivers, the Graigabbey and the Eiscir. The bank vegetation, in both cases, appears to be well developed. The fields directly adjacent to the river edge are wet in character as a result of periodic episodes of flooding (**Table 9.17**).

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Table 9.17: Summary of habitats from Carraunduff to Templemartin

From	To	Dist. (km)	Main habitat
M 4608 2798	M 4624 2791	0.17	Improved/semi-improved grassland
M 4624 2791	M 4642 2781	0.25	Scattered scrub
M 4642 2781	M 4678 2740	0.54	Improved/semi-improved grassland
M 4678 2740	M4695 2720	0.25	Scattered scrub
M 4695 2720	M 4750 2650	0.87	Improved/semi-improved grassland
M 4750 2650	M 4752 2647	0.03	Broadleaf plantation
M 4752 2647	M 4770 2620	0.32	Improved/semi-improved grassland
M 4770 2620	M 4777 2609	0.13	Scattered scrub
M 4777 2609	M 4803 2572	0.45	Improved/semi-improved grassland
M 4803 2572			River
M 4803 2572	M 4825 2591	0.84	Improved grassland
M 4825 2591	M 4824 2472	0.21	Dense/continuous scrub
M 4825 2472			River
M 4804 2472	M 5037 2222	4.49	Improved/semi-improved grassland

9.4.1.16 *Templemartin to Cappagh South*

This length of pipeline extends from Templemartin (M50372222) to Cappagh South (M53162121), close to the village of Craughwell. The general topography is that of gently rolling hills, covered by a patchwork of small, irregularly shaped, agriculturally

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improved fields. There is little or no evidence that many of these fields have increased in size through the removal of hedgerows and other boundaries. As a result, the hedgerows separating the fields are very well developed. They are often up to 5m wide in places. The proposed pipeline route traverses the River Dooyertha. The banks of this watercourse are covered in dense scrub-like vegetation, while the lands immediately adjacent are subject to periodic flooding. These fields, as a result, are marshy in character and support species such as *Agrostis stolonifera, Potentilla anserina* and *Juncus articulatus*. Another interesting feature of the area is the occurrence of patches of standing water within a number of the fields. The available information suggests that there are turloughs in the surrounding area (e.g. Turloughmartin, M50702240) and that many of the fields are subject to periods of flooding. It is likely that many of the turloughs have been modified through drainage schemes. There are also patches of mature trees, though these are concentrated around dwellings, where they provide shelter, (**Table 9.18**).

Table 9.18: Summary of habitats from Templemartin to Cappagh South

From	To	Dist. (km)	Main habitat
M 5037 2222	M 5205 2156	1.87	Improved/semi-improved grassland
M 5205 2156	M 5217 2148	0.15	Wet/marshy grassland
M 5210 2152			River
M 5217 2148	M 5316 2121	10.75	Improved/semi-improved grassland

9.4.2 Fauna

The potential for fauna along the route sections was firstly assessed by means of examination of Geofilm. This examination allows for an initial assessment of the habitats present and the wildlife potential.

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Field surveys were conducted in August and October 2000, in generally good weather conditions. Ideally bird surveys should be undertaken over an entire year to identify summer and winter breeding birds. With this in mind additional information on bird species present in the general geographical area of the pipeline was obtained from the Countryside Bird Survey (BirdWatch Ireland).

Because of the limitation on time available for field surveys it was decided to use an evaluation of habitat potential for mammals as a first stage assessment of impacts. Field surveys were then carried out in sections of, and near/adjacent to, the route where important habitats were identified. Field survey and desk study results, along with additional information are presented in **Appendix 9.3.**

9.4.2.1 *Fauna potential of the habitats encountered on the route*

Upland habitats tend to be poor in distribution and abundance of mammalian species. Species present include hedgehog, pygmy shrew, bats, rabbit, Irish hare, field mouse, house mouse, brown rat, fox and badger. Species such as red squirrel and American mink are occasional. Of particular interest are the pine marten, widely distributed in Co. Mayo, and the otter, also commonly found on river systems. The frog and the common lizard are found frequently. Deer and feral goat may occur occasionally.

Upland and blanket bog areas support a relatively limited diversity of birds, but in conjunction with adjoining conifer plantations, farmland, hedgerow, scrub and woodland, the species count is as high as it is in lowland. Several species are of note. These include birds of prey, such as the sparrowhawk, kestrel, merlin, and potentially the hen harrier. Other species of interest are the golden plover and, in north Mayo, the crossbill, which favours mature cone-bearing spruce plantations. Freshwater lakes and pools are frequent in upland areas, providing refuge for wildfowl.

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Lowland improved grasslands form the major part of the eastern sections of the route and it is relatively poor as a habitat for wildlife. Within these landscapes, the abundance and distribution of vertebrates is largely related to the presence and distribution of scrub, woodland, and boundaries of scrub, hedgerow and treeline. Most mammalian species are to be found in the area, except those with localised distribution (such as black rat, bank vole and deer species). Most bat species are also likely to occur. Frog distribution may be limited in drier limestone areas where breeding habitat is scarce. The common lizard occurs in a wide range of habitats in Ireland.

Lowland landscapes in the eastern sections harbour a range of common avian species, the abundance and distribution of many species again being largely related to presence of particular habitat types (e.g. wet grassland) and areas of scrub and woodland in particular. Of note is the kingfisher, which may be present on larger rivers and watercourses. It is probable that many of the hedgerows along the route are host to common passerine birds and mammals.

Bird species recorded at selected sites along the proposed pipeline route during mid-August 2000 are listed in **Appendix 9.3.** It should be noted that this is a minimum species list. Species of mammal recorded at selected sites along the route between the Terminal and Galway together with additional information is also given in **Appendix 9.3.**

9.5 Terrestrial Habitats Evaluation

9.5.1 Designations and Legislation

The following is a short summary of the designations and legislation which currently apply to sites and species in Ireland - included here in order to put the sites mentioned below, in **Table 9.19** and **Appendix 9.5** in context.

9.5.1.1 *Special Areas of Conservation*

The Natural Habitat Regulations (1997) enabled the designation of Special Areas of Conservation (SACs) under Article 3 of the Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive), as part of the Natura 2000 network. This network comprises Annex I habitats - "natural habitat types of community interest whose conservation requires the designation of Special Areas of Conservation" and the habitats of Annex II species - "animal and plant species of community interest whose conservation requires the designation of Special Areas of Conservation". In addition, the directive states that: "The Natura 2000 network shall include the special protection areas classified by the Member States pursuant to Directive 79/409/EEC." They will be referred to simply as SACs with their appropriate Site Codes hereafter.

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9.5.1.2 *Proposed Natural Heritage Areas*

Legal protection for Natural Heritage Areas (NHAs) under the legislation enacted in the Wildlife (Amendment) Act 2000. A commencement date for this is awaited. Proposed NHAs were established following the review survey of Areas of Scientific Interest (ASIs), and they form the basic site network for habitat conservation. They will be referred to simply as NHAs with their appropriate Site Codes hereafter.

9.5.1.3 *Special Protection Areas*

Special Protection Areas (SPAs) are designated under Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds (the Birds Directive). Under the directive Ireland is obliged to protect the habitats of birds which are vulnerable to habitat change or to their low population numbers. Aspects of habitat protection are in the context of pollution, deterioration of habitat and disturbance. This directive is implemented in Ireland under Statutory Instrument (1985). The Wildlife Acts 1976 and 2000 encompasses this designation. They will be referred to simply as SPAs with their appropriate Site Codes

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hereafter.

9.5.1.4 Other designations and protection measures under the Wildlife Act 1976 and Wildlife (Amendment) Act 2000.

- statutory nature reserves;
- wildfowl sanctuaries;
- refuges for fauna;
- Flora Protection Order – the current FPO was issued by Statutory Instrument in 1999.

The Wildlife Act 1976 and 2000, their associated statutory instruments and Natural Habitat Regulations (for SACs) are implemented and controlled by Dúchas, Department of Arts, Heritage, Gaeltacht & the Islands. Dúchas is also responsible for the designation of sites.

9.5.2 Habitats and Flora

General

The following is an evaluation of the proposed route which highlights particular sites of note, designated and otherwise. For convenience the route is divided into the same sections as **Section 9.4** above. **Table 9.19** lists the designated conservation areas (SAC and NHA) which occur on, adjacent to, or within 1 kilometre of the proposed pipeline route. A description and explanation of their scientific value is given in **Appendix 9.5**.

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Table 9.19: Designated sites, which are on, adjacent to, or within 1 km. of the proposed pipeline route.

Site Name	No.	Proximity
Carrowmore Lake Complex	SAC 476/SPA	on & adjacent to
Slieve Fyagh	SAC 542	on & adjacent to
Bellacorick Bog Complex	SAC 1922	on & adjacent to
Lough Conn & Lough Cullen	NHA 519/SPA	< 1 km.
Carrowmore Lough Shore	NHA 1492	c. 1 km
Carrowkeel Turlough	SAC 475	adjacent to
Greaghan's Turlough	SAC 503	< 1 km.
Turlough O'Gall	SAC 331	c. 1 km
Knockmaa Hill	NHA 1288	c. 1 km.

Rare and Protected Plant Species

Information was requested from Dúchas regarding the possible presence of protected plants species along the proposed pipeline route. Grid references supplied by Dúchas have been checked against the route and no rare or protected plant species were found to occur on or adjacent to the route. Notes on a few significant species that are known to occur in areas near the route are given below in **Table 9.20**.

Non-designated wetland sites of potential conservation value

Information on the Irish Fen Inventory of non-designated sites considered conservation-worthy (Crushell, 2000) was supplied by the Irish Peatland Conservation Council (IPCC). The location of sites on this list was checked against the pipeline route and none were found to be on the proposed route.

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Table 9.20: Habitats and flora of importance identified along the proposed pipeline route

Location	Key Habitats and Flora	Conservation Value
Terminal site to Owenboy	Dominated by coniferous forestry, cutaway blanket bog with marshy and improved/semi-improved grasslands.	Low
	Short stretches of relatively intact blanket bog including plateau bog at the south-eastern end of Glencullin at junction of SACs 476 & 542;	High

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Location	Key Habitats and Flora	Conservation Value
East of Owenboy to Massbrook Lower	First part of this section is dominated by cutover blanket bog and conifer plantation. From the Deel River Crossing onwards improved and semi-improved grassland alternate with small areas of cutover bog and wet marshy grassland.	Low Low
Massbrook Lower to 0.5 km south of Gort townland	Blanket bog habitats pre-dominate in areas above an altitude of 100m. Bogs dominated by *Molinia caerulea, Myrica gale* and *Erica tetralix* On the shallower peat, on steeply sloping terrain, *Calluna* dominated vegetation. Eroded and overgrazed blanket bog.	High High Low
Gort townland to Sranalee	Varied range of habitats including eroded and cutover blanket bog, wet Juncus pasture, improved grassland.	Low
Sranalee to NW of Rockfield	Mix of improved grassland, conifer plantation and wet rushy grassland.	Low
Rockfield to southeast of Manulla Junction	Well-developed hedgerows, dominated by *Crataegus monogyna* with conspicuous trees of *Fraxinus excelsior* present. Improved semi/improved and wet marshy grassland Areas of fen	Medium Low High
Manulla Junction to Shinganagh, on the Plains of Mayo	Improved semi/improved and wet marshy grassland. Cutover bog	Low Low
Shinganagh to the townland of Carrowkeel	Improved semi/improved and wet marshy grassland. Cutover bog	Low Low
Carrowkeel townland to Roos	Improved semi/improved pasture. Pipeline route is close to Carrowkeel Turlough SAC (Site Code: 475).	Low High
Roos to northeast of the townland of Cloonsheen	Improved pasture, wet rushy grassland and cutover bog.	Low
North east of Cloonsheen to west of Knockmaa Hill	Improved pasture. Geology and hydrology of the region is associated with turloughs. During the assessment process the route was re-aligned to avoid the nearby Turlough O'Gall SAC (Site code: 331) and Greaghan's Turlough NHA (Site code: 503).	Low High
West of Knockmaa Hill to the townland of Bunoghanaun	Improved pasture. Knockmaa Hill NHA (Site code: 1288) lies	Low High

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Location	Key Habitats and Flora	Conservation Value
	within 1 km of the proposed route.	
Bunoghanaun to Cahernashilleeny, north of the Clare River	Generally improved grassland except for an area of Patchy hazel scrub over limestone.	Low Medium
Cahernashilleeny, north of the River Clare, to Carraunduff	Generally Improved pasture, wet rushy grassland except for an area of Patchy hazel scrub over limestone.	Low Medium
Carraunduff to Templemartin	Improved pasture. Most field boundaries are comprised of dry stone walls with scattered individual trees and/or shrubs.	Low Low
Templemartin to Cappagh South	Improved pasture. Well-developed hedgerows act as wildlife corridors and refuges. Sensitive local hydrology associated with nearby Turloughs	Low High High

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9.5.3 Fauna

9.5.3.1 *Species of note*

Birds

- Most birds are protected under the Wildlife Acts 1976 and 2000. The only exceptions are species regarded as pests, vermin or game species;
- principal species of interest referred to in this report are birds of prey, principally merlin, and hen harrier (Annex I species);
- other birds of interest include golden plover and kingfisher (Annex I species).

Bats

- All bat species are protected under the Wildlife Acts 1976 and 2000; the lesser horseshoe bat is protected under EU Birds Directive (Annex II species).

Otters

- Otters are protected under the Wildlife Acts 1976 and 2000, and EU Habitats Directive (Annex II species).

Badgers

- Badgers are protected under the Wildlife Acts 1976 and 2000.

Particular attention has been paid to species listed in Annex I of the Birds Directive and Annex II of the Habitats Directive. Of note is the presence of otters on most of the rivers, and potential presence of lesser horseshoe bats as the proposed route traverses south. Kingfishers may also be present on some of the watercourses; blanket bog and other upland habitats may harbour hen harrier, merlin and golden plover. Merlin are known to nest in some of the mature conifer plantations of north Mayo (information from Dúchas). The pine marten is associated with scrub and woodland and is certain to be present in the hazel-ash scrub woodlands on limestone areas.

The principal habitats of interest that have moderate to high conservation value include areas of relatively undisturbed modified blanket bog (wet heath and dry heath), raised bog, bare limestone pavement, scrub and woodland on limestone and major watercourses. Also of interest are other scrub woodlands and hedgerows; mature deciduous trees may harbour bat roosts. Invertebrate diversity is also associated with

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some of these semi-natural habitats. Sections of the route are discussed below in the context of their scientific interest in terms of fauna.

