Corrib
natural gas

16. 207212

Corrib Gas Field Development

Response to Request for Further Information Reg. Ref: P03/3343

Prepared in respect of the proposed Bellanaboy Bridge Gas Terminal and associated Srahmore Peat Deposition Site.

Prepared on behalf of
Shell E&P Ireland Limited
Corrib House
52 Lower Leeson Street
Dublin 2

by

RSKENSR Environment Limited
Spring Lodge,
172 Chester Road, Helsby,
Cheshire, WA6 OAR, UK

TES Consulting Engineers
Unit 4B/5,
Blanchardstown Corporate Park
Dublin 15

and

Tom Phillips + Associates
8-11 Lower Baggot Street
Dublin 2

March 2004

TPA
TOM PHILLIPS + ASSOCIATES
TOWN PLANNING CONSULTANTS

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Principal Administrative Officer
Planning Section
Mayo County Council
Áras An Chontae
Castlebar
County Mayo

Thursday, 11 March 2004
By Hand

Dear Sir/Madam

Re: Response to Further Information Request on a Planning Application by Shell E&P Ireland Limited for the Development of a Gas Terminal at Bellagelly South, Bellanaboy Bridge, Co. Mayo, and associated peat deposition site at Srahmore and Attavally, Bangor-Erris, Co. Mayo

Mayo County Council Register Reference: P03/3343

This submission is in response to the *Request for Further Information* (RFI) issued by the Planning Authority, dated 17th February 2004 in respect of the above development. Each of the 28 items detailed in the RFI are addressed in the attached documents. The attached documents consist of two folders; one folder contains the response to Volume 4, Item 1 of the request, (a detailed Traffic Management Plan); the other folder contains the applicant's responses to the remaining 27 items.

We have enclosed 10 copies of the response to the further information request. As agreed with the planning authority, a further 35 copies will be provided to you by Friday, 12 March 2004.

We have taken note of the Planning Authority's request, in accordance with article 35(1)(C) of the *Planning and Development Regulations, 2001*, to advertise that significant additional information is being submitted. In this regard, a notice to this effect will be advertised in the Irish Independent on Friday, 12 March 2004.

I trust that enclosed documents are in order and look forward to an acknowledgement from you at your earliest convenience, and subsequently, to an early and favourable response. Should the Planning Authority have any queries in respect of the application documentation, I would be pleased if the Authority would revert to me.

Yours faithfully

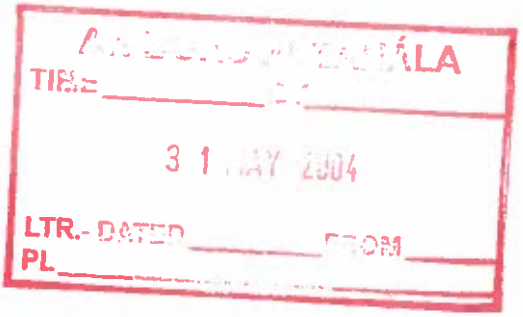
Tom R. Phillips
Managing Director
Tom Phillips and Associates

Encl.

1. A fully detailed traffic management plan.

A detailed Transport Management Plan is provided in a separate folder. It addresses local traffic flows relating to the following elements:

- Upgrading the local roads;
- Construction of the Srahmore peat deposition site
- Construction of the gas terminal, including enabling works and peat haulage;
- Construction of the gas import pipeline;
- Construction of the Mayo to Galway pipeline.



2. *Written confirmation from the relevant regulatory authority that the design of the proposed gas pipelines from the terminal compound to the site boundary is suitable to ensure the structural stability of the pipelines constructed in deep peat soil.*

There are two gas pipelines which run from the terminal compound to the site boundary. These are the import pipeline which runs from the landfall site at Dooncarton to the inlet gas pig receiver in the Terminal and the export pipeline which runs from the sales gas pig launcher in the Terminal to the Bord Gais Eireann (BGE) network at Craughwell.

The import pipeline is to be constructed in accordance with the consent obtained by Shell on 15th April 2002 from the Department of the Marine and Natural Resources pursuant to section 40 of the Gas Act, 1976. A copy of this consent is provided. This consent is subject to technical and environmental conditions with which Shell is obliged to comply.

The export pipeline is to be constructed, owned and operated by BGE. This pipeline is to be constructed in accordance with the consent obtained by BGE on 4th March 2002 from the Department of Public Enterprise pursuant to section 8(7) of the Gas Act, 1976. A copy of this consent is provided.

Both of these consents are based on detailed licence applications that included the design details of the pipelines. In this regard, the consents themselves (as attached) provide the written confirmation requested under this item.

Department of the Marine and Natural Resources

Roinn na Mara agus Acmhainní Nádúrtha

Our Ref: A05/05

15 April 2002

Mr. Brian O'Cathain,
Managing Director,
Enterprise Energy Ireland Limited,
Corrib House,
52 Lower Leeson Street,
Dublin 2.

Re: Corrib Gas Field
Consent to construct a pipeline

Dear Mr. O'Cathain,

I am pleased to inform you that I have today 15th April 2002 approved your application for consent to construct a pipeline in connection with the Corrib Gas Field development under Section 40 of the Gas Act 1976, as amended.

This consent is subject to the following conditions:

Technical

1. Prior to installation operations, the Minister's consent to install and commission is obtained in accordance with the requirements of Part 7 of the Rules and Procedures Manual for Offshore Petroleum Production Operations.

2. The pipeline route is to be fixed near inhabited buildings to ensure that a minimum proximity distance of 70 metres is achieved.

3. The Onshore Pipeline Quantified Risk Assessment is to include an assessment of the effect of leaks from valves and small bore pipework at the beach valve station, and justification for the use of a 0.72 design factor at road crossings.

Leeson Lane, Dublin 2. Tel: [illegible] e-mail: [illegible]
Lána Cliff Mhachaire, [illegible]
Baile Átha Cliath 2. [illegible]

and will be subject to review and acceptance by PAD prior to pipeline installation.

4. The line inspection and maintenance procedures will be subject to review and acceptance by PAD prior to commissioning.

5. To ensure that hooking of trawl boards does not occur, the maximum allowable span height for the offshore section of the export pipeline is 0.57 metres. Where a line inspection shows a span height exceeding the maximum allowable, appropriate rectifying action will be taken within 8 months.

6. To ensure that liquid slugs can be safely accommodated in the onshore piping, additional transient analysis is to be undertaken and will be subject to review and acceptance by PAD prior to pipeline installation.

7. The pipeline section from KP 0 to KP 3 will be visually inspected during the first few days of operation, when it is operating at its maximum temperature, to ensure that any pipeline lateral movement as a result of buckling has not left the pipelne exposed with excessive spans.

8. The proposed measures for mitigating upheaval buckling of the flexible in-field flowlines should be subject to review and approval by PAD. The proposals are to be submitted at least 6 months prior to installation of the lines.

9. In order to minimise the potential for damage to the untrenched umbilical from trawl gear, the length of time between umbilical laying and trenching will be as short as possible and monitoring vessels will be used during the intervening period to warn all fishing vessels approaching the area.

10. The Pipeline Integrity Philosophy document, the hydrotest/pre-commissioning procedures and the Terminal Quantified Risk Assessment will be subject to review and acceptance by PAD prior to commissioning.

Environmental Conditions

11. Prior to the commencement of works an Environmental Management Plan (EMP), shall be drawn up for the approval of the

Minister (subject to such modifications, if any, as he may deem appropriate).

The proposed development has the potential to impact adversely on the environment in a number of ways. While it is accepted that the best standards will be applied by EEI, there is also the possibility of equipment failure, human error, etc. Accordingly the Minister requires that an Environmental Management Plan be drawn up by the developer for his approval, to provide detailed construction methodology and to further consider all potential and predicted impacts and how they shall be managed, the mitigation and control measures and how they will be implemented as well as monitoring proposed. The EMP shall also give details of the targets for emissions, the measures to be undertaken to ensure that the targets are met in light of construction and operational requirements. The Plan should address, separately, both the construction aspects and the operational aspects and should, as a minimum, include:

i. Traffic management – both onshore and offshore;
ii. Noise control procedures;
iii. Dust control procedures;
iv. Land/landfall restoration plan;
v. Waste management plan;
vi. Oil spill control plan; and
vii. Environmental emergency procedures and contingency plans.

Other issues identified in other recommendations below and in the main body of the MLVC report should also be included in the EMP and submitted to the Minister for his approval.

11. Prior to construction commencing, the developer shall provide to the satisfaction of the Minister details of Monitoring Programmes to be undertaken. The proposed monitoring plans shall be submitted prior to the commencement of each specific phase of construction.

Detailed monitoring programmes shall be submitted for the approval of the Minister in respect of the following activities:

i. operations at the wellhead;
ii. impact of the pipeline on seabed conditions and
iii. benthos along the pipeline route;

iv. impact of the pipeline on the route of the pipeline onshore, including landfall;

v. impact of the discharge from the outfall pipe on water chemistry sediments and biota.

13 The Minister in consultation with Mayo County Council will establish an Environmental Monitoring Group to ensure, inter alia active adherence to the agreed Environmental Management Plan (EMP) and overview of subsequent monitoring protocols including the power to make and agree changes to EMP and in respect of other ongoing environmental issues.

The expenses of the Group, including all reasonable travel and subsistence costs incurred by members, shall be met by the developer.

14 The outfall point of the discharge pipeline shall be located outside the cSAC, not closer than 12 kilometres from the landfall site.

A benthic survey of the area at the discharge location shall be carried out by the developer, in agreement with the Marine Institute, prior to the commencement of discharges.

15 The pipeline shall be trenched along its entire length, where the geology allows, unless the developer submits evidence to the satisfaction of the Minister, that demersal trawling can safely proceed over unburied sections of the pipeline without risk to fishing vessels or fishing gear.

16 The methodology of pipelaying within Broadhaven Bay, at the landfall and between the landfall and the Terminal shall be agreed with the Department before commencement of construction. The methodology shall be developed in full consultation with Duchas to ensure that it meets its requirements for the protection of habitats and species.

The methodologies to be used may have impacts on certain protected species and it is imperative from a conservation point of view that methods and timing be such as to prevent adverse impacts on such species. Similarly there are protected species and important fisheries on the onshore pipeline route (including river crossings). It is essential that timing and methodologies be such as to prevent unacceptable damage to these species or their habitats.

Works or measures which would significantly adversely impact upon protected species should be avoided.

17 Construction in the nearshore, the landfall and subsequent terrestrial routes for the pipeline to the Terminal shall consider particular periods of sensitivity of birds, fish and wild mammals.

The developer shall prepare a detailed construction constraints schedule demonstrating compliance with the ecological sensitivities. This will include details of the timing of construction works and protection measures for each of the protected species concerned. The construction methodology and timing shall be agreed with Dúchas and included as part of the Environmental Management Plan.

The status of protected species at all construction sites shall be ascertained by survey. In the event that any such species are found, the developer must notify Dúchas and agree to comply with the requirements of that body under relevant legislation including EU Birds and Habitats Directives and national legislation.

Any nests located on site prior to the construction period shall be marked and workers shall be informed of the presence of nesting species so that these birds are not disturbed.

The timing and methodology of any additional survey work to be carried out must be with the prior approval of Dúchas. During the construction of the pipeline and Terminal, the developer shall maintain contact with the Development Applications Unit of Dúchas and must comply with all requirements of Dúchas made in the exercise of its statutory functions in relation to activities along the route of the pipeline or otherwise in connection with this project.

18. The Erris Inshore Fishermen's Association and the Killybegs Fishermen's Organisation shall be informed of all developments and the Fisheries Liaison Officer posts shall be maintained for the duration of works between the wellhead and the landfall.

19 The developer shall undertake additional traffic studies and submit a Traffic Management Plan for approval by Mayo County Council for the management of construction traffic associated with pipeline and landfall construction activities. This plan shall also address emergency access for emergency response vehicles.

The developer shall submit, for the information of the Minister, a copy of the Traffic Management Plan as approved by Mayo County Council together with evidence of the acceptance of the plan by Mayo County Council.

Construction traffic management shall be such as to avoid peak hours and particularly those hours when children will be likely to be going to or from school.

20. Immediately prior to and during construction, monitoring of suspended sediment loads in local surface water bodies be provided in respect of each work area, and in particular Sruwaddacon Bay.

21. A monitoring programme for juvenile salmonid densities in the water courses adjoining the Terminal site shall be produced and agreed with the North Western Regional Fisheries Board and the Marine Institute and that the programme should utilise the monitoring stations used in previous surveys.

Monitoring (electro-fishing surveys) shall be carried out in salmonid fisheries sites through, and for a period of 2 years following construction in order that the success of mitigation measures be assessed and reported on to the Minister.

Construction works involving crossings of watercourses shall be carried out only during the timeframe to be agreed with Duchas so as to reduce potential impacts on salmonid migrations.

Visual monitoring of redd abundance shall be carried out as part of the ongoing monitoring programme on the salmonoid spawning success and distribution within the catchment.

22. Particular regard shall be had for the impacts of noise on properties within 100 metres of the working area and, prior to work commencing, details of the expected impacts shall be provided to the Minister and to residents affected and such details shall indicate, for the information of the residents, comparative information to assist in assessing the impact of the noise. Meteorological considerations shall be taken into account and presented as part of the report.

Duration, likely frequency and noise associated with flaring of both the HP and LP flares should be kept to a minimum in accordance with best industry practice.

23. Information on the location of wells along the pipeline route and in the area of the Terminal should be provided, together with a statement outlining the impacts that may be expected on each and mitigation measures should be proposed.

24. The developer shall be required to keep all construction sites and subsequent operational sites neat and tidy at all times.

I will be grateful if you would acknowledge and indicate your acceptance of the above conditions.

I look forward to the Corrib Gas Field making its contribution to the national energy supply and I would like to wish Enterprise Energy Ireland Limited and your Co-Ventures, well in its production operations.

Yours sincerely,

Frank Fahey, T.D.,

Minister for the Marine and Natural Resources.

C.C. R.G. Walsh

An Roinn Fiontar Poiblí,
14 Sráid Chill Dara,
Baile Átha Cliath 2.

Department of Public Enterprise,
44 Kildare Street,
Dublin 2.

Attn: G. Breen
T. Considine

Copies: MJS
BM

4th March, 2002

Mr. B.J. Barry
Secretary
Bord Gais Eireann
P.O. Box 51
Gasworks Road
Cork

05 MAR 2002
SECRETARY'S OFFICE
D.C.E.

Re: Section 32 Acquisition Orders in respect of the Natural Gas Transmission Pipeline from Mayo to Galway.

Acquisition Orders nos: MG.04,MG.05,MG.10,MG.10A,MG.13,MG.21,MG 22, MG.23, MG.26A, MG.29A,MG.33,MG.38,MG.138A,MG.139,MG.142,MG.144,MG.146,MG.147,MG.166,MG.179,MG.179B,MG.181A,MG.184, MG.198, MG.213, MG.214, MG.217,MG.227,MG.227B,MG.228, MG.233,MG.234A,MG.235,MG.235A,MG.242B,MG.243,MG.244,MG.272,MG.275,MG.280,MG.281A,MG.281B,MG.281C,MG.284,MG.298,MG.304,MG.305,MG.310,MG.313,MG.314,MG.321,MG.339,MG.343,MG.343A,MG.343B,MG.347,MG.350A,MG.363,MG.388A,MG.412,MG.476,MG.477,MG.479,MG.489,MG.494,MG.522A,MG.542,MG.544,MG.545,MG.547B,MG.548,MG.551,MG.552,MG.555,MG.557,MG.573A,MG.579,MG.582,MG.587A,MG.593,MG.599,MG.602,MG.615,MG.616,MG.617,MG.624,MG.626,MG.627,MG.634,MG.AGI.02,MG.AGI.03,MG.AGI.04,MG.AGI.05,MG.AGI.06,MG.148A,MG.288A

Dear Mr. Barry,

Pursuant to Section 32 of the Gas Act, 1976, as amended, the Minister of State made the necessary Orders (listed above) on 28th February,2002.. Certified true copies of the Orders will issue under separate cover.

Pursuant to the provisions of Article 9 of the Gas Act, 1976, as amended, I am also to convey confirmation of the deviation limits as shown and separately distinguished and delineated and coloured green on the plans.

Yours sincerely,

Peter O'Neill
Gas (Regulatory) Division

ARUP Cork
Job No: Cork, IC
File: (B) C
Proc Man: EL Init: EL Date: 6 MARCH 2002.
Date: 06 MAR 2002 BM

To	Init.	Date	To:	Init.	Date
EL					

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Telephone: (01) 670 7444 Lo-Call 1890 443311 Direct Dial: (01) 604_____ Fax: (01) 670 9633 http://www.dpe.ie

c.c. R.G. Walsh

An Roinn Fiontar Poiblí,
44 Sráid Chill Dara,
Baile Átha Cliath 2.

Department of Public Enterprise,
44 Kildare Street,
Dublin 2.

Attn: G. Breen ✓
T. Considine

Copies: TJS
BM

4th March, 2002

Mr. B.J. Barry,
Bord Gáis Éireann,
P.O. Box 51,
Gasworks Road,
Cork.

Re: Gas Act, 1976, Section 8(7) consent for the natural gas pipeline from Mayo to Galway

Dear Mr. Barry,

I am directed by Mr. Joe Jacob, T.D., Minister of State at the Department of Public Enterprise to refer to your letter of 20th March 2001 concerning the proposed construction of a natural gas transmission pipeline by Bord Gáis Éireann from Mayo to Galway.

In line with Section 8(7) of the Gas Act, 1976, as amended, I am to convey the consent of the Minister of State to the construction of the pipeline. The consent is given with the concurrence of the Minister for Finance. The Minister for Arts, Heritage, Gaeltacht and the Islands (Dúchas) has been consulted. Dúchas has no objections to the proposal subject to the conditions as outlined in their letter of 21st December, 2001 (copy attached).

The Minister for the Environment and Local Government was also consulted. That Department stipulates that Bord Gáis Éireann consult and agree with the relevant local authorities in relation to the depth at which the pipeline will cross proposed and existing roads, watermains or other services and the specifications or reinstatements.

Additional conditions of consent include:-

- Bord Gáis Éireann shall ensure that all of the mitigation measures identified in the document entitled "Mayo –Galway Gas Pipeline _ List of Mitigation Measures " (Copy Attached) submitted by BGÉ, on the instructions of the Inspectors, shall be complied with.
- That the pipeline be constructed in accordance with the plans, specifications and other documents furnished to the Minister as part of the application for this consent.
- The construction of the pipeline shall be in accordance with:

Telephone: (01) 670 7444 Lo-Call 1890 443311 Direct Dial: (01) 604_____ Fax: (01) 670 9633 http://www.dpe.ie

- Council Directive 85/337/EEC as implemented by the European Communities (Environmental Impact Assessment) Regulations (S.I. 349 of 1989)

- Council Directive 97/11/EC on the assessment of the effects of certain public and private projects on the environment (S.I. 51 of 1990)

- Council Directive 85/337/EEC as implemented by the European Communities (Environmental Impact Assessment) (Amendment) Regulations, 1994 (S.I. 84 of 1994)

- Council Directive 85/337/EEC as implemented by the European Communities (Environmental Impact Assessment) (Amendment) Regulations, 1996 (S.I. 101 of 1996)

- The European Communities (Environmental Assessment) (Amendment) Regulations, 1998 (S.I. 351 of 1998), and

- Council Directive 97/11/EC as implemented by the European Communities (Environmental Impact Assessment) (Amendment) Regulations, 1999 (S.I. No. 93 of 1999).

- That the necessary planning permissions shall be in place prior to construction.

This consent is to construct but not to operate the pipeline. On completion of the certification of fitness process separate conditions relating to the operation of the pipeline will be issued.

Yours sincerely,

Peter O'Neill
Principal
Gas (Regulatory) Division

An Roinn Ealaíon, Oidhreachta, Gaeltachta agus Oileán
Department of Arts, Heritage, Gaeltacht and the Islands

Dúchas
The Heritage Service

Rannóg na nIarratas Forbartha
Development Applications Section

7 Plás Ely, Baile Átha Cliath 2, Éire
7 Ely Place, Dublin 2, Ireland

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Web www.heritageireland.ie

Our Ref: DAS-G2001/ 329

21st December 2001.

Secretary General,
Department of Public Enterprise.
44 Kildare Street,
Dublin 2.

FAO: Ms. Orla Ryan.

Re: Mayo to Galway Pipeline

I refer to the above project and previous correspondence, in particular this Department's letter of 6th November, Brendan Mangan's (Bord Gáis) letter of 7th December to the Department of Public Enterprise, and Rose M. Cleary's (Project Archaeologist employed by Bord Gáis) letter of 5th December to this Department, in respect of the protection and conservation of the natural and archaeological heritage along the proposed pipeline. The proposed development has been evaluated from an archaeological and ecological perspective and outlined below are our comments:

1. Archaeological Heritage.

This Department outlined our position in relation to the archaeological heritage (including terrestrial and underwater archaeology and the ongoing monitoring of the project) in our letter of 6th November. We are satisfied that, on the basis of the measures outlined in the letter issued by Rose M. Cleary (Project Archaeologist employed by Bord Gáis) on 5th December (copy attached) being fulfilled, our concerns in this regard will be addressed.

2. Natural Heritage.

In our letter of 6th November we outlined our position in relation to the natural heritage (including a number of specific concerns). We are satisfied that on the basis of the measures outlined in the letter issued by Brendan Mangan (Project Co-Ordinator, Bord Gáis) on 7th December (copy attached) being fulfilled, our concerns in this regard will be addressed.

On the basis of the above, with particular regard to the ongoing liaison with and the future agreement of this Department where appropriate, we have no further objections to the proposed development proceeding.

Is mise le meas,

Patrick Gilhooley,
Development Applications Section.

December 5th, 2001

FAO: Edward Bourke

Dúchas

Department Arts, Culture, Gaeltacht and the Islands,

Dun Scéine,

Harcourt Lane,

Off Harcourt St.,

Dublin 2

Re: Mayo-Galway Gas Pipeline

Dear Ed,

Further to a letter issued by your department on November 6th, inst. I wish to respond on behalf of Bord Gais Eireann to a number of issues the issues raised in the correspondence (Dúchas letter of 6/10/01 to Department of Public Enterprise).

Built Heritage – Archaeological - Terrestrial

1. The pipeline route has been examined in the field by a number of highly qualified archaeologists and the assessment included consultation with Dúchas archaeological staff, a review of all available cartographic and documentary sources including topographic in the National Museum and Dúchas archives. The pipeline route was chosen so that all known archaeological sites were avoided by a minimum of 30m. Bord Gais Eireann has also agreed to finance a programme of paleoenvironmental analyses and archaeological probing in bog land areas.
2. Archaeological monitoring will be undertaken in all areas where ground disturbance is scheduled to take place, including topsoil stripping, trenching and wayleaves.

3. Wetland archaeology: The archaeological consultant and contractor on this project, Margaret Gowen and Co. Ltd. has available specialists in the wetland archaeology field and has previous experience on large scale developments on wetland archaeological sites.
4. Underwater archaeology: Bord Gais Eireann has commissioned a baseline study on the potential underwater archaeological component of the project (M. Gowen and Co. Ltd., November 2001). Twenty three major river crossings have been identified as requiring further underwater investigation by means of a metal detector and diver survey. Nine river crossings will require a wading and metal detector survey. These surveys have been commissioned on our behalf by M. Gowen and Co. Ltd. and based on the results and in consultation with Dúchas archaeological staff, any mitigation strategies required for the protection of the archaeological heritage will be put in place.
5. Test trenching and excavation of sites identified during the construction monitoring phase: Bord Gais Eireann has agreed to finance the resolution of any archaeological sites discovered during the construction stage of the pipeline.
6. Temporary construction facilities: These areas have been inspected in the field by Margaret Gowen and Co. Ltd. No above ground archaeological remains were discovered. All ground works necessary for the construction of storage areas will be monitored by an archaeologist from M. Gowen and Co. Ltd.
7. Hard standing areas: These sites will be treated in a similar fashion to the temporary storage facilities and ground disturbance will be archaeologically monitored by Margaret Gowen and Co. Ltd.
8. Boundaries / Townland boundaries: Archaeological staff from Margaret Gowen and Co. Ltd. will record these during the construction phase of the pipeline.
9. Drainage channels: These will also be archaeologically monitored during the construction phase of the pipeline.
10. Archaeological sites discovered during pipeline construction: The treatment of all archaeological sites discovered during the construction phase will be subject to recommendations from Dúchas archaeological staff. Any necessary mitigation strategies to resolve the sites including archaeological excavation and preservation *in situ* will be put in place.

11. Provision for the discovery of archaeological sites during the construction stage: Bord Gais Eireann will allow for adequate time for the resolution of newly discovered sites. M. Gowen and Co. Ltd. are currently preparing a cost proposal and contingency funding for major discoveries will be part of these estimates.
12. Reroutes: All reroutes will be archaeologically assessed in advance of development and the results will be forwarded to your department.

Underwater Archaeology

In order to address the underwater archaeology component of the project, M. Gowen and Co. Ltd. have prepared a baseline assessment study of all river and stream crossings. The following schedule is in response to individual issues raised in your department's letter of November 6th, 2001.

1. Desktop study of all archaeological sites and finds associated with the river and streams: This has been carried out and the results submitted to your department. The drainage works records on various streams and rivers are included in the report.
2. Archaeological surveys: Bord Gais Eireann agrees to finance all necessary surveys of river and stream crossings. The surveys are to include wading and metal detector surveys of smaller watercourses and diver surveys and metal surveys of larger rivers. All surveys with metal detectors will be licensed by Dúchas.
3. Assessment of temporary construction works: The surveys on water courses will include assessments of construction works and the potential impact on underwater archaeological and riverbank/terrestrial sites. In consultation with Dúchas and required mitigation strategies will be put in place to protect the archaeological heritage.
4. Changes in hydrology of rivers and streams: If archaeological material is detected in the underwater archaeological surveys, this will be addressed prior to the construction phase and any recommendations by Dúchas archaeological staff will be integrated in the works schedule.

5. Resolution of impact of pipeline on underwater archaeology: The results of any studies/assessments of the underwater component of the project will include mitigation strategies for the resolution of archaeological sites. These mitigation strategies will be discussed with Dúchas archaeological staff and any further recommendations will be incorporated into the works schedule.
6. Methods statement on underwater archaeology:
   (a) A list of stream and river crossings on the development corridor has been submitted to your department by M. Gowen and Co. Ltd.
   (b) The above report includes a desktop assessment of the archaeological potential of the stream and river crossings.
   (c) The underwater and metal detector surveys have been commissioned on behalf of Bord Gais Eireann by M. Gowen and Co. Ltd.
   (d) Appropriate licences will be applied for in order that the above surveys are carried out.
7. Strategy for underwater archaeology: The strategy for underwater archaeology is dependent on the appropriate surveys and the results of same. Any necessary mitigation measures to preserve/protect/preserve by record of newly discovered archaeological sites will be discussed with Dúchas archaeological staff and by agreement all necessary strategies will be put in place.

Finally, Bord Gáis Éireann now request that Dúchas indicate to the DPE that they are satisfied with BG E's proposals in relation to the archaeological matters referred to in Dúchas' letter of the 6/10/01.

Yours Sincerely

Rose M. Cleary
Project archaeologist BGE

7 December, 2001

Ms Orla Ryan,
Gas (Regulatory) Division,
Department of Public Enterprise,
44 Kildare St.,
Dublin 2.

Re: Mayo to Galway Natural Gas Pipeline – EIS,
Letter from the Department of the Arts, Heritage, Gaeltacht and the Isla.

Dear Ms Ryan,

We refer to your letter dated 6th November 2001, which enclosed a letter dated 6th November 2001 from Mr Neil McDonough of the Department of the Arts, Heritage, Gaeltacht and the Islands. We would comment on the Nature Conservation issues raised in Mr. McDonough's letter as follows:

The heading numbers are those in Mr McDonough's letter.

1. Nature Conservation

1.1.1 General Concerns

1.11 A Consultant Ecologist will be employed by Bord Gais and a liaison mechanism agreed whereby the Consultant Ecologist will work closely with Dúchas throughout the construction phase. Method statements for the construction of the pipeline in sensitive areas will be submitted to, and agreed with, Duchas.

1.12 Bord Gáis will seek approval for the source and disposal of water for hydraulic testing. Dúchas, the Local Authorities and the Regional Fisheries Board will be consulted in this respect.

1.13 The removal of hedgerows will be kept to a minimum. The species composition of hedgerows will be recorded and the hedge-rows will be fully reinstated following completion of the pipeline. Unfortunately, it will not be possible to avoid hedgerow removal in the period March 1 to August 31 as this is the weather-window period during which this type of construction activity takes place. See attached Dúchas letter in respect of the proposed Gas Pipeline to the West, which is also due for construction during the summer of 2002.

1.14 Disposal of spoil will not take place in Natural Heritage Areas, Special Areas of Conservation or Special Protection Areas.

1.15 The mechanism for on-going liaison with Dúchas local staff should ensure that Bord Gáis is kept fully up to date with ongoing site designations on to the pipeline route. In areas of

woodland, every effort has been made to route the pipeline through existing gaps. The contractor will be required to minimise the construction width in areas of woodland and hazel scrub and to treat sensitively other areas of local importance.

1.16 Bord Gáis Éireann is very conscious of the need for extreme care during the construction of the pipeline across or in close proximity to SACs and NHAs, such as at Glencullin Upper and the Eskeragh fen. As indicated in section 1.11, method statements will be submitted to, and agreed with, Dúchas prior to construction.

1.17 A monitoring scheme for six such areas has been discussed with Dúchas Research Section and the initial field work, to set up the agreed monitoring baselines, has already been carried out. The report on the field work will be submitted to Dúchas shortly.

1.18 The construction of the pipeline across the listed rivers has been discussed with the Regional Fisheries Boards. Again, methods statements for the construction of the pipeline across the rivers and their main tributary streams will be submitted to, and agreed with, Dúchas. The contractor will be required to carry out works in the rivers in the time period suggested by the Fisheries Boards, typically May to August or September, in order to minimise any adverse impact.

Specific Concerns

1.21 The method statements for the construction of river and stream crossings, referred to above, will include a description of the proposals to control silt and to prevent contaminants entering the rivers or streams.

1.22 The requirement for approval of the construction method statements should minimise the impact of pipeline construction on the river habitats.

1.23 Prior to construction, a survey will be undertaken along the pipeline route to search for habitats and breeding places of Horseshoe bats. If any such places are found, Bord Gáis Éireann will consult Dúchas about appropriate mitigation measures.

1.24 A method statement for construction of the pipeline in the vicinity of Carrowkool Turlough will be agreed with Dúchas.

1.25 See 1.16 above.
Bord Gáis Éireann assures Dúchas that the measures specified for the other rivers will also apply in the case of the Ballymunnelly River.

The archaeological matters, referred to in Mr. McDonough's letter, have bee addressed in the letter dated 5/12/01 from Ms. Rose Cleary, Bord Gais Project Archaeologist to Mr. Ed Bourke of Dúchas.

If you have any queries in relation to the above please contact me.

Yours sincerely.

Brendan Mangan.

Cc Mr. Neil McDonough, DAHGI
Mr. Ed Bourke, DAHGI

BORD GÁIS TRANSMISSION

MAYO - GALWAY GAS PIPELINE

LIST OF MITIGATION MEASURES

BORD GÁIS
TRANSMISSION BUSINESS UNIT

ARUP

List of Mitigation Measures

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List of Mitigation Measures

1.0 Introduction

The mitigation measures for the pipeline are described below. BGE will be responsible for the implementation of the mitigation measures. The construction management team will supervise the implementation of the construction phase mitigation measures.

It should be noted that the proposed mitigation measures are standard practice in the construction of cross-country gas pipelines. These measures have been refined and proven over many years and are implement as part of normal construction on cross-country, underground pipelines in Ireland and overseas.

2.0 Design Phase

The overall pipeline length, and the length of the pipeline in wet ground, at ecologically or archaeologically sensitive locations, and at road and river crossings, has been minimised.

Where feasible the pipeline route has been adjusted to avoid areas with sensitive ecology and areas with significant archaeological potential. The route has been adjusted to give a buffer of at least 30m to all know archaeological features.

A reroute vetting procedure has been used whereby all reroutes, no matter how minor, have been approved by the design team and the archaeological and ecological consultants.

The above ground installations (AGIs) have been sited to avoid areas of scenic amenity. The sites have been chosen to use existing hedgerows and trees and the topography to provide screening.

The archaeological and ecological consultants have assessed the sites of the AGIs and the construction and storage compounds. None of these are located in areas of archaeological or ecological sensitivity.

The design and routing of the pipeline has had regard to the best industry practice with respect to safety and risk minimisation. The pipeline has been designed to IS 328 Code of Practice for the Design and Installation of Gas Transmission Pipelines. The design stage Project Supervisor (Design) has been appointed and the Health and Safety plan, appropriate to the design stage has been prepared.

3.0 Pre - Construction

General

Landowners, occupiers and residents will be notified by visit, mail drop or advertisements placed in local newspapers prior to the commencement of construction.

Agricultural liaison officers will liaise with landowners and occupiers.

A mechanism for liaison, notification, inspection, approval and incident reporting will be agreed with the Dúchas regional ecological staff and the Regional Fisheries Boards staff.

A mechanism for liaison, approval and incident reporting has been agreed with Dúchas archaeological section. This implements the procedures recommended in the recently agreed Code of Practice between Bord Gáis and the Minister for Arts, Heritage, Gaeltacht and the Islands to protect the archaeological heritage. The Project Archaeologist, as recommended by the Code of Practice, has been appointed. Bord Gáis will follow the recommendations of the Code of Practice for the project.

A mechanism for liaison, notification, inspection, approval and incident reporting will be agreed with County Council staff.

A liaison, notification, inspection, and incident reporting mechanism will be agreed with ESB and the other utilities and service providers.

The sources of water for pressure testing the sections of pipeline will be agreed with the relevant County Council. The locations of discharge points will be agreed with the relevant Regional Fisheries Board and County Council.

Specific Measures

Ecology

The route will be inspected for badger setts, otter holts and bat roosts located on the route, from which it will be necessary to relocate the mammals under licence. The necessary licences will be obtained from Dúchas and the mammals will be relocated.

The limestone areas adjacent to Knockdoe and Caltragh will be checked for bat roosts in caves or crevices.

The precise alignment of the route of the pipeline on the north side of the Glencullin valley, where a series of streams are crossed, will be agreed with the NorthWestern Regional Fisheries Board.

Archaeology

The river and stream crossing points, which require archaeological dive or wading inspections will be agreed with Dúchas, the necessary licences will be obtained and the inspections undertaken.

Archaeological probing of the blanket bog areas on the route alignment will be agreed with Dúchas, the necessary licences will be obtained and the probing undertaken.

Trees and Hedgerows

In the detailed routing and setting out of the pipeline, mature trees will be avoided where feasible.

Where feasible the pipeline will be routed through gaps in hedgerows, sections that are poorly managed or out of character. The hedgerows, which will have to be removed, will be surveyed and the species recorded.

In the detailed routing and setting out of the pipeline, springs and seepage lines will be avoided where feasible.

Monitoring Baselines

Vegetation survey baseline quadrants will be set up at specific locations, identified by Dúchas, to facilitate the monitoring of the effects of construction and the efficacy of the reinstatement.

Standpipes have been installed in boreholes located in the vicinity of the locations at which the vegetation baseline monitoring will be undertaken.

Approval of Method Statements

The contractor's methods statements for the construction of the pipeline in sensitive areas of peat, hazel scrub and karst areas will be reviewed by the design team and revised if necessary. Following approval by the design team, the method statements will be submitted to Dúchas for approval.

The contractor's methods statements for the construction of the river crossings, and the crossings of streams which are tributaries of important rivers, will be reviewed by the design team and revised if necessary. Following approval by the design team, the method statements will be submitted to the relevant Regional Fisheries Board and Dúchas for approval.

Management Plans

The contractor will prepare, and submit to the design team for approval, a Pollution Control Plan, a Spill Management and Contingency Plan, an Environmental Management Plan and a Waste Management Plan.

The environmental management plan will provide details of the liaison/inspection procedures listed above and identify the staff responsible for implementing the procedures and the other environmental mitigation measures. It will set out the details of the environmental information and training to be given to employees. The plan will have audit procedures to monitor its implementation.

The waste management plan will determine the nature, method of recording quantities, quantities, collection, on site storage and disposal of all wastes. Consideration will be given to waste minimisation, segregation of wastes, reuse and recycling. The plan will detail daily inspection of vehicles to ensure there are no leaks. Waste disposal contractors will be audited to ensure they have the appropriate licences. The transport of materials to and along the working width will be planned and rationalised to minimise trips etc. The plan will be audited prior to construction and twice during construction. All site personnel will received training and tool box talks on the waste management plan.

The contractor will prepare a Traffic Management Plan. This will be reviewed by the design team and revised if necessary. When approved by the design team, the traffic management plan will be submitted to the relevant County Council for approval. The construction manager will monitor the implementation of the traffic management plan.

The traffic management plan will identify the roads to be used by construction traffic, the access points onto the working width, the warning signs required etc. Consultation with the County Councils will identify any advance road improvement, strengthening or junction works, which they might required.

Suppliers and hauliers will given information about the traffic management plan and will be required to comply with it. Regular checks will be made to ensure that the hauliers follow the designated routes and that their vehicles are road-worthy and that the exhausts are in good order.

The traffic management plan will provide a method statement and schedule for each road crossing. This will identify road closures and alternative routes. Road reinstatement techniques will be describes in the plan.

The traffic management plan will also describe access, signage and parking arrangements for the construction compounds. It will identify approved routes between the access points to the working width and the construction compounds and pipe storage compounds.

Noise Emission Information

The contractor will submit information on the noise levels to be generated by his chosen construction methods and equipment, including a detailed method statement for noise control. This will include provision for out of hours working, notification of residents, timing of blasting, location of equipment and acoustic screening.

The construction manager will set noise and vibration limits for blasting operations. These will be based on the Environmental Protection Agency's document Guidance Note for Noise in Relation to Scheduled Activities, 1995.

Safety

BGE will appoint the Project Supervisor (Construction) will be appointed and the Health and Safety plan will be amended, as appropriate, for the construction stage will be prepared.

4.0 Construction

General

Agricultural liaison officers will continue to liaise with landowners and occupiers. The construction timing and access will be agreed with the landowners and occupiers

There will be ongoing liaison with Dúchas, the Regional Fisheries Boards and the County Councils.

The workforce will be briefed on the relevant environmental issues including pollution control. The sensitive ecological areas will be identified and the specific requirements and methods for working in each area will be explained. The areas, which were identified in the contract documents as areas which the contractor must not disturb, and the reasons for these precautions, will be explained.

In the blanket bog areas, there will be very little construction activity from November to March thus avoiding disturbance of over-wintering waterfowl.

Specific

Trees and Hedgerows

Where the pipeline passes through trees or scrub, the working width will be reduced to ensure that the number of trees to be felled is minimised. The reduced working width will not apply to conifer plantations.

All trees to be felled will be clearly identified.

Specialists will be employed to do any trimming or felling of trees, to ensure that there is minimal damage to adjacent trees.

Where the pipeline passes close to trees, which are to be retained, the trees within the working width will be fenced off to prevent damage.

Where construction traffic has to pass over tree roots, the soil around the roots, to the extent of the canopy, will be protected to prevent compaction. The protection will be mats or a layer of subsoil.

Where a tree to be retained is within the topsoil or subsoil storage zones, the tree will be fenced off and topsoil or subsoil will not be stored within the fenced area.

The topsoil will not be stripped from the root zone to the extent of the canopy.

Any length of hedgerow to be removed will be clearly marked. Where hedgerows have to be removed, the working width will be reduced to 10 - 15m.

Where roads bounded by hedgerows are to be crossed using trench-less techniques, the trench-less crossing will be extended under the hedgerows also.

Stone Walls and Rock Outcrops

Existing stone walls will be dismantled and the stones stored for re-use.

In areas where rock outcrops, the boulders will be collected and stored for reuse in the reinstatement.

Field Drainage, Water Supply and Other Services

Landowners will be compensated for crop loss.

Drainage ditches will be flumed to allow the flow to continue.

Temporary drainage will be installed if existing field drains have to be severed. The field drainage will be reinstated following completion of pipe laying. This may involve laying of new drains.

A water supply will be laid on for livestock in agreement with the landowner/occupier, if an existing water supply will be disrupted.

Temporary supplies of any other services will be provided if the existing service will be disrupted.

Fencing and Access

The type of fencing, to be used to enclose the working width, will be agreed with the landowner/occupiers.

Access across the working width will be provided in agreement with the landowner/occupier to avoid severance of fields.

Security gates will be installed across the working width at road crossing points.

Topsoil and Subsoil

Handling soils that have a very high moisture content can lead to loss of soil structure and fertility. Soils will be handled only when conditions are suitable. The construction work, which involves soils handling, will be undertaken between April and October.

Topsoil will be stripped on a field by field basis and stored in a mound on un-stripped land in the working width. Topsoil mounds will be treated with herbicide to control weeds.

Subsoil removed from the trench will be stored in a mound on the opposite side of the working width on un-stripped land. Different sub soils will be stored separately. The soil mounds will be kept free of disturbance.

Excessive water will be removed from the trench prior to backfilling.

Where the trench cuts through different sub soils, the sub soils will be replaced into the trench in sequence, to ensure that layers are compatible.

Any bedrock removed will be replaced with sand or similar material immediately around the pipe.

Where the ground is steeply sloping, if considered necessary, impermeable barriers will be installed at intervals in the trench to prevent the trench acting as a longitudinal drain.

Traffic

Vehicle traffic will be confined to the running track in the working width and to the roads designated in the Traffic Management Plan. Warning signs and direction signs, providing information for deliveries to the working width and the construction compounds, will be erected and maintained.

The running track will be re-graded frequently to ensure a good surface. This will reduce traffic noise and dust. Vehicle speeds will be restricted to minimise dust.

During dry or windy weather the working width will be sprayed with water to minimise dust.

Roads being used by construction traffic will be cleaned regularly to remove mud and dust.

Noise

The contractor will comply with the requirements of BS 5228:1997 Noise Control on Construction and Open Sites. The contractor will comply with the noise and vibration limits imposed for blasting. The construction manager will monitored compliance with the limits.

Construction will take place during the hours 07.00 - 19.00 on weekdays and 07.00 - 16.00 on Saturdays. Work outside these hours will be avoided if possible. If it is necessary to undertake any activities outside these hours the local residents will be consulted.

A limited number of activities may have to continue on a 24 hour basis. These include horizontal directional drilling, which is a relatively noisy operation, and pipe cleaning and hydrostatic testing which are relatively low noise activities. The local residents will be consulted before these activities are carried out.

Local residents will be kept informed of the schedule and duration of any particularly noisy activities such as blasting.

In noise sensitive areas, stricter controls will be applied in the early mornings and at weekends, than will apply during normal working hours.

The contractor will be required to avoid unnecessary noise from the spread, particularly at night.

Prevention of Spread of Livestock Disease

To prevent disease being carried from one farm to the next, BGE and the contractor will take all precautions recommended by the Department of Agriculture, Food and Rural Development.

Stock proof fencing will be erected. The workers will be instructed not to have contact with farm animals, or the buildings which house them, and not to leave machinery near boundary fencing.

Soil from one field will not be transferred for storage into another, and gates will be shut when not in use.

If there is an outbreak of highly infectious animal disease, the Department will be contacted and precautionary measures taken.

The construction manager and the contractor will consult the Department and local farmers to check if animal or plant diseases are present along the route. If any diseases are present precautions will be taken to prevent their spread.

Ecologically Sensitive Area at Glencullin

The construction works will comply with the method statement approved by the Dúchas, and the agreed precautions will be implemented. The works will be closely monitored by the construction management team which will include an ecologist.

Access to the sensitive area, during construction of the section of pipeline through it, will be carefully controlled and kept to a minimum. The area will be 'locked out', that is no access will be allowed, following completion of the section of pipeline.

The work will be undertaken as quickly as is practical. The work will not be undertaken in inclement weather.

The minimum vegetation will be stripped and stored very carefully, upright, and kept watered.

The material excavated from the trench will be stored carefully, and kept watered. The surface of the adjoining ground will be protected with geotextile sheeting prior to placing of the excavated material. The trench will be backfilled will the excavated material. The material will be replaced in the sequence in which it was excavated, that is material excavated last will be replaced first.

The surface of the trench will be slightly domed to allow for future settlement. The turves will be replaced.

Watercourses

The construction works will comply with the method statement approved by the relevant Regional Fisheries Boards, and agreed precautions will be implemented.

If the relevant Regional Fisheries Board has a requirement for fish rescue, this will be undertaken by the Fisheries Board itself or by contractors employed by the Fisheries Board who will supervise the work.

All construction works in watercourses will be undertaken in the months specified by the relevant regional fisheries board.

The in-river and bank works will be undertaken and the river bed reinstated as quickly as is practical.

Where requested by the fisheries board and agreed with the landowner/occupier, styles or gates will be provided in the fencing of the working width at the river banks, to allow anglers to travel along the river bank.

River bed and bank material will be stored separately to facilitate reinstatement.

Other Sensitive Areas

The construction works will comply with the method statement approved by the Dúchas, and the agreed precautions will be implemented. The works will be closely monitored by the construction management team which will include an ecologist.

Pollution Prevention

Silt traps will be used to prevent silt entering watercourses from the working width. Water from trench de-watering will be discharged via silt traps.

Drip trays will be used for pumps and other stationary plant. Refuelling of plant will not be permitted within 30m of a water course. Changing engine oil or routine maintenance on equipment will not be permitted on the working width.

All equipment will be inspected for fuel and oil leaks before being accepted onto the working width. Regular inspections will be carried out to minimise the risk that leaking machinery will contaminate of the soil or water courses.

Fuel and lubricants will be stored in designated areas. Fuel tanks will be in bunds, each bund having a capacity of 110% of the largest tank. Rainwater in the bunds will be collected and disposed of to a licensed waste disposal facility.

Machinery on the working width will be refuelled by bowsers. Refuelling operations will be supervised and drip trays or absorbent pads will be used to prevent fuel spills contaminating the soil. The bowsers will park in a paved area overnight.

The spill management and contingency plan will include for the provision of spill absorbent materials and grab packs to be provided at strategic locations, which will be clearly marked, and to be readily accessible, particularly close to watercourses. The workforce will be trained in the use of the spill absorbent materials.

In the event of a spillage, it will be contained and cleaned up. The contaminated material will be taken off site and disposed off to a licensed waste disposal facility.

All spillages will be reported and recorded.

Drilling mud, used in some of the trenchless methods, will be re-circulated. Drilling mud reservoirs will be monitored for losses. Used drilling mud will be taken off site and disposed off to a licensed waste disposal facility.

Portable toilets will be provided along the working width. These will be emptied regularly by a specialist contractor and disposed off as agreed with the relevant County Council.

To minimise air emissions the contractor will be require to ensure that all plant and equipment is well maintained and correctly adjusted.

Where portable lighting units are used, they will be positioned to minimise glare outside the working width.

The waste management plan will be implemented and audited.

Appropriate containers for waste will be provided on the working width and at the construction compounds. Waste will be collected, stored in the appropriate containers and disposed of by licensed contractors to licensed facilities.

The contractor will keep the working width and construction compounds free of litter and netting will be used as appropriate to ensure debris does not fall from lorries using public roads.

Archaeology

All operations, in which topsoil will be stripped or the ground disturbed during the construction of the pipeline, will be monitored by archaeologists. An archaeologist will advise on the placement of spoil.

Existing field boundaries, particularly townland boundaries will be archaeologically assessed and if necessary recorded prior to removal of sections for the construction of the wayleave.

In the event of the discovery of archaeological features or finds, Dúchas and the National Museum of Ireland will be informed. Where the pipeline disturbs subsurface archaeological deposits, all construction work will be halted in the area until it has been fully archaeologically resolved to the satisfaction of the Dúchas.

All archaeological finds will be fully recorded and removed from site. Each find is required to be appropriately conserved, numbered and accompanied by a finds report before being accepted by the National Museum of Ireland.

All archaeological findings will be made available to the public, and Bord Gáis will fund all archaeological research to a standard which will meet with the approval of the Minister.

Safety

Safety of the workforce, the landowners/occupiers, local residents and the general public will be give top priority by BGE, the construction manager and the contractor. The key safety issues will be covered in the safety induction course, which each construction worker will be required to attend before commencing work on the project, and in frequent tool box talks for the duration of the project. Procedures will be put in place for dealing with all hazards associated with the project.

5.0 Reinstatement

General

Land Reinstatement

Land drains will be re-installed.

The land will be graded to the original profile.

The running track will be ripped to remedy compaction. Surplus sub-soil will be spread in the working width, in agreement with the landowner/occupier. Stones and debris will be removed. The topsoil will be replaced when in a suitable dry condition, in order to prevent compaction, and spread evenly.

The stones will be picked from the topsoil and the land will be reinstated to its original condition in agreement with the landowner/occupier. Pasture will be seeded with an appropriated mix and a selective herbicide will be used if required to control weeds. Arable land will be cultivated to the landowner's requirements and left fallow.

In agreement with the landowner/occupier, fencing will be removed on arable land but left in place on pasture to prevent livestock entering the area until the re-seeded sward has grown.

All construction materials will be removed.

The stone used for temporary roads, temporary fencing, gates etc. will be offered to the landowner/occupier for reused. If not required they will be removed and, if possible, sold for reuse elsewhere. If they cannot be reused the materials will be disposed of to a licensed facility.

Trees and Hedgerows

Felled trees will be replaced with native provenanced species. However, trees will not be planted within 7m of the pipe centre line. All newly planted areas will be protected with herbivore proof fencing. The newly planted areas will be maintained for two years after planting, and any dead stock replaced.

Hedgerows will be replanted, in an appropriate pattern, with the original species mix, using either container or bare root stock. Some additional hawthorn plants may be included to aid rapid establishment. Any damaged hedge plants in the original hedgerow will be pruned or replaced. The newly planted hedgerows will be maintained, the weeds will be controlled and any dead stock replaced for two years after planting. They will be protected by a double fence to prevent damage to the young plants from livestock and rabbits. The fencing will be tied into the existing hedgerow at either end.

Other Field Boundaries

Stone walls will be rebuilt with the original stones, in the style and technique of the existing walls. Earth bank field boundaries will be rebuilt to match the existing. Field boundaries which consist of a combination of earth bank and hedgerow will be reinstated to match the existing.

Fences will be replaced, the type to match the existing, in agreement with the landowner/occupier.

Areas of Exposed Rock

Boulders will be carefully replaced to match the surrounding rocky ground.

Watercourses

All reinstatement measures will be agreed with the relevant Regional Fisheries Board.

The any flume pipes or temporary bridges will be removed and the water courses will be reinstated with the original bed and bank material. If there is insufficient original material, imported material of similar type will be used.

At crossings of spawning or nursery areas the selection of bed material, and its placing, will be done in agreement with Fisheries Board staff. If silt has been deposited on spawning beds during the construction process it will be removed by raking.

Pools and other in-channel features will be reinstated to their original profile and condition.

The banks will be re-formed to the original profile. If required by the relevant Regional Fisheries Board, boulders may be placed to stabilise the banks of some rivers, in order to prevent erosion.

The river corridor vegetation will be reinstated according to the requirements of the relevant Regional Fisheries Board. Newly planted river corridor vegetation will be protected with herbivore fencing, and maintained, in a similar manner to the newly planted trees and hedgerows.

Ecologically Sensitive Area at Glencullin and Other Ecologically Sensitive Areas

Stock proof fencing will be maintained in place for the length of time agreed with Dúchas. The reinstatement will be closely monitored, in co-ordination with the Dúchas field ecologists and any mitigation measures such as weed control and reseeding will be agreed with Dúchas.

AGIs

The boundaries of AGI sites will be planted with a screen of native species, using a mix of species reflecting those present in hedgerows and woodlands in the vicinity of the AGI.

Roads

At road crossings temporary surfacing will be placed immediately on completion of the crossing. After the time period required by the County Council, the permanent surfacing will be laid. The specification of the reinstatement and surfacing will be agreed with the County Council. Mayo County Council requires a two year delay prior to laying the permanent surfacing. Galway Council requires the permanent surfacing to be laid after one year.

6.0 Testing

Waste from pigging operations, typically debris such as mill scale, rust and weld splatter, will be collected and disposed of, off site, to a licensed waste disposal facility.

Water from pressure testing will be tested to ensure it is not contaminated. It will be discharged through filters and using break tanks, at locations agreed with the relevant Regional Fisheries Boards and County Council.

Test operations, which could cause a noise nuisance, will be undertaken only during normal working hours and the contractor will liaise with local residents prior to these operations.

7.0 Post Construction

There will be ongoing liaison by BGE with landowners/occupiers. A post construction survey will be carried out with the landowners/occupiers to confirm that the reinstatement is satisfactory. Any defects will be made good.

Monitoring of the reinstatement in sensitive locations, as described above, will be undertaken in consultation with Duchas.

There will be maintenance of the replanted trees, scrub and hedgerows for two years following completion.

BGE has prepared a plan to respond to an emergency or hazardous situation in any of its pipelines.

The BGE Pipeline Integrity Monitoring System (PIMS), which will be in operation for the pipeline's lifetime, is an electronic system which monitors gas pressure, temperature and flow. The PIMS is designed to detect any changes to these parameters which could indicate a leak or hazardous situation. If a leak is detected, the system will shut the block valves which will isolate the length of pipe with the leak, thus minimising the leak.

The pipeline route is flown regularly by helicopter and the route is walked and inspected on the ground. Any works or disturbance of the ground near the pipeline is investigated. A Pipeline Integrity Gauge is used to inspect the internal condition of the pipeline at frequent intervals.

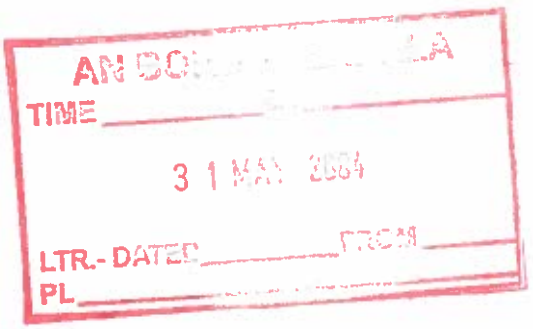
BGE will supervise any excavation work which has to be undertaken close to the pipeline.

3. *Proposals for system of collection and storage of any pumped water containing deleterious substances, including concrete, separate from the surface drainage network and settlement ponds, and to provide for its safe disposal.*

Our understanding is that this request relates primarily to the use of cement binder to improve the load bearing capacity of the peat. This response should therefore be read in conjunction with the report submitted in response to Question 11, which discusses the risks associated with the proposed use of cement for soil stabilisation. The general arrangements for intercepting any contaminated water during excavation are described in Section 9.5.1 of Volume 1 of the EIS. However, in the event that there are residual concerns relating to the general management of 'deleterious substances' we wish to point out that, in addition to the very comprehensive site drainage management plans described in sections 2, 3 and 9 of volume 1 of the EIS, mobile tankers with pumps will be provided on site. These will be located wherever 'at risk' operations are being carried out close to drains or other open water features in order to capture any accidental releases of both solids and liquids immediately. The tankers will then take the effluent to a licensed facility offsite for treatment.

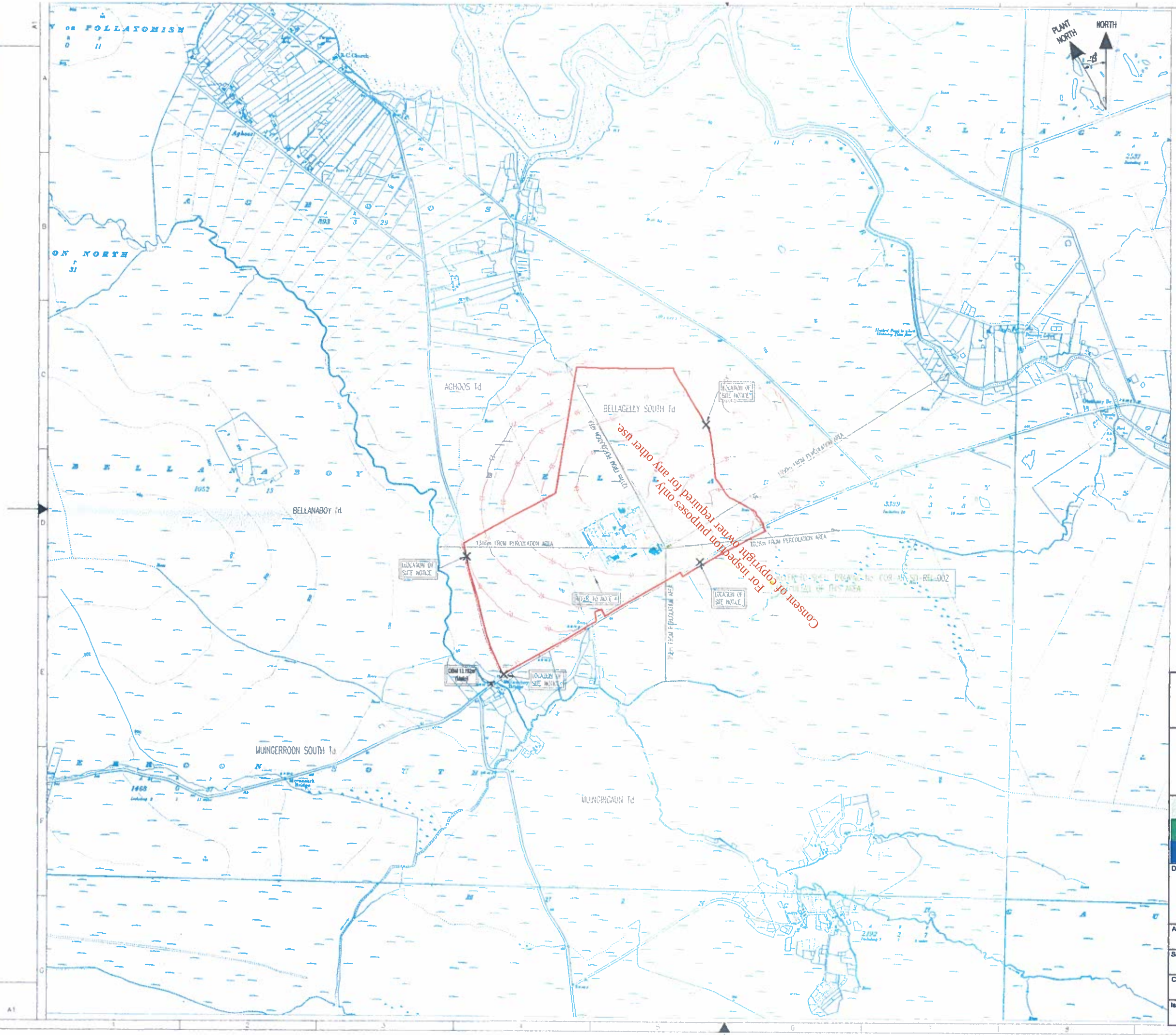
The flow of water in the site ditches will be impeded by localised temporary drain blocking where required at the stabilisation works. Once drains are blocked, any fugitive cement particles will adhere to the bottom of the ditch and will be immobilised. Consideration has been given to the use of a perimeter ditch to intercept potentially contaminated water, but stabilisation will only take place within a small area at any one time, therefore rendering localised containment generally more effective.

The quality of water in the ditches will be monitored. As discussed in Section 3 of Volume 1 of the EIS, any accidental spills of diesel or other liquids will be contained and removed and thus will not enter the surface water drains. If part of a spill were to escape, the fluids would become mixed with the surface water and would flow to the silt ponds where the contaminated water could be retained. This water would then be either pumped back for treatment on site or pumped out into a tanker for delivery to an appropriate treatment plant.



4. *A map showing the location of the septic tank, the puraflo unit and the percolation area, in relation to the Bellanaboy River, the Leanamore Stream and any tributary of the Glenamoy River.*

Map COR-AR-SD-RFI-001, attached, shows the location of the septic tank, the Puraflo unit and the percolation area in relation to the Bellanaboy River, the Leanamore stream, the Glenamoy River and its tributary stream. Due to the scale of map required to show these rivers and streams and the terminal site, it is not possible to show detail of the layout of the septic tank, the Puraflo unit and the percolation area on this map. Detail of the layout of the septic tank, the Puraflo unit and the percolation area is shown on map COR-AR-SD-RFI-002.



NOTES.

1. SITE LOCATION MAP EXTRACTED FROM 6 INCH (1:10,560) ORDNANCE SURVEY MAPPING REFERENCE Nos. s M0011, M0012, M0018 & M0019.
2. REPRODUCED FROM THE ORDNANCE SURVEY BY PERMISSION OF THE GOVERNMENT. LICENCE No. EN 0002803.
3. REFER TO TES DRAWINGS FOR SRAHMORE SITE LOCATION MAP.
4. THE ORIGIN OF THE TERMINAL CO-ORDINATE SYSTEM IS LOCATED AT E 86325.475, N 332799.578 WITH REFERENCE TO THE IRISH NATIONAL GRID SYSTEM. THE TERMINAL CO-ORDINATE SYSTEM IS ROTATED 29° ANTI-CLOCKWISE FROM GEOGRAPHICAL NORTH.

Corrib Field Development

Bellanaboy Bridge Gas Terminal

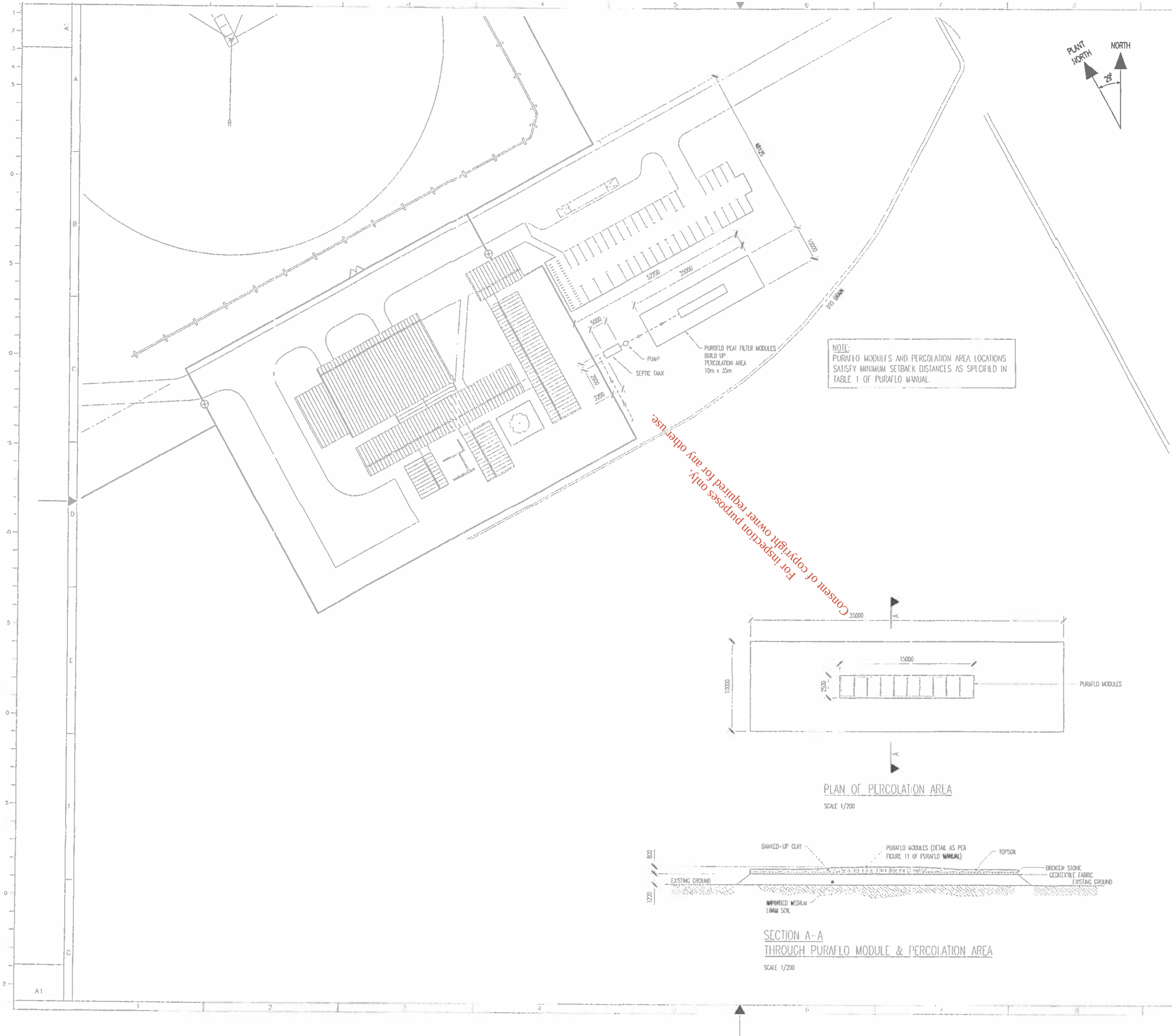
Shell E&P Ireland Limited

ARUP Consulting Engineers — 35 Clare Plunkett Street, Cork. Tel 021-4270270 Fax 021-4272345 Email cork@arup.com — DUBLIN CORK LIMERICK

Drawing Title:

BELLANABOY BRIDGE GAS TERMINAL
LOCATION MAP FOR PURAFLO SYSTEM

Arup Drawing No. C066			Sheet No. 1 of 1
Size: A1	Scale: (at full size) 1:10,560		Drawn by: D.Kalsi
Checked: S.Cullen	Approved: E. Lynch		Date: FEBRUARY 2004
Issue: For Planning Application			Shell Drawing No. COR-AR-SD-RFI-001



NOTES:

1. THE ORIGIN OF THE TERMINAL CO-ORDINATE SYSTEM IS LOCATED AT E 86325.475, N 332799.578 WITH REFFERENCE TO THE IRISH NATIONAL GRID SYSTEM. THE TERMINAL CO-ORDINATE SYSTEM IS ROTATED 29° ANTI-CLOCKWISE FROM GEOGRAPHICAL NORTH.

NOTE:
PURAFLO MODULES AND PERCOLATION AREA LOCATIONS SATISFY MINIMUM SETBACK DISTANCES AS SPECIFIED IN TABLE 1 OF PURAFLO MANUAL.

PLAN OF PERCOLATION AREA
SCALE 1/200

SECTION A-A
THROUGH PURAFLO MODULE & PERCOLATION AREA
SCALE 1/200

Corrib Field Development

Bellanaboy Bridge Gas Terminal

Shell E&P Ireland Limited

Corrib natural gas

ARUP Consulting Engineers DUBLIN CORK LONDON
15 Dawson Pleasant Street, Cork. Tel 021-4276670 Fax 021-4272345 Email cork@arup.com

Drawing Title:
BELLANABOY BRIDGE GAS TERMINAL
LOCATION MAP FOR PURAFLO SYSTEM

Arup Drawing No.: C067		Sheet No.: 1 of 1
Size: A1	Scale. (at full size): 1:500	Drawn by: D.Kalsi
Checked: S.Cullen	Approved: E. Lynch	Date: FEBRUARY 2004
Issue: For Planning Application		Shell Drawing No.: COR-AR-SD-RFI-002

5. *Full details of the proposed sewage disposal system, including any water-table and percolation tests and the design of a suitably sized percolation area.*

As stated in Volume 1 Sections 2.5.11 and 10.4.7 of the EIS, the proposed sewage disposal system is a Bord na Mona Puraflo Peat Filter System.