Table 9.21: Fauna of importance identified along the proposed pipeline route

Location	Key Fauna	Conservation Value
North Mayo section of the route	Large tracts of blanket bog hold species such as golden plover and kestrel. The habitat has the potential to host rare species such as merlin and hen harrier.	High
	Conifer plantations- nesting Merlin and crossbill.	High
	Freshwater lakes and blanket bog hold nationally and internationally important populations of birds, including greenland white-fronted geese, overwintering waterfowl and wildfowl, merlin, golden plover and gulls.	High
Gort to Sranalee	Vertebrate species present or likely to occur would be typical of many parts of Co. Mayo and the West.	Low
	Undisturbed areas of heath and the raised bog areas provide feeding areas and refuges for a variety of vertebrates, particularly birds, and may also harbour invertebrate species of interest.	Moderate to High
	Open heath provides a habitat for scarce birds of prey such as merlin and hen harrier and also golden plover.	High
North west of Rockfield to Derrynacross	Principal habitats of interest that serve as wildlife refuges include the ash-hazel woodland, the willow scrub woodland and in particular the two major rivers.	Moderate to High
	Otters are certainly present along the river systems, and pine marten are likely in scrub woodland. Badgers are also present. Kingfisher may be present.	
South of Ballinvoash to Manulla	Hedgerow and scrub boundaries provide refuge and wildlife corridors.	Moderate
	Principal habitat is the Manulla River and tributary streams, with otters likely to be present, and potentially kingfisher.	High
Carrowkeel Turlough, Greaghan's Turlough and Turlough O'Gall	These sites attract over-wintering birds and Greaghan's Turlough in particular is known to hold whooper swans. The small meadows around Turlough O'Gall have potential for corncrake. Lapwing were recorded at Carrowmore Turlough.	High
Cloonsheen to Caltragh	Uniform grassland landscape and some limited wet grassland and scrub in the vicinity of the River Togher.	Low
	There is potential for lesser horseshoe bats in this area.	High

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Location	Key Fauna	Conservation Value
Kilgill to Cahernashilleeny	Uniform grassland landscape bounded by bare stone walls.	Low
	Limestone pavement at Knockdoe supports Pine martin and there is potential for lesser horseshoe bats.	High
Cregmore to Craughwell (Garracloon South)	Uniform grassland landscape bounded by bare stone walls.	Low
	Principal areas of wildlife interest are 4 rivers and also the larger areas of scrub and scrub woodland. Semi-improved calcareous grassland at Garracloon South. All provide a refuge for vertebrates and invertebrates. Otter and kingfisher are likely to occur.	High

9.5.4 Impacts And Mitigation Measures

9.5.5 Impacts

In view of the sensitive nature of the designated conservation areas which the proposed pipeline route crosses, is adjacent to or passes within 1 km, it is essential that specialised construction methods are used to suit the particular habitats in order to minimise any potential impact. This is particularly important in relation to blanket and raised bogs, and other wetland sites. **Table 9.22** lists the designated areas and highlights the potential risk associated with the proposed pipeline development. The water regime for each site is the key issue here. Thus anything which interferes with the hydrological integrity of bog and wetland (including turlough) sites is a potentially serious threat to the whole ecology of these areas.

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Potential impacts on fauna include loss of habitat and wildlife refuge, disturbance to feeding, breeding or overwintering birds, loss of bat roosting sites, destruction of badger setts, and impacts on watercourses (sedimentation and pollution). **Table 9.23** lists the potential impact on fauna in designated areas.

9.5.5.1 *Bellanaboy to Owenboy*

It has been shown above that there are, in particular, two highly sensitive and potentially highly vulnerable (in ecological terms) sites between the Bellanaboy and Owenboy which are either transversed by or close to the proposed route. It is essential that damage to the hydrology of these high-quality blanket bog areas is either avoided or minimised. These critical route sections are:

Glencullin Upper

The area of plateau bog at the southeastern end of Glencullin where *SAC 476 & SAC 542* join has to some extent been degraded as a result of overgrazing and subsequent erosion. However there are intact areas that are potentially at risk particularly during the construction phase. In addition to terrestrial ecological concerns, the area at Glencullin is also sensitive in view of the potential threat to the headwaters of the Glencullin River (see **Section 10**).

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Eskeragh

The blanket bog/base-rich fen, south of the road near Eskeragh *SAC 1922*, is adjacent to the proposed route.

Any disturbance to this base-rich fen at Eskeragh would be severely damaging. It is a small fen with preferential flows and it is vital that these are not interfered with or cut off. For this reason during consultations Dúchas have requested that the hydrology of the wider area be investigated to ascertain the direction of flows including water shed effects. In this regard, and in order to avoid focussing flows, the position of streams, feeder heads, and water flow directions will be considered.

9.5.5.2 *Rockfield to southeast of Manulla Junction*

This section of pipeline that runs closest to Carrowmore Lough Shore NHA (Site code: 1492). Although the lough itself lies a considerable distance from the proposed pipeline route and will not be impacted on directly, indirect impacts may result from crossings of various minor watercourses feeding into the lake. The wetland habitats west of Manulla and in the vicinity of Manulla Bridge will be checked by field visit.

9.5.5.3 *Manulla Junction to the townland of Carrowkeel*

The proposed pipeline route through this section of Mayo is confined to areas of land that have been improved for agricultural purposes and bog that has been man-modified. This land is of low conservation value.

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9.5.5.4 *Carrowkeel to Roos*

A potential problem along this section of pipeline is the proximity of Carrowkeel Turlough SAC (Site Code: 475). The proposed pipeline route passes within 250m of the boundary of the site. The proximity of the pipeline has potentially serious implications for the local hydrology, which is crucial to the conservation and management of this turlough, an Annex I priority habitat type in Ireland, under the EU Habitats Directive. Discussions have been held with Dúchas personnel who are concerned about the impact the pipeline construction may have on the local hydrology. The depth of the surrounding till may be crucial. It is felt that should there be a need to blast the underlying bedrock, that there is a real danger of creating artificial drainage channels, which could impact negatively on the stability and functioning of the turlough. Special mitigation measures need to be put in place in this instance.

9.5.5.5 *Roos to north east of Cloonsheen*

The proposed pipeline route through this section of Mayo and Galway is confined to areas of land that have been improved for agricultural purposes and bog that has been man-modified. This land is of low conservation value.

9.5.5.6 *North east of Cloonsheen to west of Knockmaa Hill*

Although this length of pipeline in Co. Galway passes through habitat of low conservation value, the complex hydrology of the region is a potential problem. The route has already been adjusted to avoid Turlough O'Gall SAC (Site code: 331). There is potential for indirect impact on Greaghan's Turlough NHA (Site code: 503), to the west of the route, if there is an underground channel link between these two systems..

9.5.5.7 *West of Knockmaa Hill to the townland of Bunoghanaun*

Knockmaa Hill NHA (Site code: 1288) lies within 1km of the proposed pipeline route. The

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proposed construction will not have a direct impact on this limestone knoll, the highest point in the locality.

9.5.5.8 *Bunoghanaun to Templemartin*

It has been stated above that the habitats of interest on this stretch are areas of patchy hazel scrub over limestone where the rock is at the surface and there is a very thin soil cover. While this habitat is not considered of particularly high conservation value, it is becoming increasingly rare in Ireland and it is recommended that measures are taken to ensure that the impact is minimal on the best examples of this habitat type.

9.5.5.9 *Templemartin to Cappagh South*

The well-developed hedgerows are of ecological importance, serving as wildlife corridors and refuges and it is important that they be further assessed and maintained wherever possible.

It is recommended that the local hydrology of this area is investigated, although it appears that the adjacent turloughs have already been damaged through drainage schemes with the exception of the internationally important Rahasane Turlough (W847531). Rahasane Turlough itself lies a considerable distance from the proposed pipeline route and will not be impacted on directly. Indirect impacts may result from the crossing of the River Dooyertha, which feeds into the turlough basin (**Section 10**).

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Table 9.22: Designated sites, which may be subject to impact from the proposed pipeline route development.

Site Name	No.	Proximity	Comment/Concern
Carrowmore Lake Complex	SAC 476/SPA	on & adjacent to	East of Glencullin the route crosses the watershed where 476 & 542 meet.
Slieve Fyagh	SAC 542	on & adjacent to	ditto
Bellacorick Bog Complex	SAC1922	on & adjacent to	Of particular concern is the section near Eskeragh where the route is near the base-rich fen – potential impacts on feeder streams.
Lough Conn & Lough Cullen	NHA 519/SPA		See sections 9.5. & 9.7
Carrowmore Lough Shore	NHA 1492	c. 1 km	There should be no impact on this NHA as the pipeline in routed to the west of Manulla.
Carrowkeel Turlough	SAC 475	adjacent to	The proximity of the pipeline has potentially serious implications for the local hydrology, which is crucial to the conservation and management of this turlough, an Annex I priority habitat type in Ireland, under the EU Habitats Directive. Possible impacts on the local hydrology?
Greaghan's Turlough	SAC 503	< 1 km.	No direct impact.

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Turlough O'Gall	SAC 331	c. 1 km	No direct impact
Knockmaa Hill	NHA 1288	c. 1 km.	No direct impact

Site Name	No.	Proximity	Comment/Concern
Rahasane Turlough	SAC 322	> 1.5 km	Indirect impacts may result from the crossing of the River Dooyertha, which feeds into the turlough basin. (Section 10)

Table 9.23: Potential impacts on fauna in designated areas

Site Name	No.	Impact
Carrowmore Lake Complex	SAC 476/SPA	Indirectly, the pipeline construction may cause some disturbance to birds utilising the protected bog bordering the lake. The envisaged speed of the construction is such that any additional disturbance in the area will be quite short. Overall development impact is considered to be low.
Slieve Fyagh	SAC 542	Whilst golden plover and kestrel have been recorded in the area, the amount of habitat to be disturbed is limited. Whilst construction may disturb these birds in the short term, they are likely to relocate to elsewhere within the protected site. Consequently, impact is considered likely to be low.
Bellacorick Bog Complex	SAC 1922	Whilst the fringes of the protected site may be additionally disturbed during construction phases, such disturbances are not considered likely to have a significant impact on fauna, especially birds. Where the pipeline traverses the protected site, this again is close to the road, is a relatively narrow development and will be completed in a short time period. The pipeline will be at least a kilometre from the Owenboy Nature Reserve and any associated disturbance effects on birds there is considered likely to be insignificant.
Lough Conn & Lough Cullen	NHA 519/SPA	Lough Conn is host to important populations of birds, but there is likely to be ample habitat within the lough to act as refuge for any birds that are temporarily disturbed by the pipeline construction.
Carrowkeel Turlough	SAC 475	In the absence of interference of the water table of the turlough, the fringes of the site may be disturbed during the construction phase. Such disturbance, if properly timed, is considered unlikely to have a significant impact on fauna.

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Site Name	No.	Impact
Greaghan's Turlough	SAC 503	It is considered unlikely to have any significant effects on the associated fauna of the turlough.
Turlough O'Gall	NHA 331	A route has been chosen to avoid the pipeline being constructed close to Turlough O'Gall. As such, therefore, it is not envisaged that there will be any significant effects on the site's associated fauna.

9.5.6 Mitigation Measures for Habitats And Vegetation

9.5.6.1 General

The proposed pipeline has been routed to avoid sensitive habitats wherever possible. However, it is acknowledged that this is not always possible due to engineering and health and safety constraints. For this reason, it is essential that every effort should be made to minimise impacts where they may occur.

The Contractors will be required to provide detailed method statements for work in ecologically sensitive areas. Dúchas will be consulted with regard to the method statements.

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9.5.6.2 Blanket bogs and Raised bogs

It has been shown in **Tables 9.19** and **9.22** that most of the sensitive bog sites are adjacent to the pipeline rather than being traversed – with the exception of the head of the Glencullin Valley (where two SACs meet).

Where it is necessary for blanket bog or raised bog to be crossed, special reinstatement measures and special construction techniques will need to be employed in order to minimise damage and achieve reinstatement as quickly as possible. All measures are subject to agreement with Dúchas. Prior to construction baseline studies will be undertaken. Reinstated sites will need to be monitored throughout the construction phase and at regular intervals subsequently by an experienced vegetation ecologist who has experience with these habitat types.

It is recommended that the following mitigation measures be implemented where required:

- appropriate construction materials to be used;
- where the pipeline passes through - or is in relative proximity to - any intact bog, fen etc. precautions against undermining and sub-bog drainage such as **inert plugs** should be used around the pipeline channel at distances of 50 metres and measures taken to mitigate against surface damage and compaction.
- stock proof fencing should be used and maintained after construction, so that sheep, in particular, are excluded to reduce surface impact which could lead to erosion and to give the best opportunity for re-growth of the vegetation;
- temporary roads should be constructed on geotextile or bog mats which should be in position for the shortest time possible to avoid die back under the road;
- the trench line only should be turved and the turves kept alive on site by irrigation;
- low ground pressure vehicles should be used for all operations e.g. bog crawlers,

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use of floatation tyres etc. in order to minimise the impact on the surface;

- if re-seeding is to be undertaken, this seed should be collected prior to construction and stored – depending on the longevity and capacity to remain viable in storage;
- alternatively seed should be collected from adjacent areas and spread.

As part of the consultative process, a workshop on pipeline construction and habitat reinstatement techniques - with special emphasis on bog reinstatement - was organised for Dúchas personnel. The initial construction techniques addressed above were discussed and views raised taken on board.

9.5.6.3 *Turloughs*

Where the pipeline is routed in the vicinity of turloughs, a hydrological investigation should be carried out into the water regime prior to construction. There has already been a route re-alignment to avoid Turlough O'Gall NHA and its associated geological/hydrological system. The route adjacent to Carrowkeel Turlough has been similarly investigated.

9.5.6.4 *Grasslands*

Any impacts of pipeline construction on agricultural grassland will be minimised. Appropriate pipeline reinstatement techniques will be employed, such as re-seeding with a mix that closely reflects the species composition of the original sward, subject to agreement with the landowner.

Bog mats or other low ground pressure techniques will be use in areas of wet, rushy grassland to minimise disturbance and to prevent excessive compaction.

9.5.6.5 *Trees and Areas of Scrub*

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The proposed pipeline has been routed to avoid, wherever possible, substantial areas of woodland and isolated large trees. The crossing of small areas of semi-natural scrub and smaller strips of woodland will need careful construction methods, detailed routing and consideration of timing of works to minimise impact on these areas. Where required, this would be undertaken in consultation with Dúchas and/or the local planning authority. Any other trees that may be affected by the pipeline will be occasional ones within field boundaries and, wherever possible, these too will be avoided by minor amendments to the route.

Any trees within the working width will be left in situ wherever practical and fenced off prior to construction. In the event that some trees need to be trimmed or felled, this will be carried out with as little disturbance to remaining trees as possible.

During pipeline positioning and trench excavation, the fact that tree roots can extend beyond the canopy will be taken into account. Root pruning during excavation can damage tree roots, and this can affect trees some distance away from the pipeline. As well as increasing the chances of a tree dying they also become unstable and more prone to windthrow.

In addition, mitigation measures will include:

- trees only to be felled where required;
- prior to Right of Way clearance, all trees to be removed will be clearly identified;
- all felling will be carried out by experienced and approved personnel;
- reduce working width;
- where it is necessary to remove limbs from trees to facilitate passage of construction traffic, this will be undertaken by experienced and approved personnel;
- where construction traffic has to pass over the roots of trees, protection will be used

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to minimise compaction damage. Suitable protection would include subsoil or wooden excavation mats to the extent of the tree canopy;

- where a tree which is to be retained occurs within the topsoil or subsoil storage areas, care will be taken to prevent damage to that tree. Suitable protection shall include the erection of a temporary fence and all spoil being stored outside this fence;
- topsoil will not be stripped from the root zone of trees to the extent of the canopy;
- replace lost trees with native provenance species;
- all newly planted areas to be protected with herbivore proof fencing;
- where necessary, an aftercare programme for scrub reinstatement will be developed and implemented. This shall include replacement of any dead stock for a minimum period of two years after planting.

9.5.6.6 *Hedgerows*

Prior to construction, a field survey will identify the impact of the pipeline on hedgerows. Impacts will be minimised by, wherever possible, routing the pipeline through existing gaps, or sections that are out of character with the hedgerow or which have been poorly managed. Whenever this is not possible, the minimum width of hedgerows will be removed, consistent with safe working and good practice. If the pipeline is bored beneath a crossing e.g. road, any associated hedgerow breach will be reduced subject to access requirements. In this situation, the pipeline will be bored under the hedgerow as well as the crossing. Any length of hedgerow to be removed will be clearly marked.

Under the Wildlife (Amendments) Act 2000 there is provision for further hedgerow protection in the context of the annual protection period. The start of this will be brought forward from mid-April (currently) to 1st March.

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All hedgerows removed as a result of pipeline construction will be replanted using indigenous species. Consideration will also be given to other techniques such as cutting the hedgerow flush with the existing ground level to preserve the roots and seedbed. The cut hedgerow can then be covered with a geotextile layer and soil, which is maintained throughout works. The soil and geotextile are then removed to re-expose the hedgerow roots. The only portion of the hedgerow that is totally removed is that over the trench width. However, this technique is limited in its application, as it cannot be used where there are banks associated with the hedgerow.