The very extensive site investigation undertaken on the site, included comprehensive permeability measurements and water table level monitoring, as described in the EIS Volume 1, Technical Appendix 1 Geology, Hydrogeology, and Global Stability Report, Section 8. Thus percolation and water table tests, such as those specified in S.R. 6 "Septic Tank Systems Recommendations for Domestic Effluent Treatment and Disposal from a Single Dwelling House", were not carried out. The site investigation indicated that there is a perched water table in the peat and that the peat is relatively impermeable. For these reasons the Puraflo unit and percolation area will be constructed on top of the existing ground surface. This is a standard technique for use in these circumstances.

The percolation medium will be an imported medium loam soil, as specified by Bord na Mona, the manufactures of the Puraflo system.

The Puraflo system works as follows:

- Wastewater flows from the building into a watertight primary/septic tank. The solids settle and the liquid effluent flows by gravity to a pump / sump chamber.
- The liquid effluent is pumped intermittently into the Puraflo modules where it is distributed evenly onto the biofibrous peat filter.
- A combination of biological, chemical and physical process treat the wastewater as it filters down through the modules.
- Treated liquid emerges from the base of the Puraflo unit and is dispersed into the percolation area (also called a polishing filter).

While the anticipated staffing level at the terminal during its operational phase is between 12 and 18 people per shift, the design of the Puraflo treatment system has been based on manning levels for the terminal of 50 people (ref. Section 2.4.3 of Volume 1 of the EIS, for further details). Basing the design on these staffing levels provides a robust and conservative design.

The design loading criteria for the system is 60 litres of effluent per person per day and 30g BOD per person per day. Based on 50 people, this means that the total mass of BOD produced per day is:

$$50 \times 30 = 1500 \text{ g BOD/day}$$

This figure is converted to a 'Population Equivalent' (PE) by dividing by 60g BOD/day, in this case:

$$\text{Population Equivalent} = \frac{1500}{60} = 25 \text{ PE}$$

This is conservative approach, as the typical occupancy of the terminal will be 12 to 18 people.

Each Puraflo module has a capacity of 2.5PE, therefore a total of 10 Puraflo modules are required for the terminal site.

The percolation area is determined on the basis of the total volume of effluent through the system, in this case:

$$\text{Total Flow} = 50 \times 60 = 3000\,\text{l/day}$$

The percolation area will consist of a 1.2m depth of medium loam soil deposited above ground level. This material has a percolation value, 'T', of between 10 and 20seconds per 25mm. For a percolation value in this range, Bord na Mona recommends that the percolation area size should be based on a percolation of 50l/m² of percolation trench. This requires that:

$$\text{Area of trench required} = \frac{3000}{50} = 60\,\text{m}^2$$

Each trench is 450mm wide and has a maximum permissible length of 20m, thus the number of trenches required is:

$$\text{Number of Trenches} = \frac{60}{(20 \times 0.45)} = 6.667$$

The spacing of the trenches must be at least 2m, therefore the percolation area required is:

$$\text{Percolation Area} = 6.667 \times (20 \times (2 + 0.45)) = 326.7\,\text{m}^2$$

Consequently, the percolation area that has been specified is 350m².

IRISH AGRÉMENT BOARD

BUILDING PRODUCT CERTIFICATION

CERTIFICATE No. 99/0060

Cl/SfB (52.3)

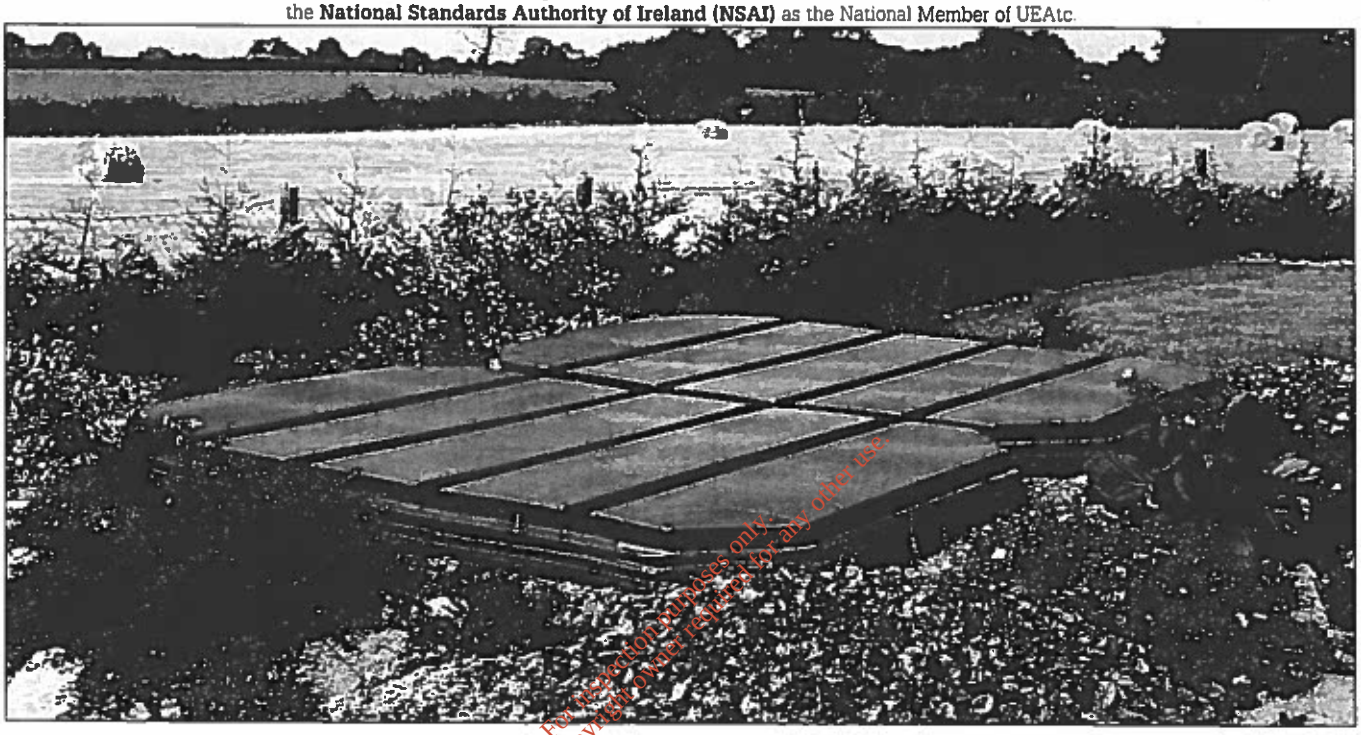
Bord na Móna, Environmental Division,
Newbridge, Co. Kildare, Ireland.
Tel: 045-431201 Fax: 045-431647

PURAFLO LIQUID EFFLUENT TREATMENT SYSTEM

Systèmes de traitement des eaux résiduaires
Abwasseraufbereitung

The Irish Agrément Board is designated by Government to issue European Technical Approvals. Irish Agrément Board Certificates establish proof that the certified products are **'proper materials'** suitable for their intended use under Irish site conditions, and in accordance with the **Building Regulations 1997.**

The Irish Agrément Board operates in association with the **National Standards Authority of Ireland (NSAI)** as the National Member of UEAtc.



PRODUCT DESCRIPTION:
This Certificate relates to Puraflo™ Liquid Effluent Treatment System.

USE:
For the treatment of septic tank effluent from single dwellings.

MANUFACTURING AND MARKETING:
The system is manufactured and marketed by:
Bord na Móna Environmental Division,
Newbridge, Co. Kildare, Ireland.

PART 1 CERTIFICATION

1.1 ASSESSMENT

In the opinion of the Irish Agrément Board (IAB), the Puraflo™ Liquid Effluent Treatment system is satisfactory for the purpose defined above, and meets the requirements of the Building Regulations 1997 as indicated in Section 1.2 of this Certificate.

1.2 BUILDING REGULATIONS 1997

Requirements:

Part D – Materials and Workmanship.
The Puraflo™ Liquid Effluent Treatment System is made of acceptable materials as indicated in Part 4 of this Certificate.

Part H – Drainage and Waste Disposal

H1 – Drainage Systems:
The Puraflo™ Liquid Effluent Treatment System is easily integrated with new and existing septic tanks constructed to meet Building Regulations requirements.

H2 – Septic Tanks:
The Puraflo™ Liquid Effluent Treatment System is an aerobic system and is used in addition to a septic tank fitted with an outlet filter system. The Puraflo™ Liquid Effluent Treatment System can be used where septic tank systems and their percolation areas are not acceptable, or where sites do not comply with the recommendations of S.R.6.: 1991 *Septic Tank Systems Recommendations for Domestic Effluent Treatment and Disposal from a Single Dwelling House* and/or where septic tank percolation systems have failed.

2.1 DESCRIPTION

This Certificate relates to the Puraflo™ Liquid Effluent Treatment System. The system consists of a filter system fitted to the outlet of the connected septic tank, an effluent collecting chamber (sump), a pump and a number of biofibrous media containing modules. The Puraflo™ modules (Figs. 1a and 1b) are manufactured from polyethylene. Each module utilises approx. 2.5 cubic metres of biofibrous media which is compacted into 2 cubic metres. The effluent from the septic tank is evenly distributed over the surface of the biofibrous media and percolates through the media before emerging as a treated liquid at the base of the unit. The treatment of the waste within the system is achieved by a combination of physical, chemical and biological interactions between the pollutants and the biofibrous media. The system is designed to treat the waste water from single dwellings with a total population of up to 15 persons using 2, 4 or 6 modules as required.

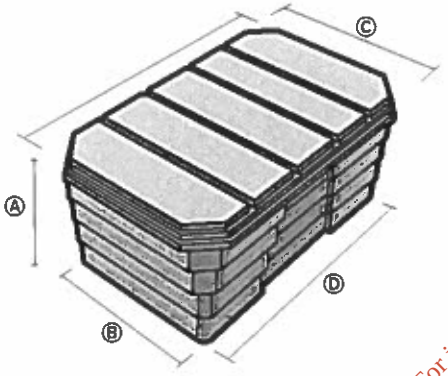


Figure 1a: Puraflo™ Module.
(Dimensions shown in Section 3.2.5)

Septic Tank Outlet Filter

A special baffle filter similar to that illustrated in Fig. 2 is fitted on the outlet pipe from the septic tank to retain solids.

Pump Sump & Pump Unit

The pump sump consists of a concrete or corrosion free polyethylene sump (Figs. 3, 4, 5) fitted with a submersible pump (0.30 kW rating, single phase) with thermal overload protection. Effluent from the septic tank flows by gravity to the sump from where it is pumped via a 40–50mm (1.5–2 in.) pump line to the modules containing the biofibrous media. The standard pump can cater for a head of up to 6 metres. An alarm float is installed in the sump and a visual/audible warning unit is located in the dwelling served by the system to alert the owner to pump malfunctions.

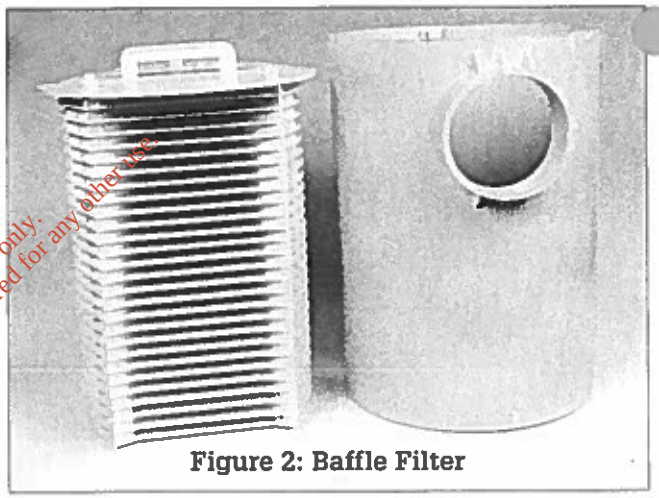


Figure 2: Baffle Filter

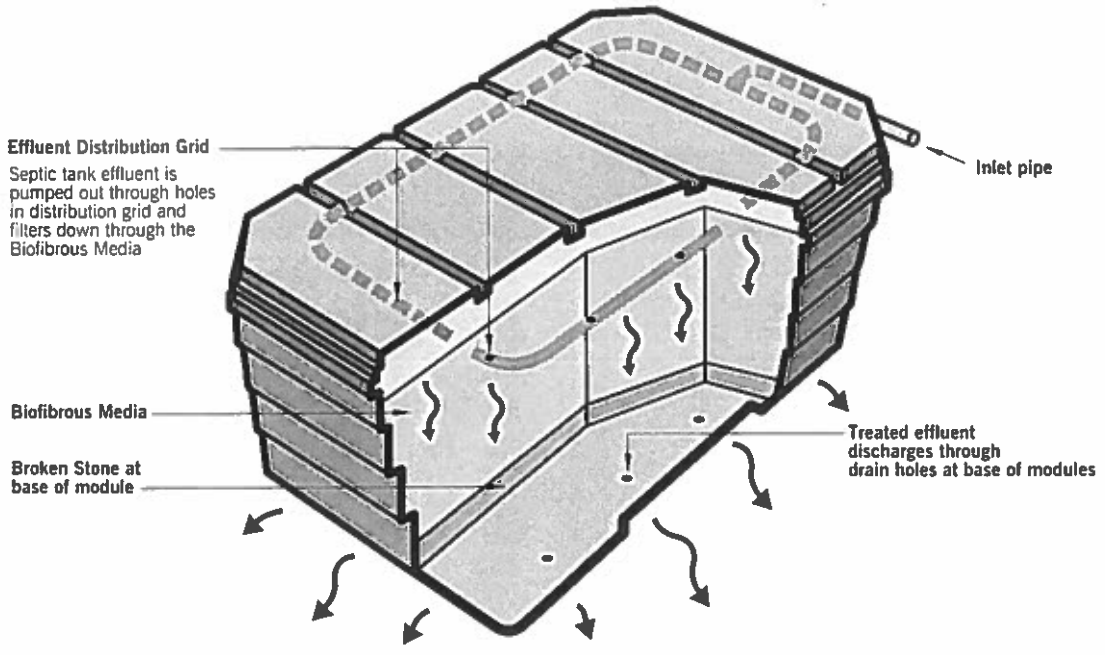


Figure 1b: Cutaway View of the Puraflo™ Module.

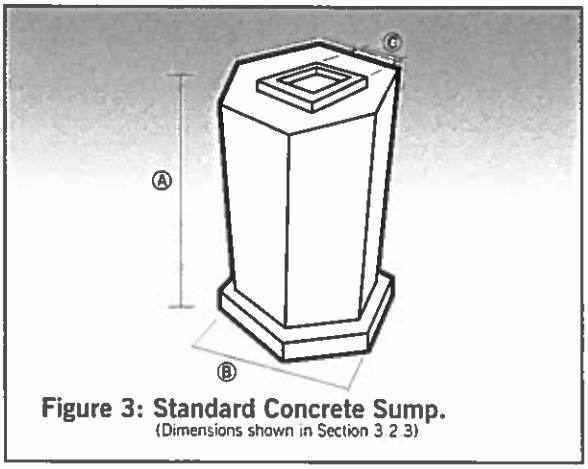


Figure 3: Standard Concrete Sump.
(Dimensions shown in Section 3.2.3)

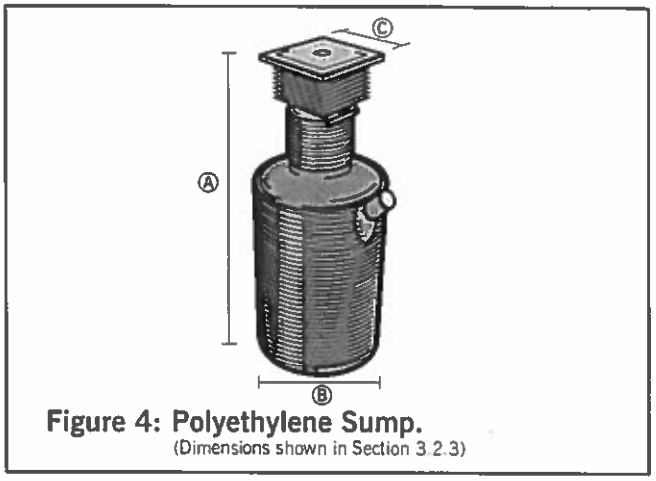


Figure 4: Polyethylene Sump.
(Dimensions shown in Section 3.2.3)

Puraflo™ Modules
Biofibrous media is filled in layers into Puraflo™ modules approx. 0.76m deep x 2.5m² with a contained volume of approximately 2m³ of compacted biofibrous media.

Product Range
The Puraflo™ Liquid Effluent Treatment System is supplied in combinations of Puraflo™ modules to suit the following applications:

- Single house unit using two modules of total area 5m² to serve a population of up to 6 persons.
- Single house unit using 3 modules of total area 7.5m² to serve a population of up to 9 persons.
- Single house unit using 4 modules of total area 10m² to serve a population of up to 11 persons.
- Single house unit using 5 modules of total area 12.5m² to serve a population of up to 13 persons.
- Single house unit using 6 modules of total area 15m² to serve a population of up to 15 persons.

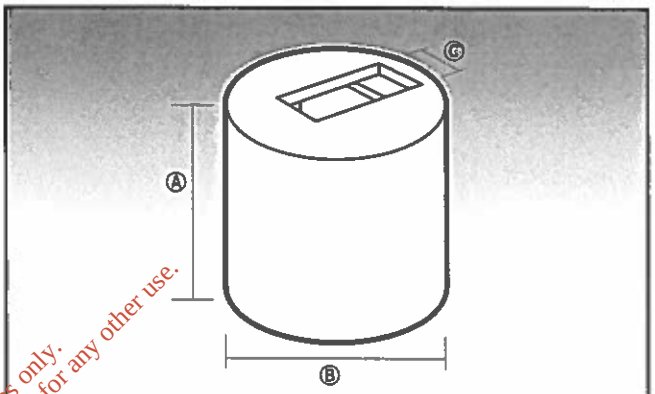


Figure 5: Baffle Wall Sump.
(Dimensions shown in Section 3.2.3)

2.2 PIPEWORK/ASSEMBLY
Pipework used for the manifold and distribution system is in accordance with BS 3505: 1986 *Specification for unplasticised polyvinyl chloride (PVC-U) pressure pipes for cold potable water* and relevant parts of BS 4346: *Joints and fittings for use with unplasticised PVC pressure pipes*. A pump, a sampling chamber (Fig. 6) and a PVC distribution manifold complete the pipework assembly. All electrical connections are completed on site.

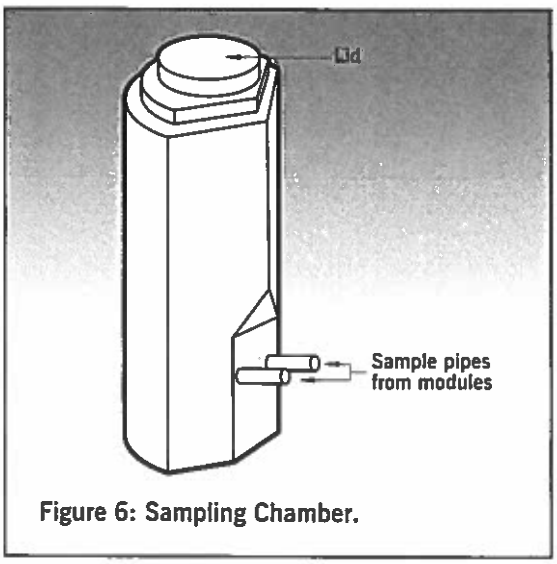


Figure 6: Sampling Chamber.

2.3 DELIVERY, STORAGE AND MARKING
The Puraflo™ modules are completed ready for delivery at the manufacturer's works. Off-loading of each individual module must be carefully supervised using chains, steel cables or lifting bars with SWL of 800kg and should conform with the requirements of the Safety, Health and Welfare at work Act, 1989. The manufacturer's instructions must be followed to avoid damage to the modules during off-loading and placing in the excavation. Suitable lifting equipment must be employed.

The modules are labelled on the outside to indicate the IAB identification Mark incorporating the number of this Certificate.

2.4 INSTALLATION PROCEDURE

2.4.1 GENERAL
The Puraflo™ modules can be installed above or at ground level depending on the height of the local watertable or vertical separation requirements.

(i) For connection to a septic tank meeting the requirements of the Building Regulations 1997, and permitting the fitting of an outlet baffle filter, a concrete (or polyethylene) sump is installed adjacent to the septic tank as illustrated in Fig. 7.

(ii) For connection to septic tanks not permitting the fitting of an outlet baffle filter, a special concrete sump is installed as illustrated in Fig. 8. This sump is comprised of 2 chambers with the first chamber designed to accommodate the outlet filter and to provide for desludging.

Installation and the sequence of steps are detailed in the manufacturer's instruction manual, must be followed exactly.

2.4.2 SITE PREPARATION

Site Preparation is as follows:

(i) *Septic Tank*
For installations where a new septic tank is required excavations to the necessary depth are made to receive a septic tank conforming to the requirements of the Building Regulations 1997 including all necessary blinding of the base to ensure a uniform bearing support.

(ii) *Pump Sump*
A suitable excavation is prepared downstream of the septic tank to receive the concrete or polyethylene pump sump.

(iii) *Puraflo™ Modules*
An area is prepared and levelled to create an even surface on which to place concrete blocks and lintels to support the modules.

Broken stone approx. 25–50mm is filled level with the top of the concrete blocks and lintels over this area to a depth of 200mm approx.

Depending on site conditions, various designed lengths of stone filled drain may be required extending from the stone base under the modules.

A pipe trench 450mm deep (minimum) x 150mm wide is excavated from the sump to the modules.

(iv) *Electrical Supply*
A trench 450mm deep (minimum) x 150mm wide is excavated from power source to the sump for an armoured cable electrical supply to the pump.

(v) *Disposal of Treated Effluent*
The disposal route for the treated effluent will depend on local conditions. Normally the treated effluent is disposed of by soil percolation. The materials in percolation areas are chosen and laid as described in Section 2.4.8 of this Certificate.

2.4.3 PLACING AND LEVELLING OF MODULES

(i) Using a lifting frame, the modules are positioned carefully on the lintels. Each module is checked for level when fitted.

(ii) Effluent inlet pipes are checked for proper orientation for connecting to the pump line.

2.4.4 INSTALLATION OF SUMP AND ASSOCIATED PIPEWORK

(i) The sump is fitted at least 0.5m from a new septic tank or at least 1m from an existing septic tank.

(ii) The septic tank outlet is connected to the sump using a 110mm dia. pipe at a gradient of 1 in 100.

(iii) Backfilling is compacted around the sump below the outlet pipe and the cable entry ensuring that the material used for backfilling is free of stones and material which could damage the sump.

(iv) A pump line 40–50mm dia. is laid from the sump to the modules.

(v) The pump line is connected to the outlet from the pump.

(vi) The pump line is connected to the manifold at the modules.

(vii) The manifold is placed in position and connected by 40mm dia. plastic flexible pipes to the effluent distribution grids in the modules.

2.4.5 CONNECTION OF ELECTRICAL SUPPLY

(i) The armoured cable from the power source to the sump is placed unstretched in the bottom of the cable trench. A 5 core 5mm PVC SWA cable is used.

(ii) The armoured cable is connected to the terminal box provided in the sump.

(iii) The control panel is installed. The power supply to the control panel is taken from an independent MCB to avoid nuisance tripping to existing circuits. The control panel has an ELCB fitted to protect the pump and control system.

(iv) The cable from the sump is connected to the control panel.

2.4.6 COMMISSIONING

(i) The alarm float is suspended approximately 150mm above the submersible pump.

(ii) The pump MCB is switched off at the Puraflo™ panel.

(iii) The sump is filled with clean water until the alarm float lifts; under these conditions the alarm should indicate a fault.

(iv) The pump MCB is switched on to restore the power supply to the pump. With the pump operating properly the alarm will switch off when the water level in the sump drops below the level specified in (i) above.

(v) All pipe connections in the sump and at the modules are checked for leaks.

2.4.7 LOCATION

The septic tank should not be closer than 7 m from the dwelling served and should not be nearer than 20 m from the nearest point of any other dwelling.

The Puraflo™ Liquid Effluent Treatment System and septic tank should not be located in any area where vehicles could traverse or damage them and provision should be made for access for a tank emptying vehicle and its equipment.

The separation distance from wells should be not less than 20 m except in the case of very sandy soils or gravels, where a minimum distance of 40 m should be maintained. In all cases the percolation area should be located down gradient of any nearby well. Where it is not possible to locate the percolation area down gradient of any nearby well a separation distance of least 100 m, depending on percolation conditions, must be maintained. If necessary a mound of top soil (of appropriate characteristics) may be constructed to

achieve the required 0.5 m minimum vertical separation between the base of the Puraflo™ unit and the seasonally high water table. Typical setback distances for the Puraflo™ system are shown in Table 1 below.

Feature	Minimum Setback Distances (m)	
	Treatment Modules	*Percolation Area*
Dwelling served	7	5
Adjacent dwelling	10	5
Site boundaries	3	1
Watercourse	3	3
Roads	3	1
Walls	3	1
Drinking Water Sources	20	20–100

Table 1: *Recommended setback distances for various elements of the Puraflo™ Liquid Effluent Treatment System.*

2.4.8 TREATED WASTE WATER DISPOSAL

Treated waste water may be disposed of by either of the following means:

(a) *Sub-Surface Disposal:*
The treated effluent from the base of the Puraflo™ Liquid Effluent Treatment System passes downwards into a prepared area filled with 25–50mm approx. broken stone to a depth of 250mm. The extent of the percolation area will be determined by the population served and the subsoil type at the site in accordance with the recommendations in Tables 2a, 2b and 2c. Percolation drains are constructed (see Fig. 9) adjacent to the Puraflo™ modules to make up the required percolation area. Percolation drains, 400mm wide x 400mm deep (approx.) depending on site conditions shall be filled to a depth of 250mm with 25–50mm (approx.) broken stone and covered with geotextile or other protective material before backfilling (to prevent the entry of silt). A typical subsurface disposal field is illustrated in Fig. 9.

(b) Alternatively the treated effuent can be collected and pumped to irrigation in which case a site specific engineered design will be prepared.

(c) *Surface Water Disposal*
Treated effluent from the base of the Puraflo™ Liquid Effluent Treatment System can be discharged directly or via a stone filled drain to receiving waters (ditch or drain). If this option is selected a licence to discharge to waters, (on a case by case basis) will be required from the local authority to comply with the Water Pollution Acts (1977–1990 incl. amendments).

2.4.8.1 GENERAL GUIDANCE FOR THE SIZING OF PERCOLATION AREA

The required percolation areas for treated effluent are derived from consideration of the effluent quality (e.g. 95% reduction in BOD and 99% reduction in faecal bacteria) and the soil percolation characteristics.

Table 2a refers only to percolation characteristics. Table 2a should be regarded as guidance only so that water logging of sites does not occur. For each site a test shall be carried out in accordance with approved percolation test procedures in order to confirm the suitability of the percolation system (see section 2.4.8.2).

Different configurations of percolation areas are acceptable. This also applies to sites where split percolation areas are needed to obtain the recommended total area.

Soil Group	Soil Classification Description	Percolation Rate
1	Sand, gravels, loam sand	Very good
2	Sandy loam, loam, sandy clay loam	Good
3	Silty loam, clay loam, silty clay loam	Moderate
4	Sandy clay, silty clay, clay	Poor

Table 2a: *Identification of soil groupings*

2.4.8.2 PERCOLATION TEST PROCEDURES

A standard "T" test (or other approved soil percolation test) is carried out by the developer/owner to identify the soil group and measured percolation rate. The size of the soil disposal area required is based on the results of this test used in conjunction with the physical properties of the soil and the level of effluent treatment achieved. The depth within the soil profile where this test should be conducted will reflect the invert level at which the effluent will be introduced to the soil. In the majority of instances this will be within 30cm of the surface.

2.4.8.3 SOIL PERCOLATION AREA

	Percolation area (m²)			
	Soil Group			
Population served	Group 1	Group 2	Group 3	Group 4
up to 6	10	20	45	65
6–11	15	30	60	95
11–15	20	40	80	120

Table 2b: *Soil percolation area with Puraflo™ system in various soil classification groupings.*

2.4.8.4

The relationship between the 'percolation area', reported in Table 2b and the 'linear pipe (m)' length of percolation trench required is 1:1. In Table 2b the figures can be expressed as m² percolation area or linear m of percolation trench. An actual length of 10m is allowed within the prepared area beneath and surrounding the **Puraflo™** modules. Additional length of percolation trench is installed by inserting drains of up to 20m in length and a minimum of 2m apart.

2.4.8.5 MAXIMUM 'LONG TERM' HYDRAULIC LOADINGS

Maximum hydraulic loading l/m²/d			
Soil Group			
Group 1	Group 2	Group 3	Group 4
135	68	34	23

Table 2c: *Maximum 'long term' hydraulic loadings applied to the soil percolation areas in each soil group*

2.5 COMMISSIONING

Commissioning will be carried out by Bord na Móna Environmental Division personnel or their appointed agents after installation is completed and all services are connected.

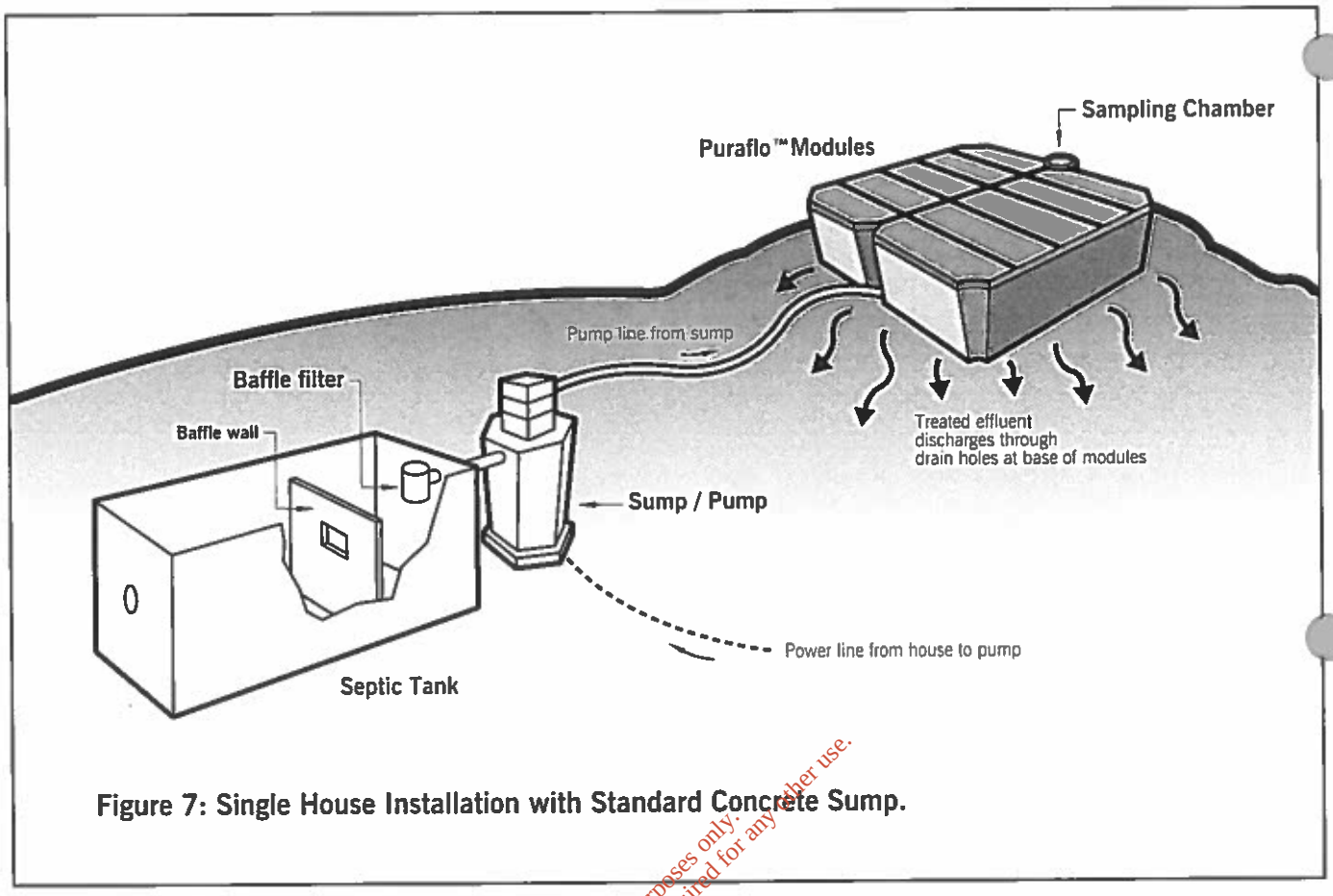


Figure 7: Single House Installation with Standard Concrete Sump.

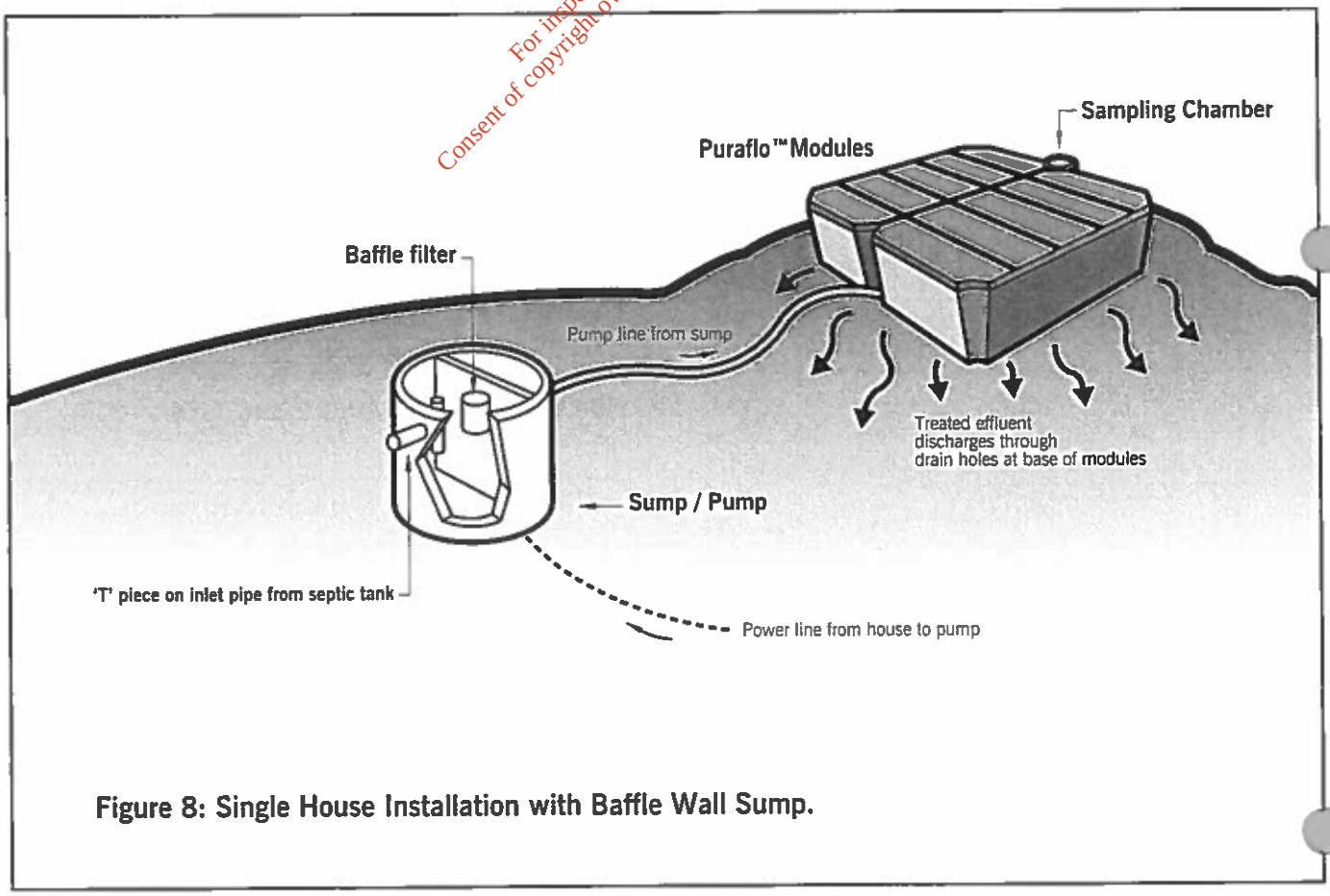


Figure 8: Single House Installation with Baffle Wall Sump.

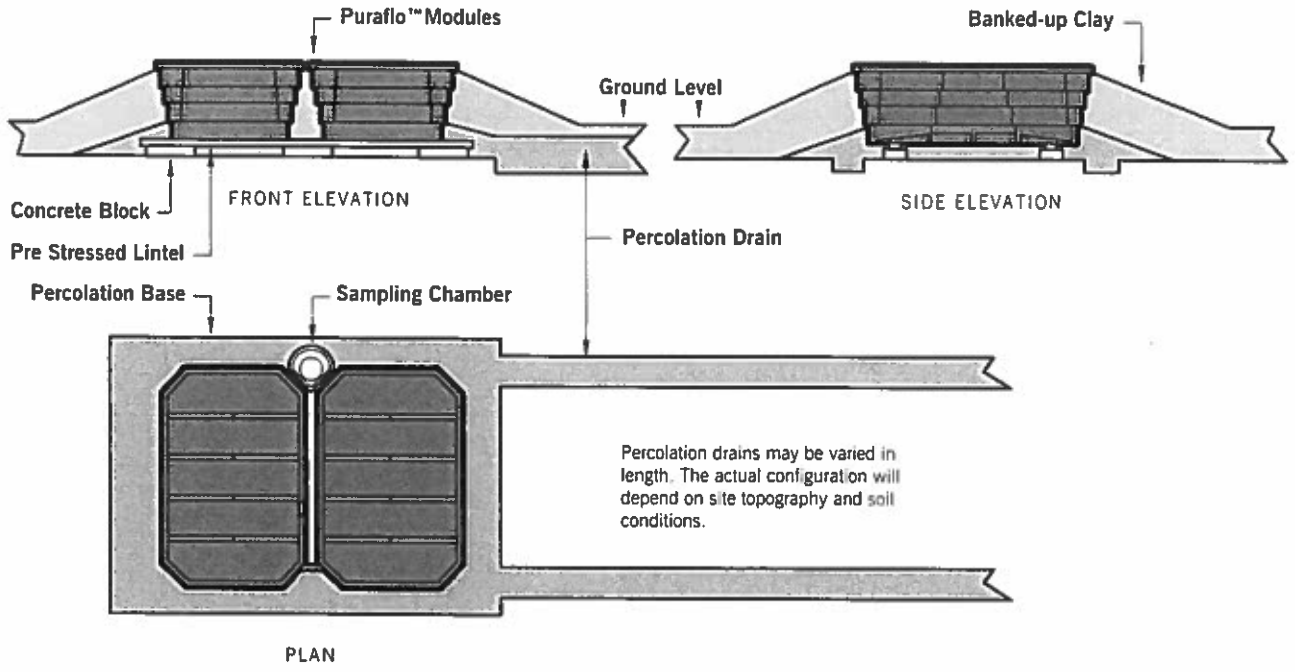


Figure 9: Typical Sub-Surface Disposal Field. (Drawing not to scale)

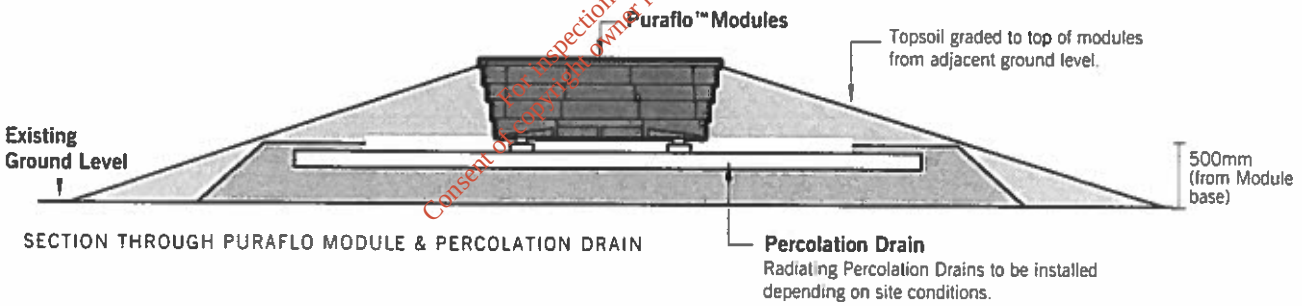


Figure 10: Disposal for Site with High Water Table. (Drawing not to scale)

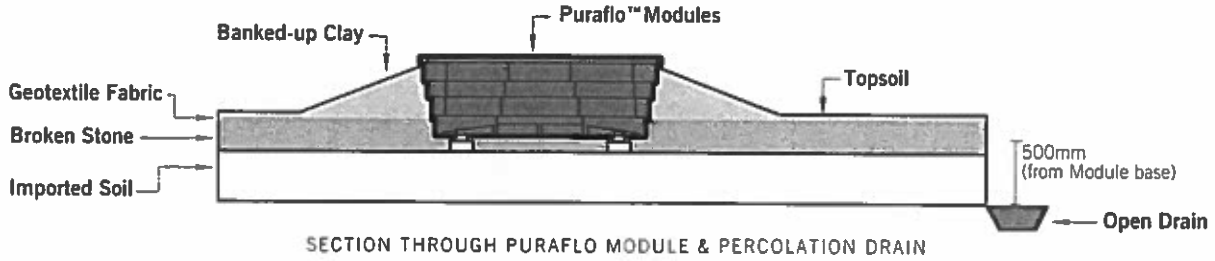


Figure 11: Disposal for Site with Poor Percolating Soil and Receiving Water. (Drawing not to scale)

PART 3 DESIGN DATA

3.1 GENERAL

The Puraflo™ Liquid Effluent Treatment System has been designed to treat domestic waste water from up to 15 persons. It is suitable for installation at sites where a septic tank and percolation system does not afford an environmentally safe and acceptable means of disposing of domestic waste water. Such sites include those where the water table is high and where soil types do not afford good percolation. To ensure optimum efficiency the drainage of the premises served must be checked to ensure that storm water from roofs and paved surfaces does not discharge into the system.

The system is designed and installed in accordance with the Puraflo™ Liquid Effluent Treatment System Specifications. Due to the high quality effluent treatment achieved (see Table 4, Section 3.2.10) the Puraflo™ Liquid Effluent Treatment System may be installed close to habitable buildings, as indicated in Section 2.4.7 subject to any special requirements of the particular site.

The Puraflo™ Liquid Effluent Treatment System is supplied with an alarm which will alert the owner to a pump malfunction and this will enable corrective action to be taken before overflow occurs. Details of corrective actions are contained in the Puraflo™ maintenance manual supplied with the unit.

3.2 DESIGN BASIS

The Puraflo™ liquid effluent treatment system is supplied in a modularised configuration. Daily waste water loadings of up to 3.0m³/d (equivalent to a population of 15 persons) can be treated. Table 3 details the range of populations served, the associated hydraulic generation and the modular arrangement used in each case.

Max. Population Served	Daily Flow m^3d^{-1} (max)	Puraflo™ area required (m^2)	No of Modules
6	1.2	5	2
9	1.8	7.5	3
11	2.2	10	4
13	2.6	12.5	5
15	3.0	15	6

Table 3: *Modular configuration*

DESIGN CRITERIA

Assumptions:

Hydraulic loadings	200 l/p/d*
Organic Loadings	60g BOD_5/p/d
Solid Loadings	40g TSS/p/d

Max. Application rates *(to the biofilter after primary settlement)*

Hydraulic loadings	240 l/m²/d
Organic loadings	average 72g BOD/m²/d
Solid Loadings	average 24g TSS/m²/d

3.2.1 SEPTIC TANK

The Septic tank should meet the requirements of the Building Regulations 1997. The septic tank should allow for the fitting of an outlet baffle filter; otherwise the baffle wall sump shown in Fig. 5 will be installed to provide for the fitting of the baffle filter in the first chamber of this sump, while the second chamber acts as the pump sump.

3.2.2 FILTER

An outlet baffle filter (see Fig. 2) is installed upstream of the pump sump to retain solids.

3.2.3 SUMP

The sump used may be single chamber concrete, single chamber polyethylene (Figs. 3 and 4) or a concrete sump with baffle wall and baffle filter (Fig. 5) as described in Section 2.4.1. Where the concrete sump with a baffle wall is employed access via a manhole is provided to facilitate desludging.

Pump sump dimensions are shown below with reference to Figs. 3, 4 and 5.

	DIMENSIONS (mm)		
Sump type	**A**	**B**	**C**
Polyethylene	1840	720	480
Concrete (standard)	1480	880	500
Baffle wall sump	1300	1440	380

3.2.4 Pump Unit and Electrical Installation

The irrigation pump used is of a standard submersible type which can vary in size depending on site conditions. It delivers a discharge volume of 0.2 to 2.0 l/s. against a discharge head of 1 to 6m. All models are single phase 220–240 volt 50-Hz motor with enclosures to IP 68. Effluent from the tank flows by gravity to the sump from where it is pumped via a 40–50mm diameter pumping main to the biofilter modules containing the biofibrous media. A visual/audible warning unit is installed to alert the owner to pump malfunctions.

The design and installation of the pump and electrics are in compliance with 'The National Rules For Electrical Installations' (ETCI), published by the 'Electro-Technical Council of Ireland'. (Document no. ET101/1991: A1/1997)

3.2.5 MODULES and MEDIA

The Puraflo™ modules (see Fig. 1) are manufactured from high density polyethylene. A minimum of two Biofilter modules shall be installed with dimensions as shown below.

(i) *Biofilter Module Dimensions, mm, are shown below and illustrated in Fig. 1.*

Biofilter Module	DIMENSIONS (mm)				
	A	B	C	D	E
	760	1185	1400	2150	1935

(ii) *Fibre*
The peat fibres consist of root residues of eriophorum (cottongrass) plants extracted from bog peats.

Specifications of Fibres

Moisture content	50–70% by weight
Fines content (<5mm)	30% max.

(iii) *Typical Physical Characteristics of Fibre Media*

Loose density (range @50% m/c)	110–140 kg/m^3
Organic matter content	>95% w/w (anhydrous basis)

(iv) *Typical Botanical Composition of Fibre Media*

Fibre (eriophorum)	50% (v/v)
Humic materials	40% (v/v)
Sphagnum materials	10% (v/v)

(v) *Typical Design Specification for Puraflo™* single house system.

PARAMETER	SPECIFICATION
Media Type	100% fibre (Biofibre)
Compaction	50%
Depth of compacted media	0.7m
Distribution of septic tank effluent over modules	Rectangular pipe grid
Minimum Number of modules per installation	2 modules
Total Hydraulic load (max.)	3.0m/day (6 modules)
Total Organic loading (max.)	0.900 kg/day (septic tank and Puraflo™ System) 0.630 kg/day (Biofilter alone) (6 modules)
Sample Chamber	In all installations

3.2.6. BROKEN STONE
The stone filter under the Puraflo™ modules and in the drainage trenches is composed of 25–50mm approx. broken stone.

3.2.7 LIQUID EFFLUENT ANALYSIS
The pH, BOD and suspended solids (T.S.S.) concentrations demonstrated in Table 4 will be attained within a few weeks of commissioning. It is predicted that the stipulated nitrate (NO_3) and ammonia (NH_3) values will be consistently achieved over the lifetime of the biofibrous media, currently estimated to be at least 10 years.

3.2.8 MONITORING SYSTEM ALARM
The installed electrical warning system will signal an alarm to indicate impending flooding or failure of the pump unit.

3.2.9 COMMISSIONING
Commissioning of the unit must include testing of the alarm system and the completion of all safety checks.

3.2.10 MAINTENANCE SYSTEM
During desludging of the septic tank the sump unit must also be de-sludged. Following removal of the sludge the pump should be hosed down and the resulting sludge removed from the sump.

The units should not be opened or the media disturbed. Any such disruption of the media may result in channelling of the effluent or over-compaction leading to flooding.

Table 4: *Treated Waste Water Quality*

PARAMETER	CONCENTRATION
pH (pH units)	5–8
B.O.D. (mg/l)	< 15
T.S.S. (mg/l)	< 15
NH_3-N (mg/l)	< 5
Nitrate-N (mg/l)	20
Total Coliforms elimination	> 99.9%
Faecal Coliforms elimination	> 99.9%
*Pathogenic Bacteria	Absent

**Including Salmonella spp, Shigella spp, Sulphide reducing Clostridia, Staphylococcus spp and Psudomonas aeruginosa*

PART 4 TECHNICAL INVESTIGATIONS

4.1 ENVIRONMENTAL ASSESSMENT

The treated waste water from a number of working installations has been comprehensively monitored for 18 months. The test results show that values stated for the parameters listed in Table 4 are consistently achievable over a range of operating conditions.

4.2 STRENGTH

The design and testing of the plant has been assessed as satisfactory. The modules and sumps have adequate resistance to handling stresses, the loads applied by ground pressure and internal liquid loads.

4.3 WATER PENETRATION

The plant and modules with its pipe connections when correctly installed will not allow seepage either into or from the surrounding soil.

4.4 DURABILITY

The biofibrous media when installed, used and maintained in accordance with the requirements of this Certificate will have a life of at least 10 years. The mechanical components of the system excepting pumps will have a life in excess of 20 years.

Spent treatment media should be disposed of in accordance with National Waste Regulations.

4.5 CLEANING AND MAINTENANCE

All Puraflo™ units are inspected by Bord na Móna personnel for their performance after one year approx. of operation and the effluent analysed. As part of routine maintenance the owner must keep the inlet and outlet from the septic tank free from blockages and desludge the septic tank. The septic tank and the first chamber of the two chamber sump (where this option is used) should be desludged at least once per annum.

4.6 SAFETY

4.6.1 SAFETY OF PERSONNEL

The Puraflo™ Liquid Effluent Treatment System is generally installed above ground level. All pump sump covers are securely fixed, to prevent unauthorised access.

The treatment system should be positioned, or marked, or protected to prevent superimposed loading or accidental impact by vehicles and underground electric cables should be marked with warning tape.

4.6.2 SAFETY OF SYSTEM

The Puraflo™ Liquid Effluent Treatment System has a visual/audible warning device connected to the pump/sump unit to alert the owner to malfunctions of the pump.

4.7 TESTS AND ASSESSMENTS WERE CARRIED OUT TO DETERMINE

- Watertightness
- Strength of covers, modules & sumps
- Resistance of units to hydrostatic pressure
- Quality of treated effluent

4.8 OTHER INVESTIGATIONS

(i) Existing data on the history of use of previous installations was assessed.

(ii) The manufacturing process was examined including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

(iii) Site visits were conducted to assess the practicability of installation.

(iv) A user survey and visits to established sites were conducted to evaluate performance in use.

(v) No failures of the product in use have been reported to the IAB.

5.1 CONDITIONS OF CERTIFICATION

The National Standards Authority of Ireland ("NSAI") following consultation with the Irish Agrément Board ("IAB") has assessed the performance and method of installation of the product/process and the quality of the materials used in its manufacture and certifies the product/process to be fit for the use for which it is certified provided that it is manufactured, installed, used and maintained in accordance with the descriptions and specifications set out in this certificate and in accordance with the manufacturer's instructions and usual trade practice. This certificate shall remain valid so long as:

(a) the specification of the product is unchanged;

(b) the Building Regulations, 1997 and any other regulation or standard applicable to the product/process, its use or installation remain unchanged;

(c) the product continues to be assessed for the quality of its manufacture and marking by NSAI;

(d) no new information becomes available, which in the opinion of the NSAI would preclude the granting of the certificate;

(e) the product or process continues to be manufactured, installed, used and maintained in accordance with the description, specifications and safety recommendations set out in this certificate.

5.2 The IAB mark and certification number may only be used on or in relation to products/processes in respect of which a valid certificate exists. If the certificate becomes invalid, the certificate holder must not use the IAB mark and certification number and must remove them from products already marked.

5.3 In granting this certificate, the NSAI makes no representation as to:

(a) the presence or absence of patent rights subsisting in the product/process; or

(b) the legal right of the certificate holder to market, install or maintain the product/process; or

(c) whether individual products have been manufactured or installed by the certificate holder in accordance with the descriptions and specifications set out in this certificate.

5.4 This certificate does not comprise all installation instructions and does not replace the manufacturer's directions or any professional or trade advice relating to use and installation which may be appropriate.

5.5 Any recommendations contained in this certificate relating to the safe use of the certified product or process are preconditions to the validity of the certificate. However, the NSAI does not certify that the manufacture or installation of the certified product or process in accordance with the descriptions and specifications set out in this certificate will satisfy the requirements of the Safety, Health and Welfare at Work Act, 1989 or of any other current or future statute or current or future common law duty of care owed by the manufacturer or by the certificate holder.

5.6 The NSAI is not responsible to any person or body for loss or damage, including personal injury, arising as a direct or indirect result of the use of this product or process.

5.7 Where reference is made in this certificate to any Act of the Oireachtas, regulation made thereunder, statutory instrument, code of practice, national standards, manufacturer's instructions or similar publication, it shall be construed as reference to such publication in the form in which it is in force at the date of this certification.

THE IRISH AGRÉMENT BOARD

This Certificate No. 99/0060 is accordingly granted to Bord na Móna on behalf of the Irish Agrément Board.

Date of Issue: 02 June 1995

Signed: _____

Director of Standards, NSAI

Readers may check that the status of this Certificate has not changed by contacting the

Irish Agrément Board,
NSAI, Glasnevin, Dublin 9. Ireland.

Telephone: (01) 807 3800.
Telex: 32501.
Telefax: (01) 807 3838.

Re-printed Feb. 99

IRISH AGRÉMENT BOARD

BUILDING PRODUCT CERTIFICATION

Irish Agrément Board,
NSAI,
Glasnevin,
Dublin 9.
Ireland.
Telephone: (01) 807 3800.
Telex: 32501.
Telefax: (01) 807 3838.

6. *Submit a map outlining phosphate hot-spots, quantities of contaminated material, details of the analysis of the occasional occurrence of high levels of phosphorous detected in peat samples on the site and proposals to deal with the same including disposal. The format of the response shall include a comparison between the total concentrations (above background levels), that may theoretically, result from the development works and other land use activities that regularly occur in the area e.g. afforestation, clearfelling etc*

Phosphate Results in Soil

Seventeen phosphorous sample points were located within the footprint of the terminal site. The samples were tested using the UKAS accredited method (Molybdate Reactive Phosphate Method). This allows the determination of leachable orthophosphate (leachable means phosphate that is able to be washed from the soil by percolating rain or ground water). The results obtained indicate that leachable orthophosphate concentrations in near-surface samples (ground level to 0.15m depth) are typically less than 50mg/l with the exception of an isolated area within the northeastern part of the terminal footprint, where the maximum reported leachable orthophosphate concentration was 219mg/l. It should be noted that the peat in this location is exceptionally dry and less than 1m thick. The average concentration of leachable orthophosphate within the terminal footprint at shallow depths (surface to 0.15m depth) was 30.4 mg/l, and the minimum reported concentration was less than 1mg/l.

Thirty-six samples were also taken outside of the terminal footprint, to the east and north. At shallow depth (surface to – 0.15m depth) the maximum reported leachable orthophosphate concentration was 130mg/l. However, this was in an isolated area, and the concentrations were generally below 50mg/l, with the average concentration at this depth reported to be 28.9mg/l. These areas will be left undisturbed.

Orthophosphate concentrations decrease significantly with depth. Between 0.15 and 0.30m depth, the maximum reported leachable orthophosphate concentration was 74mg/l, with an average leachable orthophosphate concentration of 5.8mg/l. At greater depths (up to 5.1m depth) reported leachable orthophosphate concentrations decreased to below 5mg/l at all sample locations. The results of the leachable orthophosphate concentrations in peat samples are summarised in Table 6.1 below and are presented graphically, as contour plots. Two contour plots have been produced; the first is for the shallow samples (surface to 0.15m depth) and the second is for the next sample depth interval (from 0.15m to 0.30m depth).

Location	Sample Depth Interval	Max P Conc. (mg/l)	Min P Conc. (mg/l)	Av.P Conc. (mg/l)
Terminal Footprint	0.00-0.15	219	1.0	30.4
Terminal Footprint	0.15-0.30	31.0	1.0	5.8
North east of Terminal Footprint	0.00-0.15	130.0	2.0	28.9
North east of Terminal Footprint	0.15-0.30	74.0	1.0	11.6
All	0.00-0.15	219.0	1.0	29.4
All	0.15-0.30	74.0	1.0	9.7
All	0.00-0.30	219.0	1.0	19.7

Table 6.1 - Summary of Leachable Orthophosphate Concentrations at the Terminal Site. [1]

The principal source of the orthophosphate in the near surface peat samples is considered to be rock phosphate which was used as a fertiliser when the site was under the control of An Foras Taluntas (Department of Agriculture) and Coillte from 1955 onwards. During this time the site was used as a peat land experimental station; rock phosphate was applied as a fertiliser in order to undertake research into its effects on the growth of plants such as conifers, and for other agricultural purposes. The presence of the elevated leachable orthophosphate concentrations in certain parts of the site may be explained by the fact that these areas were located where rock phosphate was more recently applied as part of the research programme. Another possible source for some of the elevated concentrations may be from the ring cattle feeders which were present on the site until recently. It is important to note that rock phosphate is commonly used as an agricultural fertiliser on peatland sites in Ireland, where it is often applied at a rate of 350kg per hectare.

RSK ENSR is unaware of any legislative standards or guideline values relating to leachable concentrations of phosphates in Irish peatland soils. However, orthophosphate impact to surface watercourses from phosphate-impacted soils is widely recognised as being a major concern in certain parts of Ireland, because it can lead to eutrophication of lakes and rivers. The principal migration pathway via which orthophosphate typically impacts surface watercourses is via surface runoff. This is because below the upper 0.3m of the peat (known as the acrotelm) the permeability of the peat is typically very low, of the order of $1x10^{-7}$ m/sec. Experiments undertaken by Minerex Environmental Ltd. (MEL) and have shown that the average permeability of the peat at the terminal site, below a depth of approximately 0.3m, is $1.05 x10^{-7}$ m/sec. The permeability of the peat in the upper 0.3m is typically much higher at approximately $1x10^{-5}$ m/sec. This results in a preferential lateral flow on, within and along the base of the acrotelm.

Based on the coefficients of permeability, and the preferential lateral flow of the phosphate in surficial peat horizons, it has been estimated by MEL that it would take phosphate at a point X at the base of the acrotelm peat 5000 days (or 13.7 years) to

[1] The above data is presented in detail in the Minerex Environmental Limited (MEL) Report entitled 'Groundwater and Subsoil Investigations at the Bellanaboy Bridge Terminal Site', Volume 1 of 2 – Text, MEL doc. Ref. 1322-1286 (Final).doc, dated April 2002.

reach a receptor 50m away from the terminal site. The flux rate of 1cm per day used by MEL is likely to be generous due to factors such as retardation, leakage, ion exchange and in-homogeneity. A more realistic flux rate of approx 1mm/day may be more realistic, in which case it would then take 137 years for the leachable phosphate to reach the receptor 50m away from the terminal site. It may therefore be concluded, that the phosphate in its *in-situ* state is practically immobile. This is demonstrated by the surface water quality monitoring data for phosphate in surface water courses in the vicinity of the terminal site, as discussed below.

Phosphate Results in Water

Guidance on acceptable concentrations of phosphorous in surface watercourses in Ireland is provided by SI 258 (1998), commonly known as the "Phosphorous Regulations". This indicates a maximum limit for orthophosphate in river waters of 0.05 to 0.07 mg/l, and 0.02 to 0.05 mg/l in lake waters (drains and other standing water bodies (ponds, pools, etc.) are not included in these regulations). In view of this, it is important to ensure that runoff waters from phosphate-impacted sites do not result in concentrations of phosphorous in surface watercourses exceeding the above limits. . The proposed development works include mitigation measures such as flow retardation and settlement ponds (into which all site drainage will flow) with an iron oxide mesh in order to reduce dissolved concentrations of phosphorous in runoff waters, if necessary.

Water quality data has been obtained from sampling locations adjacent to and in the vicinity of the terminal site. The data is summarised in Table 6.2 below and indicates that the maximum reported phosphate concentrations in surface watercourses in the vicinity of the site are all well below the limits noted above. The only exceedence of the limits was for Drain 22 that had a maximum reported phosphate concentration of 0.131 mg/l.

In view of the above the site is not considered to pose a risk to nearby controlled waters in its current state, because there has been no attributable, measured impact on nearby surface watercourses. Table 6.2 also includes surface water quality data taken from other agricultural/forestry sites in Ireland. It highlights the fact that surface water quality in other areas is significantly poorer than that identified in the vicinity of the terminal site. Overall the quality of the water at the monitoring sites detailed in Table 6.2 in the vicinity of the Terminal site is considered to be very good with regards to reported phosphate concentrations.

Site	Phosphate Conc. (mg/l)[2]	Location
Sites in Close Proximity to Proposed Terminal Site		
Lake Outlet	0.0037	Sites in the vicinity of the proposed terminal
Glencullen River	0.00305	Sites in the vicinity of the proposed terminal
Glenturk River	0.00734	Sites in the vicinity of the proposed terminal
Bellanaboy Br.	0.0181	Sites in the vicinity of the proposed terminal
Muiningaun R.	0.0108	Sites in the vicinity of the proposed terminal
Drain 16	0.0321	Immediately adjacent to the proposed terminal
Aghoos R	0.00733	Sites in the vicinity of the proposed terminal
Drain 22	0.131	Immediately adjacent to the proposed terminal
Drain 62	0.0165	Immediately adjacent to the proposed terminal
Glenamoy Br.	0.0118	Sites in the vicinity of the proposed terminal
Other Sites Within Agricultural/ Forestry Areas		
Cowlands	17	Johnstown Castle Research centre
Warren 1	4	Johnstown Castle Research centre
Warren 2	8	Johnstown Castle Research centre
D1	1.1	Water samples taken from a stream in the River Dripsey Catchment, on a farm near the village of Donoughmore, Co. Cork, Ireland
D2	4.4	Water samples taken from a stream in the River Dripsey Catchment, on a farm near the village of Donoughmore, Co. Cork, Ireland

Table 6.2 - A Comparison of Phosphate Concentrations in Streams and Drains in the Vicinity of The Terminal Site, and Background Concentrations at Streams and Drains Within Farmland in Ireland.[3]

General Considerations Relating to the Proposed Development

The attached contour plots show the distribution of elevated leachable orthophosphate concentrations within the footprint of the terminal site. It is estimated that approximately 40% of the peat to be removed from the terminal site as part of the proposed development, from surface to 0.15m below ground level (bgl), and approximately 5% of the peat to be removed, between 0.15 and 0.30m bgl will have elevated leachable orthophosphate concentrations.

Section 8.6.1 of Volume 1 the EIS states that the proposed terminal will involve the excavation of approximately 450,000m^3 of peat, and about 200,000m^3 of mineral soils, terrace deposits and weathered rocks, over an area of 113,000m^2 within the footprint of the main terminal building.

The total volume of peat with elevated leachable orthophosphate concentrations is approximately 7627.5 m^3 (6,780 m^3 from surface to 0.15m bgl and 847.5 m^3 from 0.15 to 0.30m bgl). This constitutes only approximately 1.6% of the total volume of peat to be excavated, and 1.1% of the total volume of all materials to be excavated (including peat and mineral soils). It will be removed from site sequentially over a time period of *circa* 5 months and will not be taken off site *en bloc*.

Furthermore, the majority of the peat to be excavated that shows elevated leachable orthophosphate concentrations is present in the driest areas of the terminal site. When this peat is excavated and stored prior to removal to Srahmore, very little free water is likely to leach from it. Excavated peat will be stored for a short period at the terminal site (see Section 3, Volume 1 of the EIS) prior to removal from site to allow any free

[2] These values represent maximum recorded concentrations

[3] Source: Teagasc Synthesis Report. *Quantification of Phosphorous Loss From Soil To Water*

water to drain off. The stored material will be covered with waterproof sheeting in periods of high rainfall.

In view of the above, it is considered very unlikely that the excavated materials removed from terminal site will impact on the water qualities of Carrowmore Lake and its in-flowing water courses or to the water environment at the Bord Na Móna peat reception site at Srahmore.

Planning Application Boundary

Nutrient Pit

Phosphate Contours

Terminal Site

Pt32 Pt30 Pt34 Pt31 Pt33 Pt29 Pt28 Pt58 Pt55 Pt50 Pt51 Pt27 Pt54 Pt49 Pt52 Pt60 100 Pt48 Pt43 Pt46 Pt56 PT47 Pt44 Pt61 Pt45 Pt8 Pt41 Pt53 200 Pt39 Pt40 Pt10 Pt18 PT38 PT37 Pt11 Pt7 Pt16 Pt20 PT36 Pt12 Pt15 Pt21 PT35 Pt14 Pt22 Pt26 Pt23 Pt25 Pt24

Rev	Date	Description	Drn	Chk	App
01	26.02.04	Appendix N1	DL		

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BELLANABOY BRIDGE TERMINAL

Corrib natural gas

TITLE: **SPATIAL DISTRIBUTION OF PHOSPHATE (0.00 - 0.15m)**

NOT TO SCALE | REV 01

FILE NAME: P40036\CT -Phosphate_N1.WOR

Planning Application Boundary

Nutrient Pit

Phosphate Contours

Rev	Date	Description	Drn	Chk	App
01	26.02.04	Appendix N2	DL		

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BELLANABOY BRIDGE TERMINAL

Corrib natural gas

TITLE: **SPATIAL DISTRIBUTION OF PHOSPHATE (0.15 - 0.30m)**

NOT TO SCALE | REV 00

FILE NAME: P40036\CT -Phosphate_N2.WOR

7. *Details of site drainage of terminal and silt control measures proposed at the various stages of construction and peat excavation. A clear and detailed map of the existing site drainage, and of the site drainage works and silt ponds proposed at the various stages of construction and peat excavation, should be provided.*

The proposed site drainage and silt control measures, at various stages of construction and peat excavation, are described comprehensively in the planning application documents.

Section 3 of Volume 1 of the EIS, contains a comprehensive description of the proposed site drainage and silt control measures, at various stages of construction and peat excavation. In particular:

- The upgrading of the existing land drains is described in Section 3.4.6 and Figure 3.2.
- The settlement ponds are described in Section 3.4.7
- General drainage of the area of excavation is described in Section 3.5.5
- The sequence of peat removal and related drainage issues are described in Section 3.5.6 and illustrated in Figures 3.4, 3.5, and 3.6
- The drainage mitigation measures during the construction phase are described in Section 9.5.1

The Technical Appendix 3 (Site Drainage Report) to Volume 1 of the EIS describes all aspects of the proposed site drainage, including during construction. In particular:

- The surface water drainage is described in Section 2, with Section 2.1 presenting the design parameters and Section 2.2 presenting the description of the drainage during the construction phase. Drawings COR-AR-SD-005 and COR-AR-SD-006 show the site drainage during the construction phase and Calculations 1, 2, and 3 provide the design calculations for the site drainage during the construction phase.
- The settlement ponds are described in Section 4, with Section 4.1 presenting the design parameters and Section 2.2 describing the operation of the settlement ponds during the construction phase. Drawing COR-AR-SD-003 shows the construction phase operation of the permanent and field settling ponds. Calculations 6, 8, and 9 provide the design calculations for the construction phase operation of the permanent and field settling ponds.
- The drainage of the site during the early stages of construction is described in Section 5.