In addition, other measures will be adopted to reduce the extent and duration of impacts and to maintain the wildlife and landscape value of hedgerows as follows:

- damaged tree branches as appropriate will be treated by a competent tree surgeon and any damaged hedge plants will be pruned or replaced as necessary;
- hedgerow and tree protection will be included in the induction and/or briefing sessions by the contractor to his workforce;
- following soil reinstatement any hedge banks or ditches that were disturbed during construction will be reformed;
- replanting of the hedge (where necessary) will reflect, as far as possible, the original species mix and pipeline integrity requirements. Some additional hawthorn plants may be included to aid rapid establishment and thereby reduce the duration of impact. Although replanting will be undertaken immediately after reinstatement, it is likely that the newly planted sections will remain identifiable for 5 to 10 years;
- hedgerows will be replanted in an appropriate pattern so that they blend with the structure of undisturbed sections;
- all hedge reinstatement will be effected using container-grown plants or root-trained cell grown stock of native origin. All such material will be obtained from reputable

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suppliers, and delivered to the site ready for planting;

- all newly planted sections of hedgerow will be protected by a double fence to prevent damage to the young plants from livestock. Rabbit proof fencing shall be installed. Such fencing will be tied into the existing hedge to ensure a stock-proof barrier is formed;
- where required, an aftercare programme for hedgerow reinstatement will be developed and implemented. This will include weed control, maintenance of fencing, scrub clearance and replacement of any dead stock for a minimum period of two years after planting.

9.5.7 Mitigation measures for Fauna

Potential impacts include loss of habitat and wildlife refuge, disturbance to feeding, breeding or overwintering birds, loss of bat roosting sites, destruction of badger setts, and impacts on watercourses (sedimentation and pollution).

Mitigation measures include habitat restoration, maintenance of water table in areas of peat, avoidance of habitats of especial interest, phasing of removal of vegetation with regard to birds and bats, and measures to maintain water quality in watercourses during construction and operational phases, **(Section 10)**.

Additional field survey will be undertaken in specific areas, with more detailed survey of the route corridor for badger setts and otter holts.

9.5.7.1 *Birds*

- While pipeline construction should ideally take place *outside* of the principal breeding season for birds, it is acknowledged that is not necessarily feasible in the context of a large linear project;
- on blanket bog habitats, it is preferable to reduce disturbance to overwintering birds, avoiding the November to March period. This will be feasible.

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9.5.7.2 *Bats*

- The pipeline will be routed to avoid mature trees. Where trees with the potential to be used as breeding or overwintering bat roosts will be felled, such work will need to be undertaken at an appropriate time of year. These include March, April, May, September, October or November;
- if specialised bat survey reveal any roosts, all bats must be removed by experts, under licence from Dúchas;
- the limestone area west of Caltragh will be checked for presence of bats in caves. Any roosts should be avoided by the pipeline;
- A survey will be undertaken to assess the potential impact on bat roosts in caves/crevices in limestone areas at Knockdoe and vicinity.

9.5.7.3 *Otters*

- Where construction will take place, rivers known to harbour this species will be checked prior to disturbance for presence of otter holts;
- otters, whilst relatively sensitive, will maintain territory on rivers after disturbance and there is not expected to be any long-term impacts on this species.

9.5.7.4 *Badgers*

- It is a requirement that badgers in affected setts be removed, relocated, or evacuated

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prior to construction taking place;

- the pipeline route will be checked for breeding or other large setts (main, annexe setts or other active setts). Where active setts are identified the pipeline should be re-routed to ensure a distance of 30 m from the working width to the setts. Where this is not feasible the badgers must be removed under licence by experts. Smaller occasional setts will be blocked off by experts prior to construction taking place also.

9.5.8 Mitigation measures for watercourses

(see also **Section 10**)

- Measures must be taken to minimise sedimentation and pollution of watercourses during construction and operation phases to minimise impacts on scarce protected species such as otter, kingfisher, salmon and freshwater crayfish.
- where permanent or temporary access tracks have to be created during construction or for maintenance in operation phase.

9.5.9 Timing of Construction/Reinstatement

The ideal construction period in terms of minimising ecological impacts is late summer, early autumn. In such instances, the disturbance is likely to be limited and in the medium to long term, bird species are most likely to habituate and re-use previously disturbed sites.

However, with such a large project, this will not be possible and agreement will be sought with Dúchas to ensure impacts are minimised through the most sensitive habitats.

9.5.10 Residual Impacts

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9.5.11 "Dry" Habitats

If the appropriate reinstatement techniques and after care are correctly applied, the long-term residual impacts on drier habitats of improved /semi-improved grassland, hedgerows, scrub etc. should be minimal.

9.5.12 Wetlands

In wetland habitats (including bogs, fen, wet heath etc.) the residual impacts will depend entirely on the success of special reinstatement measures which are put in place in order to minimise compaction, erosion, surface drying, drainage (either directly or by capillary action along the pipeline), and chemical change.

9.5.13 Fauna

The proposed pipeline should not affect habitats and vertebrate species to a substantial extent as a result of to careful routing, the limited corridor of operations and the relatively short construction timespan. Habitat reinstatement and appropriate timing should minimise impacts further on sensitive sites and species provided that the construction does not lead to long term changes in habitat quality.

At the southern end of the proposed route, residual impacts on fauna should be minimal provided that habitats of conservation interest such as limestone pavement/outcrop and woodland /scrub woodland/scrub on pavement are avoided.

9.6 Summary of surveys to be undertaken prior to construction

The following provides a summary of the additional surveys required prior to construction:

- more detailed flora and fauna studies will be required on those parts of the route not subject to field survey to date;

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- baseline vegetation studies will be necessary along sections of the route specified by Dúchas prior to construction in the following areas:
  - Glencullin Valley stream crossings;
  - Upper Glencullin – at junction of SACs 476 and 542;
  - Eskeragh Fen and environs;
  - SW end of Carrowkeel Turlough
  - Greaghan's Turlough
  - wetland habitat west of Manulla and in the vicinity of Manulla Bridge
- well developed hedgerows will require detailed assessment;
- field surveys will be undertaken to identify badger activity;
- otter surveys will be undertaken along those rivers crossed by the proposed route known to support this species;
- bat surveys in limestone areas west of Caltragh and at Knockdoe;
- baseline hydrological studies will be required in sensitive wetland areas including: blanket bog, raised bog, fen, and in particular in the vicinity of turloughs (Carrowkeel).

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10 EXISTING AQUATIC HABITATS

10.1 Methodology

Selection of Crossing Points

Aquatic Services Unit (ASU) were supplied with colour photocopies of 1:50,000 and 1:10,000 ordnance survey maps with the route of the proposed pipeline superimposed on them. Using these, all of the small, medium and large-sized watercourses crossed by the proposed pipeline were listed along with the 8 figure Irish National Grid Reference as measured from the maps. Almost all of these crossings were of named rivers or tributaries of named rivers. Not every crossing marked on the map was selected for assessment, some were thought to probably be too small to be of any great ecological or fisheries importance. It is accepted however that some of the small channels, which have not been selected, may be more important than others and a decision was made that during fieldwork a selection of these would be checked visually to see whether they warranted more detailed assessment.

Notification of Relevant Authorities

Once the main crossings were selected, a tabulated list was sent to the two regional fisheries boards within whose regions the proposed pipeline is due to be laid, namely the North Western Regional Fisheries Board (NWRFB) and the Western Regional Fisheries Board (WRFB). Accompanying the list were the colour maps showing the pipeline route and allowing the recipients to judge whether the selection was adequate from the fisheries standpoint. In addition, photographs of each of the crossing, taken during fieldwork, as well as general substrate and habitat descriptions were supplied for most of the listed crossings.

Meetings

Meetings were held with fisheries, environment and administrative personnel of the two regional fisheries boards to discuss the fisheries implications of the crossings.

Fieldwork

At each proposed crossing point the physical attributes of the channel and banks were measured or estimated and a description of the substrate and habitats present were obtained. A note was made of the composition of the soil in the bank and the principal vegetation type and dominant species present. Note was also taken of the adjoining land-use on each side of the crossing. A list of the main in-channel and marginal aquatic plants were recorded and a qualitative assessment of the macroinvertebrates was made either using pond net sweeps or kick-samples. The EPA macroinvertebrate-based biotic index, used to estimate water quality conditions in Irish rivers, was assigned to each site at which macroinvertebrates were collected. In the present study the index values ranged from Q3 to Q5. Q3 refers to moderately polluted water, Q 3-4 slightly polluted water, and Q4, Q4-5 and Q5 refer to unpolluted water of increasing quality, Q5 being the highest. The fisheries status of each site was gauged based on substrate, depth, velocity and general channel habitat characteristics.

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10.1.1 Selected Crossings

Table 10.1 lists the names of the **22 selected** crossings, along with their national grid references, locations catchment and general habitat features. **Appendix 10.1** presents the detailed results of fieldwork at each proposed crossing point including a description of the physical characteristics of the river channel at the crossing, bankside dimensions, bankside soil composition, bankside and in-channel vegetation, fisheries habitats and estimated fisheries value based on site characteristics and macroinvertebrates. Note that the precise location of a number of crossings have been altered since fieldwork. These principally include the Castlebar River whose final crossing point is 750m further downstream of the study reach and the Manulla River, which will be crossed 1150m upstream of the study reach reported on in the detailed site descriptions. Despite these changes, however, the results of the fieldwork at the original proposed crossing points for both these rivers are considered likely to be broadly representative of that of the finally chosen crossings.

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Table 10.1 Selected Principal Watercourse Crossings

No.	River Name	Catchment	Grid Ref.	Additional Info/Townland	Dimensions etc.	Substrate
1	Unnamed Tributary of Carrowmore Lake (east side)	Owenmore	F 8703 3132	Muingingaun	W 3.5m D 13cm Clear water	Riffle/ glide/pool
2	Unnamed Tributary of Carrowmore Lake (east side)	Owenmore	F 8699 2955	Glenturk More	W 1.5 m D 5-7cm	Cobbles / boulders Peat silt & algae
3	Unnamed Tributary of Carrowmore Lake (east side)	Owenmore	F 8841 2767	Glenturk Beg	W 2m Brown scum and trailing algae present on stones	Boulders, cobbles and small stones
3a	Glencullin River	Owenmore	F 8900 2702 to F 9242 2500	Glencullin Upper	Not surveyed	Not surveyed
4	Oweniny River	Owenmore	F 9722 2039	500m Upstream of Bellacorick Bridge	W 18-23m D 10-30cm Glide-riffle	Cobbles and boulders Peat silt & trailing algae in slacker flows
5	River Muing	Owenmore	G 9805 1995	1 km east of Bellacorick	W 4.5m D 30cm	Peat silt on gravel Water discoloured
6	Shanvolahan River	Lough Conn / River Moy	G 0617 1801	Downstream of Road Bridge	W 5m D <15cm Shallow glide – riffle/glide	Small stones & gravel Cloudy

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No.	River Name	Catchment	Grid Ref.	Additional Info/Townland	Dimensions etc.	Substrate
7	River Deel	Lough Conn / River Moy	G 0756 1490	Carrowgarve South (NW of L. Conn)	W 18m D 50-60cm Glide (v. slack)	Boulders and cobbles on coarse gravel
8	Castlehill River	Lough Conn / River Moy	G 1142 1095	ENE of Lahardaun (W of L. Conn)	W 5-6m D 5-14cm shallow riffle glide/riffle	Cobbles, small stones and gravel Clear
9	Lecarrow River	Lough Conn / River Moy	G 1254 0995	Ballymac-redmond (Laharadaun)	W 1.5-2m D 10-24cm Riffle/pool turbulent	Boulders, cobbles, gravel Clear
10	Addergoole River	Lough Conn / River Moy	G 1492 0920	Cuilkillew (W of L. Conn)	W 6-7m D 1m Deep pool /glide, slack	Peaty
11	Clydagh River	Lough Cullin / River Moy	M 1820 9404	~1 km downstream of Clydagh Bridge	W ~11m D 30-50+cm Glide & pool (slow to mod flow)	Coarse and fine gravel and coarse sand
12	Castlebar River	Lough Cullin / River Moy	M 1903 9278	WSW of Turlough (Leckeen)	W ~8m D 50cm Pool/glide Mod-slow	Peaty mud ?
13	Manulla River	Lough Cullin / River Moy	M 2089 8831	W of Manulla Br. Kilknock	W 12-15m D 1m (+)? Dead slow	Peaty/mud ?
14	Stream to Needhams Lough	Lough Cullin / River Moy	M 2342 8413	2 km east of Ballagh	W 3.5m D 40cm Slow, mod/slow	Cobbles, small stones gravel and silt; clear

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No.	River Name	Catchment	Grid Ref.	Additional Info/Townland	Dimensions etc.	Substrate
15	Robe River	Corrib (via L. Mask)	M 2905 7136	Between Hollymount and Claremorris	W 9m D 30-60cm (glide/riffle) mod/swift	Boulders on fine gravel & coarse sand
16	Black River	Corrib	M 3216 5893	Upstream of Ardour Br.	W 3m	Muddy, plant-choked
17	Kilshanvy River (upper trib. of Black River)	Corrib	M 3217 5800	Near Kilshanvy	W 4-5m D 60cm (very slack flow)	Plant -choked on silt
18	Togher River (trib of Black River which flows to Lough Corrib)	Corrib	M 3283 5430	Cloonbar	W 3.4-5m D 10-30cm (slack glide)	Peaty
19	Clare River	Corrib	M 4166 3373	0.7km upstream of Cregmore Bridge 5km ENE of Claregalway	W 15m D 20-40cm riffles; 40cm+ pools (mainly glide)	Cobbles & boulders
20	Lavally River	Clarinbridge	M 4804 2570	1.3km SW Athenry	W2.5-3.0m D 7-13cm (glide, riffle/glide)	Boulders, cobbles and small stones
21	Eiscir River	Clarinbridge	M 4931 2480	2.5km SSW Athenry	dry	Boulders and cobbles
22	Dooyertha River	Dunkellin	M 5215 2156	1.5km NE Craughwell	W 4-8m D 15cm (Very slack glide/pool & riffle) Dry downstream	Cobbles, gravel and boulders

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10.1.2 Fisheries Overview of Watercourses Crossed by Pipeline

The proposed pipeline route crosses over 8 significant and 13 medium to minor watercourses ones on its way through County Mayo and County Galway traversing two fisheries board regions, NWRFB to the north and WRFB to the south. The principal catchments traversed are the Lough Carrowmore – Owenmore System of North West Mayo, Lough Conn / River Moy Catchment, which drains north eastern and central Co. Mayo and the River Clare / Lough Corrib System which drains central and southern County Galway. Notable watercourses in the list include the Oweniny which is an important spawning and nursery river in the Owenmore catchment, the Deel which is an important salmon and trout recruitment and angling water in the Lough Conn / Moy catchment, the Robe which is an important brown trout fishery in the Corrib and the Clare which is an important salmon and trout angling river in the Corrib system. Finally, the Glencullin River (crossing no. 3a) has also been listed even though the proposed route does not cross the river. Its inclusion after consultation with the North Western Regional Fisheries Board, is to highlight the fact that the proposed route passes very close to its northern bank for about 3km where several minor streams draining to it are traversed by the pipeline route. The Glencullin is the main spawning river of the entire Owenmore system and the stretch in question is the most valuable on the river. Many of the lakes and rivers in these catchments are famous for the quality of their salmon, seatrout and brown trout fishing and consequently represent and an important source of tourist revenue to the entire region.

Coarse fish or fish angling do not appear to be a feature of the crossings along the proposed route. The possible exception to this is the likely presence of some pike in the larger slow-flow waters of rivers such as the Castlebar and the Manulla. Eel (*Anguilla anguilla*) are also likely to be widespread within the system.

Lampreys, primitive jawless fish which are of no commercial or recreational value in Ireland but which are protected under European environmental legislation due to their widespread decline especially on the Continent, are likely to be widespread within the catchments in question. Lampreys are known to occur in both the Lough Conn / River Moy catchments and the Corrib System. The recorded species are *Petromyzon marinus* the Sea Lamprey and *Lampetra planeri*, the Brook Lamprey. *Lampetra fluviatilis*, the River Lamprey has not been specifically identified in these waters but may well occur there also. Lampreys are also likely to occur in the Owenmore system although they do not appear to have been recorded there to date, (Kurz &Costello 1998).