In addition to the proposed drainage works, drawings COR-AR-SD-005 and COR-AR-SD-006 show the existing site drains, and also show how the existing site drains will be modified at various stages of the construction and peat excavation.

Three additional drawings are attached:

- Drawings COR-AR-SD-RFI-003 and COR-AR-SD-RFI-004 are based on drawings COR-AR-SD-005 and COR-AR-SD-006, which were part of Technical Appendix 3, Volume 1 of the EIS. The temporary, pumped drainage measures for the faces of the excavation, which are described in Section 3.5.6 of Volume 1 of the EIS, are shown on drawings COR-AR-SD-RFI-003 and COR-AR-SD-RFI-004, in addition to the information in the original drawings.
- Drawing COR-AR-SD-RFI-005 shows the drainage layout and details when the excavation and peat removal operations have been completed.

1. DURING CONSTRUCTION OF THE TERMINAL SURFACE WATER WITHIN THE TERMINAL WILL BE STAPED AND PUMPED TO THE EXISTING FIELD DRAINS.
2. REFER TO CORRIB GAS FIELD DEVELOPMENT, ES, VOLUME 1, BELLANABOY BRIDGE TERMINAL, APPENDIX 2, EARTHWORKS REPORT, SECTION 3.8.2 FOR FURTHER INFORMATION ON SURFACE WATER DRAINAGE WITHIN THE TERMINAL DURING CONSTRUCTION
3. THIS DRAWING HAS BEEN PREPARED BASED ON DRAWING No. COR-AR-SD-005 AS SUBMITTED PREVIOUSLY AS PART OF CORRIB GAS FIELD DEVELOPMENT, ES, VOLUME 1, BELLANABOY BRIDGE TERMINAL, APPENDIX 3, SITE DRAINAGE REPORT

LEGEND:

- OPEN CHANNEL
- EXISTING OPEN CHANNEL
- CULVERT

PLANT NORTH

NORTH

20°

EXISTING FIELD DRAIN

FIELD DRAIN SILT POND AS PER DETAIL 1

EXISTING OPEN CHANNEL 001

EXISTING OPEN CHANNEL 004

CULVERT EXISTING DRAIN

CULVERT 004 AROUND TEMPORARY CONSTRUCTION FACILITY

CATCH DRAIN

2.5m DEEP OPEN DRAIN

TEMPORARY CONSTRUCTION FACILITY

900mm DIAMETER SEE DETAIL 03

PLANT

3 WAY MANIFOLD

PETROL INTERCEPTOR

EXISTING OPEN CHANNEL 001

OPEN CHANNEL 001

TEMPORARY CONSTRUCTION FACILITY

SEE DETAIL 4

EXISTING TREES

900mm DIAMETER SEE DETAIL 05

0.5m DEEP OPEN DRAIN

900mm DIAMETER SEE DETAIL 05

0.5m DEEP OPEN DRAIN

CULVERT 001 AND CULVERT 003 AS PER DETAIL 03

PETROL INTERCEPTOR

EXISTING OPEN CHANNEL 004

TEMPORARY CONSTRUCTION FACILITY SILT POND SEE DETAIL 6

EXISTING OPEN CHANNEL 001

EXISTING OPEN CHANNEL 004

ROAD DRAIN SILT POND AS PER DETAIL 7

EXISTING ROAD DITCH TO BE DIVERTED UNDER ROAD ENTRANCE AND DISCHARGE TO EXISTING CULVERT TO ROAD DITCH

DETAIL 02
TYPICAL SECTION
THROUGH SILT POND ON FIELD DRAIN
SCALE 1:50

DETAIL 06
TYPICAL SECTION
THROUGH SILT POND ON D99
SCALE 1:50

DETAIL 07
TYPICAL SECTION
THROUGH SILT POND ON ROAD DRAIN
SCALE 1:50

DETAIL 01
TYPICAL DRAINAGE LAYOUT
SCALE 1:500

DETAIL 04
TYPICAL SECTION B-B OF ROADSIDE DRAIN
SCALE 1:25

DETAIL 05
TYPICAL SECTION
THROUGH CULVERT CROSSING OF MAIN PERIMETER DRAIN
SCALE 1:25

DETAIL 03
TYPICAL SECTION A-A OF ROADSIDE DRAIN
SCALE 1:25

Corrib Field Development

Bellanaboy Bridge Gas Terminal

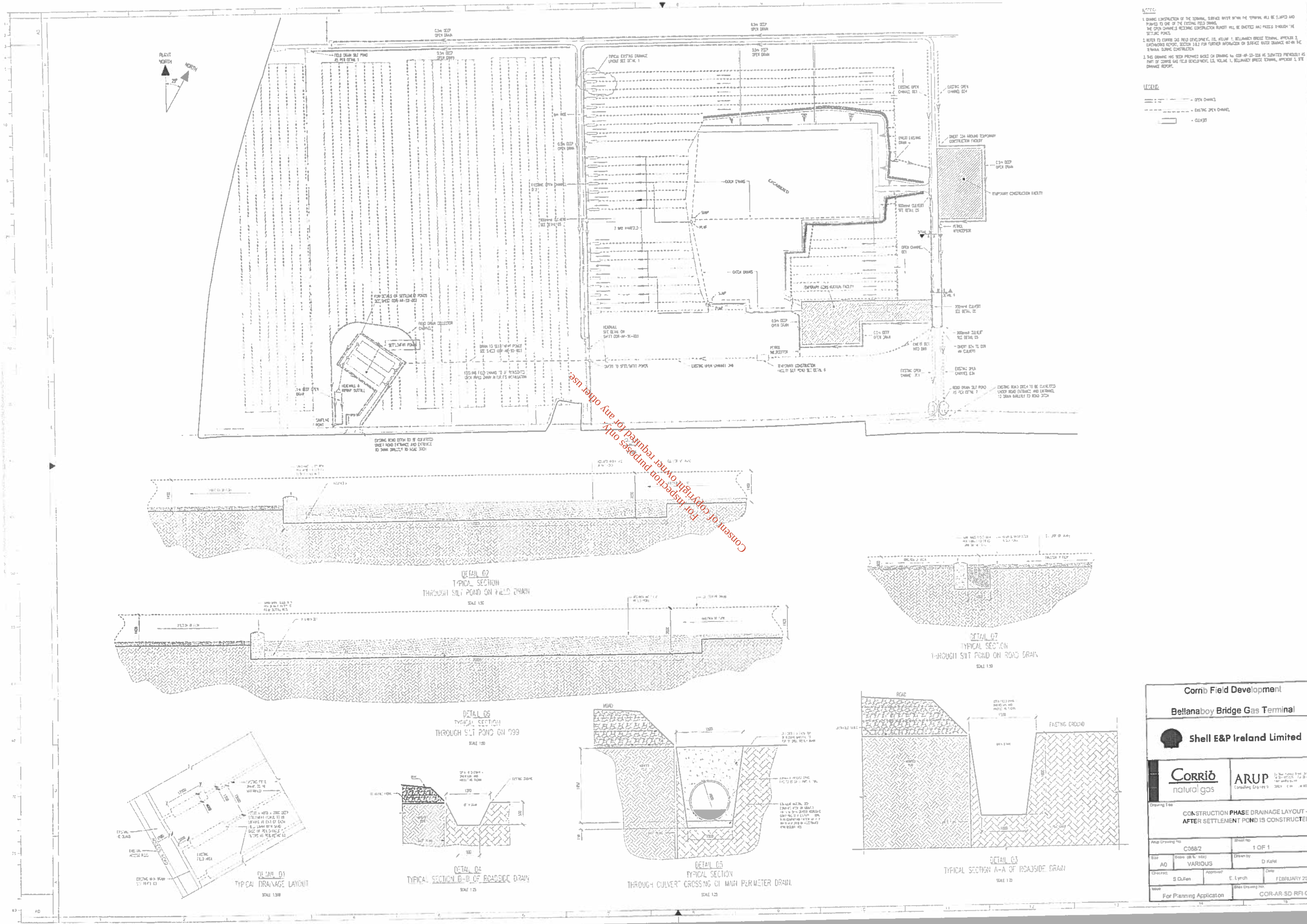
Shell E&P Ireland Limited

Corrib natural gas

ARUP

Drawing Title
CONSTRUCTION PHASE DRAINAGE LAYOUT - BEFORE SETTLEMENT POND IS CONSTRUCTED

Arup Drawing No. C068/1	Sheet No. 1 OF 1
Size A0	Scale (at full size) VARIOUS
Drawn D Kane	
Checked S Cullen	Approved E. Lynch
Date FEBRUARY 2004	
Status For Planning Application	Shell Drawing No. COR-AR-SD-RFI-003



Corrib Field Development

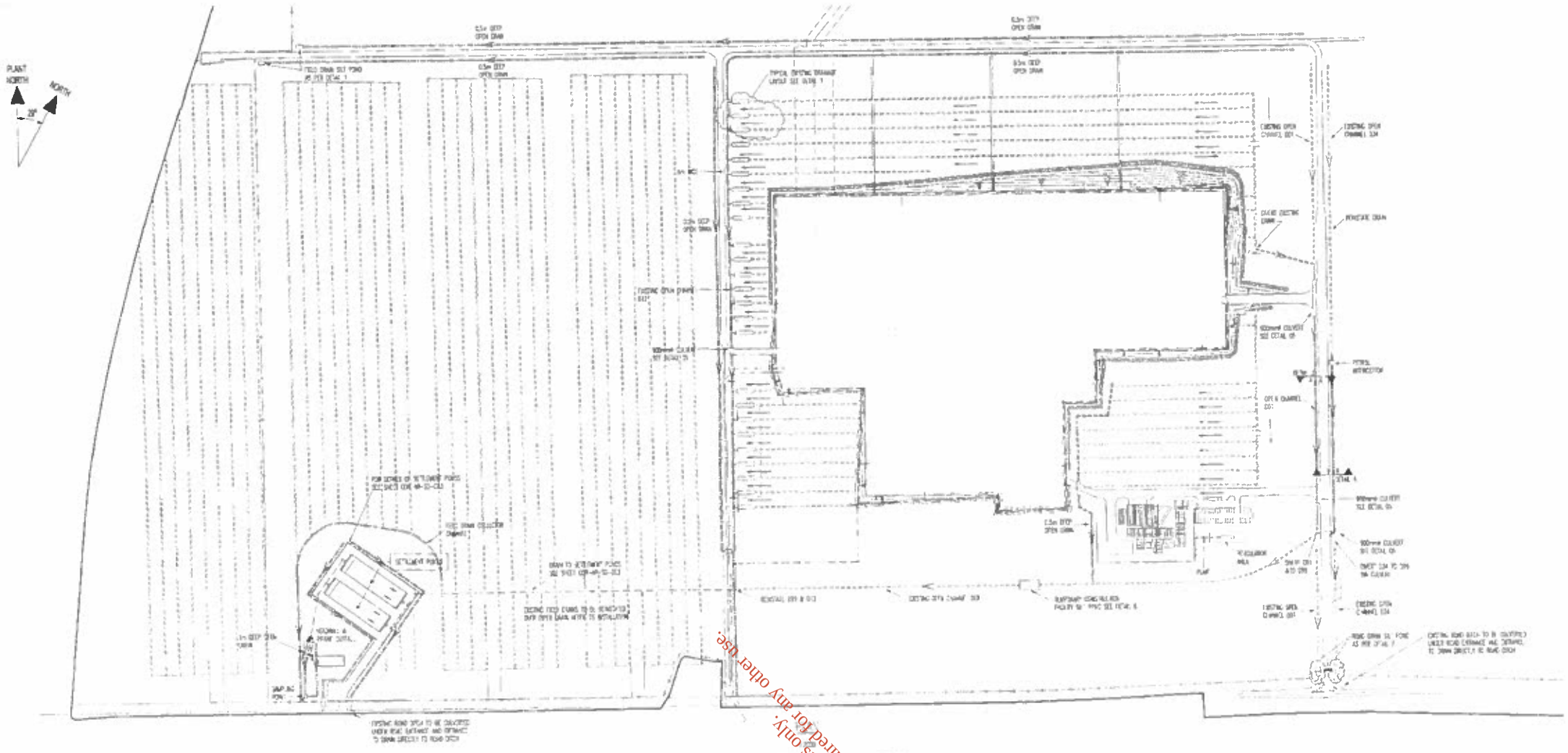
Bellanaboy Bridge Gas Terminal

Shell E&P Ireland Limited

Corrib natural gas | ARUP

Drawing Title: CONSTRUCTION PHASE DRAINAGE LAYOUT - AFTER SETTLEMENT POND IS CONSTRUCTED

Arup Drawing No.	C0882	Sheet No.	1 OF 1
Size	A0	Scale	VARIOUS
Drawn by	D Kehel	Checked	S Cullen
Approved	E Lynch	Date	FEBRUARY 2004
Issue	For Planning Application	Shell Drawing No.	COR-AR-SD-RFI-004

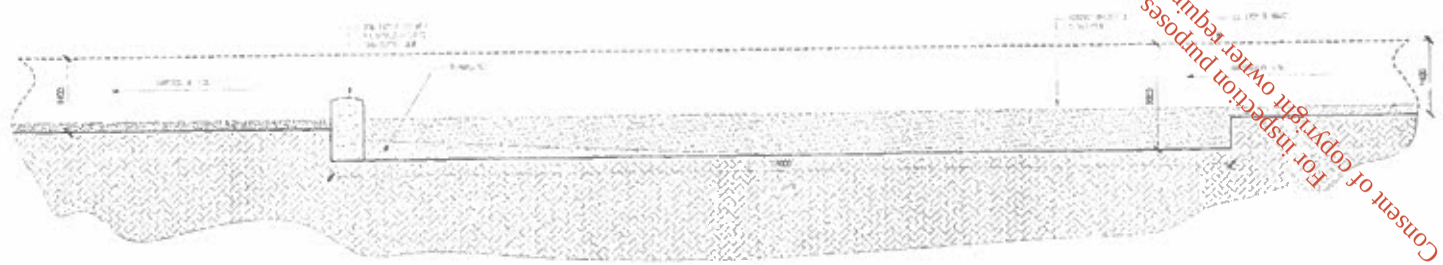


1. DURING CONSTRUCTION OF THE TERMINAL, SURFACE WATER WITHIN THE TERMINAL WILL BE COLLECTED AND PUMPED TO ONE OF THE EXISTING FIELD DRAINS. THE OPEN CHANNELS EXISTING CONSTRUCTION RUNOFF WILL BE CONTACTED AND PASSED THROUGH THE SETTLING PONDS.

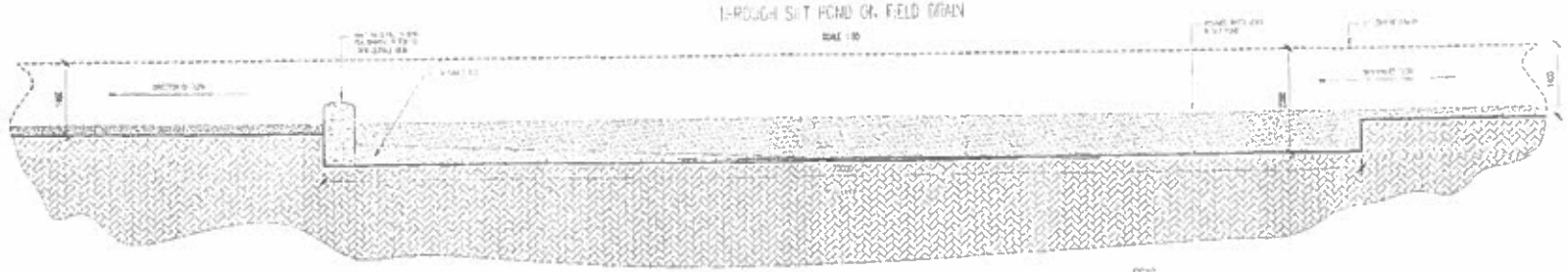
2 REFER TO CORRIB GAS FIELD DEVELOPMENT, ES, VOLUME 1, BELLANABOY GAS/OIL TERMINAL, APPENDIX 3, EARTHWORKS REPORT, SECTION 3.8.3 FOR FURTHER INFORMATION ON SURFACE WATER DRAINAGE WITHIN THE TERMINAL DURING CONSTRUCTION

LEGEND:

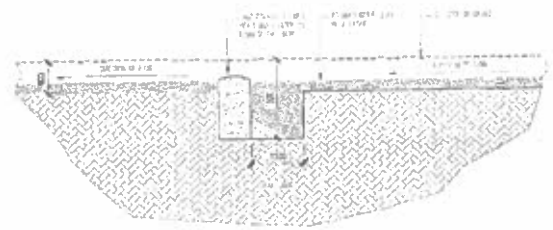
- OPEN CHANNEL
- EXISTING OPEN CHANNEL
- CULVERT



DETAIL 02
TYPICAL SECTION
THROUGH SILT POND ON FIELD DRAIN
SCALE 1:50

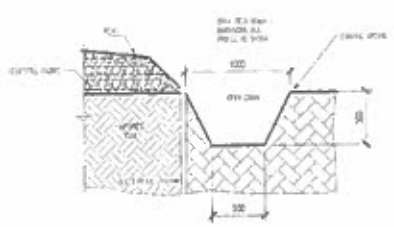


DETAIL 05
TYPICAL SECTION
THROUGH SILT POND ON D99
SCALE 1:50

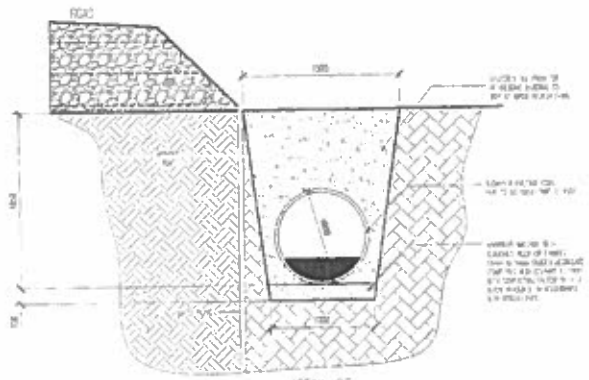


DETAIL 07
TYPICAL SECTION
THROUGH SILT POND ON ROAD DRAIN
SCALE 1:50

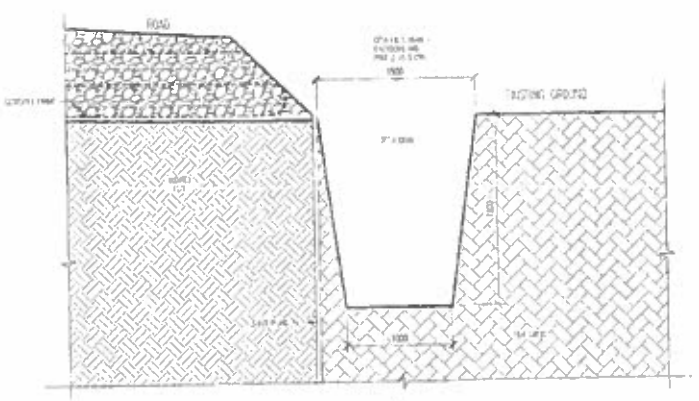
DETAIL 01
TYPICAL DRAINAGE LAYOUT
SCALE 1:500



DETAIL 04
TYPICAL SECTION B-B OF ROADSIDE DRAIN
SCALE 1:25



DETAIL 06
TYPICAL SECTION
THROUGH CULVERT CROSSING OF MAIN PERIMETER DRAIN
SCALE 1:25



DETAIL 03
TYPICAL SECTION A-A OF ROADSIDE DRAIN
SCALE 1:25

Corrib Field Development	
Bellanaboy Bridge Gas Terminal	
Shell E&P Ireland Limited	
Corrib natural gas	ARUP
Drawing Title: CONSTRUCTION PHASE DRAINAGE LAYOUT - AFTER TERMINAL PLATFORM DRAINAGE IS CONSTRUCTED	
Arup Drawing No: C068/3	Sheet No: 1 OF 1
Size: A0	Scale (at full size): VAR/DUS
Drawn by: D Kavanagh	
Checked: B Cullen	Approved: E. Lynch
Date: FEBRUARY 2004	
Issue: For Planning Application	Other Drawing No: COR-AR-SD-RFI-005

8. *Baseline physico-chemical data on water quality conditions in and around the site.*

The enclosed report provides a summary of the baseline physico-chemical data on water quality conditions around the site. Sampling locations are also shown.

1 Introduction

The information provided in this report summarises the water quality data which were collected from water courses both within the boundary of the terminal development site (Drains 16, 22 and 64), and in the vicinity of it (various streams and rivers). The data summarised were produced from monthly surveys carried out between June 2001 and May 2002. It should be noted that sampling of the drains was introduced in the middle of that period, and therefore a full year's data do not exist for those sites.

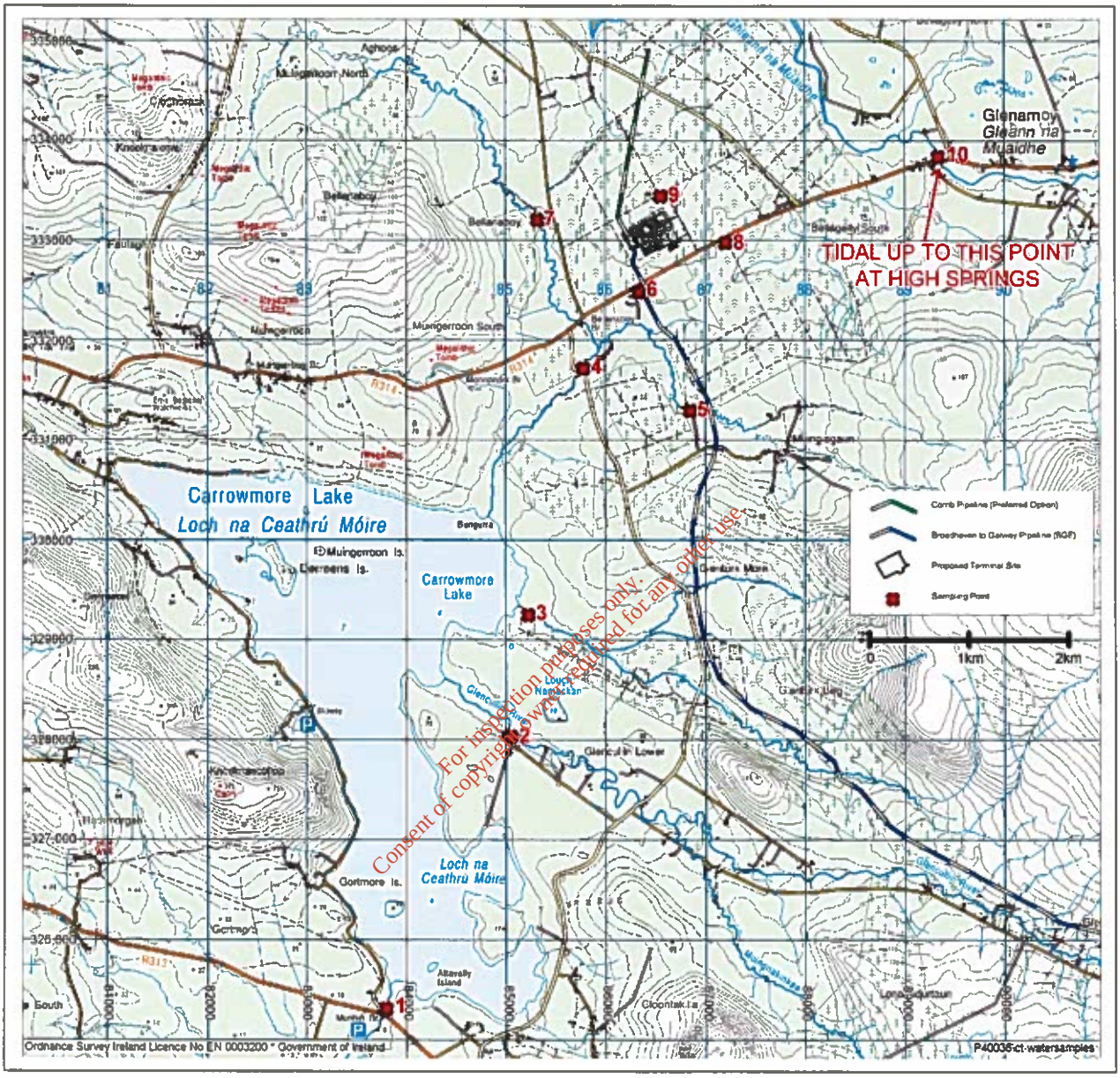
Table 1 summarises the number of samples taken from each of the locations, and Figure 1 shows the locations of those sites.

Table 1: Numbers of samples taken at each survey location

Location Ref.	Location Name	No. of samples/site
Site 1	Lake outlet	12
Site 2	Glencullen River	12
Site 3	Glenturk River	12
Site 4	Bellanaboy Bridge	12
Site 5	Muingingaun River	12
Site 6	Drain 16	7
Site 7	Aghoos River	12
Site 8	Drain 22	7
Site 9	Drain 62	5
Site 10	Glenamoy Bridge	12

It should be noted that the regulations against which all sites have been compared are not applicable to all sites, in particular the drains (sites 6, 8 and 9) are not considered "lotic" (flowing). Comparisons of data from the drains against the regulations are therefore provided for information only.

Figure 1: Locations of sampling sites in and around the proposed Terminal Development



2 Comparison of Field Data Against Regulatory Values

A short commentary on the comparison of survey data against regulatory values is provided beneath each of the following tables.

In several cases the average values reported in the tables are prefixed with a "less than" sign (<). This is because when readings were provided by the laboratories some samples were shown to contain less of the parameter measured (the 'analyte') than the detection limit for that parameter. In those cases, the detection limit was used to calculate the average. Thus, where the average is prefixed with "<", a worst case average has been calculated (as the true concentration of the analyte may have been much lower than the detection limit).

There are also a number of points where the average is prefixed by "<", but the minimum value does not have the same prefix. This is due to an improvement in detection limits for that particular analyte during the twelve months of sampling (i.e. if in June 2001 the detection limit was 0.05mg/l for nitrite, and a sample contained less than that, the reading used in the "average" calculation would be 0.05, resulting in a "less than" prefixed average. However, if later in the year the detection limit improved to 0.01mg/l, we may have achieved a positive reading of 0.02mg/l, which of course is lower than the original detection limit.

Table 2: Data from the sampling locations compared with Temperature limits under the Quality of Salmonid Waters Regulation 1988 (EC Freshwater Fish Directive)

Sampling Site	Parameter	Standard	Lower Limit	Upper Limit	Number of Readings	Average	Range		No. Exceeding Limit
							Min.	Max.	
Lake Outlet	Temperature (°C)	Quality of Salmonid Waters Regulation 1988 (EC Freshwater Fish Directive)	10 °C	21.5°C	12	11.6	5.9	17.4	1
Glencullen River	Temperature (°C)		10 °C	21.5°C	12	10.8	5.1	16.1	2
Glenturk River	Temperature (°C)		10 °C	21.5°C	12	10.4	5.6	13.8	2
Bellanaboy Bridge	Temperature (°C)		10 °C	21.5°C	12	10.4	5.1	14.5	1
Muingingaun River	Temperature (°C)		10 °C	21.5°C	12	10.4	4.9	15.3	1
Drain 16	Temperature (°C)		10 °C	21.5°C	7	8.1	5.8	10.1	1
Aghoos River	Temperature (°C)		10 °C	21.5°C	12	10.7	4.9	15.6	2
Drain 22	Temperature (°C)		10 °C	21.5°C	7	8.0	5	10	0
Drain 62	Temperature (°C)		10 °C	21.5°C	5	8.2	5.7	11.1	0
Glenamoy Bridge	Temperature (°C)		10 °C	21.5°C	12	10.6	4.8	15.8	2
Limit values for temperature are determined by the Quality of Salmonid Waters Regulation 1988 (EC Freshwater Directive). Temperatures should not exceed 21.5°C in the period between 1st May and 31st October. During the period between 1st Nov - 30th April, the temperatures should not exceed 10°C.									

There were a number of elevated temperature readings at the sampling locations during the period June 2001 – May 2002. All sampling locations had at least one value higher than the recommended Regulation value. All exceedances occurred during the period 1st November – 31st April when the regulatory level for temperature is 10°C.

Table 3: Data from the sampling locations compared with pH limits under the Quality of Salmonid Waters Regulation 1988 (EC Freshwater Fish Directive)

Sampling Site	Parameter	Standard	Lower Limit	Upper Limit	Number of Readings	Average	Range		Number of readings outside limits
							Min.	Max.	
Lake Outlet	pH	Quality of Salmonid Waters Regulation 1988 (EC Freshwater Fish Directive)	pH 6	pH 9	12	7.29	6.00	7.85	0
Glencullen River	pH		pH 6	pH 9	12	7.16	5.48	7.77	1
Glenturk River	pH		pH 6	pH 9	12	6.14	4.93	7.75	6
Bellanaboy Bridge	pH		pH 6	pH 9	12	6.53	5.16	7.33	1
Muingingaun River	pH		pH 6	pH 9	12	6.85	5.87	7.50	1
Drain 16	pH		pH 6	pH 9	7	6.43	5.53	7.07	2
Aghoos River	pH		pH 6	pH 9	12	6.49	4.96	7.37	3
Drain 22	pH		pH 6	pH 9	7	6.37	5.36	6.96	1
Drain 62	pH		pH 6	pH 9	5	5.01	4.60	5.54	4
Glenamoy Bridge	pH		pH 6	pH 9	12	6.95	5.58	7.77	1

With the exception of Site 1 (Lake Outlet), the lower limit pH value of 6 was breached by at least one sample at all sampling locations throughout the June 2001 – May 2002 monthly sampling period. There were no exceedances for the upper limit of pH 9 throughout the June 2001 – May 2002 monitoring programme.

Table 4: Data from the sampling locations compared with pH limits under the EC Drinking Water Regulations 2000

Sampling Site	Parameter	Standard	Lower Limit	Upper Limit	No. of Readings	Average	Range		Number of readings outside limits
							Min.	Max.	
Lake Outlet	pH	EC Drinking Water Regulations 2000	pH 6.5	pH 9.5	12	7.29	6.00	7.85	1
Glencullen River	pH		pH 6.5	pH 9.5	12	7.16	5.48	7.77	2
Glenturk River	pH		pH 6.5	pH 9.5	12	6.14	4.93	7.75	6
Bellanaboy Bridge	pH		pH 6.5	pH 9.5	12	6.53	5.16	7.33	6
Muingingaun River	pH		pH 6.5	pH 9.5	12	6.85	5.87	7.50	3
Drain 16	pH		pH 6.5	pH 9.5	7	6.43	5.53	7.07	3
Aghoos River	pH		pH 6.5	pH 9.5	12	6.49	4.96	7.37	5
Drain 22	pH		pH 6.5	pH 9.5	7	6.37	5.36	6.96	3
Drain 62	pH		pH 6.5	pH 9.5	5	5.01	4.60	5.54	4
Glenamoy Bridge	pH		pH 6.5	pH 9.5	12	6.95	5.58	7.77	2

At least one reading from each of the sites recorded through the June 2001 – May 2002 monthly sampling period was lower than the lower limit (pH 6.5) under the EC Drinking Water Regulations 2000. There were no exceedances for the upper limit of pH 9 throughout the June 2001 – May 2002 monitoring programme.

Table 5: Data from the sampling locations compared with dissolved oxygen limits under the Quality of Salmonid Waters Regulation 1988 (EC Freshwater Fish Directive)

Sampling Site	Parameter	Standard	Lower Limit	Upper Limit	Number of Readings	Average	Range		Number of samples less than 6mg/l) (failures)	Sites where less than 50% of samples are greater than 9mg/l (failed)
							Min.	Max.		
Lake Outlet	Dissolved O_2	Quality of Salmonid Waters Regulation 1988 (EC Freshwater Fish Directive)	6 mg/l O_2	9 mg/l O_2	12	9.15	5.39	11.50	1	Fail (<6mg/l)
Glencullen River	Dissolved O_2		6 mg/l O_2	9 mg/l O_2	12	8.95	5.79	11.30	1	Fail (<6mg/l) & (7/12 < 9mg/l)
Glenturk River	Dissolved O_2		6 mg/l O_2	9 mg/l O_2	12	8.51	5.25	11.30	2	Fail (<6mg/l) & (7/12 < 9mg/l)
Bellanaboy Bridge	Dissolved O_2		6 mg/l O_2	9 mg/l O_2	12	8.68	6.04	11.70	0	Fail (7/12 < 9mg/l)
Muingingaun River	Dissolved O_2		6 mg/l O_2	9 mg/l O_2	12	9.21	6.22	11.60	0	
Drain 16	Dissolved O_2		6 mg/l O_2	9 mg/l O_2	7	9.59	8.01	11.90	0	
Aghoos River	Dissolved O_2		6 mg/l O_2	9 mg/l O_2	12	9.26	7.05	11.60	0	Fail (7/12 < 9mg/l)
Drain 22	Dissolved O_2		6 mg/l O_2	9 mg/l O_2	7	9.59	8.78	11.20	0	
Drain 62	Dissolved O_2		6 mg/l O_2	9 mg/l O_2	5	8.79	6.55	10.70	0	0
Glenamoy Bridge	Dissolved O_2		6 mg/l O_2	9 mg/l O_2	12	8.74	5.08	11.90	2	Fail (<6mg/l)
NB: Samples outside limits. No sample should be below 6mg/l, and 50% of samples need to be greater than 9mg/l over a year of sampling										

Only the Muingingaun River passes both regulatory limits. Less than 50% of the readings taken at Bellanaboy Bridge and the Aghoos River contained 9 mg/l O_2 or more, while the Lake Outlet and Glenamoy River failed on the basis that one or more readings were below 6mg/l in the year. The Glencullen and Glenturk Rivers failed on both test parameters.