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10.1.2.1 *Fisheries Status of Individual Watercourses and Crossing Points*

The following account of the fisheries status of the crossings is based firstly and principally on information supplied by the NWRFB and the WRFB in writing and during consultation. This is supported by on-site habitat evaluation undertaken as part of the Environmental Impact Assessment as well as background information supplied by Regional Fisheries Board publications and Dr. Martin O'Farrell, fisheries consultant. The 22 numbered crossings are discussed in a north - south direction. Although the list is considered to be comprehensive, it may not be exhaustive and Fisheries Board personnel will have an opportunity at any stage to point out any small crossings which may have been overlooked by the screening and fieldwork procedures and which may be of fisheries significance.

Crossings 1-3 Tributaries of Carrowmore Lake

The tributaries of the Carrowmore Lake are small spawning and nursery streams, probably mainly for seatrout but in the case of Crossing No.1 in the townland of Munigingaun, salmon are known to spawn there also. In fact there is some evidence that the crossing stretch in this small stream may be the most productive of the three in terms of salmonid recruitment. The other two are somewhat torrential, appear to suffer from significant bankside erosion and are showing strong signs of peat siltation and some nutrient enrichment

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3a Glencullin River

The Glencullin River is considered the most important seatrout spawning river in the entire Carrowmore Lake / Owenmore system and therefore of prime importance from a fisheries standpoint. It was subject to catastrophic flood-related landslide siltation just three years ago, which may have temporarily reduced its recruitment capacity and it is important that the proposed development does not impact on it. Although the pipeline route will not cross the Glencullin, it is very close to it (50-200m) over a length of about 3.3km (F 8900 2702 – F 9242 2500) in the townland of Glencullin Upper. Along this stretch it also traverses 8 small streams/drains flowing directly to the Glencullin. For this reason there will be considerable opportunity for sediment from the construction to enter the spawning areas of the river. There is also a possibility that these minor side streams may be utilised for a limited amount of spawning. It is important to point out that the ground in question is steep and quite possibly prone to erosion once the topsoil layer is removed.

Crossing 4 Oweniny

The Oweniny is an important upper tributary of the Owenmore and is an important seatrout and salmon river. The wide shallow stretch of river, which will be crossed, is 500m upstream of Bellacorick Bridge. This is principally a nursery / feeding stretch and most of the principal spawning areas are further upstream. There was evidence of both peat siltation and a degree of eutrophication (trailing filamentous green algae growth) during the site visit to the proposed crossing point.

Crossing 5 River Muing

The Muing, which is part of the Owenmore catchment, has a sluggish flow and peaty bottom and does not appear to be of any fisheries significance.

Crossing 6 Shanvolahan River

The Shanvolahan River is has suffered significantly from peat siltation in the past with a consequent reduction in water quality, although in recent years it has improved somewhat. It is a spawning / nursery tributary stream of the River Deel (making it part of the Lough Conn / Moy System) and has undergone significant fisheries development / rehabilitation in recent years. The later work under the Tourist Angling Measure (TAM) was undertaken just upstream of the confluence with the Deel in the main spawning areas.

Crossing 7 River Deel (Knockbrack)

The River Deel is an important trout angling and spawning river with salmon also important. It is one of the main tributaries of Lough Conn, joining it east of Crossmolina. The stretch being crossed by the proposed pipeline is a pool/glide stretch for at least 200m, which would be suitable for fish holding and perhaps angling. However, further downstream there are important areas of spawning.

Crossing 8 Castlehill River

The Castlehill River is a western tributary of Lough Conn with excellent water quality and all along the crossing stretch holds excellent spawning and nursery habitats for salmon and trout. Furthermore, considerable EU and national funding has already been invested under the TAM in respect of fisheries enhancement works on this river.

Crossing 9 Lecarrow River

The Lecarrow River is also a western tributary of Louh Conn, situated just south of the Castlehill River, which it resembles in many respects although smaller. Although salmon spawning does not take place at the site of the proposed crossing some spawning occurs further downstream.

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Crossing 10 Addergoole River

The proposed crossing point in the Addergoole is deep and slow flowing and therefore not suitable for spawning. Nevertheless the river, which is a tributary to the southern basin of Lough Conn holds salmon and trout spawning habitats upstream and downstream of the proposed crossing point.

Crossing 11 River Clydagh

The Clydagh holds stretches of salmon and trout spawning and in recent years has undergone considerable fisheries rehabilitation work, which includes the opening of an impassable falls to fish passage and spawning upstream of the proposed crossing point. There has also been a return of spring salmon in recent years. The proposed crossing stretch may not be a spawning area but very important spawning habitat is present in the stretch immediately downstream.

Crossing 12 Castlebar River

The Castlebar River holds large brown trout and pike, the latter, which are subject to culling by the fisheries board to improve the trout survival. It is an important brown trout angling river and has recently be heavily promoted by the NWRFB in a angling brochure produced by them. Spawning and nursery habitats are absent either at or downstream of the crossing.

Crossing 13 Manulla River

The Manulla is also a part of the Lough Conn / Moy system. The proposed crossing point, which is deep and canal-like, does not hold any salmonid spawning. However, the river does include some salmonid spawning and in particular, spring salmon spawning (upstream).

Crossing 14 Stream to Needhams Lough (Loughnaminoo Stream)

The Loughnaminoo stream is small and sluggish and although it may hold some small brown trout, is not believed to be of any fisheries importance. It can be crossed at any time of year.

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Crossing 15 Robe River

The Robe River is the most northerly crossing in the Western Fisheries Board Region. It is an important tributary of Lough Mask contributing about 50% of the fish to that lake, as well as being an important trout fishery in its own right; pike are culled in the river and the lake (Rogers and de Barra 2000). The water quality of this hard-water river began to deteriorate in the late 1970's and early 1980's and the river reaches both upstream and downstream of the proposed crossing point have been slightly to moderately polluted for several years (EPA 1999). The catchment of the Robe is the subject of several in-depth investigations by the EPA and the Western Regional Fisheries Board into diffuse and point source pollution with particular emphasis on phosphorus sources, especially from agriculture. Eutrophication in the River has resulted in a deterioration in the brown fishery something, which is thought to be having an adverse knock-on effect in Lough Mask where trout catches have declined since 1981 (see Rogers and de Barra, 2000 for overview). The proposed pipeline crossing point is not a spawning or nursery area but probably holds larger fish. A large pool about 100m downstream may be suitable for angling, and angling certainly takes place at Hollybrook further downstream.

The Robe also holds an important riverine population of the White-Clawed Crayfish. As this is a protected (Annex II) species under the EU Habitats Directive it must also be taken into account when planning and timing the pipeline crossing.

Crossing 16 River Black (upper reaches)

The proposed route crosses the River Black at a very insignificant crossing point which at the time of the survey was virtually dry.

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Crossing 17 Kilshanvy River

When monitored by the EPA in 1997 the bridge at Kilshanvy just downstream of the proposed crossing was shown to be un-polluted (Q4) but previously had been slightly polluted. The proposed crossing point of the Kilshanvy River is slow and plant-choked and more than likely of very little or no importance from a salmonid fisheries standpoint. There was a substantial population of stickleback present during sampling.

Crossing 18 Togher River

The Togher River is a small tributary of the Black River, which flows to Lough Corrib. Its water quality does not appear to be monitored by the EPA but samples taken during the present EIS indicate unpolluted conditions. The proposed crossing point is shallow and plant-choked and it is most unlikely to judge from the size of the channel and the nature of the habitats that it is of any importance from a salmonid fishery standpoint. However, some brown trout may be present.

Crossing 19 Clare River

The Clare River is an important brown trout fishing river and tributary of Lough Corrib. This is another hard-water river whose quality has deteriorated significantly since the late 1970's and much of its length is now slightly to moderately polluted. Nevertheless, the river remains a very important fishery for both brown trout and salmon. The proposed crossing-point and further downstream comprises good feeding and holding areas, and angling is carried out throughout the stretch.

Crossing 20, 21, 22 Lavally / Clarinbridge River & Dooyertha River

The most southerly part of the proposed pipeline route crosses two small upper tributaries of the Clarinbridge River which flow to Galway Bay ESE of Galway City. The first of these Crossing No. 20, is of an unnamed river, which is an upper extension of the Lavally River also know as the Clarin or Clarinbridge River. The more southerly crossing, No. 21, is of the Eiscir River another upper tributary of the Clarin, which eventually joins up just below both crossings and flows on to become the Clarinbridge River. The crossings are SW and SSW of Athenry. The Lavally / Clarin River is a salmonid river with Salmon spawning taking place upstream and immediately downstream of Athenry and in the lower reaches upstream of Calrinbridge (pers. comm. Mr. Kevin Rogers WRFB). However, the area of the crossing (No. 20) is not noted as a spawning area. The Escir River (crossing No. 21) is a temporary watercourse and is therefore unlikely to be of great fisheries importance.

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10.1.2.2 *Macroinvertebrates*

The macroinvertebrate status of the watercourse crossings was typical of riverine waters in Ireland generally and reflected the predominance of riffle-type habitats in watercourses whose quality was either unpolluted or slightly polluted. It is likely that in some cases the diversity of the insect fauna would have been more diverse in term of both mayflies and stoneflies in particular earlier in the season. Nevertheless the assemblages recorded in each case are considered to have been quite representative of the range normally occurring at the crossings. A full list of the species taken at each of the proposed crossing points is given in **Appendix 10.1** – Detailed Site Descriptions.

Frequently encountered groups were *Heptageniidae*, *Ephemerella* and *Baetis* (mayflies), *Leuctra* (stoneflies), *Rhyacophila*, *Hydropsyche* and *Sericostoma* (caddisflies), *Elmidae* (water beetles), *Simuliidae* and *Chironomidae* (midges) *Gammarus* (crustaceans), *Potamopyrgus*, *Lymnea*, *Valvata*, *Bithynia* and *Physa* (snails) and *Glossiphonia* (leeches). Harder and slower-flow water saw a greater diversity and abundance of snails (e.g. the Manulla and Togher rivers). Water

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beetles other than Elmidae, were not particularly common at any site, the sole exception being the Manulla River. None of the macroinvertebrates taken in net-sweeps or kick-samples is know to be rare. One noteworthy species, is the White-clawed Crayfish (*Austropotamobius pallipes*) which is protected under EU legislation and is known to occur in many hard waters in Ireland. It was very abundant at the River Robe proposed crossing point where both adults and juveniles were very common despite the slightly polluted conditions prevailing. The young hatch out in April while still being carried underneath the female who retains them until early July when she releases them. One specimen was also taken in a kick sample in the River Deel at Knockbrack (Crossing No.7).

10.1.2.3 *Aquatic Macrophytes*

In-channel and emergent vegetation was dominated by a small range of species which included the mosses *Rhynchostegium riparioides* and *Fontinalis antipyretica*, in swift flow riffles, and *Potamogeton natans*, *Myriophyllum* cf. *alterniflorum*, *Sparganium emersum*, *Nuphar lutea*, *Lemna Minor*. *L. triscula* and *Callitriche* spp. in moderate to slow flow situations. Emergents tended to be dominated by *Apium nodiflorum*, *Sparganium erectum*, *Phalaris arundinacea*, and herbs such as *Valeriana officinalis*, *Mentha aquatica*, *Equisetum fluviatile* etc. Diversity at most sites was relatively low. None of the plants encountered is rare or protected. A full list for each site is given in **Appendix 10.1** (Detailed Site Descriptions).

10.2 Aquatic Habitats: Impacts and Mitigation

10.2.1 Relevant Characteristics of the Development

10.2.1.1 *Crossing Methodology in Brief*

As a preamble to a discussion of the potential impacts of the pipeline construction on the watercourses being crossed, reference should be made to **Section 6.0**.

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10.2.2 Potential Impacts

10.2.2.1 *General*

Essentially, the principal impacts from the proposed pipeline construction at watercourse crossings relate to the evolution of suspended sediment from the works at crossing points. Other potential impacts include destruction of habitat, prevention of fish passage through flumes / temporary culverts and pollution caused by the accidental spillage.

10.2.2.2 *Potential Sources of Suspended Solids*

(i) Bankside excavations;
(ii) run-off from sloping bankside ramps;
(iii) installation of temporary running track and flumes in dry-cut crossings;
(iv) removal of running track;
(v) bank reinstatement;
(vi) riverbed reinstatement;
(vii) pipeline trench excavation in wet open-cut crossings;
(viii) de-watering of trenches and other excavations.

It is important to note that some soils and bankside materials may be more likely to erode and give rise to suspended solids than others, especially sandy or silty soils and these will be treated with greater care.

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10.2.2.3 ***Potential Impacts of Excessive Suspended Solids***

(i) smothering of fish spawning redds

Salmon and trout eggs or fry present in spawning redds may be smothered by excessive deposits of silt or spawning fish may avoid traditional spawning areas if these are covered in silt deposits. It is likely that spawning lampreys would suffer the same fate as their spawning requirements are very similar to those of salmonids. Salmonids spawn and fry hatch in the period October to the end of April. Coarse fish spawn in the period May to June

Coarse fish lay their eggs among aquatic weeds and it is reasonable to assume that these too would succumb to excessive amounts of suspended solids in the water column.

(ii) fish health damage

Fish gills are susceptible to abrasion by excessive exposure to elevated suspended solids levels, which in turn can give rise to health problems in the form of gill disease. Younger fish tend to be more susceptible. Direct fish mortality from elevated inert solids is rare.

(iii) Interference with angling

Excessively turbid waters are likely to reduce or eliminate angling success (game and coarse angling), which would be particularly problematic during periods of intense angling activity, fishing competitions and in waters where anglers are paying large fees to fish. The proposed pipeline potentially affects examples of each of these types of water.

(iv) smothering of macroinvertebrates

Aquatic macroinvertebrates including, insect larvae, molluscs (snails and bivalves), crustaceans (shrimps and crayfish), leeches and worms etc., may be smothered by excessive deposits of silt from suspended solids. Moreover, deposits of silt in otherwise stony substrate gives rise to a change in the macroinvertebrate species composition favouring less diverse assemblages.

(v) smothering or stunting of aquatic plant communities

Aquatic plant communities, especially submerged growths, are likely to be eliminated or stunted by excessive deposition of suspended sediment or a reduction in photosynthesis due to excessive water turbidity.

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10.2.2.4 ***Fish Passage***

If the flumes or other temporary crossing structures placed in watercourses are undersized or poorly installed they may present a barrier to fish passage either through excessive water velocity or physical obstruction. This would be particularly detrimental in certain watercourses if it occurred during the spawning season when migratory salmonids were moving upstream.

10.2.2.5 ***Habitat Destruction***

The proposed pipeline will cross a number of rivers where spawning habitats are known to occur at or immediately downstream of salmonid short stretches of spawning habitat. It may not be possible to re-instate these successfully using the stockpiled excavated river material.

Pools or other in-channel fish lies may be removed or damaged by the construction of a crossing.

Certain banks-side features e.g. vegetation or bank overhangs may facilitate the temporary residence of catchable fish at a particular spot in a river. Their removal may reduce the value of such stretches for angling. In the case of the Clydagh, both banks, but especially the northern bank, are very heavily timbered with many

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large deciduous trees overhanging the channel.

10.2.2.6 *Pollution from Bulk Liquid Cement and Fuel Oil*

The use of bulk liquid cement in some situations for bedding the pipe within the trench may possibly lead to spillage of liquid cement to a watercourse giving rise to a sharp increase in pH and potentially giving rise to very serious fish kills. Spillage of fuel, lubrication or hydraulic oils either from bulk storage or from construction vehicles or plant and equipment operating close to watercourses or drainage ditches which connect to watercourses may cause damage to aquatic flora and fauna communities.

10.2.3 Mitigation

In order to minimise the potential impacts of the construction on watercourses of fisheries, macroinvertebrates and aquatic plants, particularly those arising from excessive suspended solids release, a wide range of direct and indirect mitigation measures will be employed. These fall under the headings:

- Method Statements and briefing;
- appropriate crossing method;
- appropriate design & materials;
- appropriate timing of crossings;
- fish rescue;
- adequate reinstatement;
- re-routing;
- consultation and notification.