Table 6: Data from the sampling locations compared with suspended solids limits under the Quality of Salmonid Waters Regulation 1988 (EC Freshwater Fish Directive)

Sampling Site	Parameter	Standard	Upper Limit	Number of Readings	Average	Range		No. Exceeding Limit
						Min.	Max.	
Lake Outlet	Suspended Solids	Quality of Salmonid Waters Regulation 1988 (EC Freshwater Fish Directive)	25 mg/l	12	<22	<3	109	2
Glencullen River	Suspended Solids		25 mg/l	12	<12	<3	56	1
Glenturk River	Suspended Solids		25 mg/l	12	<14	3	52	2
Bellanaboy Bridge	Suspended Solids		25 mg/l	12	<11	3	52	1
Muingingaun River	Suspended Solids		25 mg/l	12	<10	<3	32	1
Drain 16	Suspended Solids		25 mg/l	7	<13	<3	40	2
Aghoos River	Suspended Solids		25 mg/l	12	<12	<3	56	1
Drain 22	Suspended Solids		25 mg/l	7	<15	<3	68	1
Drain 62	Suspended Solids		25 mg/l	5	<8.	<3	24	1
Glenamoy Bridge	Suspended Solids		25 mg/l	12	<15	<3	50	2

Throughout the sampling period June 2001 – May 2002, the Regulatory Suspended Solids (SS) levels were exceeded by at least one sample at all sampling locations. However, all sites had an annual average <25mg/l SS, which is within the regulatory limit.

Table 7: Data from the sampling locations compared with nitrite limits under the Quality of Salmonid Waters Regulation 1988 (EC Freshwater Fish Directive)

Sampling Site	Parameter	Standard	Upper Limit	No. of Readings	Average	Range		No. Exceeding Limit
						Min.	Max.	
Lake Outlet	Nitrite (mg/l NO_2)	Quality of Salmonid Waters Regulation 1988 (EC Freshwater Fish Directive)	0.05 mg/l NO_2	12	<0.07	0.01	0.33	2
Glencullen River	Nitrite (mg/l NO_2)		0.05 mg/l NO_2	12	<0.06	0.01	0.30	2
Glenturk River	Nitrite (mg/l NO_2)		0.05 mg/l NO_2	12	<0.07	0.01	0.34	2
Bellanaboy Bridge	Nitrite (mg/l NO_2)		0.05 mg/l NO_2	12	<0.08	0.01	0.44	2
Muingingaun River	Nitrite (mg/l NO_2)		0.05 mg/l NO_2	12	<0.07	0.01	0.31	2
Drain 16	Nitrite (mg/l NO_2)		0.05 mg/l NO_2	7	<0.11	0.02	0.50	2
Aghoos River	Nitrite (mg/l NO_2)		0.05 mg/l NO_2	12	<0.07	0.01	0.38	2
Drain 22	Nitrite (mg/l NO_2)		0.05 mg/l NO_2	7	<0.10	0.03	0.37	2
Drain 62	Nitrite (mg/l NO_2)		0.05 mg/l NO_2	5	0.09	0.02	0.30	2
Glenamoy Bridge	Nitrite (mg/l NO_2)		0.05 mg/l NO_2	12	<0.07	0.01	0.39	2

Two samples from all sampling locations throughout the sampling period exceeded the regulatory and nitrite (NO_2) levels. The regulatory limit allows only 5% of samples to be above 0.05mg/l before the site fails the standard. As a maximum of twelve samples were taken from each site, in combination with the fact that at least one sample from each location failed, indicates that all sites failed on the nitrite standard.

Table 8: Data from the sampling locations compared with nitrite limits under the EC Drinking Water Regulations 2000

Sampling Site	Parameter	Standard	Upper Limit	No. of Readings	Average	Range		No. Exceeding Limit
						Min.	Max.	
Lake Outlet	Nitrite (mg/l NO_2)	EC Drinking Water Regulations 2000	0.5 mg/l NO_2	12	<0.07	0.01	0.33	0
Glencullen River	Nitrite (mg/l NO_2)		0.5 mg/l NO_2	12	<0.063	0.01	0.30	0
Glenturk River	Nitrite (mg/l NO_2)		0.5 mg/l NO_2	12	<0.07	0.01	0.34	0
Bellanaboy Bridge	Nitrite (mg/l NO_2)		0.5 mg/l NO_2	12	<0.08	0.01	0.44	0
Muingingaun River	Nitrite (mg/l NO_2)		0.5 mg/l NO_2	12	<0.07	0.01	0.31	0
Drain 16	Nitrite (mg/l NO_2)		0.5 mg/l NO_2	7	<0.113	0.02	0.50	0
Aghoos River	Nitrite (mg/l NO_2)		0.5 mg/l NO_2	12	<0.07	0.01	0.38	0
Drain 22	Nitrite (mg/l NO_2)		0.5 mg/l NO_2	7	<0.10	0.03	0.37	0
Drain 62	Nitrite (mg/l NO_2)		0.5 mg/l NO_2	5	0.09	0.02	0.30	0
Glenamoy Bridge	Nitrite (mg/l NO_2)		0.5 mg/l NO_2	12	<0.07	0.01	0.39	0

All readings from all sites were within the limits set for Nitrite in the EC Drinking Water Regulations

Table 9: Data from the sampling locations compared with total ammonium limits under the Quality of Salmonid Waters Regulation 1988 (EC Freshwater Fish Directive)

Sampling Site	Parameter	Standard	Upper Limit	No. of Readings	Average	Range		No. Exceeding Limit
						Min.	Max.	
Lake Outlet	Total Ammonium (mg/l NH_4)	Quality of Salmonid Waters Regulation 1988 (EC Freshwater Fish Directive)	1 mg/l NH_4	12	0.12	0.00	0.945	0
Glencullen River	Total Ammonium (mg/l NH_4)		1 mg/l NH_4	12	0.17	0.00	0.784	0
Glenturk River	Total Ammonium (mg/l NH_4)		1 mg/l NH_4	12	0.19	0.00	0.98	0
Bellanaboy Bridge	Total Ammonium (mg/l NH_4)		1 mg/l NH_4	12	0.39	0.00	2.70	1
Muingingaun River	Total Ammonium (mg/l NH_4)		1 mg/l NH_4	12	0.34	0.00	1.50	2
Drain 16	Total Ammonium (mg/l NH_4)		1 mg/l NH_4	7	0.97	0.00	3.86	2
Aghoos River	Total Ammonium (mg/l NH_4))		1 mg/l NH_4	12	0.47	0.00	2.57	2
Drain 22	Total Ammonium (mg/l NH_4)		1 mg/l NH_4	7	0.74	0.07	2.57	2
Drain 62	Total Ammonium (mg/l NH_4)		1 mg/l NH_4	5	0.27	0.04	1.00	0
Glenamoy Bridge	Total Ammonium (mg/l NH_4)		1 mg/l NH_4	12	0.42	0.00	3.60	1

Lake Outlet, Glencullen River and Glenturk River had no exceedances of the 1mg/l total ammonium standard. At least one sample from the other sites was greater than that level, meaning that these sites exceed the limit set (as 1 failure in 12 is more than 5%).

Table 10: Data from the sampling locations compared with total ammonium limits under the EC Drinking Water Regulations 2000

Sampling Site	Parameter	Standard	Upper Limit	No. of Readings	Average	Range		No. Exceeding Limit
						Min.	Max.	
Lake Outlet	Total Ammonium (mg/l NH_4)	EC Drinking Water Regulations 2000	0.3 mg/l NH_4	12	0.17	0.00	0.94	4
Glencullen River	Total Ammonium (mg/l NH_4)		0.3 mg/l NH_4	12	0.17	0.00	0.78	4
Glenturk River	Total Ammonium (mg/l NH_4)		0.3 mg/l NH_4	12	0.19	0.00	0.98	6
Bellanaboy Bridge	Total Ammonium (mg/l NH_4)		0.3 mg/l NH_4	12	0.39	0.00	2.70	6
Muingingaun River	Total Ammonium (mg/l NH_4)		0.3 mg/l NH_4	12	0.34	0.00	1.50	7
Drain 16	Total Ammonium (mg/l NH_4)		0.3 mg/l NH_4	7	0.97	0.033	3.86	3
Aghoos River	Total Ammonium (mg/l NH_4))		0.3 mg/l NH_4	12	0.47	0.00	2.57	6
Drain 22	Total Ammonium (mg/l NH_4)		0.3 mg/l NH_4	7	0.74	0.07	2.57	3
Drain 62	Total Ammonium (mg/l NH_4)		0.3 mg/l NH_4	5	0.27	0.039	1.00	1
Glenamoy Bridge	Total Ammonium (mg/l NH_4)		0.3 mg/l NH_4	12	0.42	0.00	3.60	5

Total Ammonium (NH_4) values exceeded the EC Drinking Water Regulatory values at all sampling locations for almost 50% of the sampling frequency in the twelve month sampling period, June 2001 – May 2002. A single breach of the limit means that the site has failed.

Table 11: Data from the sampling locations compared with nitrate limits under the EC Drinking Water Regulations 2000

Sampling Site	Parameter	Standard	Upper Limit	No. of Readings	Average	Range		No. Exceeding Limit
						Min.	Max.	
Lake Outlet	Nitrate (mg/l NO_3)	EC Drinking Water Regulations 2000	50 mg/l NO_3	12	<1.00	0.01	3.00	0
Glencullen River	Nitrate (mg/l NO_3)		50 mg/l NO_3	12	<1.33	0.01	3.55	0
Glenturk River	Nitrate (mg/l NO_3)		50 mg/l NO_3	12	<1.82	0.01	5.04	0
Bellanaboy Bridge	Nitrate (mg/l NO_3)		50 mg/l NO_3	12	2.26	0.04	5.80	0
Muingingaun River	Nitrate (mg/l NO_3)		50 mg/l NO_3	12	<1.41	0.01	4.01	0
Drain 16	Nitrate (mg/l NO_3)		50 mg/l NO_3	7	<0.65	<0.05	3.00	0
Aghoos River	Nitrate (mg/l NO_3)		50 mg/l NO_3	12	<2.78	0.01	10.41	0
Drain 22	Nitrate (mg/l NO_3)		50 mg/l NO_3	7	0.74	0.20	2.00	0
Drain 62	Nitrate (mg/l NO_3)		50 mg/l NO_3	5	<0.13	0.01	0.30	0
Glenamoy Bridge	Nitrate (mg/l NO_3)		50 mg/l NO_3	12	<1.90	0.03	4.67	0

All readings from all sites were within the limits set for Nitrate in the EC Drinking Water Regulations.

Table 12: Data from the sampling locations compared with conductivity limits under the EC Drinking Water Regulations 2000

Sampling Site	Parameter	Standard	Upper Limit	No. of Readings	Average	Range		No. Exceeding Limit
						Min.	Max.	
Lake Outlet	Conductivity ($\mu S\ cm^{-1}$)	EC Drinking Water Regulations 2000	2500 $\mu S\ cm^{-1}$ (20 °C)	12	158	97	242	0
Glencullen River	Conductivity ($\mu S\ cm^{-1}$)		2500 $\mu S\ cm^{-1}$ (20 °C)	12	202	110	336	0
Glenturk River	Conductivity ($\mu S\ cm^{-1}$)		2500 $\mu S\ cm^{-1}$ (20 °C)	12	157	106	253	0
Bellanaboy Bridge	Conductivity ($\mu S\ cm^{-1}$)		2500 $\mu S\ cm^{-1}$ (20 °C)	12	203	117	394	0
Muingingaun River	Conductivity ($\mu S\ cm^{-1}$)		2500 $\mu S\ cm^{-1}$ (20 °C)	12	217	114	580	0
Drain 16	Conductivity ($\mu S\ cm^{-1}$)		2500 $\mu S\ cm^{-1}$ (20 °C)	7	227	143	310	0
Aghoos River	Conductivity ($\mu S\ cm^{-1}$)		2500 $\mu S\ cm^{-1}$ (20 °C)	12	203	111	391	0
Drain 22	Conductivity ($\mu S\ cm^{-1}$)		2500 $\mu S\ cm^{-1}$ (20 °C)	7	213	155	254	0
Drain 62	Conductivity ($\mu S\ cm^{-1}$)		2500 $\mu S\ cm^{-1}$ (20 °C)	5	197	137	235	0
Glenamoy Bridge	Conductivity ($\mu S\ cm^{-1}$)		2500 $\mu S\ cm^{-1}$ (20 °C)	12	188	104	357	0

All readings from all sites were within the limits set for conductivity in the EC Drinking Water Regulations.

Table 13: Data from the sampling locations compared with orthophosphate ratings under the Water Quality Standards for Phosphorous Regulations (1998)

Sampling Site	Parameter	Standard	Upper Limit	No. of Readings*	Average	Range		WQSPR
						Min.	Max.	
Lake Outlet	Othophosphate as P	Phosphate Regs 1998	See table below for biological rating of watercourse with respect to orthophosphate loading	3	1.9	1.00	3.71	5
Glencullen River	Othophosphate as P			3	1.68	1.00	3.05	5
Glenturk River	Othophosphate as P			3	3.11	1.00	7.34	5
Bellanaboy Bridge	Othophosphate as P			3	8.84	1.00	18.10	5
Muingingaun River	Othophosphate as P			3	7.04	3.40	10.80	5
Drain 16	Othophosphate as P			3	13.11	3.45	32.1	5
Aghoos River	Othophosphate as P			3	3.93	1.99	7.33	5
Drain 22	Othophosphate as P			3	103.45	75.9	131.00	≥2
Drain 62	Othophosphate as P			3	6.77	1.06	16.5	5
Glenamoy Bridge	Othophosphate as P			3	5.45	1.00	11.8	5
WQSPR = Water Quality Standards for Phosphorous Regulations								

* - phosphate concentrations were measured for samples taken throughout the survey period, however, it was not until March 2002 that a laboratory was located that could provide a detection limit low enough to read the concentrations found at the sampling sites. The majority of other readings from samples taken during earlier samples were below detection limits.

All sites, with the exception of Drain 22 are assessed as Unpolluted with respect to the standards below.

Table 14 Quality Standards for Rivers (Local Government Act 1977) (Water Quality Standards for Phosphorous Regulations) 1998.

Biological Quality (Q) Rating		Molybdate Reactive Phosphate Median Concentration (mg PO_4–P/l)
5	Unpolluted	0.015
4-5	Unpolluted	0.020
4	Unpolluted	0.030
3-4	Slightly Polluted	0.030
3	Moderately Polluted	0.050
2-3	Moderately Polluted	0.070
≥2	Seriously Polluted	0.070

3 Comparison to Standards

In this section, the data presented in Section 2 is compared to the standards in the Salmonid Waters Regulations, EC Drinking Waters Regulations and the Phosphate Regulations.

3.1 Salmonid Waters Regulations

It can be seen from Table 15 below, and the specific tables in Section 2, that under the Salmonid Waters Regulations, all sites sampled failed on at least one parameter, with the exception of suspended solids. Specifically:

- Temperature - all sites fail with the exception of drains 22 and 62;
- pH - all sites fail on the lower limit with the exception of the Lake Outlet (no sites fail the upper limit);
- suspended solids – all sites fail;
- dissolved oxygen - all sites fail except the Muingingaun River and the three drains (no data for drains during warmest months of the year);
- nitrite – all sites fail;
- total ammonium – only Lake Outlet, the Glencullen and Glenturk Rivers and Drain 62 pass.

Table 15: Summary of site failures against the Salmonid Waters Regulations

	Lake Outlet	Glencullen River	Glenturk River	Bellantaboy Bridge	Muingingaun River	Drain 16	Aghoos River	Drain 22	Drain 62	Glenamoy Bridge
Temperature										
pH										
Dissolved Oxygen										
Suspended Solids										
Nitrite										
Ammonium										

Key:

	Fail

3.2 EC Drinking Water Regulations

All sites passed the EC Drinking Water Regulations limits for conductivity, nitrite and nitrate, but all failed on pH (failures all of the lower limit) and ammonium (Table 16).

Table 16: Summary of site failures against the EC Drinking Water Regulations

	Lake Outlet	Glencullen River	Glenturk River	Bellanaboy Bridge	Muingingaun River	Drain 16	Aghoos River	Drain 22	Drain 62	Glenamoy Bridge
pH										
Conductivity										
Nitrite										
Nitrate										
Ammonium										

Key:

	Fail

3.3 Phosphate Regulations

With regard to the Water Quality Standards for Phosphate Regulations, there is no pass or fail as such; the waters are graded on their phosphate content. All sites with the exception of Drain 22 were classified as unpolluted, whereas Drain 22 was classed as seriously polluted under the Regulations (Table 13).

It can be seen from the above that the existing environment in the vicinity of the terminal, and the natural and anthropogenic activities that have occurred and are occurring, in the area, currently cause the waters in the rivers and drains to be outside the limits for the Directives described above.

9. *Information and proposals to address the possible impacts of free water from excavated peat on water quality, including pH and loading of humic and other acids.*

The excavation and windrowing of the *in situ* peat at Bellanaboy, for the purposes of shedding free water, will lead to the production of drainage water. The proposed technique for shedding this free water is widely used by Bord na Móna and typically reduces the water content from 93-95% by weight to 82-87% by weight (see Appendix B – Bord na Móna Investigation into the Handling of Raw Peat).

However, due to the well-drained nature of the peat at the Bellanaboy site, the quantity of free water has already been considerably reduced. Consequently, there will be relatively small volumes shed and no substantial alteration to flow patterns from the site following the excavation and windrowing of the peat. The effect of rainfall events on water levels has been monitored, and it is considered that the impact due to the increased water during a rainfall event would more than mask the input of the small volumes of drainage water from the windrowed peat.

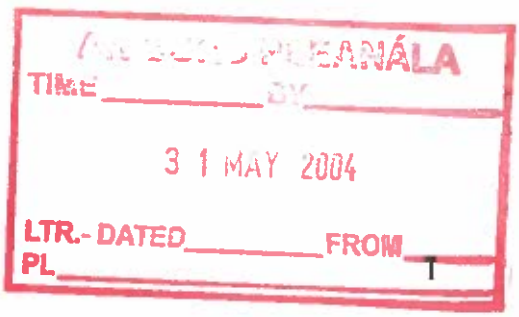
The design for the drainage system is based on a 45mm/hr rainfall event, which is more than sufficient to cope with silt-removal and storage of storm water draining off the peat. Temporary and permanent drains are to be installed during construction to collect rainwater runoff and groundwater. These will discharge to the settlement ponds. The ponds have been designed specifically to allow suspended particles to settle out. Humic acids are soluble (except below a pH of 2, which is not the case at Bellanaboy), so they will remain in solution, rather than settling out with the sediment. The settlement ponds will provide a more than adequate buffer for any minor differences between the quality of the water released from the peat, and that present in the drains from other sources. Furthermore, only peat excavation will be a gradual process and the disturbed ground will be a small proportion of the whole.

The drainage system has been designed in sympathy with the local aqueous environment (rainfall, surface water runoff, hydrology and hydrogeology) and the runoff from the terminal site will be managed in order to minimise the impact and not significantly alter the flow. Water from the ponds will be released in a gradual and controlled manner, minimising erosion damage in the receiving watercourses. Water quality at the outlet from the settlement ponds will be monitored.

The settlement ponds will be managed in line with a procedure that forms part of the environmental management system for the site, during construction and operational stages.

Widespread monitoring has been carried out at the site, and has shown that pH fluctuations are almost entirely absent in site drains and receiving waters. The addition of a relatively small volume of drainage water from the cut peat will not significantly alter this. Bord na Móna's experience of monitoring drainage discharge from industrial peatlands indicates that such run-off is also mildly acidic with pH typically 7.5. This has never been an issue either from a compliance point of view with regard to Bord na Móna's IPC Licence No 505, or in terms of complaint from any relevant Authority.

It should be noted that the physico-chemical properties of the water seeping from the peat and the groundwater are similar. It is therefore considered that there will be no significant change to the receiving water quality with respect to pH or humic acid concentration.



10. A schedule of sensitive periods for wildlife when construction works on the terminal should cease or be curtailed (these are referred to in the EIS but are not specified).

General

As a result of field surveys and consultations carried out to date, and in view of the habitat types present in the areas of the site which will be subject to impact by construction activities, the indications are that it is unlikely that any seasonal constraints will apply.

There were some marginal dense scrubby areas where the density of the vegetation prevented a thorough search of the undergrowth and ground surface, and so might have obscured mammal resting places present – including "previously unidentified" badger setts and otter holts. For this reason the clearance of vegetation and earthworks will be monitored during construction to ensure that best practice is maintained at all times and, in the eventuality of a sett or holt being found, then the mitigation measures set out in Section 6.7 of Volume 1 will be implemented.

In the case of bird species, a pre-construction breeding bird survey will identify which species are breeding in the construction areas of the site. The habitats present indicate that, assuming the pre-construction mitigation measures as set out in Chapter 6 are implemented, then breeding birds are unlikely to impose any seasonal constraint in the construction areas.

It is noted that a query has been raised in the context of the Hen Harrier (*Circus cyaneus*) - an Annex 1 species under the Birds Directive. This species has been observed flying overhead on a number of occasions during field surveys from 2001 to 2003. The Hen Harrier nests in leggy (mature) heather or young plantation on moorland (heather moor). Neither of these habitats occurs within the areas that will be affected by construction ie. the terminal footprint or the construction laydown area. The vegetation ground layer of the immature plantation in the construction laydown area comprises wet rushy grassland which is dominated by very tall Soft Rush (*Juncus effusus*) – visible in Plate 6.4 - which is similar in composition to that present on the terminal footprint (Plate 6.1). In addition, it should also be noted that the habitats present on those areas of the site which will be affected by construction are not suitable nesting places for the Corncrake - *Crex crex* (Annex 1 species).

Conclusion

The attached table summarises the concerns and criteria upon which the need for implementation of mitigation measures for each species will be assessed, and indicates the seasonal constraints for these species in the unlikely event of there being an issue.

Seasonal vulnerability (constraints) will apply only in very limited circumstances – please refer to the summary table below.

Finally, it is considered that if preconstruction measures including: breeding bird surveys and the monitoring of vegetation clearance; along with - where necessary - the implementation of recommended measures as set out in Chapter 6 of the EIS and in the table below; then there is no reason to expect curtailment or delays during construction.

Summary of potential concerns, mitigation and seasonal implications

No	Question	Response				
		Species	**Concerns**	**Activity/Criteria considered**	**Detailed mitigation**	**Season of vulnerability**
10	A schedule of sensitive periods for wildlife when construction works on the terminal should cease or be curtailed (these are referred to in the EIS but are not specified).	Badger	Concern only if setts are present	Any small sett identified - from badger surveys or during monitoring of vegetation clearance - on affected portions of the site – will require attention.	i. Affected setts must be evacuated and blocked off by experts under licence from NPW ii. Two months is required in advance to obtain such licence.	There are no particular seasonal constraints for this procedure.
				Any larger (Main breeding or Annexe sett) identified on affected portions of the site or within 30m of construction acivity - though none are expected:	i. Such setts should be evacuated and blocked off by experts under licence from NPW. ii. Two months is required in advance to obtain such licence. iii. The setts should then be destroyed by experts, by means of excavation. iv. The procedures for evacuation of larger setts requires c. 3 weeks.	Such setts should not be evacuated during the period mid-December – end June (breeding season). Work involving heavy machinery suspended to within 30m of sett until end of June.
		Otter	Concern – only if otter breeding sites (holts) are present	If otter holt is found within 40 metres of construction activities: implement detailed mitigation	Any holt will require evacuation of otters in similar manner to that required for badgers and under licence from NPW.	Principal breeding season April to September
				If an otter holt is found within 200 meters of construction activities: implement detailed mitigation	i. Consult with NPW. ii. Implement mitigation or remedial measures to limit disturbance to breeding otters (e.g. protection through screening, prevent access to holts etc).	
		Birds	Concern only if breeding Annex 1 species are present	Hen Harrier - nesting on terminal footprint and construction lay down areas is unlikely because of the lack of suitable habitat type.	Pre-construction breeding bird survey to be conducted to confirm situation. If present consult with NPW on necessary mitigation measures and implement.	Nesting period April – August/September
				Corncrake – no suitable habitat is present on the terminal footprint or other construction areas	Pre-construction breeding bird survey to be conducted to confirm situation. If present consult with NPW on necessary mitigation measures and implement.	Nesting period April to July/August.
		Frog	No real concern		Removal of adults, tadpoles and spawn under licence from NPW.	No particular seasonal constraint.

11. Information on the possible impacts on water quality, aquatic ecology and surrounding peatlands arising from the use of the highly alkaline lime/cement binder to comparatively small parts of the site. The information should include technical information and assessments to support the use and appropriateness of this method of peat improvement in this location.

A report on the proposed peat improvement works is provided . The proposed peat improvement works will have no impact on the quality of groundwater or surface waters, or their associated ecosystems, outside the Terminal boundary.

P03/3343

CORRIB GAS FIELD DEVELOPMENT

RESPONSE TO REQUEST FOR FURTHER INFORMATION 17/02/04

Prepared in respect of the proposed Bellanaboy Bridge Gas Terminal and associated Srahmore Peat Deposition Site

Volume 1 Question 11
PEAT STABILISATION

Shell E&P Ireland Limited

March 2004

RSK ENSR GENERAL NOTES

Project No:	P40036/9
Title:	Bellanaboy Bridge Gas Terminal and associated Srahmore Peat Deposition Site Response to Request for Further Information 17/02/04 Volume 1 Question 11: Peat Stabilisation
Client:	Shell E&P Ireland Limited
Issue Date:	Rev01 March 2004
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Authorised by:	*Jan Swan*	Project Manager	Date:	*08/03/04*
Authorised by:	*David Taylor*	Project QA Rep	Date:	*08/03/04*

TABLE OF CONTENTS

1 Introduction

1.1 Background

This document provides supplementary information about the soil stabilisation works outlined in Volume 1 of the Environmental Impact Statement for the proposed Bellanaboy Bridge Gas Terminal and associated Srahmore Peat Deposition Site (Shell, 2003). Stabilisation is proposed for areas of peat and associated soft soil materials at the proposed Bellanaboy Bridge terminal site.

Peat is a low density, low strength and high water content soil. As a result, trafficking vehicles on peat and construction in peat is extremely difficult. Shell E&P Ireland Limited (Shell) therefore proposes to increase the strength of the peat and associated soft soil materials through a process known as soil improvement or stabilisation. The areas proposed for stabilisation are some of the site access roads, temporary works areas and around the settlement ponds as shown on . Stabilisation is required to allow trafficking during construction and to facilitate plant access.

This document:

- describes the range of stabilisation methodologies that have been considered and the preferred methodology for the Terminal site;
- references international experience of these techniques;
- identifies potential impacts that may result from the proposed stabilisation and the mitigation measures that will be adopted to minimise adverse effects;
- identifies the predicted impacts after implementation of the mitigation measures.

1.2 Overview and Principles

Traditionally construction in peat soils has been achieved by the following methods:

- excavate and replace - which involves excavating the peat, disposal off-site and importing suitable fill;
- vertical drainage - which involves dewatering the peat;
- piling - in which metal or concrete piles are driven into the underlying bedrock.

Over the past 20 years alternative soil stabilisation techniques have been developed in Scandinavia and Japan that introduce chemical binders to *in situ* soft soils to strengthen the natural material. This provides a more sustainable alternative to traditional excavate and replace methods. Experience has shown that stabilisation is particularly suitable for peat.

Stabilisation of soils can be undertaken using the following methods:

- Shallow surface stabilisation involves harrowing cement or lime/cement to an approximate depth of 300mm below surface level to accommodate plant traffic;
- Column stabilisation makes use of the injection of a cementitious binder in vertical columns, similar to a cast in place piling operation;
- Mass stabilisation involves mixing the binder into a soil volume to create a homogenous mix up to a maximum depth of 5m.

With column and mass stabilisation a binder such as cement or cement/sand is mixed with the *in-situ* peat. When the binder sets, the resultant mixture has a higher strength than the virgin peat. These methods are discussed in detail in Section 2.1.

The geotechnical and chemical properties of the soil to be stabilised will affect the results of stabilisation and the choice of the appropriate binders. The choice of binders is discussed in Section 2.2.

Figure 2 Proposed Areas for Stabilisation

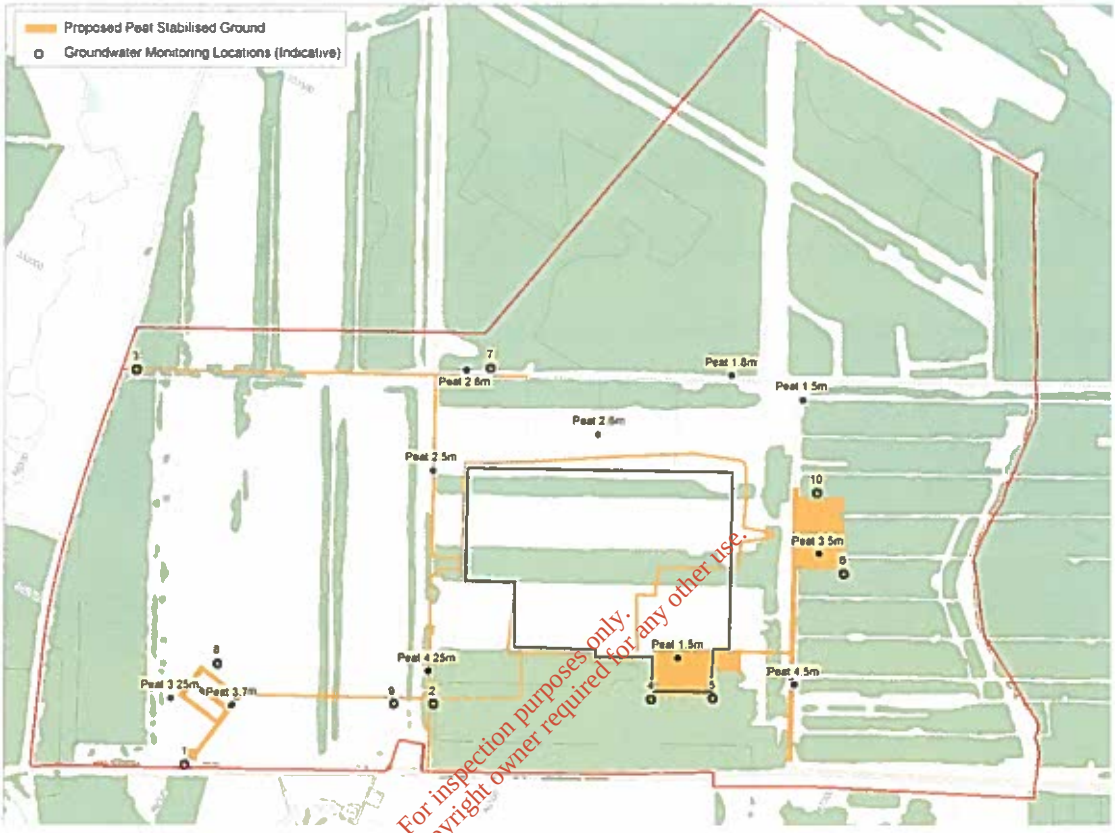


Figure 1 Proposed Area for Stabilisation

1.3 Environmental Issues

The primary environmental concern associated with stabilisation of peat relates to the introduction of alkaline binders (such as cement, lime and related products) into an acidic peat environment. The website of the European Cement Association (http://www.cembureau.be) provides a useful starting point to understand the extent of research that has been undertaken to evaluate the risks: "The question as to whether heavy metals contained in concrete could leach out has long been a subject of scientific investigation. Many tests and studies carried out by independent scientists have been reported in Europe and North America. Even when concrete was artificially spiked with heavy metals (up to 1000 times the average concentrations), leaching has always been found to be either immeasurable or significantly below levels allowed for drinking water – the most stringent regulation. Concrete has thus been proved, by independent bodies, to comply with the most stringent levels of health requirements."

1.4 Experience from Other Projects and Research

1.4.1 Overview

Strengthening using mass stabilisation and columns has been extensively used in Scandinavia and Japan for the last 20 years. About 3 to 4 million linear metres of lime-cement columns have been installed annually during the last few years. To date, limited work has been carried out in the UK (CTRL) and one project in Ireland (St George's Quay Gas Works). Some research, based on laboratory work, was undertaken at Trinity College, Dublin, as part of the EuroSoilStab research project (E. Farrell, S. Hebib).

Mass stabilisation has also gained popularity and is used primarily to reduce settlement and improve stability for infrastructure projects, such as roads and railways on soft soil deposits. During the last 4 to 5 years, the use of the mass stabilisation method has increased substantially in Swedish infrastructure projects. Mass stabilisation is also used for foundations of smaller buildings and bridges as well as for stabilisation of excavations and slopes.

Mass and column stabilisation methods are considered to offer a superior technical solution and are cheaper than conventional methods. There is also a reduction in construction time for infrastructure projects compared with other methods, and less maintenance is required. A final and important advantage is the fact, that the method is considered to be "environmentally friendly".

Japan, Sweden and Finland are the leaders in the field of soil stabilisation. Shell has consulted the State Geotechnical Institute (SGI) of Sweden to obtain information on the various methods, applications, restrictions and environmental issues with reference to the Corrib project. SGI is now contracted by Shell to provide technical support for the proposed stabilisation works at the terminal site. They have been involved in research and development of soil stabilisation for the last 20 years, but also work as specialist consultants with private and government bodies.

1.4.2 Case Studies

A summary of selected projects that have used column or mass stabilisation is given in this section.

High Speed Railway Line, Finland

The Orimattila High Speed Railway Line in Finland used mass stabilisation to provide temporary stability to a 400m section of peat bog. This facilitated access for the heavy machinery that was required to install the permanent concrete piled foundations. The equipment used was the ALLU Power Mix with which the contractor progressed at a rate of 2 linear metres per hour across the 100m wide site.

Ireland - Research

Engineers from Trinity College Dublin (TCD) have undertaken studies on the engineering properties of two peats from the Irish Midlands that were mixed with a variety of binders (Hebib & Farrell, 2003). The study showed that the compressive strength of peat stabilised with cement was significantly greater than that of the original peat. However, the degree of improvement was markedly different for the two peats even though they had a similar organic content. This variation emphasises the importance of pre-construction laboratory and field tests, such as those being undertaken on peat samples from the Terminal site. In the TCD study, cement gave better results than pulverised fuel ash (PFA) or lime. The addition of gypsum or slag to the binder mix increased the strength in one peat but not the other.