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10.2.3.1 *Method Statements and Briefing*

During the detailed design phase the Operator and/or their Contractors will produce detailed Method Statements covering, among others, the crossings of watercourses. Each Method Statement will be designed to minimise the production and escapement of suspended solids to watercourses and will be agreed with the appropriate Regional Fisheries Board. The Operator will undertake to brief all site engineers and construction personnel on environmental issues, including agreed pollution prevention and control methods, before going on site.

10.2.3.2 *Appropriate Crossing Methods*

Section 6.0 outlines the three main crossing methodologies to be employed during construction and broadly the categories of watercourse for which each will be used. However final decisions on the crossing method to be used in individual cases will be agreed in consultation with the Regional Fisheries Boards and if necessary other responsible authorities as well.

10.2.3.3 *Appropriate Design & Materials*

The design of temporary crossing points and the materials used therein will be appropriate to the watercourse being traversed and the flow it is likely to hold during the construction period. The velocity of water through pipes used in flumes will not be high enough to prevent the passage of fish upstream. Nor will the presence of the flume present a physical barrier to the upstream passage of fish.

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All imported fill and re-instatement material used for banks and pipeline trenches in and at watercourses will be chosen in order to reduce the potential for erosion or suspended solids creation. All fill, either imported or re-cycled from the site, which is used for re-instatement of spawning gravel or nursery areas or other in-stream habitats will be selected only after agreement with the relevant Fisheries Boards.

10.2.3.4 *Preferred Crossing Times and Crossings requiring Particular Attention*

From the fisheries point of view the timing of the crossings are considered critical by both Fisheries Boards. This includes the timing of both in-channel and bankside works. In the case of rivers and streams with prime salmonid spawning these should take place in the period May to September inclusive in order to avoid the hatching and early juvenile stages early in the year and the spawning period late in the year. Where a river has both spawning and angling interests, generally speaking, the spawning interests should still take precedence. Where a river, such as the Castlebar is more important for angling, then some effort should be made to construct such crossings during the closed season (October to January). Where rivers or streams have little or no fisheries importance, crossings can be made at any time of year. In the case of all rivers every effort should be made to minimise the time during which any bankside or in-channel works are taking place, this is particularly the case for prime angling areas such as the Deel, the Castlebar and the Clare.

In the case of the Glencullin River, it is recommended that the proposed crossing points of the tributary streams along its northern bank are carefully assessed by NWRFB personnel and the Operator and/or their Contractors prior to construction. This should if necessary allow for localised 'tweaking' of the route and agreement on final Method Statements in order to minimise opportunities for silt escapement.

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The Robe is important for its healthy crayfish population as well as its fishing and should be crossed if possible in the August-September period in order to minimise possible adverse impacts on this protected invertebrate.

Although there is no spawning on the Clare River in the area of the crossing or downstream, the WRFB have expressed a preference to confine the work on the crossing to the period May to October. Certainly in terms of water depths and accessibility this would be preferable. Also, there would be less chance of heavy or prolonged rain contributing to silt run-off from the associated bank earth works. However, it would be imperative to complete the crossing as promptly as possible in order to minimise any negative impact on angling downstream. In this respect, the nature of the river bed material may be critical because it may contain some limestone pavement which might slow the progress of trench excavation.

Table 10.2 lists each of the crossings and summarises the fisheries information available for each and presents the preferred crossing window for each. The latter have been directly quoted from documentation received from the relevant Fisheries Boards personnel or inferred from discussions with them.

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Table 10.2 Fisheries Summary - Pipeline River Crossings

No.	River Name	Principal Fisheries Type	Habitat type	Fisheries Status of Crossing Stretch	Recommended Crossing Window
1	Unnamed Tributary of Carrowmore Lake (east side)	salmon & seatrout	spawning and nursery	moderate	May to September
2	Unnamed Tributary of Carrowmore Lake (east side)	seatrout	spawning and nursery	minor	May to September
3	Unnamed Tributary of Carrowmore Lake (east side)	seatrout	spawning and nursery	minor	May to September
3a	Glencullin (minor tributaries)	salmon & seatrout	spawning and nursery	very important	May to September
4	Oweniny River	salmon & seatrout	nursery	moderate	June to September
5	River Muing	unknown	unknown	very low	May to September
6	Shanvolahan River	salmon and trout	nursery; spawning downstream	moderate	May to September

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No.	River Name	Principal Fisheries Type	Habitat type	Status of Crossing Stretch	Recommended Crossing Window
7	River Deel (Main channel)	salmon & trout	feeding / holding area; spawning and angling downstream	moderate	May to September
8	Castlehill River	salmon & trout	spawning & nursery	important	May to September
9	Lecarrow River	salmon & trout	spawning & nursery	moderate	*May to September
10	Addergoole River	salmon & trout	holding area; spawning and nursery downstream	moderate	May to September
11	Clydagh River	salmon & trout	spawning and nursery, spawning downstream	moderate	May to September
12	Castlebar River	trout & pike	holding	moderate	**year around
13	Manulla River	trout & pike	holding	low	year around
14	Stream to Needhams Lough	small trout ?	unknown	very low	year around

* another time will be considered (NWRFB), ** an October to January timing should be considered (NWRFB).

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No.	River Name	Principal Fisheries Type	Habitat type	Importance of Crossing Stretch	Recommended Crossing Window
15	Robe River	trout	feeding, holding / angling downstream	moderate	*August to September
16	Kilshanvy River (upper trib. of Black River)	unknown		very low	year around
17	Black River	unknown		very low or none	year around
18	Togher River (trib of Black River which flows to Lough Corrib)	trout	nursery	low	year around
19	Clare River	trout (mainly) and salmon	feeding / holding and angling	very important	May to September
20	Lavally River - Clarinbridge	salmon and trout	nursery-spawning	moderate	May to September
21	Eiscir River - Clarinbridge	seasonal or temporary watercourse	n/a	n/a	year around
22	Dooyertha River - Dunkellin	seasonal or temporary watercourse	n/a	n/a	year around

* This crossing window will also be one of the better summer periods for minimising the impact on the crayfish population in the Robe.

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10.2.3.5 *Adequate Reinstatement*

All watercourses will be re-instated to their pre-construction condition including channel and banks. Some modification of bank materials may have to be considered in some cases to ensure greater stability. Spawning gravel will be replaced either with imported or native material if some is lost from a site or degraded during construction. Where silt is inadvertently deposited on spawning beds during construction, these will be removed by raking immediately post construction. Pools and other in-channel features damaged or altered during construction will also be reinstated. All the re-instatement designs methods and materials will be agreed in advance with the Fisheries Boards.

10.2.3.6 *Fish Rescue*

Although in most situations salmonid and coarse fish are likely to be able to avoid crossings during construction, it is likely that in certain important fishery waters or at certain times of the year, fish may have to be removed from the area immediately downstream and upstream of a crossing. The requirement for and methods of fish rescue will be decided in consultation with the Regional Fisheries Boards. This work will be undertaken by the Fisheries Boards themselves or by contractors approved by the Fisheries Boards, and the work will be supervised by Fisheries Board personnel.

10.2.3.7 *Consultation and Notification*

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From the outset and throughout the planning, design and implementation phase of the project very close contact will be maintained between the project management and the statutory fisheries bodies. This will include consultation on matters such as, crossing methods to be employed, Method Statements, timing of crossings, the necessity of fish rescue, re-instatement etc. Liaison procedures / contact personnel will be agreed in advance between the project management/contractors and the Fisheries Boards in order to avoid confusions and misunderstandings in relation to notifications, Method Statements, deadlines etc. At all times the project management will provide adequate notice (to be agreed) to the Fisheries Boards when they are beginning any works at water course crossing.

10.2.3.8 *Re-Routing*

Where all other feasible mitigation methods have been examined and considered either insufficient or unemployable, then re-routing of the line will be considered in order to avoid causing damage to valuable fisheries. A minor re-route should be considered in the case of the Clydagh River to avoid unnecessary removal of the tall trees lining the channel beside the crossing. Minor re-routes in the crossings over the Glencullin River streams (on the northern bank of the river) could help to minimise the potential for silt escapement to the Glencullin itself and should therefore be explored with the NWRFB. Such minor re-routes would be the subject of further detailed design.

10.3 Residual Impacts

10.3.1 Impact on Spawning

Provided construction can be undertaken during the periods agreed and if spawning beds affected by the works are reinstated to approved specifications, then there should be no impact on the spawning capacity of any of the watercourses crossed.

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10.3.2 *Impact on Angling*

It is likely that some residual impact on angling is likely to arise at some crossings for anglers. This may be the case on the Deel, the Castlebar, the Robe and the Clare in particular. However, adequate notification to Fisheries Boards as outlined, as well as a commitment to rapid completion of all in-channel works likely to result in increased water turbidity, should minimise the duration and severity of this impact. Minimisation of angling impacts may depend in some areas on the adequate reinstatement of bankside structures and vegetation and in-channel features such as pools if these have been affected by the construction work.

10.3.3 *Impact on Aquatic Macroinvertebrates*

Temporary local damage to macroinvertebrates is likely at and immediately downstream of crossing points. However, this will be minimised by the use of the crossing protocols outlined, which will reduce siltation. Furthermore, rapid replacement and re-colonisation of the affected areas is likely to be effected by drift and migration from the immediate upstream area if riverbed reinstatement has been undertaken correctly.

10.3.4 *Impact on Aquatic Flora*

Temporary local damage to aquatic plant assemblages is likely at some plant-choked crossings, at and immediately downstream of the crossing points. However, re-vegetation of the affected areas is likely to occur at the latest at the outset of the next growing season, particularly if the re-instatement process has been carried out properly.

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11. SOILS AND GEOLOGY

11.1 Introduction

This chapter describes the solid geology, drift geology and soils along the proposed pipeline route. Because the pipeline follows an essentially cross-country route, natural ground features and sub-surface ground conditions are of primary importance.

A basic understanding of the ground is essential in order to appreciate the potential impacts of pipeline construction on:

- Aquatic and terrestrial habitats (direct and indirect effects)
- Economic minerals (such as natural aggregates and metaliferous ore minerals), which may be sterilised or made less accessible
- Landscape features which may derive much of their form from the underlying geology
- The safety and integrity of the pipeline
- The ease of pipeline construction and thus costs and logistics
- The ease and success of reinstatement.

The description of the physical environment presented in the first part of this chapter is followed by a summary of the impacts arising from pipeline construction and the measures proposed to mitigate those impacts.

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The information contained within this section is based, primarily, on a desk study of a 1km wide corridor centred on the pipeline route. The desk study has included the examination of geological maps (both published and manuscript), geological memoirs and other geological references, as well as stereo monochrome and colour aerial photographs. Much of the desk study work was carried out as part of the route selection process.

Geological information has also been obtained from the geotechnical site investigation work carried out (and currently still in progress) along the pipeline route. The whole of the pipeline route has been driven and viewed from vantage points, and selective parts have also been walked.

11.2 Geology

For the purposes of this report, the geology has been divided into 'solid' (or bedrock) and 'superficial deposits' (which includes glacial and post-glacial soil materials).

Given the relatively shallow trenching depth employed during cross-country pipeline construction (typically around 1.8-2.0m for a 660mm diameter pipeline), it is the uppermost, mainly soil deposits, which are of most importance when considering pipeline trench excavation (and hence pipeline routing). The ability of the soil to stand up in the sides of the trench, to be able to support the weight of the pipe and to provide suitable bedding and backfill material, are key issues in this respect.

Bedrock can be important, however, if it is encountered within trenching depth, because of the extra effort required in excavating the trench. The strength of the rock, and its state of weathering

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and fracture, are then key issues. The angularity of the rock, both in situ and as backfill, is also important because of the potential to damage the corrosion protection coating to the pipe.

Where non- open cut techniques, such as auger boring, thrust boring and micro-tunnelling are utilised (mainly for major road/rail crossings), the presence of rock at shallow depth is also more important; since these techniques tend to involve deeper construction, although rarely exceeding 6m.

Where horizontal directional drilling (HDD) is required (e.g. at major river crossings), drilled depths exceeding 10m may be reached and, therefore, the solid geology becomes an important (sometimes constraining) factor.

These techniques are described in Chapter 6.

11.2.1 Superficial Deposits (Drift)

There is little in the way of published information on superficial deposits along the proposed pipeline route. The Geological Survey of Ireland (GSI) has manuscript copies of 1:10,560 (6inch to the mile) drift maps that date from the early 1900s. These give a broad indication of types of drift (viz. Boulder Clay, sand and gravel, alluvium, bog) and identify areas where drift is absent (e.g. rock outcrops), but do not provide a detailed picture of the variation in type or thickness of superficial soils.

A useful summary of the superficial soils along the southern half of the route is also given on the map 'Quaternary Geology of Mid-Galway, South Mayo and North Clare' presented in Drew and Daly (1993).

However, for a detailed understanding of the superficial soil types along the route, recourse has to be made to site investigation data and to site-specific geomorphological studies (such as interpretation of stereo aerial photographs). Geomorphological studies allow near surface soil and rock conditions to be identified by virtue of their characteristic terrain and landform types.

Within the overall grouping of superficial deposits, an important distinction can be made between glacial and post-glacial materials. These are described in the following sections.

Glacial Deposits

Glacial deposits are those soil materials deposited as a result of, or in association with, the spread and decay of ice sheets. Although Ireland was completely covered by ice on a number of occasions during Pleistocene glacial period, it was during the last, so-called Midlandian Glaciation that most of the glacial soil material that we see today was deposited. The extent of ice covering and the general directions of ice movement during the Midlandian Glaciation are as indicated in Figure 11.1.

From Figure 11.1 it can be seen that the northwest corner of Mayo remained essentially un-glaciated. In terms of the pipeline route, this area covers the section between the landfall and the reception terminal. It is not, therefore, of direct relevance to the present document, but it is worth noting that (being in a periglacial region) this area experienced deep weathering of former drift deposits and shallow bedrock.

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Along the remainder of the route, however, glacial deposits are associated with Midlandian ice sheets in some form or another: either deposited directly by the ice (underneath or along its margins); or dumped by the ice when it melted and/or retreated; or washed out from the ice by melt-water streams.

Given that ice, associated with the Midlandian cold stage, only fully melted about 12,000 years ago, it is not surprising that many of the landforms associated with the different types of glacial deposits are still relatively fresh and easily recognisable.

The main landform types are shown in Figure 11.2. Although Figure 11.2 is to some extent a diagrammatic representation, it provides a useful and appropriate basis for describing the different deposits and landform features along the route.

Glacial Sands and Gravels

Glacial sands and gravels, allbeit rather clayey, underlie much of the northernmost portion of the route. They are associated with an extensive outwash plain (kame terrace) that developed as the ice retreated away from the ring of hills (Maumakeogh, Slieve Fyagh, Nephin Beg Range), which had previously halted its westerly advance.

The rather irregularly hummocky surface of this plain, typical of areas experiencing wasting of dead ice, has been somewhat smoothed by the overlying development of peat. The fact that the peat is generally thicker than 3m means that the underlying sands and gravels are often only encountered at depth i.e. in boreholes, which extend through the peat. The rather clayey nature of much of the deposits is probably due to the fact that deposition occurred from ice that melted in situ, with a minimum of water sorting of the material.

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Locally within this area, more distinctive landform features are evident, which can be seen to extend up through the peat. These occur either as isolated hills or as more elongate ridges, and are known as eskers. They formed under the ice, where localised melting and sub-glacial stream drainage deposited rather cleaner sands and gravels. A long train of eskers occurs along the N59 road through Eskeragh (see Figure 11.2). Both the road and the pipeline route have taken advantage of the better ground afforded by this ridge, compared to the thick bog on either side.

The sands and gravels have been worked along this ridge at Dooleeg and more recently just to the east of the Shanvolahan River, where the route heads southwards away from the N59 road. The high content of sandstone rock fragments in the sands and gravels throughout this area reflects the extensive presence of Carboniferous sandstone bedrock at depth.

Glacial sands and gravels are also present towards the southern end of the route in the area to the west of Athenry. Along the route, they occur particularly to the south of Knocknacraeeva hill as far as the Galway - Athenry railway line and at Millpark, close to the Lavally River. At the aforementioned location, esker ridges, orientated northwest-southwest, are evident at Rathmorrissy; while at Millpark, clusters of small hills are evident.