Road 601 Sundsvagen, Ranea, Sweden, 1995
A 700m long road section was mass stabilised with a mix of cement (40%), fly ash and blast furnace slag. Ground conditions were peat overlying silty sulphide soils. The resulting soil mass was not homogenous but the road was acceptable in terms of strength and settlement. Leaching from the stabilised embankment was too low to measure. Excess water from the initial consolidation contained dissolved elements from the binder, and it is recommended that stabilisation with a by-product (fly ash, blast furnace slag) should be carried out with caution in areas which require ground water protection.

Groene Hart Tunnel entrance, Leiderdorp, Netherlands, 2000
Column stabilisation was used at the entry shaft to support trench excavations. Ground conditions were soft clay and peat. The most suitable binder proved to be pure cement, added at 120kg per m^3 soil. Higher strength was achieved and a shorter curing time was necessary than for the more conventional cement-lime binder.

Channel Tunnel Rail Link, UK, 2000
Two 100m long and up to 6m deep localised soft areas (clay and peat) were stabilised. Cement was found to be the most suitable binder at 200kg/m^3. A mixture of furnace slag and cement was also tested as it is more cost effective but has slower chemical reactions. It was found to meet the requirements (100kPa) after 65 days curing time. Strength had increased by a factor of 10-15 and the stiffness by a factor of at least 10.

Road 45, Arvidsjaur, Sweden
Mass stabilisation was used adjacent to an existing 700m section of road, which is built directly on peat. The stabiliser used was cement and the quantity 200kg/m^3. The shear strength achieved was over 300kPa (target 40kPa). Nearly all settlement took place during the pre-loading stage before pavement construction.

Road 221, Bettna, Sweden
Construction of Road 221 involved the mass stabilisation of peat, clayey gyttja and clay. Evaluation of binders showed that a combination of cement and blast furnace slag gave the highest strength (pure cement was not included in the tests).

Veittostensuo, Highway 12, Finland, 1992
Geology comprised peat over clay. The peat was mass stabilised and the clay stabilised using columns. Shear strength of peat increased to 40-150kPa within 30 days of stabilisation. Settlements correlated well with laboratory test results.

Kivikko Test Embankment, Helsinki, Finland, 1998
Soil profile was peat overlying mud/clay. A combination of mass and column stabilisation was carried out.

Contaminated Land
Soil mixing is increasingly used for the *in situ* remediation of contaminated soils. Cement (or another binder) is mixed with the contaminated soils without excavation to "lock up" contaminants for the long term. A paper presented by Day & Ryan at GeoEnvironment 2000 details a range of examples and demonstrates the suitability of the technique. A further example is provided in Kivelo & Palolahti (2004), which describes a pilot project undertaken for the State Pollution Agency of Norway in Trondheim harbour in the Trondheim Fjord, in which sediments contaminated with heavy metals and organic substances were stabilised with cement, slag and ash. The contaminated sediment was dredged, stabilised and then replaced on the seafloor. The contaminants were successfully isolated in this environmentally sensitive area.

2 Methodology

2.1 Mixing Options

The stabilising binder may be introduced into the ground using shallow surface stabilisation, column stabilisation or mass stabilisation.

2.1.1 Shallow surface stabilisation
For shallow surface stabilisation of soft soils, the binder is spread over the ground surface and incorporated with a plough or harrow. Specially designed construction plant is used and tools such as a metal canopy with chains is used to minimise the release of dust.

2.1.2 Column stabilisation

Before injection of binder begins, a 0.5m layer of granular material is spread over the area to be treated to provide a temporary working platform. Each column is drilled to the target depth with a hollow shaft fitted with a rotating mixing tool (see Figure 3). From the target depth, the mixing tool is withdrawn at a controlled rate whilst the binder is introduced at a prescribed rate of feed through the hollow shaft (Figure 4). The binder feed is stopped when the tool reaches the underside of the temporary work platform, in order to prevent binder loss. After completion of several columns, the ground surface is surcharged by topping with 0.5m of granular material, in order to obtain the most effective increase in strength.

Figure 3 Typical Mixing Tool

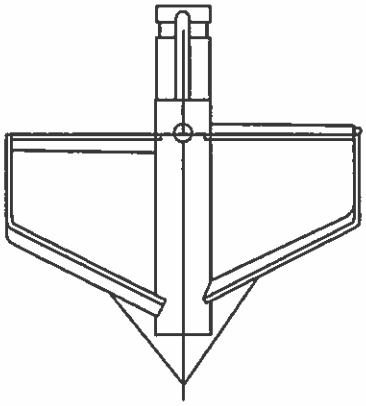
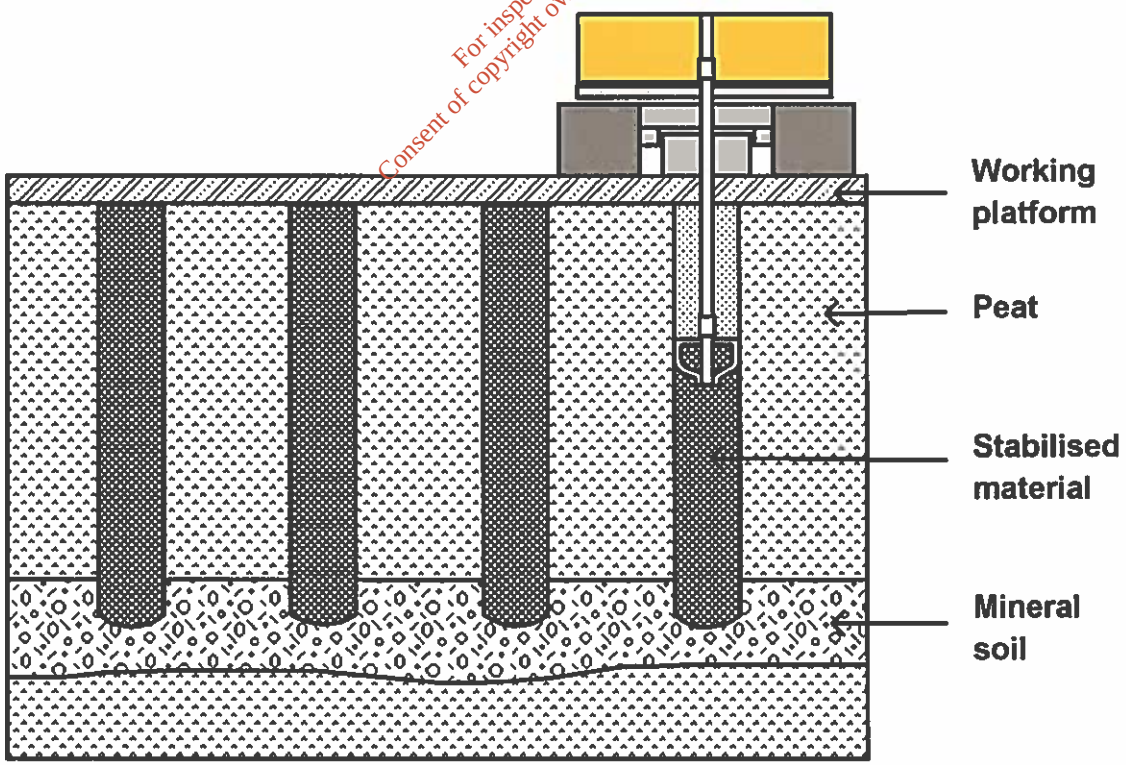


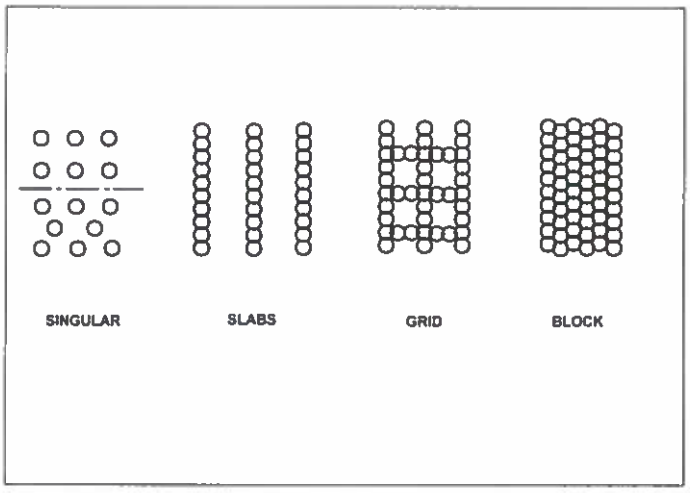
Figure 4 Column Stabilisation



This method results in columns of stabilised soil, each with a circular cross section. A maximum column depth of approximately 20m can be achieved although a few machines are capable of installing up to 40m deep columns. This method is particularly useful on peat deeper than 5m

A variety of column arrays can been used, some of which are illustrated in Figure 5.

Figure 5 Column Arrays



Deep mixing machines weigh between 50 and 80 tonnes; the height is related to the depth of the columns but is typically 20-25m.

A column stabilisation rig is shown in Figure 6.

Figure 6 Column Stabilisation Rig in Operation

2.1.3 Mass stabilisation

Mass stabilisation has been developed during the last 5 years and uses a conventional excavator equipped with a mass stabilisation mixing tool. The excavator stands on firm ground and has a modified arm, which reaches forward 3 to 4m. A pipe is fixed to the underside of the boom arm through which a binder is pumped. The binder is pumped using compressed air from a tank within 50m from the stabilising machine. The binder is fed to the mixing head while the mixer rotates in the ground to be stabilised. The stabilised block is stiffer than the original soil and will not only reduce settlement, but also improve stability. Mass stabilisation is primarily used to stabilise very soft soils such as peat. Figure 7 and Figure 8 show alternative types of mass stabilisation equipment.

Unlike column stabilisation, mass stabilisation does not require a second layer of stone as the equipment sits on firm ground and works with a reaching arm into the virgin ground. On completion of an area, the ground is surcharged with approx 0.5m of granular material. Strengthening of the ground commences once the 0.5m granular surcharge is placed and generally within 24-48 hours the stabilised ground is able to take the weight of the machinery to allow forward advance of the working area.

Mass mixing machines typically weigh about 20 to 30 tonnes and have a height of up to 7 metres.

Figure 7 Mass Stabilisation Machine

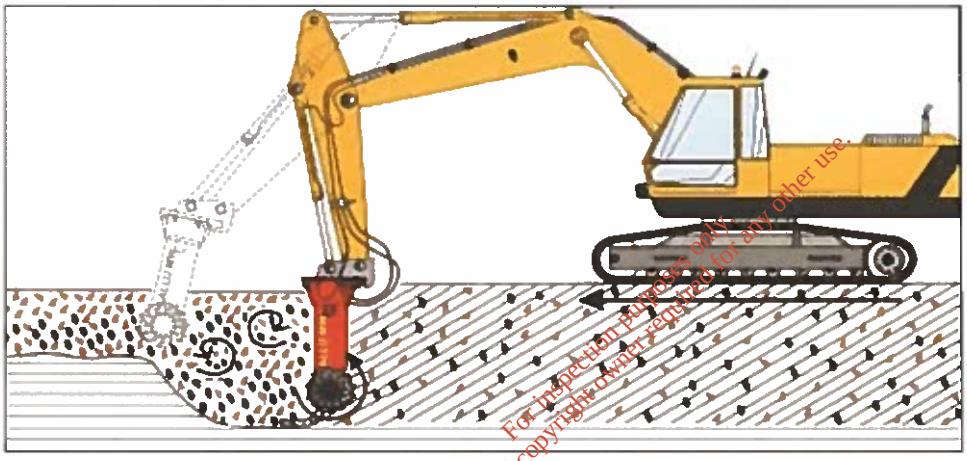


Figure 8 Alternative Mass Stabilisation Equipment

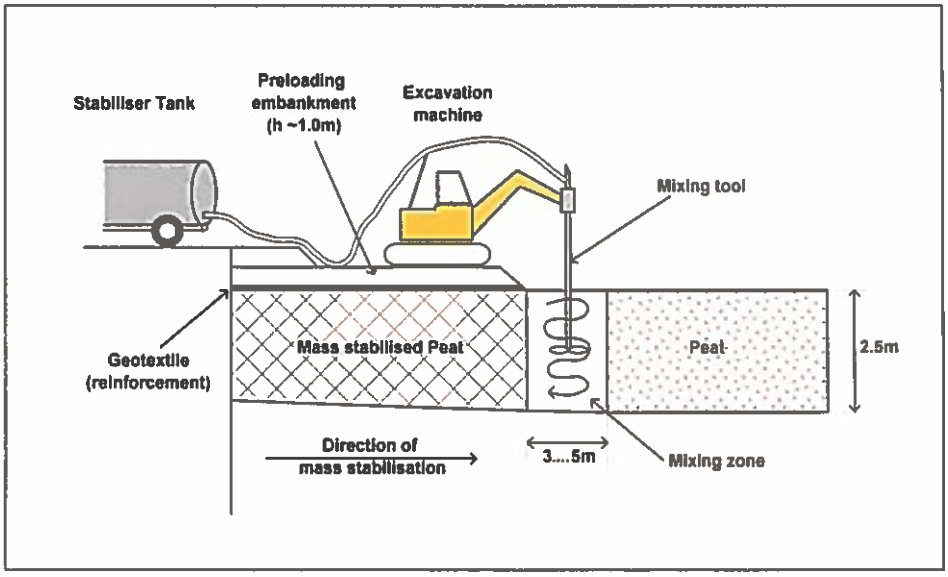


Figure 9 Mass Stabilisation Rig in Operation

2.1.4 Option selection

It is considered that column stabilisation or mass stabilisation, or a combination of the two techniques, will be feasible for the Bellanaboy Bridge Terminal site. It is proposed to use dry binder as it is considered easier to control and avoids the introduction of additional water to wet ground.

Compared to traditional methods of stabilising soils (e.g. piling) column and mass stabilisation are economical and flexible. They use less materials and energy, exploit the properties of the peat at the site and do not require the removal of peat from the site.

2.2 Binders

2.2.1 Options

Binders may be hydraulic or non hydraulic.

a) Hydraulic binders are self-setting on contact with water and can be used to stabilise almost any soil. They usually work by filling the void space in the soil; efficient mechanical mixing is therefore necessary to produce a homogenous mixture.

b) Non-hydraulic binders generally react with clay minerals in the soil, which results in a stabilised material with improved geotechnical properties. Non-hydraulic binders may also be used to activate latent hydraulic materials to produce reactive blended products.

Hydraulic binders are more suitable for the stabilisation of peat as peat has a low mineral content.
The most common binders for soil stabilisation are discussed below:

Lime

Lime is available in two non-hydraulic forms – quick lime (CaO) and hydrated lime ($Ca(OH)_2$). Hydraulic lime is also available but there is little experience of its suitability for deep stabilisation. Studies have shown that other binders produce superior results with peat; lime is not therefore discussed further in this report.

Cement

Cement is a hydraulic binder. Amorphous calcium silicate hydrate and $Ca(OH)_2$ are produced when cement reacts with water. The strength, setting, hardening and stability of hydrated cement is due primarily to calcium silicate hydrate. As cement does not depend on a reaction with soil minerals it can be used to stabilise most soils including peat. Portland cement is the most widely used type of cement for soil stabilisation but other types are also suitable. Additional materials such as slag, ash or gypsum may be used with cement to augment its properties or reduce costs.

Blast furnace slag

Blast furnace slag is granulated by cooling it fast to create a glass-like structure which is reactive. This material is then ground. Quality and reactivity varies between furnaces but, generally speaking, the finer the grain, the more reactive the slag. Blast furnace slag is chemically similar to cement and is activated by mixing it with lime or cement. It may be regarded as a low cost substitute for cement in soil stabilisation and is usually blended with other binders.

Ash

Ash is a fine-grained residue from a combustion process. The composition of ash depends on the fuel and burning process. The most common fuels are coal, peat and biofuels and the most common source of ash is power stations. The reactive components in ashes are SiO_2 and Al_2O_3.

Pulverised fuel ash (PFA), which is a by-product of coal combustion is the most widely used ash for soil stabilisation in the UK.

FGD ash is the end-product of flue gas desulphurisation; its composition depends on the desulphurisation technique employed. FGD may be pure gypsum ($CaSO_4.2H_2O$) but may also be $CaSO_4$, which is almost inert.

The pozzolanic reactivity of ash varies within wide ranges and needs to be determined for each product separately. Ashes are generally not very reactive and may be blended with other binders to reduce cost of stabilisation.

Calcium sulphate products

Calcium sulphates are normally used in combination with other binders. Natural gypsum is calcium sulphate dihydrate ($CaSO_4.2H_2O$) but loses water when heated and eventually transforms to calcium sulphate anydrite ($CaSO_4$). In combination with soluble aluminates, gypsum reacts to form ettringite.

Wet binders

Binders for wet mix stabilisation are predominantly cement. This is mixed with water before being added to the soil. It is not proposed to use wet binders at the Bellanabo Bridge terminal site.

2.2.2 Sampling and laboratory testing

At the time of writing this extensive ground investigations are underway at the site of the proposed terminal. As soils react in different ways to chemical stabilisation, comprehensive mixing trials are being undertaken in the laboratory. These trials will determine the appropriate binder composition for the soils in specific locations across the site. Shell has engaged SGI to undertake the sampling, testing and analysis. Samples of the peat were collected during February 2004 and are being tested to investigate their properties as detailed in Table 1. Previous laboratory testing has already been undertaken in the Summer 2002. The results of these preliminary tests indicated that the peat was suitable for stabilisation techniques to be successfully applied.

Table 1 Laboratory Analysis for Virgin and Stabilised Soil

Soil Properties	Analytes	Information Use
Physical Properties	Organic content Water content Density Von Post	Indicates the suitability of the soil layers for deep stabilisation and/or mass stabilisation.
Engineering Properties	Undrained shear strength Compressibility Permeability	Indicates the suitability of the soil layers for deep stabilisation and/or mass stabilisation. Provides basis for engineering design. Provides a reference point for evaluating the effectiveness of the stabilisation process.
Chemical Properties	Sulphate content Chloride content Carbonate content Humid acids/Total Organic Carbon	Informs the choice of type and amount of binder

	Cation exchange capacity pH of groundwater	
Environmental Properties	Cation exchange capacity Sulphide content (soil) Chloride content (soil) Carbonate content (soil) Humic Acids/TOC pH (groundwater)	Inform prediction of the environmental impact of stabilisation

2.2.3 Field verification

At the start of construction the engineering and environmental properties will be verified *in situ* by installing a number of trial columns or trial volumes (for mass stabilisation).

Field tests will confirm the strength of the stabilised soil, and the binder concentrations necessary to achieve the desired strength. Experience has shown that a more homogeneous mixture of soil and binder can be achieved in the laboratory than the field; laboratory conditions therefore may achieve strengths that are not necessarily achieved in the field.

2.2.4 Quantities

The quantity of binder used has a significant effect on the strength of stabilised soil. The amount and type of binder to be used at the Terminal site will be determined by laboratory and field tests (Section 2.2.2). It is currently estimated that there is approximately 156,000m^3 of peat to strengthen which will require up to 24,000 tonnes of binder and a further 178,000m^3 of mineral soils that may require strengthening which would require an additional 12,500 tonnes of binder.

2.2.5 Curing time and pre-loading

When soil is stabilised with cement, the curing process, and therefore the strength, develops over a period of time. The actual time however varies with substrate properties and local conditions (Hebib & Farell, 2003; EuroSoilStab, 2002).

Pre-loading (i.e. surcharging the ground with granular material as soon as the binder has been mixed with the peat) results in a significant increase in the compressive strength of cement-stabilised peat and reduces permeability. The strength of peat is improved significantly by pre-loading.

2.2.6 Option Selection

Tests have shown that the hardening process can be retarded in soils with a high organic content so not all binders are suitable for use with peat. However, laboratory tests undertaken during the EuroSoilStab project showed that cement binders will stabilise almost any soil. To achieve the best results the binder must be mixed well in to the soil to produce a homogeneous soil/binder mix. The tests showed that the following binders combinations worked best with peat:

- Cement
- Cement & gypsum mix
- Cement & furnace slag

Similar tests using Irish peats (Hebib & Farell, 2003) show a significant increase in strength when just cement is used as the binder.

Following literature reviews, discussions with engineering colleagues and the SGI, Shell has determined that the preferred binder for use at the proposed terminal site is cement, or possibly a cement / sand mix. The binder quantity and possible proportion of sand will be determined on the basis of laboratory and field testing. The binder will be used in a dry form.

2.2.7 Sequence of work

Stabilisation works will begin at the settlement ponds and site entrance and will then progress into the site. At the peak of activity there will be up to six stabilisation machines working simultaneously.

3 Properties of Stabilised Soils

3.1 Physical Properties

The underlying design philosophy for soft soil stabilisation is to produce a stabilised soil. The soil is stabilised to the boundaries where the binder is supplied. The potential for reaction with unstabilised soil is therefore limited to the perimeter of the unstabilised mass.

The relationship between curing time and the strength of the stabilised soil is important as the strength typically develops in a matter of days. The geomechanical properties of the stabilised material depends on the type and quantity of binder as well as the properties of the natural soil. In addition, the homogeneity of the mixing affects the resulting mass strength. The undrained shear strength of stabilised soil is normally in excess of 50 kPa. In general, the strength and brittleness of the stabilised soil increases with increasing amount of binder.

The addition of binder (in the case of the terminal site – cement) decreases the permeability of soils as it fills the void space in the soil. The permeability of stabilised peat is reduced by orders of magnitude (10 to 100 fold) after 28 days, and does not change further with time (EuroSoilStab, 2002).

Under certain circumstances, cured cement will deteriorate in an acid environment. Tests have shown that the rate of cement deterioration is greatest where acid is flowing over the cement as this replenishes the acid and removes the reaction products. However, in the natural peat soil environment the rate of groundwater water flow is usually extremely low, and therefore the rate of any deterioration will be low. The rate of acid attack is also determined by the surface area of the cement exposed to the acid flows, and hence linked to the porosity and permeability of the cement: cement with higher porosity and permeability will undergo higher rates of deterioration. As the pH of the peat at the Terminal site is around 5.5 – 6.0, it is only slightly acidic and significant degradation of the stabilised ground is not expected.

3.2 Chemical Properties

The chemical reaction between the binder and the soil begins immediately and the pH of stabilised soil rises rapidly to 11-12 as curing begins. The speed of the chemical reactions depends on the type of binder and may take from one month to several months or even years (EuroSoilStab, 2002)

When cement is used as the binder, a stabilising gel develops between the soil granules due to pozzolanic reactions[1]. Cement rapidly reacts with the moisture in the soil and releases calcium hydroxide, which is highly alkaline (pH 12.5). The possibility of uncured cement or calcium hydroxide migrating into the adjacent drainage ditches and acidic peat habitats is addressed in Section 4.1 but is limited due to the speed of the reaction.

The principal constituents of cement are calcium silicates, aluminates, ferro-aluminates and sulfates (Table 2). Small amounts of alkalis, lime and chlorides are also present together with trace amounts of chromium compounds. Typical Irish cement has to conform to the requirements of I.S. EN 197-1 for CEM 1 'Portland Cement'. Depending on the source of the cement, additional constituents may also be present such as pulverized fuel ash, limestone, and granulated blast furnace slag.

Table 2 Major Components of Cement

$3CaO.SiO_2$	Tri-calcium silicate
$2CaO.SiO_2$	Di-calcium silicate
$3CaOAl_2O_3$	Tri-calcium aluminate
$4CaO.Al_2O_3.Fe_2O_3$	Tetra-calcium aluminoferrite
$CaSO_4.2H_2O$	Calcium sulfate dihydrate (gypsum)

Cement also contains traces elements including hexavalent chromium salts, which are environmentally relevant as they are soluble in water and are a known allergen and carcinogen (see Section 4.3.8). The quantity of hexavalent chromium salts varies with the source of the cement, but is usually limited to <2ppm to limit workforce exposure.

[1] Pozzalanic pertains to the reaction between a material have little or no cementitious value and calcium hydroxide, at ordinary temperatures, to produce compounds with cementitious properties.

The cement used for stabilisation works at the terminal site will conform to the European Standards:

- I.S. EN 197-1 : 2001 Cement - Part 1 : Composition, Specifications and Conformity Criteria for Common Cements; and
- I.S. EN 197-2 : 2001 Cement - Part 2 : Conformity Evaluation.

I.S. EN 197-1 outlines specification requirements for 27 different common cements which are classified into five main cement types CEM I to CEM V. CEM I (Portland Cement) has been the cement traditionally used in Ireland for the majority of structural and non-structural concrete applications and is most likely to be used for the stabilisation works.

3.3 Leaching Tests

The EuroSoilStab project undertook leaching tests on a range of stabilised and natural soils. The binders used to stabilise the soils included fly ashes, furnace slag and gypsum.

The German Cement Works Association (Verein Deutscher Zementwerke – VDF) and the Institute for Construction Research (IBAC) in Germany have carried out extensive research into the environmental acceptability of cement products in the construction industry (www.vdz-online.de). During the reactive phase of cement and water environmentally relevant substances contained in the concrete constituents can be released into the environment relatively easily if they are present in mobile form. Substances that might find their way into the groundwater include soluble alkalis and trace element compounds. However, the research shows that trace elements in cement suspensions are predominantly insoluble and therefore unavailable for release. Hexavalent chromium is the only trace element that can be released from fresh concrete at concentrations that might be environmentally relevant. This research further confirmed that increased pH values and chromate contents occur only in the immediate contact zone of the cement (less than 60mm) and only for a very limited period of time (<24 hours). As hydration progresses, the dissolved chromate reacts so that in hardened concrete virtually all the chromium is in an insoluble state. Increased concentrations in very thin boundary layers and for short periods are not environmentally relevant and do not cause any lasting or significant adverse impact on groundwater (Brameshuber et al).

The UK Highways Authority Design Manual for Roads and Bridges (2000) also states that the possibility of cement leachate or run-off is considered to be low. If leachate were to occur from the stabilised peat it would be quickly consumed within the surrounding ground due to its reaction with the peat/water. Any migration would be very localised and would be measured in centimetres rather than metres.

The results of leaching tests on crushed concrete have been reported by VDZ (www.vdz-online.de) and are provided in Table 3. These tests were undertaken in accordance with DEV-S4, during which crushed material is shaken in water for 24 hours. The results show that the heavy metals are fixed in the hardened cement paste matrix and that the quantities released are tiny. In most cases the concentration found in the leaching water was below the detection limit of the analytical method.

Table 3 Results of leaching test (DEV-S4) carried out on crushed concrete

Element	Content in cement	Content in leaching water
	mg/kg	mg/l
Arsenic	5	<0.0002
Beryllium	1	<0.0002
Cadmium	<0.5	<0.0001
Cobalt	10	<0.0002
Chromium	58	0.003
Copper	22	0.0008
Mercury	<0.05	<0.0002
Thallium	<0.5	<0.0002
Manganese	500	0.002
Molybdenum	1	0.0004
Nickel	28	0.002
Lead	17	0.001
Antimony	1	<0.0002
Tin	3	<0.0002

Vanadium	66	<0.0002
Zinc	310	0.001

It is proposed that leaching tests will be carried out during laboratory and field testing of the Bellanaboy Bridge terminal soils (Section 2.2.2). The leachate will be subjected to a range of chemical analyses as detailed in Table 1.

4 Environmental Impacts and Mitigation

This Section discusses the potential environmental impacts resulting from column and/or mass stabilisation techniques, using a dry mix of cement and sand. Particular attention has been paid to the more sensitive receptors. Mitigation measures are recommended as necessary and the residual impact predicted.

4.1 Pathways

There are four primary pathways by which the peat stabilisation process could affect sensitive receptors:

- leaching of cement or its components into groundwater followed by a vertical or lateral movement of the contaminated groundwater;
- contamination of surface water with cement and subsequent run-off into drainage ditches;
- direct damage and disturbance by machinery; and
- airborne contamination by cement dust.

4.2 Receptors

The following sensitive receptors are identified in the EIS and may be affected by the peat stabilisation process:

- Carrowmore Lake Special Protection Area (SPA) and candidate Special Area for Conservation (cSAC) – this large shallow lake and its associated areas of blanket bog are located approximately 1.5km to the southwest of the terminal site. The site supports a number of bird species, which are of international conservation significance, including Greenland white-fronted goose, merlin, golden plover, sandwich tern and arctic tern;
- Sruwaddacon Bay SPA – this site is part of the wider Glenamoy Bog Complex cSAC and is located approximately 2km north of the terminal site. It has been designated for its wintering wildfowl and its integral role in the local salmonid fishery;
- aquatic invertebrates;
- salmon and trout fisheries;
- willow scrub;
- badgers;
- otters;
- frogs; and
- local residents and the construction workforce.

These are discussed in more detail in the relevant sections below.

4.3 Potential Impacts

4.3.1 Hydrogeology

Research has shown (www.vdz-online.de) that when ultra-fine cement binders are injected into water, significant effects on water quality are only detectable during the first 4 hours after the injection. Within 24 hours, the chemical composition of the test water was not significantly different from that of drinking water.

Subsurface flow in the area is minimal due to the near-surface water table and widespread waterlogging of the peat and underlying mineral soils and bedrock. The leaching experiments described in Section 3.3 demonstrate that the reactive phase of cement in water is limited to <24 hours and that the quantities of alkali and hexavalent chromium ions released in this time is insignificant. It is therefore considered that there is no risk of offsite groundwater contamination.

4.3.2 Hydrology

There are numerous ditches which drain the Terminal site, most of which have relatively minor flows. The project could impact on two separate catchment areas, with the boundary approximately following the eastern boundary of the Terminal. Ditches from the Terminal itself flow in a southwest direction, into the Bellanaboy River and subsequently Carrowmore Lake while run-off from the temporary construction area will flow to the north, to Glenamoy River and subsequently Sruwaddacon Bay.

Most of the shallow land drains on the Terminal site are frequently dry but there are some deeper ditches to the southwest and northeast of the site. The surface gradient and subsequent flow of surface water is towards a ditch in the southwest of the site, which empties into a sinkhole in the peat. This 1.5-2m deep hole only overflows after periods of heavy rainfall, when the overflowing water empties into a ditch (D16), which then flows adjacent to the R314.

The peat stabilisation process may result in a very localised and transient increase in alkalinity and/or sedimentation of these watercourses and drainage ditches, which under extreme circumstances could have knock-on effects on the aquatic ecology as described below. However, in reality, no adverse effects are anticipated.

4.3.3 Aquatic Ecology

Vegetation

Cement or a combination of cement and sand will be used for the peat stabilisation, leading to the possibility of watercourse sedimentation. Cement and sand could settle on submerged aquatic plants and reduce the rate of photosynthesis. However, it should be noted that sand is naturally occurring in the local watercourses.

Any increase in pH of the water from the cement may reduce plant growth and alter the species composition. This could have a subsequent impact on aquatic fauna in terms of the suitability of frog-spawning sites, shelter for fish fry from predators, etc.

Macro-Invertebrates

The baseline data acquired at and around the Terminal site show a large population of aquatic macro-invertebrates such as mayfly, dragonfly and caddis fly larvae. Often used as biological indicators, the presence, abundance and diversity of these species indicates good water quality throughout the survey area. Most aquatic larvae are sensitive to environmental changes, particularly changes in pH and/or temperature. The sedimentation of watercourses by sand could smother larvae and in the long term modify the substrate to the extent that species composition is altered.

Fish

Sea trout and salmon are known to spawn in the tributaries of the Rivers Bellanaboy and Glenamoy. Although less susceptible to changes in pH than aquatic invertebrates (both species can tolerate a relatively high pH) (www.troutandsalmon.net) they can be indirectly impacted through a change or reduction in food sources. Sedimentation of the watercourses can smother fish eggs and damage fish gills through abrasion.

4.3.4 Terrestrial Ecology

Willow scrub

Willow scrub is generally common throughout Ireland but it is relatively rare on the Terminal site and as such provides an important habitat for birds. There are two areas of willow scrub composed primarily of eared willow (*Salix aurita*) alongside the secondary / emergency access road which will be stabilised using cement injection. There is a risk of willow roots being damaged directly by machinery during the stabilisation process. Eared willow is known to prefer acid soils and as such the roots may atrophy if there is an increase in soil pH.

Badgers

The secondary / emergency access road which is to be stabilised is adjacent to an area of dense scrub where an active badger sett has previously been recorded (S5). It was noted during the survey (Volume 1 of EIS) that additional setts may have been overlooked due to the difficulty of surveying in dense scrub. There is a risk of direct harm to badgers if the sett is occupied when the peat stabilisation process begins.

Otters

Otters may be present on site throughout the year, however they are most active when opportunistically preying on frogs in the spring. Any adverse effect on common frog populations is unlikely to have an impact on otters as alternative food sources are abundant in the area. However, two day nests noted adjacent to the secondary / emergency access route may be used by otters. There is a drainage ditch adjacent to the access road which may

support an otter holt which could have been overlooked in the original survey due to the dense scrub. There is therefore a risk of direct harm to otters if the day nests or potential holt are occupied when the peat stabilisation process begins.

Frogs

If cement enters ditches or watercourses, the increased alkalinity may have a local negative impact on common frogs (a Red Data Book species which is common throughout the site). Common frogs avoid peaty ponds in favour of ruts in tracks and roadside ditches. There is therefore a risk of direct harm to common frogs when stabilising the secondary / emergency access road.

4.3.5 Air Quality

Handling and mixing of the cement-sand binding mixture will result in a minor and very localised increase in dust. However, the dust will land on the peat surface and will adhere, when the surface is damp, rather than being blown away. The most significant impact from cement dust will therefore be on the health and safety of the workforce, as discussed below. Generally, cement injection will stop short of the ground surface working platform which will overlie the area being stabilised. This will significantly reduce the potential for dust generation.