A small area of glacial sands and gravels, associated with a rather poorly defined esker ridge, is also present at Carheens, close to the Agricultural College. At this location the sands and gravels have also been worked.

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In all of the more southerly locations where glacial sands and gravels occur, the gravel content consists mainly of Carboniferous limestone, reflecting the extensive underlying presence of limestone over the southern half of the route.

Glacial Overspill Channel Deposits

During the initial retreat stage of the Midlandian Glaciation, when ice was still banked up against Slieve Fyagh, the Glencullin River valley probably acted as an overspill channel for glacial melt-water. Ice may have previously penetrated down this valley at the height of the Midlandian advance, helping to excavate the broad U-shaped form of the valley.

Deposits within this valley comprise a heterogenous mixture of sands, gravels, and boulders, many of which show signs of water sorting, but with rapid local variability. Fluvio-glacial soils of this type are typically deposited by torrential flows, such as those resulting from the periodic breaching of ice melt-water dams This situation can be visualised to have occurred when marginal moraine, banked up at the head of the valley by pulses of westerly ice movement, became overwhelmed by melt-water as the ice retreated.

Glacial Till (Boulder Clay)

The middle to southern portion of the route, around Tuam, is the region where, at the height of the Midlandian Glaciation, the ice is thought to have been thickest. An ice dome, probably many 100m thick in this area, provided the locus for snow/ice accumulation and the pressure centre for ice movement. Ice movement took place in all directions but was constrained to follow certain paths by the underlying topography.

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Along the base of the moving ice sheet, pre-existing glacial deposits and loose rock material were eroded, and then subsequently deposited as a basal or lodgement till. This material was essentially smeared onto the underlying surface as a result of pressure melting of the ice.

In such an environment, local deposition often takes place in the lee of bedrock projections, which then become nuclei for further deposition. However, because of the flowing nature of the ice, the deposition naturally becomes streamlined and elongated in the direction of ice movement.

Slightly to exaggeratedly elongate streamlined mounds of basal till are called drumlins and the middle part of the route is replete with these features. They are particularly well developed along the section of the route between Turlough and Mayo Abbey. Reference to the 1:50,000 OS map for this area, clearly shows the size and form of these features, as well as their distinctive NNE-SSW orientation.

It has been postulated (McCabe 1985) that the origin of most drumlin debris is local, and that the associated erosional, transportational and depositional mechanisms were accomplished over a distance of as little as 2km. The composition (and probably origin) of the drumlins along this middle section of the route, therefore, owes much to the underlying presence of weak shaly bedrock, in the form of the Craggagh Shale Formation. Compared to the surrounding harder rocks, this shale formation would have been relatively easily eroded and ground-up by moving ice to form clay. It is also probable that some of these landforms may be more or less moulded in situ from the underlying shale.

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Within typical trenching depth, the material over and between the individual drumlins generally comprises a stiff brown stony sandy clay. This is commonly known as Boulder Clay, and is an ideal material in which to trench and install pipelines.

Boulder Clay also extends over much of the southern portion of the route, underlain by Carboniferous limestone. However, in this area it tends to be quite thin and does not form the distinctive drumlin features, suggesting that ice movement was less active in this area. The boulder clay also contains a high percentage of angular limestone rock fragments of gravel to boulder size and the clay content tends to be quite low by comparison. It is possible that much of the clay may represent the insoluble residue resulting from dissolution of the limestone.

Glaciated Rock Surfaces

Between Gort and Ross West, the route crosses an area that was heavily glaciated by ice streaming northwards towards Lough Conn and Killala Bay. Westward movement of this ice was constrained by the high ground to the west.

The underlying bedrock in this area is granite, which is typically very resistant to ice erosion. However, such was the erosive power of the ice that it was able to not only scour off the weathered surface material but also abrade the un-weathered rock mass. Along this section, bare massive rock surfaces are common, with many showing score marks (striations) where boulders where dragged across their surface by the ice. Large boulders of granite (bigger than cars) are also common. Much of this area, not otherwise covered by peat, has a thin covering of glacial drift that would have been deposited when the ice eventually melted.

A drive along the R310 road between Pontoon and Ross West, reveals clearly the extent to which has ice has planed down the granite surface. This road, located approximately 1-2km to the east of the pipeline route, runs directly along the path of the ice.

The pipeline route, however, keeps to the edge of this ice fairway, and runs across mainly drift-covered areas that represent the marginal moraine deposited along the edge of the ice sheet. The route thus avoids the more difficult bare rock sections.

Local weakness in the granite bedrock, such as the fault zone that parallels the stream valley to the south of Gort, were also picked out by the streaming ice and over-deepened. The pipeline route also takes advantage of this stream valley, which has become in-filled by later superficial deposits.

Post-Glacial Deposits

Post-glacial deposits are essentially soil materials (in the geotechnical sense) that were deposited after the retreat and melting of the glaciers. They are, therefore, younger than 10,000 yrs and were deposited at a time when climatic conditions were approaching those of the present day and when sealevel was rising towards its present-day level. On balance, however, the climate was cooler and wetter than present, and there was significantly more water around as a result of the melting ice sheets.

The principal feature of post-glacial deposits, as they affect the pipeline, is the significantly greater content of organic matter, compared to the glacial deposits.

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Peat

Peat is the most significant of all the superficial deposits in terms of its potential to affect the pipeline.

It covers a large part of the northern section of the route between the reception terminal and Castlebar. More isolated areas of peat, which become progressively fewer in number, also occur to the south of Castlebar (see Soils Maps, Figures 11.5 to 11.11).

The occurrence of peat, and its continuing present-day growth in the west of Ireland, owes much to the climatic regime, and particularly the rainfall. Annual precipitation in excess of 800mm is required to sustain the growth of peat on a regional scale, while in areas receiving less than this amount peat growth is generally restricted to low-lying wet hollows.

Peat growth probably started in areas, such as the Oweniny basin, where the glacial legacy had created an area of occluded drainage with small shallow lakes, and an intensely water-logged granular substrate. Peat growth was probably initiated in and around the shallow lakes, as swamp and fen peat, before it began to invade the adjacent land areas as bog peat. In such primary development areas, considerable thicknesses of peat are often present.

For instance, along the route, to the south of Lough Dahybaun, peat and soft mud thicknesses of up to 9m have been measured.

An important area of fen peat, characterised by the base rich composition of the groundwater, occurs close to the route at Eskeragh. In fact, the route was purposely moved onto the north side of the N59 road to avoid this area.

The subsequent spread of bog peat, first to the inter-lake areas, then to the higher ground, coincided both with the widespread felling of trees and subsistence-type agriculture practised by neolithic settlers, and with a deterioration in climate. These events are dated to about 3000 BC (Edwards 1985) and together, they contributed to a pronounced leaching (podsolization) of the soil and an inability to support other types of vegetation.

Sphagnum moss (the main constituent of bog peat), unlike higher plants, requires no mineral or nutrient contribution from the underlying substrate to support growth. It will grow simply from minerals extracted from rainwater. Spread of bog peat (to form blanket bog) occurred, progressively, upslope; and on hillsides crossed by the pipeline, such as along the Glencullin valley, the blanket bog shows an often remarkably uniform thickness of about 3m.

Sphagnum peat is characterised by the high acidity of the contained water (pH 4.5 to 3.3), which is due to the formation of organic acids released during the initial decay of the plant matter. This high acidity not only tends to inhibit the growth of other (deep-rooted) plant species but also reduces the rate of decomposition of the peat.

Arrested decomposition, which is also promoted by the high water level in the peat reducing access for oxygen, means that the peat along much of the northern section of the route tends to contain a high content of plant fibres. Plant fibres give the peat a measure of tensile strength, which more highly decomposed peat does not possess.

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Notwithstanding this higher fibre content, peat is not a good material in which to construct pipelines and wherever possible the route has been selected to avoid areas of thick and/or intact peat and to route through areas where the thickness has been reduced e.g. by working. However, given the extent of blanket bog in NW Mayo, and other constraining factors, crossing areas of peat is unavoidable.

It is, therefore, extremely important that the behaviour of peat is understood both from an engineering construction standpoint and also from an environmental standpoint. The peat areas, of all the sections of the pipeline route, are the areas where engineering and environment considerations are likely to come most in conflict.

It is common engineering and environmental practise to divide peat into an upper acrotelm layer and an underlying catotelm layer. The acrotelm is the relatively thin (100 -600mm) surface layer in which aerobes are active, relatively un-decomposed plant remains are present and the permeability is correspondingly quite high. The upper surface of the acrotelm, the so-called mattress, is the surface that supports living plant growth.

The morphology of the mattress is frequently influenced by the type of plant growth: e.g. grasses growing in tussocks will produce a very hummocky surface. The morphology can also be influenced by water flowing over the surface. Water flow frequently occurs within small channels (water tracks) that may be partially or completely covered over by surface vegetation. Such features, often clearly visible on aerial photographs, may be difficult to detect on the ground.

The acrotelm is the layer of most concern to environmentalists, while the underlying catotelm is the layer of most concern to engineers. Peat, i.e. material that is composed primarily of decomposed plant matter, is strictly the catotelm and it is this layer that geotechnical engineers refer to when talking about peat.

It is somewhat ambiguous, however, to describe peat as a soil, because to a very large extent it is composed of water. In fact, a 5m thick section of bog peat may contain 4.7m of water and only 0.3m of solid material (Hobbs 1986). The water is contained partly as interstitial water (approx. 30%), which is water that can be relatively easy extracted, and partly as bound water (approx. 55%) within the plant structure. Bound water includes water contained in capillaries and in colloidal solution and is far more difficult to remove. Typically, peat also contains approximately 10% gas, which is usually a mixture of methane and carbon dioxide, produced by anaerobic digestion.

The solid constituents of blanket bog type peat typically comprise 90% or more organic material, with the remainder being extraneous mineral matter. Basin peats can contain more in the way of mineral matter, washed in from the surrounding area. For instance, the Oweniny basin peat worked to provide fuel for the Bellacorick power station, contains a relatively high proportion of quartz sand. This sand, being non-combustable, becomes concentrated in the waste ash.

The invariably water-logged condition of peat and its low density (by virtue of the low solids content) means that gas pipelines can be susceptible to flotation and, therefore, require some form of additional weighting to keep them below the surface.

Under load, peat will experience consolidation as a result of compression of the gas and squeezing out the interstitial water. Load induced consolidation is typically rapid at first but slows with time as the material become less permeable to water flow.

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The strength of peat (shear strength) can be very variable due to the fibre content, but is typically low. Shear deformation under load is one of the main reasons for the poor trafficability of peat and the reason why heavy construction plant cannot be used in peat areas.

Shear strength is related to the fibre content and thus, ultimately, to the degree of decomposition of the peat. Shear strength, however, is difficult to measure by normal soil mechanical methods (Landva 1980), because these cannot cope with fibre-reinforced soils. A means for describing the relative fibre content of peats is embodied in the van Post classification method (see for instance, Hobbs 1986 - Appendix A and Landva and Pheeney 1980), which in turn is a measure of the degree of humification (decomposition) of the peat. The method involves squeezing a lump of peat in the hand and noting the extent to which the material exudes out between the fingers. Although seemingly crude, the method is very effective and has been used as an index to determine variations in character of the peat with depth, at intervals along the route.

Given that the upper mattress layer is the least decomposed portion of a peat profile, it follows that it is typically the strongest part of the profile in terms of shear strength (or more accurately, tensile strength). Making use of this fact and keeping the mattress layer in place is one of the key features of being able to get construction plant across peat bog areas. This runs counter to the normal pipeline construction practise of stripping topsoil/subsoil before allowing access for construction plant.

Maintaining the mattress layer in place, however, has to be balanced against the need to protect the uppermost living portion of the mattress and the need to preserve the surface morphology and hydrological characteristics of this layer. For instance, load consolidation of the upper layer of the peat can lead to a reduction in its permeability and water transmitting qualities, while the overall settlement of the surface due to consolidation of the peat profile can result in water-logging or possibly flooding of the peat surface.

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Although there are a number of areas along the route where crossing of intact peat bog is unavoidable, by and large the peat crossed by the route is cutaway blanket bog. Cutaway blanket bog is bog that has been cut by hand to provide turf for use as domestic fuel.

Typically, the bog is cut in strips, usually on an incline to promote drainage, with up to 1.5m of peat being cut in one pass. By exposing a long cut face, drainage and drying of the peat is promoted, making it easier to cut subsequent lines. The cutting of peat by hand in this way on commonage land is an ancient right (turbary right) enjoyed by those who have access to the commonage. This form of peat-cutting is particularly evident along the section of route to the south and east of Lough Dahybaun and at Cunnagher North, to the north of Ross West.

The resulting irregular ridge and furrow surface of the peat makes for additional difficulties for construction of the pipeline. Careful consideration also has to be given to the depth of installation of the pipe, bearing in mind the potential depth of future peat-cutting on either side of the permanent wayleave.

Elsewhere along the route, peat cutting tends to be on a more local scale, e.g. on individual land-owner parcels. The designation of large tracts of intact peat bog as conservation and heritage areas has also helped to arrest the spread of peat cutting.

Within the Oweniny basin area, extensive tracts of peat-land have also been cut by mechanical methods, to supply fuel to Bellacorick Power Station. To the east of the Oweniny River, along the pipeline route, as far as the Muing River, the peat has been worked out and the land is being

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reinstated. To the west of the power station, along the route as far as Tawnaghmore, the peat is still being actively worked, although some portions have already been stripped down to the underlying glacial surface.

The pipeline has purposely been routed through these actively working or worked-out peat areas in order to avoid crossing large thicknesses of intact peat.

To the south of Castlebar, many of the peat hollows shown (see Figure 11.5) as being crossed, or routed in close proximity to, by the pipeline, have been extensively drained and reclaimed for agriculture. Once drained, peat becomes a far more suitable material in which to install pipelines. However, consideration still has to be given to flotation, because of its low density and potential for water-logging.

Alluvium

Alluvium is a river-deposited material and along the pipeline route it is associated with some of the larger rivers, which have a distinct floodplain. The floodplain is the flat-lying area extending on either side of the river channel that is susceptible to inundation during times of flood.

Arterial drainage measures, instituted during the last 150 years, however, have served to reduce the extent and frequency of inundation of the river floodplains and also to reduce the water-logging that previously characterised floodplain areas. It is now often quite difficult to determine the extent of river floodplains and alluvial areas from their surface morphology.

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The groundwater table still tends to be high in these areas, however, and the risk of inundation means that consideration has to be given to pipeline flotation, depending on the nature of the soil used as backfill.

Alluvium, which is the material that underlies the floodplain, does not constitute one soil type, but rather it varies depending on the size and type of river and geology within the upstream catchment area. Its thickness is also very variable.

As a general rule, however, the grain size of the material tends to diminish in passing upwards through an alluvial sequence. This is because the amelioration in climate that characterised the post-glacial period, resulted in a reduction in flow in the rivers and their capacity to transport coarse material. In a typical alluvial profile, therefore, sands and gravels are often succeeded by silts and clays.

The initial sand and gravel stage was characterised by braided river channels, which tended to migrate across the floodplain. The subsequent fine-grained deposition stage was associated with the spread of vegetation onto the floodplain areas, helping to further reduce the speed of overland flow. Peat development is, therefore, often a feature of the upper fine-grained portions of many alluvial sequences.

The Deel River is a good example of a river floodplain that conforms to the typical fining-upwards type of sequence. By contrast, the Addergoole River and the Manulla River show an upper peaty horizon underlain by soft clay. In both instances, the river has only recently come to develop a channel by silting up of what was once an extensive lake system or series of interconnected loughs.

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Some of the smaller rivers that emerge from upland areas, such as the tributary streams of the Glencullin River, still show a very coarse alluvium, with braided channel tendencies.

Those rivers that flow across limestone bedrock on the southern part of the route tend to have diminutive amounts of alluvium, partly because a significant portion of their flow probably takes place through the underlying bedrock. The finer alluvial fractions may also have been washed down into the rock.

At least two of the rivers – the Clare River and the Eiscir River – also run in artificially excavated channels that are not related to the original floodplain. In both these rivers, where they are crossed by the pipeline, the bed of the river is in rock and there is no alluvium on either side.

11.2.2 Solid Geology

The solid geology is very much subordinate in importance to the pipeline, compared to the superficial deposits, to the extent that along sizeable sections of the route the nature of the underlying bedrock is largely immaterial.

The bedrock geology becomes important, however, in the following situations:

- Where rock is at or close to the surface and will (or may) be encountered during trench excavation
- To the east of Castlebar and along much of the southern half of the route where karstified limestone bedrock may affect ground stability.

Bedrock geology is also of indirect importance in relation to landscape development. This is because different bedrock lithologies vary in terms of their contribution to upland and lowland landscape features.

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Information on bedrock geology for the northern half of the route has come from the 1:100,000 map 'Geology of North Mayo' and the accompanying memoir (Long et al 1992). As yet, no corresponding published geological maps are available for the southern half of the route. However, a useful summary of the bedrock geology along this portion of the route is given in the map: 'Bedrock Geology of Mid-Galway, South Mayo and North Clare', presented by Drew and Daly (1993).

For convenience of description along the pipeline route, the bedrock is divided into limestone and non-limestone lithologies. How these divisions relate to the northern portion of the route is shown in simplified form in Figure 11.3.

Non-Limestone Lithologies

To the north of the Clydagh River, save for a short section between the Deel River and Lahardaun, the route is underlain entirely by non-limestone strata.

Starting at the reception terminal and extending as far as the middle of the Glencullin valley, ancient metamorphic sedimentary rock types (of the Dalradian) underlie the route. Wherever these are seen at outcrop, which is only very infrequently along the route, they tend to be quartz-base in composition, either quartzitic sandstones or quartzites. They are intensely hard and this strength is responsible for their having formed prominent upland features such as the western

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facing slopes of Slieve Fyagh, the isolated hill at Glencullin Lower, and Carrafull hill, further to the south.

Approaching Bangor Erris from the east, along the N59 road, there is a large quarry on the southern flank of Carrafull hill, which provides good exposures of these rock types.

Higher up the Glencullin valley, there is a significant change in age of the underlying bedrock, to Lower Carboniferous, although the lithology remains essentially the same. Quartzitic sandstones of the Glencullin and Minnaun Sandstone Formations underlie the upper Glencullin section of the route. Despite their having contributed significantly to the coarse granular drift deposits, these formations are not seen at outcrop along the route.

However, good exposures of these medium- to thickly-bedded sandstones are to be seen in road cuttings along the N59 road to the east of Bangor Erris.

Carboniferous sandstones complete the ring of hills that encircle the Oweniny basin on its western side. They form the main summit of Slieve Fyagh and the somewhat lower hill to the south of Glencullin Upper.

The uppermost part of the Glencullin valley, and the huge expanse of the Oweniny basin that lies to the east, is underlain by much weaker Carboniferous strata, namely mudstones and siltstones of the Downpatrick Formation. The flatness of this area, at an average elevation of between 60-100mOD, is in stark contrast to the hills to the north, west and south.

Needless to say, bedrock in this area is nowhere exposed, being deeply buried beneath glacial deposits and thick peat.

There is a further short section of Carboniferous sandstone (Mullaghmore Sandstone Formation) underlying the route, which extends from the point where the route heads southwards away from the N59 road to just before its crossing of the Deel River. But again, it is deeply buried beneath glacial deposits and thick peat.

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South of the major fault (shown in Figure 11.3), which crosses the alignment at the White River, (to the west of Lahardaun), there is a return to ancient metamorphic rocks. In this case, mica schists predominate. Although these tend to occur at relatively shallow depth beneath the glacial deposits and were encountered during the site investigation, they tend to be deeply weathered to a readily excavatable soil material.

However, just to the west of crossing of the road that runs north-south through Lahardaun (Figure 4.3 G1356 0863), harder schists make an appearance and also outcrop on the hill at Knockfarnaght.

Immediately east of this road crossing, however, the route extends into the valley of the Addergoole River and thick drift and peat again overlies the bedrock. This drift cover masks a change back to Carboniferous sandstones, which occurs beneath the valley, although blocks of hard Capnagower Sandstone occur at shallow depth in the region of the first road crossing following the River Addergoole crossing.

Carboniferous sandstone continues to underlie the route, although deeply buried beneath drift and peat, as far as the stream crossing to the south east of the sharp bend in the R615 (Figure 4.3 G 1633 0502). There is then a short section underlain by quartzite (Leckee Quartzite), which

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is probably similar in lithology to that at the start of the route (but is not exposed), before the route extends onto granite.

The granite (or more accurately, granodiorite) in this area forms the western-most extension of the Ox Mountains Granite. It contributes to the formidable peak of Farbreiga, to the south, and to the steep craggy slopes that extend down to Pontoon on Lough Conn/Lough Cullin, to the northeast. Upland continues also to the southwest of Farbreiga, so the route is obliged to cross this topographically difficult area at some point.

During the Midlandian Glaciation, the northern flank of Farbreiga lay in the 'wind-shadow' with respect to ice streaming northwards towards Lough Conn and Killala Bay, as described in 'Glacial Deposits' (Section 11.2.1.1). The granite on this side of the lower slopes of the mountain is thus largely covered by detritus, mainly coarsely granular hillwash and scree, that was shed from higher up.

Above the 100mOD level there is more or less continuous rock outcrop over much of the mountain. However, it would appear that glacier ice never extended above this level during the last (Midlandian) glaciation and so while the exposed rock was subjected to intense periglacial weathering, it was never overwhelmed by moving ice. Periglacial weathering has picked out weakness in the rock, such as faults and fractures, causing a general degradation (frost shattering) at the surface and a downslope washing of detached rock fragments.

By initially keeping at just below the 100mOD level and then following the alignment of a major north-south trending fault zone, the route avoids the main areas of craggy bare rock. The north-south trending fault zone is responsible for the formation of a narrow 'wind gap' through the granite uplands. Although small knolls of rock are present locally, the gap is essentially flat-floored and underlain by gritty sands (fault gouge and weathered granite), with a thin covering of peat. Craggy rock outcrops occur on either side of the gap.

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Granite continues to underlie the route to the south of the gap, but this time on the flanks of Farbeiga that experienced the full effect of ice sheet erosion.

Along the route, however, marginal moraine provides a more or less continuous covering to the rock, allowing the route to avoid the more difficult bare rock areas to the southeast. Shallow rock is present, however, just to the east of the stream crossing south of Gort (Figure 4.4 G 1790 0037) but thereafter, south from this location, there is a relatively thick covering of peat, with drumlins making a local appearance at Ross West.

A change from granite to Leckee Quartzite occurs beneath the thick drift-covered area around Sranalee but the quartzite is not seen along the route until after the crossing of the R310 road. Across the rather flat, peat-covered area between the road and the northern edge of the Clydagh River floodplain, patchy rock outcrops are evident, with a more continuous outcrop occurring along the low escarpment that overlooks the river. These outcrops are probably a combination of quartzite, quartzose sandstone and schist, and various acidic and basic igneous rocks that are intruded into the Leckee and Slieve Gamph Group sequences, which form the southern limit of the ancient rocks along the route.

South of the Clydagh River only Carboniferous strata underlie the route.

Underlying the Clydagh River floodplain, the geological map indicates a narrow band of basal Carboniferous Moy Sandstone. This formation is the stratigraphic equivalent of the Capnagower

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and Minnaun Sandstones described further north along the route. However, its low-lying position along the river valley in this area suggests that the locally higher content of siltstone has rendered the sandstone more susceptible to erosion.

Between the Clydagh River and Manulla Bridge limestones are present, which are described in the next section.

Southwards from Manulla Bridge, there is an unspecified length of crossing of Craggagh Shale Formation, which lies deeply buried beneath thick glacial drift, moulded into drumlins. This is an area for which there is no recent bedrock geological mapping. The shale is thought to extend possibly as far as the road crossing east of Lough Nambrackkeagh (Figure 4.5 M 2328 8445).

Limestone Strata

Two isolated sections underlain by limestone strata are present along the northern portion of the route (as shown in Figure 11.3).

From just west of the Deel River crossing to just west of Lahardaun, Ballina Limestone underlies the route. Outcrops of grey crystalline limestone are indicated on old drift maps in the bed of the Castlehill River, just upstream of where the pipeline crosses the river (Figure 4.3 G 1142 1097), but nowhere along the route does the limestone appear to approach the surface.

To the south of the Clydagh River, as far as Manulla Bridge (approximately), a southeasterly dipping sequence of limestones is crossed. These comprise, firstly, the Castlebar Limestone, which underlies the valley of the Castlebar River, then the Aille Limestone and finally the Barney Limestone. The Castlebar Limestone consists of a dark grey medium bedded rather muddy limestone, which is well exposed in man-made cuttings along the N5 road either side of the pipeline crossing and in a small overgrown shallow quarry just to the west of Clogher.

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While exposures on the north side of the Castlebar River appear to be rare, with the rock largely buried beneath a relatively thick drift cover, the rock appears closer to the surface immediately to the south of the river and the N5 road.

The succeeding Aille and Barney Limestones are cleaner limestones and to this extent would be considered susceptible to karstic weathering (as discussed in Section 11.2.3). However, evidence of karstification is only seen around Drumcorrabaun, where the rock approaches the surface and where a number of large water-filled swallows are present just to the north of the route. Elsewhere, between Clogher and Drumcorrabawn, the rock is largely cover by drift (drumlins) with peat in the hollows. However, at Derrynacross there are again signs that the rock approaches the surface.

South of the aforementioned Craggagh Shale area, limestone underlies the remainder of the route as far as the Craughwell AGI.

As previously mentioned, there is no recently published bedrock geological mapping for the southern half of the route, but in their report on Groundwater and Karstification in Mid-Galway, South Mayo and North Clare, Drew and Daly (1993) record the broad bedrock sub-divisions and their mapped extent.

Along the route a relatively simple two-fold sub-division into Muddy Limestone and Pure Limestone is indicated. Note that these subdivisions are lithotypes (based purely on rock

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lithology) and do not necessarily bear any relation to the mapped stratigraphic formation sub-divisions described further north along the route.

Based on Drew and Daly (1993), the two groups have the following characteristics:

Muddy Limestone - is a dark grey to black, clayey limestone with black calcareous shales, which becomes cherty towards its base. It is well-bedded with most beds being less than 80mm in thickness.

Pure Limestone - is a pale to medium grey, bedded, fossiliferous, coarse to medium grained limestone (calcarenite). It is generally not clayey but there are discernible variations in grain size, degree of crystallisation, occurrence of chert and shale bands. In stratigraphic terms, Pure Limestone appears to overlie Muddy Limestone.

Muddy Limestone underlies the route southwards to about the point where the pipeline crosses the road north-east of Knockrickard (Figure 4.5 M 2810 7698), although there is little sign of rock near the surface, with much of the route being underlain by relatively thick drift.

Pure Limestone then extends southwards as far as Davros (Figure 4.6 M 3056 6228). But while rock outcrops (generally described on old drift maps as near-horizontally bedded grey limestone), occur along the road between Lissatava and Bushfied, at Kilglassan and at Annefield House (all to the west of the route), along the route itself the rock generally lies buried beneath relatively thick drift. Evidence of karstification of the rock (that would accord with the high purity limestone lithology), is seen in Carrowkeel Turlough (Polleamagur Lake) and in the nearby smaller turloughs, and in Carras Lough, which is also a turlough.

The implication of the mapped extent of Pure Limestone in this area, is that it forms part of a shallow syncline orientated northeast-southwest. The southern (faulted) limb of this syncline is indicated as occurring along the route to the south of Davros, where Muddy Limestone is again mapped. However, continuing evidence of karstification, in the form of swallow holes on the eastern side of the route and nearby outcrop descriptions recorded on old drift maps, would both seem to suggest Pure Limestone continuing to underlie the route.

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However, the rock generally appears to be quite thickly drift-covered along the route, with frequent low-lying hollows filled with peat.

South of Beagh More, much stronger evidence of karstification, in the form of turloughs (Turlough O'Gall) and widespread swallow holes as well as more frequent rock outcrops (recorded on old drift maps) and evidence of shallow rock on aerial photographs, all point to the continuing presence of Pure Limestone. From here to the end of the route, Pure Limestone is also shown on the Daly and Drew (1993) map.

Although small rock outcrops and larger areas of limestone pavement are common, the main areas of outcropping rock are: on the hills to the south of Castlehacket, on Knockdoe hill and on Knocknacreeva hill. The route generally avoids these hill areas, and outcropping rock areas in general, although it does extend across shallow rock at Knocknacreeva hill.

Natural outcrops commonly consist of ledges or flat pavement areas of near horizontally bedded light grey limestone, which typically have an irregular water-worn appearance. The latter is a result of solution etching of the surface. At outcrop the rock is typically compact and strong, with little sign of loose weathered material.

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Elsewhere, where the rock is covered by drift, a weathered rock (regolith) layer is typically present. This consists of detached fragments of limestone, typically very angular in outline, varying in size from gravel to boulders. The size and frequency of the boulders generally increases with depth down to the bedrock surface. The process of detachment of the rock fragments from the bedrock and their reduction in size is by solution, as part of the surface karstification of the rock.

11.2.3 Karstification of Limestone Bedrock

Karstification is a complex process, giving rise to a potentially wide range of bedrock and soil profile weathering effects. However, because many of these processes take place underground, surface evidence may be relatively scant and an appreciation of karst and its implications for the pipeline may depend on the recognition of only subtle features at the surface.

At its most simplistic level, karstification is the dissolution of limestone (and other soluble rocks) by water flowing through the rock. The dissolution process is relatively slow in human time scale terms, but relatively fast in geological time.

In Ireland, it is mainly the Carboniferous limestones that undergo karstification. Because of the extent to which the country is underlain by these limestones compared to its overall size, there is a commonality of karst development, which means that similar features are often developed in different parts of the country. Before considering the local features along the pipeline route, it is appropriate to describe the general features of karst in Ireland.

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Since by far the bulk of the dissolution takes place at or close to the surface, limestone areas (regardless of limestone type) experience a general lowering of the outcrop surface. Carboniferous limestone areas are, therefore, typically of low relief and flat-lying compared to other non-soluble bedrock types and this is particularly noticeable along the southern portion of the pipeline route, where the surface is generally at or below 50mOD.

Since surface karstification is accelerated both by mechanical weathering (causing fracturing) and by soil formation, a two-speed process of surface down-wasting occurs, with bare massive rock tending to stand proud of areas with a thick soil cover. This explains why limestone hills, such as those at Castlehackett, Knockdoe and Knocknacreeva can develop in an otherwise flat landscape. Pinnacles of massive rock, not visible at the surface, can also occur beneath an otherwise thick soil and regolith (fragmented weathered rock) cover.

Although virtually all types of limestone will experience some degree of internal karstification, it is the high purity limestones that are most susceptible. This is because the more muddy limestones produce an insoluble residue, which tends to inhibit water flow and further dissolution. Because most limestones tend to have low porosities, water-flow takes place primarily through fractures and joints (discontinuities). In high purity limestones these discontinuities become greatly enlarged, allowing increased water flow in a self-perpetuating process that leads to a progressive reduction in overall rockmass density and an increase in overall rockmass permeability. In the limit, solution enlargement may produce structural instability within the rock mass and ravelling or wholesale collapse into voids.

Certain factors can serve to accelerate the karstification process:

- Water flowing off sandstone or peat will tend to be acidic and more aggressive in terms of limestone solution.

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- During the Pleistocene, periods of glaciation and de-glaciation were particularly conducive to karstification because of the increased amounts of cold water (limestone is more soluble at low temperatures).
- Periods of glaciation were also important because of the associated lowering of sealevel, which tended to promote groundwater flow through the rock and the establishment of subterranean river systems.
- Permeable soils (e.g. glacial sands and gravels) will allow more in the way of downward percolation of surface water so tending to increase the rate of karstification compared to less permeable soils (e.g. boulder clay).

Along the pipeline route, apart from the obvious landscape features noted above, the most common features indicative of karst are swallow holes (otherwise known as dolines, shake holes or sluggies) and turloughs (karst lakes). Caves and disappearing streams, which tend to be fewer in number, are also symptomatic of karstification.

Swallow holes are directly associated with ground instability and to this extent are of concern for the pipeline. They form by a process of progressive collapse of soil overburden into openings in the bedrock; typically, by migration of a cavity upwards through the soil profile until it breaks though at the surface. The initial surface breakthrough (crown hole) is generally circular in plan 0.5-1.0m in diameter with vertical or overhanging sides. With time, the sides tend to degrade to form the familiar shallow circular depression. Further collapse of soil into the bedrock may take place, resulting in progressive enlargement of the swallow hole, although enlargement is typically arrested by choking of the soil cavity or plugging of the bedrock opening.

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The extent of previous swallow hole development along the pipeline route cannot easily be gauged from ground level. This is because:

- It is often difficult to visually discern shallow depressions.
- Many swallow holes have been in-filled as part of agricultural land improvement.
- Arterial and land drainage have reduced the likelihood of swallow hole formation, by reducing fluctuations in groundwater level.
- Recently formed swallow holes tend to be in-filled quickly (at the crown-hole stage) because they represent a hazard to livestock.

Old aerial photographs can provide a much clearer picture of their occurrence and extent, and so as part of the route selection process 1973-74 photography was used to record the locations of swallow holes. By way of example, Figure 11.4 shows an area along the pipeline route just to the south of Castlehackett. The extent of pock-marking, often by what appear to be recently formed swallow holes on the earlier photography, is in stark contrast to the present day smoother appearance of the ground.

Although isolated swallow holes occur in limestone areas to the north of Beagh More (Turlough O'Gall), the main area of development, along the pipeline corridor, is to the south, as far as the Craughwell AGI. There are three main reasons for this:

- High purity limestones predominate.
- The overlying drift is generally more granular.
- Bedrock occurs at shallower depth.

Within any one area, the latter two factors can also be seen to contribute to a variation in the concentration of swallow holes. This is because granular drift tends to facilitate the upward

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migration of cavities through the soil profile and the cavities are less likely to choke before reaching the surface if the drift is thin.

In some areas adjacent to the pipeline route, average swallow hole concentrations as high as 5 per ha have been noted.

Swallow holes represent the end product and visual manifestation of ground instability. To this extent their occurrence and concentration in an area can be taken as an index of potential further instability in that area. The local environment within a swallow hole can also be seen as an area of potential further ground subsidence.

The risk to the pipeline, in terms of potential for localised ground subsidence, is not dissimilar to old (i.e. undocumented) pillar and stall mine workings. To reduce the risk, the pipeline has been purposely routed, as far as possible, to avoid individual swallow holes and areas of high swallow hole concentration. While to better evaluate the risk to the pipeline, a staged geophysical investigation approach has been adopted as part of the site investigation work along the route.

Swallow holes are also discussed under 'Groundwater' (in Section 13.2) in relation to aquifer issues.

Karst features along the route are indicated on Figures 11.9 and 11.10.

11.2.4 Economic Geology

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Pipelines have the potential to sterilise areas of potential mineral resource and to adversely affect their economic working. Equally, the legacy of past mineral working (mining and backfilled quarry workings) can impact on pipeline stability.

A search of County Council and Geological Survey of Ireland records, has revealed that along the pipeline route there are no past underground mineral workings, while visual evidence indicates that surface workings are limited to the following:

- Extensive and localised working of peat.
- Localised working of sand and gravel for aggregate.
- Localised working of hard rock for building stone.

Although, as yet, undiscovered economic metaliferous mineral deposits may be present at depth anywhere along the route, the lack of past underground or surface ore workings indicates a low potential.

The pipeline will have a relatively minor impact on the extensive peat workings around Bellacorick Power Station, for two reasons:

- Peat-burning power generation is due to cease at Bellacorick in 2004, when much of the mechanised peat extraction by Bord na Mona will also cease.
- The pipeline crosses areas that have been largely worked out or where workings have ceased.

Although old (disused) sand and gravel pits, and quarries used for local building stone occur dotted along the route, none of these are actually crossed by the route or occur in close proximity to the pipeline. Save for the overgrown sand and gravel pit at Carheens, close to the Agricultural

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Institute (see Figure 11.4). The Geological Survey of Ireland's most recently published directory of active quarries and pits (GSI, 1988) also records that there were no actively working rock quarries or sand and gravel pits within the 1km wide corridor in the late 1980's.

Recently a small sand and gravel pit has been opened up near Eskeragh in an esker deposit of sand and gravel. The pipeline route is located on the edge of the esker feature sufficiently distant and on the opposite side from the main road (N59) not to affect the economics of working.

A recently opened quarry in outcropping limestone is also present at Ardgaineen, (Figure 4.7 M 3764 4047). The pipeline route runs within about 150m of the western edge of the quarry, but the area of working is bounded by a minor road, and the route purposely skirts around the area of bedrock outcrop.

11.2.5 Landfills and Contaminated Land

Consultation with the Environmental Protection Agency, Galway County Council and Mayo County Council, has revealed that there are no landfills and no records of contaminated land along the route.

Likewise, the county councils have no plans to develop landfill sites within the 1km corridor along the route.

The only known area where waste disposal has occurred along the route is adjacent to Bellacorick Power Station, where the route runs close to the ash disposal facilities. The ash is not considered to be a source of contamination and its disposal is being monitored by the EPA.

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11.3 Soils

In this section, soils are considered mainly in their pedological (soil science, rather than geological/geotechnical) sense. Pedological soil development has implications mainly in terms of agricultural potential.

Information for this section was obtained from the General Soils (1985) 1:575,000 scale National Map (see Figure 11.5). No regional guides for this area are available, therefore little information on the characteristics of the soils with regard to workability or properties is available.

Soil types shown on the National Map are divided into six categories:

- Mountain and Hill (Soil Numbers 1-5),
- Hill (Soil Numbers 6-11),
- Rolling Lowland (Soil Numbers 12-24),
- Drumlin (Soil Numbers 25-29),
- Flat to Undulating Lowland (mainly dry mineral soils) (Soil Numbers 30-38)
- Flat to Undulating Lowland (mainly wet mineral and organic soils) (Soil Numbers 39-44).

There are nine soil types that occur along the pipeline route.

Peaty podzols and blanket peat are part of the Mountain and Hill category and occur on higher ground between Bellacorick Bridge and Lough Dahybaun, a distance of approximately 4km.

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Three soil types are part of the Rolling Lowland category. Podzols, gleys and blanket peat (lowland level). These soils underlie the proposed route in patches, between Broadhaven and Eskeragh (with the exception of the section between Bellacorick Bridge and Lough Dahybaun), a distance of approximately 20km (including the landfall to reception terminal length); and the section between Lahardaun and Castlebar (with the exception of the section between Levally Lough and Ross West), a distance of approximately 10km.

Grey brown podzols are part of the Drumlin category and occur between Castlebar and Mayo Abbey, a distance of 10km.

Two soil groups, degraded grey brown podzols and shallow brown earths and rendzinas are part of the Flat and Undulating Land category. The degraded grey brown pozolics occur between Eskeragh and Lahardaun. The shallow brown earths and rendzinas occupy approximately 35km or the pipeline route, underlying the section between Mayo Abbey and Galway. These soils are likely to be dry mineral soils.

Basin peat is the only soil type within the Flat and Undulating Land category, which is likely to constitute the wet mineral or organic soils. This soil type occurs in patches from Mayo Abbey to Galway, and underlies approximately 5km of the proposed route.

11.4 Evaluation of Impacts

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11.4.1 Topography

The pipeline has been purposely routed to avoid steep slopes and irregular upland topography. While such avoidance is relatively easy along the southern half of the route, because of the general flatness of the terrain south of Mayo Abbey, the northern half of the route is more topographically challenging.

The following are local situations where steep slopes and topographical difficulties are present:

- Some of the stream crossings between the reception terminal and top of the Glencullin valley have quite steep banks due to active down-cutting and erosion.
- To the south and east of Lough Dahybaun, where strip working of the peat has resulted in a very irregular surface along the pipeline route.
- Just to the west of the road that runs north-south through Lahardaun (Figure 4.3 G 1356 0863) the route is crossed by a series of shallow rock ridges that produce a very irregular topography.
- Where the route passes through the gap in the mountains on the northwest flank of Farbreiga, the working width is locally constrained by rocky cliffs on either side.

The latter section (extending over a length of 1.5km) is expected to be topographically the most difficult portion of the whole route.

11.4.2 Superficial Deposits (Drift)

It is appropriate to consider potential impacts associated with superficial deposits (i.e. engineering soils) in terms of: trafficability, excavatability, trench stability, pipe floatation, corrosivity and reinstatement.

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For simplicity, the superficial deposits occurring along the pipeline route can be grouped into three categories of increasing difficulty: glacial deposits, alluvium and peat.

Glacial Deposits

These include glacial sands and gravels, overspill channel deposits and glacial till (boulder clay). By virtue of their mode of deposition and lack of organic matter content, they tend to be relatively stable, easy to excavate, have good load-bearing characteristics, low corrosivity and allow easy reinstatement.

Boulder clay can be considered an ideal medium in which to construct pipelines, since vertically sided trenches can be dug that will remain stable without support for long periods. Clean (i.e. non-clayey) sands and gravels, however, tend to be rather more unstable, with trench sides collapsing to an angle of about 30-35^0, which represents the natural angle of repose of the material. It is also often difficult to shore trenches in clean sands and gravels.

Trenches in boulder clay tend to make little water, and what water does seep in can typically be dealt with by pumping from sumps. Sands and gravels excavated below the water table, however, can make a lot of water and large scale pumping may be required. Along the pipeline route in the majority of the situations where sands and gravels will be encountered in open trench, the water table will be below or towards the bottom of the trench.

Loose water-logged fine sands, in particular, can develop a running condition, whereby the sand flows with the water that is seeping out. Running sands are virtually impossible to trench (without prior dewatering) because the trench tends to fill up and enlarge as fast as it is excavated.

Since pockets and lenses of fine sand can occur in boulder clay as well as in sands and gravels, it is often very difficult to anticipate where running sand conditions might occur.

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Some of these issues are considered again under Groundwater (in Section 13.2)

Virtually all glacial deposits are chemically inert, being formed from rock fragments, and so corrosivity is not generally a problem.

Glacial deposits also make suitable backfill material and generally facilitate trench reinstatement. The specific gravity of the soil particles also means that provided a reasonable level of backfill compaction can be achieved, glacial soil materials will resist pipe flotation.

However, deposits containing large boulder-size rock fragments can be less suitable in respect of backfill and reinstatement. Selective use, to exclude the large material, may be required.

Alluvium

Alluvium typically falls between glacial deposits and peat in terms of suitability as a medium in which to construct pipelines.

Being located in low-lying floodplain areas, groundwater will generally be encountered within trenching depth. However, construction during the summer at times of low flow in the river will help to reduce the effect of high groundwater.

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The presence of near surface peat and/or soft clay/silt soils will reduce trafficability to the extent that normal construction plant may not be suitable. Some of the alluvial crossings, such as the Addergoole River and the Manulla River, may have to be treated as if they were peat areas.

The likely presence of sand and gravel at shallow depth, possibly in hydraulic continuity with the river, will mean that pumping out may not be possible and a flooded-trench form of construction may have to be adopted. Running sand conditions are a likely possibility in alluvial areas.

The generally soft/loose nature and frequently high organic content of alluvial soils means that they do not make good backfill materials and measures to combat pipe flotation will generally be required.

The fluvial environment also means that careful consideration has to be given to the potential for downstream suspension transport of fine-grained soils exposed during excavation. The potential for subsequent erosion of the banks, means that reinstatement needs to be carried out carefully and with due regard to the flood flows in the river.

Information on river flows is given in Surface Waters (in Section 13.1) .

Peat

At the other end of the spectrum (from boulder clay), peat represents about the most difficult natural material in which to construct pipelines. It is important to appreciate that all of the factors, such as trafficability, excavatability, trench stability, etc., which in other soil materials can be considered singly, become inter-dependent critical constraints in the case of peat.

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Many of the characteristics that influence the behaviour of peat in relation to pipelines are covered in the earlier section on superficial deposits. In this section, some of the critical inter-relationships are considered.

For instance:

- Normal methods of roadway construction in peat areas to provide access for construction (e.g. geotextile and crushed stone) can lead to permanent settlement and difficulties for reinstatement.
- Trenches dug in peat can be stable in isolation but can be rendered unstable when heavy equipment, such as side-booms, are located nearby.
- Concrete weight-coating, normally used to combat flotation, increases the weight of plant required to transport the pipe along the spread and lower it into the trench.

Some of the peat areas crossed by the pipeline have been designated as conservation and/or heritage areas. Many other areas of intact bog, not currently designated, are nevertheless considered worthy of preservation. Pipeline construction in all these areas needs to consider minimising change to the peat environment and maximising the quality of reinstatement.

11.4.3 Bedrock

Additional site investigation work, currently in progress, is intended to refine the understanding about areas along the route where bedrock may be present at shallow depth. This shallow rock investigation is concentrated in two areas:

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- In the blanket bog areas at the northern end of the route, where the presence of rock at shallow depth beneath the peat could cause problems for the pipeline if it sinks through the peat. Shallow bedrock could also preclude the use of embedment anchors (as an alternative to concrete weight-coating) to combat flotation.
- In the limestone areas over the southern part of the route where massive rock may approach the surface without any obvious surface signs. Shallow rock could cause problems for trench excavation and increase the requirement for protection to the anti-corrosion coating.

Apart from these potential impacts on the pipeline, the pipeline construction has potential to impact on the bedrock in two possible areas:

- At the gap through the upland area to the NE of Farbrelga, where granite cliffs on either side of the route form part of this scenic and geologically interesting area.
- In highly karstified limestone areas where the underlying rock mass may be potentially unstable, pipeline construction may induce collapse at depth, affecting groundwater flow through the rock.

This latter situation is considered in more detail under Groundwater (in Section 13.2).

11.5 Mitigation Measures

There are two principal ways in which mitigation has been approached:

- By identifying and delineating the extent of impacts within the route corridor in order to avoid, or at least reduce the length of significant crossing, of those impacts.
- By fully understanding the residual impacts and their consequences either for the pipeline or for the impacted feature.

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As part of the route selection process potential geological and soils impacts have been identified and delineated by a combination of desk study, field study and consultation with relevant authorities. The refined route has been selected primarily on this basis, but with interrogation by other disciplines having an influence on route selection.

By an iterative process, geology and soils impacts have been weighed against one another and against other competing impacts in order to arrive at the current route, which can thus be considered: the Best Practicable Environmental Option.

The outcome of this process is a residue of 'unavoidable' or 'residual' impacts, many of which are still in the process of being evaluated.

In order to alert the Contractor to the presence of these residual impacts, the route has been divided into lengths designated as Special Locations for construction purposes. Once fully evaluated, the aim is to develop method statements that will enable appropriate measures to be taken during construction to reduce to the absolute minimum the consequences of (or for) the impact.

In Appendix 6.1 a check-list is provided of the measures that the Contractor will be expected to take when preparing method statements for working in sensitive areas, including those affecting Geology and Soils.

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11.6 Impact and Mitigation Summary

Residual Soils and Geology impacts occurring along the pipeline route can be summarised as follows:

- Crossings of peat areas, particularly towards the northern end of the route
- Crossings of river flood plain areas, particulary those rivers north of the Castlebar River
- Crossings of any low-lying sand and gravel areas, particularly towards the northern end of the route
- The gap through the mountain area at Farbreiga
- Areas underlain by karstified limestone over the southern half of the route
- Areas of shallow hard rock (which have yet to be fully defined).

Mitigation measures, either already instituted or set in train, include:

- Reducing the length of crossing of these area and their associated construction difficulties to a minimum (as part of route selection)
- Identifying the length of crossing and designating these areas as Special Locations for construction
- Establishing a protocol for preparing method statements, which will provide the basis for construction procedures on site.

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