4.3.6 Noise and vibration

Soil stabilisation is often used where a reduction of vibrations is required e.g. where heavy construction plant is required to traffic over soft soils (EuroSoilStab, 2000). The stabilisation process itself is not noisy in comparison to other construction procedures and any vibrations generated by construction traffic will be dissipated through the stabilised mass.

4.3.7 Traffic

The stabilisation works will require up to 280 vehicle movements a month for delivery of the binder. This is significantly lower than would be required for alternative means of stabilisation (removal off site or piling). Delivery will be over a period of 6 months.

4.3.8 People

Cement is a light powder that poses little immediate hazard. A single short-term exposure to the dry powder is unlikely to cause serious harm. However, when cement is mixed with water or becomes damp it undergoes an exothermic reaction and produces a strong alkaline solution. The heat is unlikely to cause thermal burns, but if the solution comes into contact with the eyes or skin it may cause serious chemical burns and ulceration. The eyes are particularly vulnerable and damage will increase with contact time.

Strong alkaline solutions in contact with the skin tend to damage the nerve endings first before damaging the skin, therefore chemical burns can develop without pain being felt at the time. Cement mortar and concrete mixes may, until set, cause both irritant and / or allergic contact dermatitis:

- irritant contact dermatitis is due to a combination of the wetness, alkalinity and abrasiveness of the constituent materials;
- allergic contact dermatitis is caused mainly by the sensitivity of an individual's skin to hexavalent chromium salts;

Generally, cement injection will stop short of the ground surface working platform which will overlie the area being stabilised. This will significantly reduce the potential for dust generation.

Fresh cement may contain traces of hexavalent chromium. Hexavalent chromium is a known allergen to some people although sensitisation normally requires months to years of repeated exposure. Wet cement is extremely corrosive and quickly destroys skin surfaces, which allows the hexavalent chromium to penetrate skin layers and enter skin cells. Once someone is sensitised they are usually sensitised for life and exposure to a small amount of cement may trigger a severe reaction. In an effort to improve workforce safety, the chromium content of cements has been decreased in recent years and the number of cases of chromate dermatitis has fallen.

4.4 Mitigation Measures

Run-off and Leachate

The flow of water in the site ditches will be impeded, where required, by localised drain blocking at the stabilisation works. Once drains are blocked, any fugitive cement particles will adhere to the bottom of the ditch and will be immobilised. Consideration has been given to the use of a perimeter ditch to intercept potentially contaminated water, but stabilisation will only be taking place within a small area at any one time, therefore rendering localised containment generally more effective

Water quality in the ditches and settlement ponds will be monitored regularly as described in Section 4.5.1 of this document. The drainage on site during construction will be a managed system, which can be isolated to deal with any local incident.

Contact will be maintained with the North-western Regional Fisheries Board (NWRFB) throughout the planning and implementation phase of the project as described in Section 7.7.3 of Volume 1 of the EIS.

Physical Damage

It will not be possible to avoid damaging willow roots where scrub has developed alongside the proposed secondary / emergency access road. However, it may be possible to carry out alternative planting of willow elsewhere on the site and so retain the ecological interest of this habitat.

An additional survey for badger setts will be carried out immediately prior to works starting on site. If sett S5 is found to be occupied, or any other active setts are found in proximity to the stabilisation areas, a licence to close the sett(s) will be obtained from National Parks and Wildlife Service (NPWS) (see Section 6.7.3 of Volume 1 of the EIS).

Similarly an additional survey for otter holts will be carried out prior to works commencing and any animals found will be moved under licence from NPWS.

It will not be possible to avoid impacting on ruts in the tracks or drainage ditches, which may support spawning common frogs. As outlined in Section 6.7.4 of Volume 1 of the EIS, it is recommended that suitable frog spawning habitat is created elsewhere on the site (not within the peaty woodland) and existing spawning areas in-filled in autumn / early winter, i.e. before the spawning season. Animals can then be translocated to the new ponds under licence from NPWS.

Airborne Dust

Measures will be put in place to miminise the risk to people from cement dust. These will include operation procedures such as:

- the use of a granular working platform which will cover the ground surface;
- damping down the working area; and
- the erection of a wind break around the working areas, during strong winds;

Measures will be put in place via method statements, training and correct protective equipment to minimise the risk to the work force from cement dust. Staff will be required to wear the correct personal protective equipment (PPE) during stabilisation works. PPE will include gloves, goggles, dust masks and long sleeves. Emergency eye wash facilities will be available and appropriate awareness signs will be erected. Special attention will be paid to the loading/unloading of vehicles and when filling tanks on stabilisation equipment.

Cement will be delivered in bulk by road tanker, which will discharge via a hose into purpose built tanks linked to the stabilisation plant. During filling, air in the spreader will be expelled through filter apparatus to minimise dust.

If necessary a water spray will be used to damp down any surface dust.

Skin Contact
All staff handling dry cement powder or wet cement will receive training on the hazards associated with it. PPE will be issued as described above. The contractor will be required to develop strict handling procedures which will be monitored by Shell.

Containment
The contractor will prepare a detailed procedure/method statement for the stabilisation works, which will address the prevention of accidental spillage and emergency procedures for containment and clean up should spillage occur (see below).

The pressurised mixing containers will be inspected regularly to detect imperfections/damage that may result in reduced safety margin in the event of accident or vandalism.

The cement binder will be stored in dry conditions in a sealed tank system.

Traffic management
All vehicles will adhere to the traffic routes outlined in the EIS and detailed in the transport management plan.

Management procedures/method statements
The Contractor will be required to produce detailed method statements and procedures for the stabilisation works which will address the following topics as a minimum:

- Plant and equipment;
- Safe operating procedures;
- Material safety data sheets (MSDS);
- Monitoring instrumentation;
- Monitoring and reporting procedures;
- Access arrangements;
- Spill recovery procedures;
- Emergency response measures.

4.5 Monitoring

4.5.1 Leachate

Ground water monitoring will be undertaken to evaluate the environmental risks that are specific to the proposed binder/peat combination at the Bellanaboy Bridge Terminal site. Tests will include measurement of pH and electrical conductivity in the downstream gradient from the stabilised area as these parameters determine the rate of transport and the distribution of the area influenced by the stabilisation. Piezometers will be placed in the stabilised and non-stabilised ground at varying distances from the boundary of the stabilised material. A typical suite could be placed at distances at 0.5m, 1m, 5, 10m and 50m distances down-gradient of the stabilisation areas at the locations shown in Figure 1. In addition, a suite of instruments will be installed up-gradient of the area to be stabilised. Monitoring will continue at regular intervals for at minimum of 12 months to demonstrate that leaching has not occurred.

Sampling, storage and chemical analysis of the peat, binder and stabilised peat will be carried out in accordance with the procedures detailed in EuroSoilStab 2002.

4.5.2 Surface Water Monitoring
Analysis of surface waters upstream and downstream from the stabilisation works will also be undertaken. As for groundwater monitoring, tests will include electrical conductivity and pH.

4.5.3 Airborne Dust

Dust levels will be monitored and maintained below the 8hr Time Weighted Average (TWA) Occupational Exposure Standards (OES) for cement which are:

- Total inhalable dust 10mg/m^3
- Respirable dust 4mg/m^3

5 Predicted Impacts

The peat stabilisation works will have no residual effect on the quality of groundwater or surface waters or their associated ecosystems outside the Terminal site boundary.

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12. *The basis for all assumptions used in relation to the drainage calculations provided and the design of the settlement ponds.*

Technical Appendix 3 (Site Drainage) of Volume 1 of the EIS, provides the design philosophies, design assumptions, design calculations and design details for the drainage and settlement ponds for the construction phase and permanent drainage of the site.

The basis of the calculation of storm water runoff (flow), which is used to design the storm water system, is the 'modified rational method'. This method is the standard technique for estimating storm water runoff from small catchments (area to be drained) because of its simplicity and flexibility. Note 'small' in this context is an area of less than 1.5 km^2. This method provides a close approximation of runoff rates for small catchments. As the size of the catchment increases, the method tends to over-estimate the runoff values. The result of using a larger runoff is that the design will be more conservative.

The maximum drainage area for the terminal site is 0.35 km^2 (35 hectares), the area to be drained during the construction phase. This is well within the catchment size for which the modified rational method is appropriate.

The model uses two parameters, impervious areas and rainfall intensities, to calculate the peak runoff. This gives a robust design.

In the case of the Bellanaboy Bridge terminal, as described in Technical Appendix 3, the design assumptions are as follows:

The maximum construction phase runoff is calculated, based on the assumption that the entire drainage area is impermeable. This assumption is based on the site investigation tests, which indicated very low permeability in the peat - refer to EIS Volume 1 Technical Appendix 1 Geology, Hydrogeology and Global Stability Report, Section 8.3.

The 'time of concentration' is the time it takes for rain water, which falls on the furthest point of the area to be drained, to reach and enter the drainage system. The speed of the water, and thus the time taken, depends on the nature of the ground surface over which the water has to travel in order to get to the drainage system. Hydraulic tests performed in the catchment indicated that the time of concentration of the catchment, prior to development, is two hours. The drainage calculations indicated that the time of concentration following installation of the drainage system will be one hour.

During the permanent phase, the area to be drained is much less than for the construction phase, as it extends only to the terminal footprint and cut faces of the earthworks. The areas of impervious ground, which include all hard standing areas (paved) plus 60% of the gravelled areas, are entered into the computer model. The rainfall intensities, calculated from the times of concentration, are generated for each point within the model. Therefore, by recalculating the time of concentration along all points in the model, the rainfall intensities are continuously updated as the calculation progresses from the upstream end of the model to the settling ponds. At the entrance to the settling ponds, the time of concentration is in the order of 30-40 minutes. The retention time in the ponds (length of time water takes to travel through the pond), based on the peak flowrate and pond geometry, is in the order of 20-30 minutes. Adding the two times gives a total time of concentration of approximately 1 hour.

Other hydrologic runoff calculation methods were not used for several reasons. Foremost of the reasons is that the modified rational method, for reasons stated above, is the industry standard method for computer modelling of small catchments. Other methods often require additional, more detailed information regarding the catchment characteristics, which may not be readily available or applicable to the catchment, without adding a significant degree of complexity. This

information can include soil types, overland slopes, channel slopes, which may not be representative of the catchment as a whole.

The design method for the settlement ponds in the Bellanaboy Bridge terminal is described Volume 1 of the EIS, Technical Appendix 3, Section 4. The design is based upon achieving the required pond flow-through velocity, minimum particle settling velocity and water depth over the outflow weir. As stated in Section 4.1 of this report, the design methodology is that used by Bord Na Mona, including for settlement ponds at Bord Na Mona's facilities, which have been licensed by the Environmental Protection Agency.

The design features of the settlement ponds are as follows:

- The design provides for inflow and outflow weirs across the width of the pond, ensuring even flow distribution within the pond.
- To ensure pond side stability, sheet piling and peat strengthening are incorporated into the rectangular pond cross design.
- In order to minimize erosion of the peat surface at the outfall of the settling ponds, the design incorporates an energy-reducing rip-rap outfall from the ponds and provides drains to control the overland flow area, and provides a sampling point for the settled and polished site runoff.

13. *Investigation of the feasibility of only allowing surface water which is actively pumped from the site entering the settlement ponds and ensuring that site drainage during construction is a totally pro-active hydrometric process rather than a semi passive one. (Parameters would involve setting a maximum allowable output flow rate from the site and in the event that this flow rate is exceeded, flooding of the site is the end result, rather than dealing with the risk of overloading of the settlement ponds).*

The construction phase rainwater runoff collection system, as described in the Corrib Field Development EIS Volume 1, Technical Appendix 3, Corrib Terminal: Bellanboy Bridge - Site Drainage Report, Section 2.2, is a totally pro-active hydrometric process. All the rain water runoff within the excavated areas, including runoff from the windrowed peat, is collected in localized catch drains which outfall to temporary surface water sumps. The runoff collected in the sumps will be intermittently pumped to a 7-way manifold to distribute the pumped water over 7 field drains/settling ponds. The localized catch drains and temporary sumps will be extended and/or moved as necessary, as the cut face of the excavation moves. In the later stages of the excavation, as the size of the area to be drained increases, two temporary sumps, with associated pumps and 7-way manifolds, will be used to collect and distribute the runoff. For clarification, the temporary sumps and pumps in the construction phase have been shown on drawings COR-AR-SD-RFI-003 and COR-AR-SD-RFI-004, which are enclosed with the response to Item 7 (Volume 1).

14. *Examine the practicability of relocating the settlement ponds further to the north of the site allowing a greater distance for any surcharge of the ponds to flow over ground and examine how this would affect the stability of the underlying peat.*

A number of locations for the settling ponds were investigated in the design phase, including locations further to the north of the current location. The proposed location is considered to be the optimum for a number of reasons.

The proposed location allows the entire site to drain by gravity. The drainage system has been designed for the 1 in 100 year storm. If the ponds were located further to the north, it would be necessary to pump the storm water into the ponds. Since pumping would involve the consumption of energy and would have higher operating and maintenance costs, is not desirable on environmental or economic grounds. It is not practical to cater for the 1 in 100 year storm run off by pumping.

In relation to the hydrogeological regime of the site, the ponds and outflow location are at a preferred location in order to minimize supplementary groundwater recharge at higher elevations.

The outflow from the settlement ponds is allowed to flow over the natural ground surface for final polishing. However the overland flow is confined by perimeter drains, in order to limit the overland flow area. The drains also provide a storm water runoff sampling point. By moving the ponds further to the north, the length and width of the overland flow area would increase, creating greater uncontrolled loading which could have implications for the stability of the existing peat.

15. A data history setting out the hydrological dynamics of the site to date. In particular the relationships between rainfall events, flows in perimeter drains and levels of phosphates and suspended solids.

Introduction

This response expands on the information supplied in Volumes 1 & 2 of the Environmental Impact Statement (EIS) that has been submitted in respect of the proposed Bellanaboy Bridge Gas Terminal and the associated Srahmore Peat Deposition Site.

A data history setting out the hydrological dynamics of the Terminal site to date is provided. In particular the relationships between rainfall events, flows in perimeter drains and levels of phosphates and suspended solids is detailed.

Meteorological data was collected from a site-based weather station. Parameters measured were: rainfall, wind speed, wind direction, solar radiation, air temperature and relative humidity

Baseline monitoring was carried out in January 2002, involving the measurement of the following parameters: Colour, turbidity, suspended solids, nitrite, nitrate, total nitrogen, ammoniacal nitrogen, total phosphorous, ortho-phosphate.

Data Summary

A brief summary of the data acquisition in relation to meteorological, hydrological and hydrochemical information is given below.

After consultation with the Marine Institute and the North-western Regional Fisheries Board, flow weirs and associated flow measuring meters were installed in the main discharge arteries from the terminal site. These flow measuring weirs, located in drains D16, D22 and D62, continuously logged surface water coming off-site and logged results were downloaded on a monthly basis. Between June 2001 and March 2003 flow measurements were recorded in the above mentioned drains on the terminal site.

Between June 2001 and May 2002 baseline chemical and physical water quality data were collected[1]. This included continuous data logging for a limited number of parameters at a number of different locations in and around the terminal site. All of these locations were spot sampled on a monthly basis and the water samples sent for analyses in an accredited laboratory.

Figure 1 shows the locations of the sampling locations and Table 1 names each of the locations sampled.

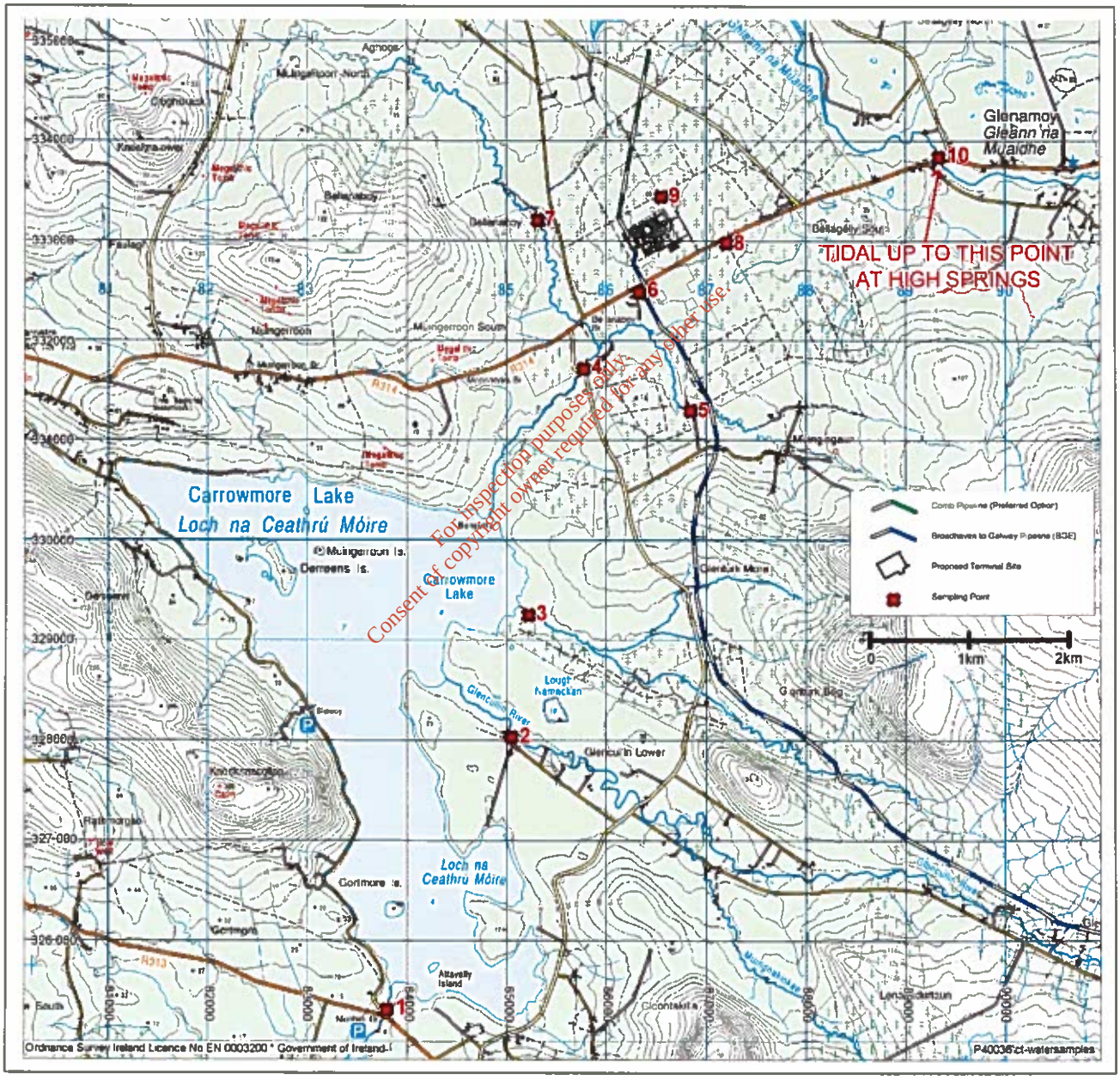
Table 1: Numbers of samples taken at each survey location

Location Ref.	Location Name	No. of samples/ site
Site 1	Lake outlet	12
Site 2	Glencullen River	12
Site 3	Glenturk River	12
Site 4	Bellanaboy Bridge	12

[1] Minerex Environmental Reports 1322-966 Dec-Jan (final); 1322-1820 May 2002 (final); 1322-1680 April 2002 (final)

Site 5	Muingingaun River	12
Site 6	Drain 16	7
Site 7	Aghoos River	12
Site 8	Drain 22	7
Site 9	Drain 62	5
Site 10	Glenamoy Bridge	12

Figure 1: Locations of sampling sites in and around the proposed Terminal Development



A more detailed breakdown of the history of data acquisition is summarised in Table 2.

Based on data acquired from 2001 to 2003 a ground investigation database, including information on geology, hydrogeology, hydrochemistry and geotechnical stability, was compiled. This has resulted in a detailed understanding of the surface hydrology and hydrogeology of each of the strata-types present on site and their inter-relationship with the hydrology of the site.

The information obtained from the continuous data logging has confirmed a direct relationship between rainfall events and increased flows in perimeter drains. This monitoring has also established the relationship between rainfall events (storms) and increased turbidity, (indicatively monthly data for January 2002 is provided in Figures 1a/b). Phosphate levels have not been continuously measured, however, data has been acquired over a long period with varying flow levels in perimeter drains/ weirs.

The two main variables used to measure the hydrochemical and hydrological relationship were turbidity and flow. The other parameter, which showed a close relationship diagrammatically with turbidity, was electrical conductivity (EC), which also correlates well with flow, Figures 2 a/b.

This has lead to the conclusion that the shape of the relationship between EC and flow, which was evident in the similarity between turbidity and EC, is probably due to the nutrient levels. The parameter EC appears to be an indicator of nutrient loading. Figures 3 a/b show nutrients correlated with EC (units µ siemens/cm – µS/cm) and the same pattern of clusters appear for total phosphorous, ammoniacal nitrogen and total nitrogen.

In respect of drier conditions figure 4 shows a summary for the month of May 2002 where 'storm' events only had rainfalls of about 1.5mm as opposed to over 2mm in other months. There are also periods of drier conditions.

In conclusion the data indicates that there were no significant changes in phosphate concentrations with increased flow rates or increased suspended solids. Data available for weir 1 at drain 16, for example indicates low phosphorous concentrations (all less than 0.1 milligrams per litre) for a range of suspended solids of between 12 and 26 milligrams per litre, over a range of measured flows of between 10 and 140 litres per second, as shown in Figure 5.

Figure1a storm event

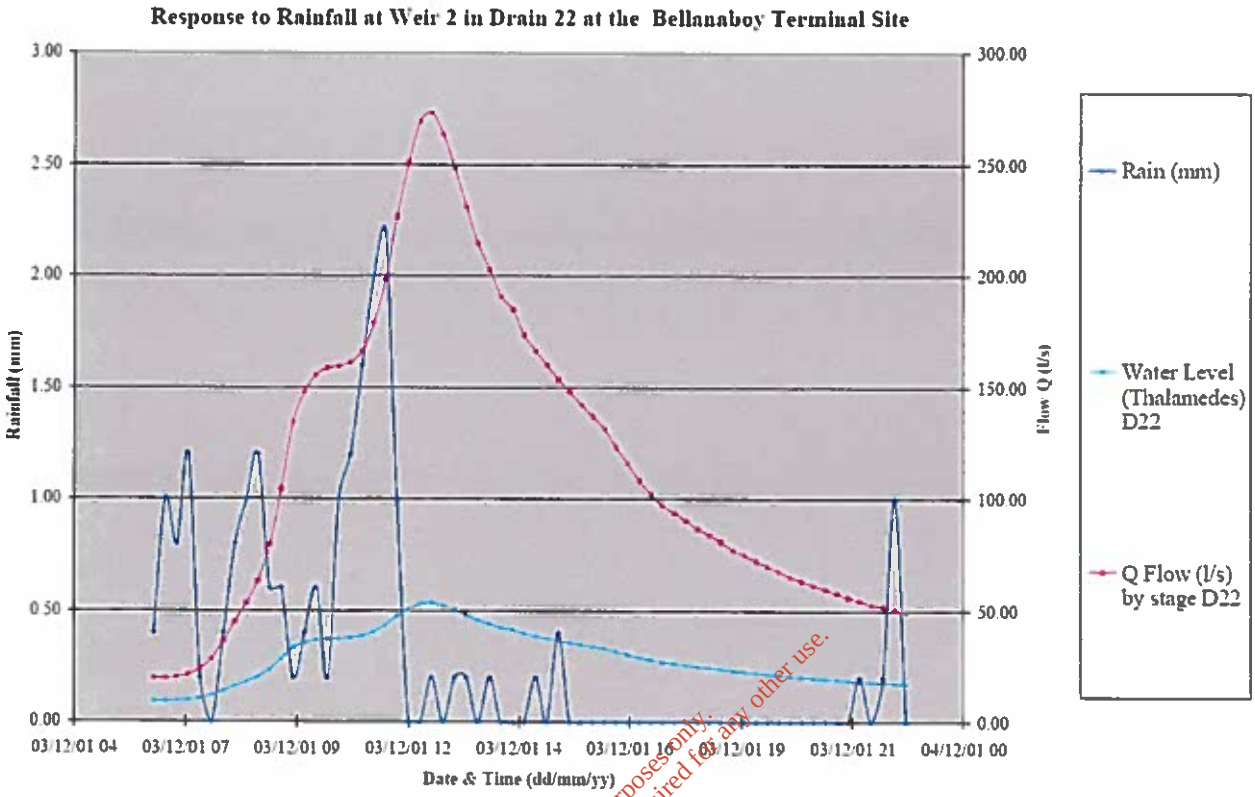


Figure1b storm event

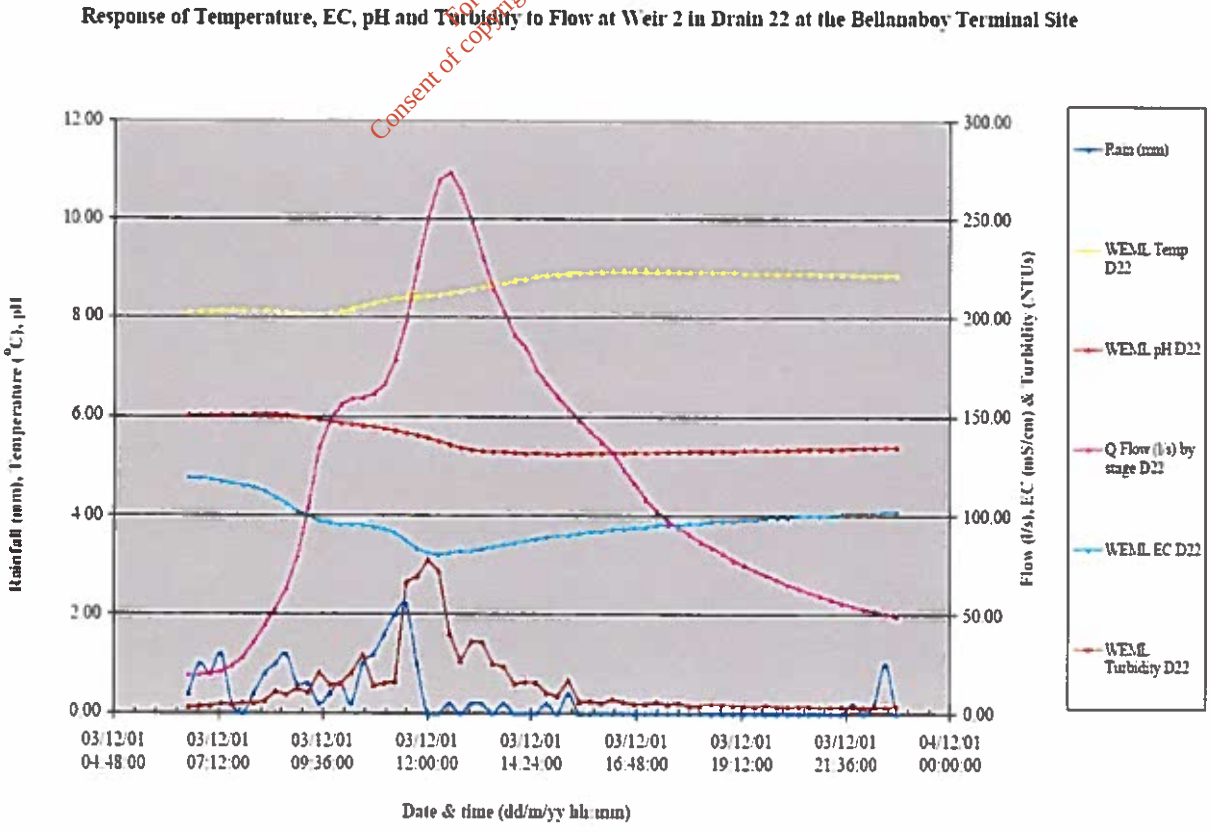


Figure2a

Response of Temperature, EC, pH and Turbidity to Flow at Weir 1 in Drain 16 at the Bellanaboy Terminal Site

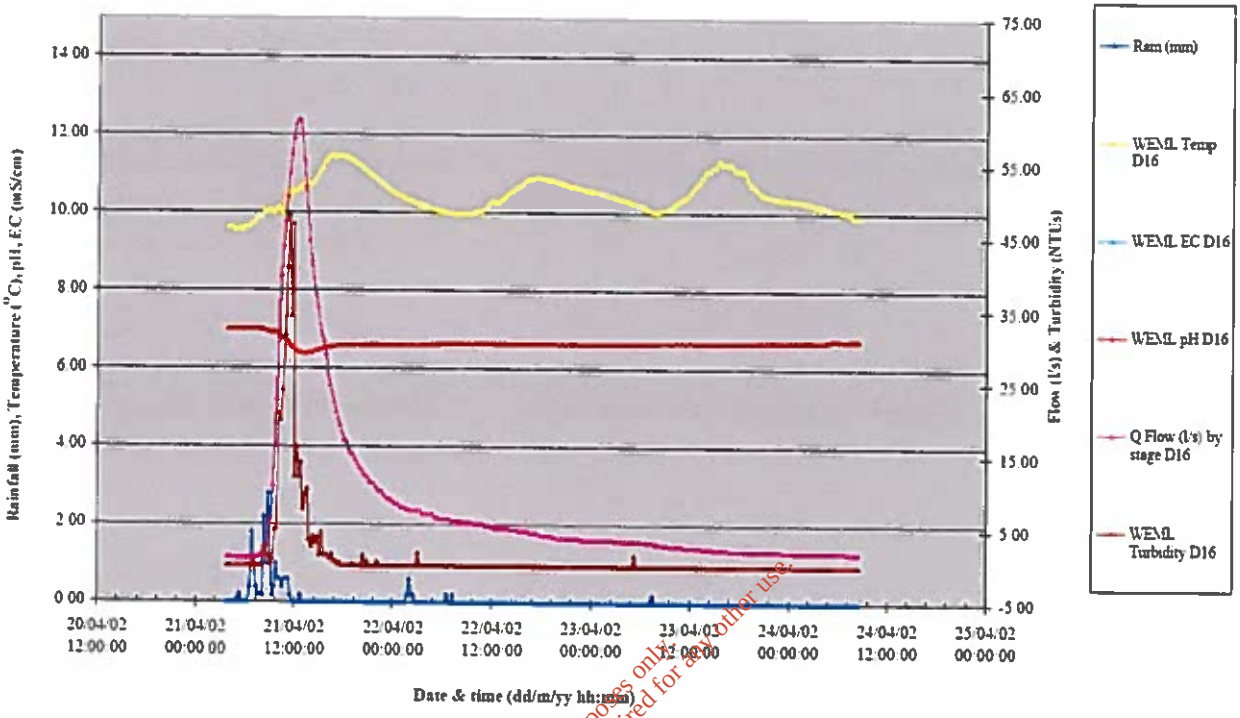


Figure2b

Response of Temperature, EC, pH and Turbidity to Flow at Weir 2 in Drain 22 at the Bellanaboy Terminal Site

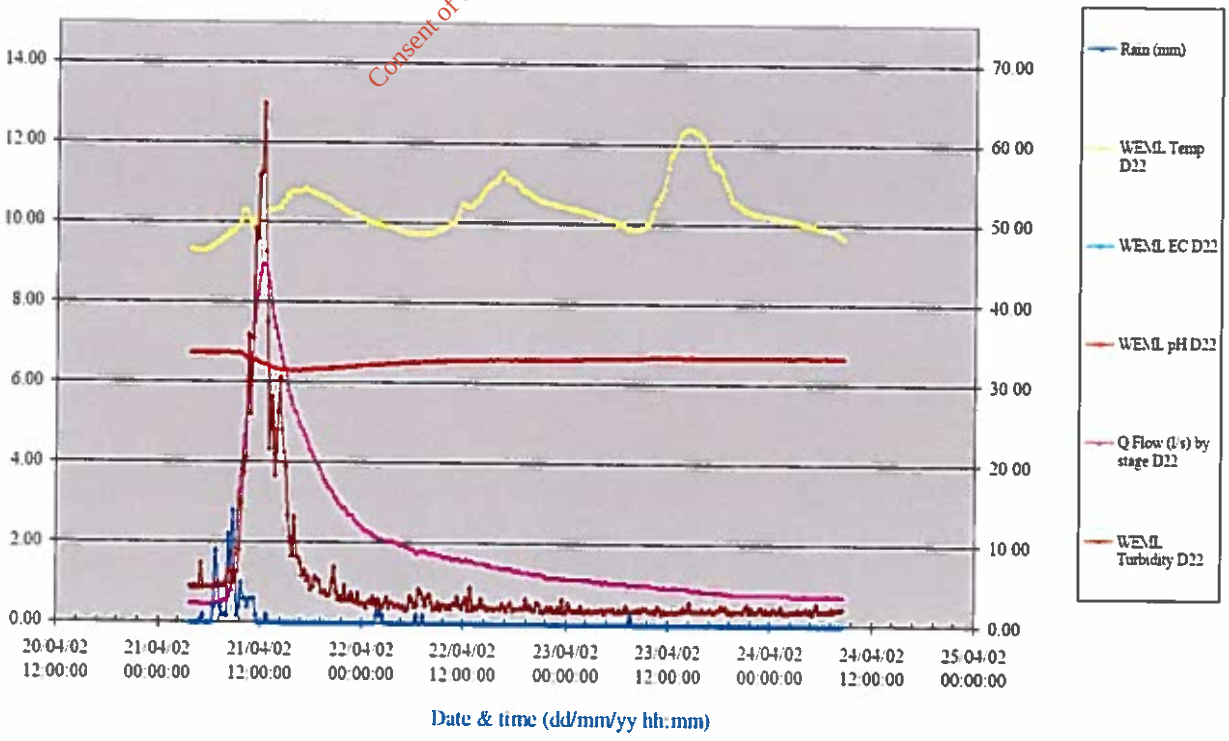


Figure3a

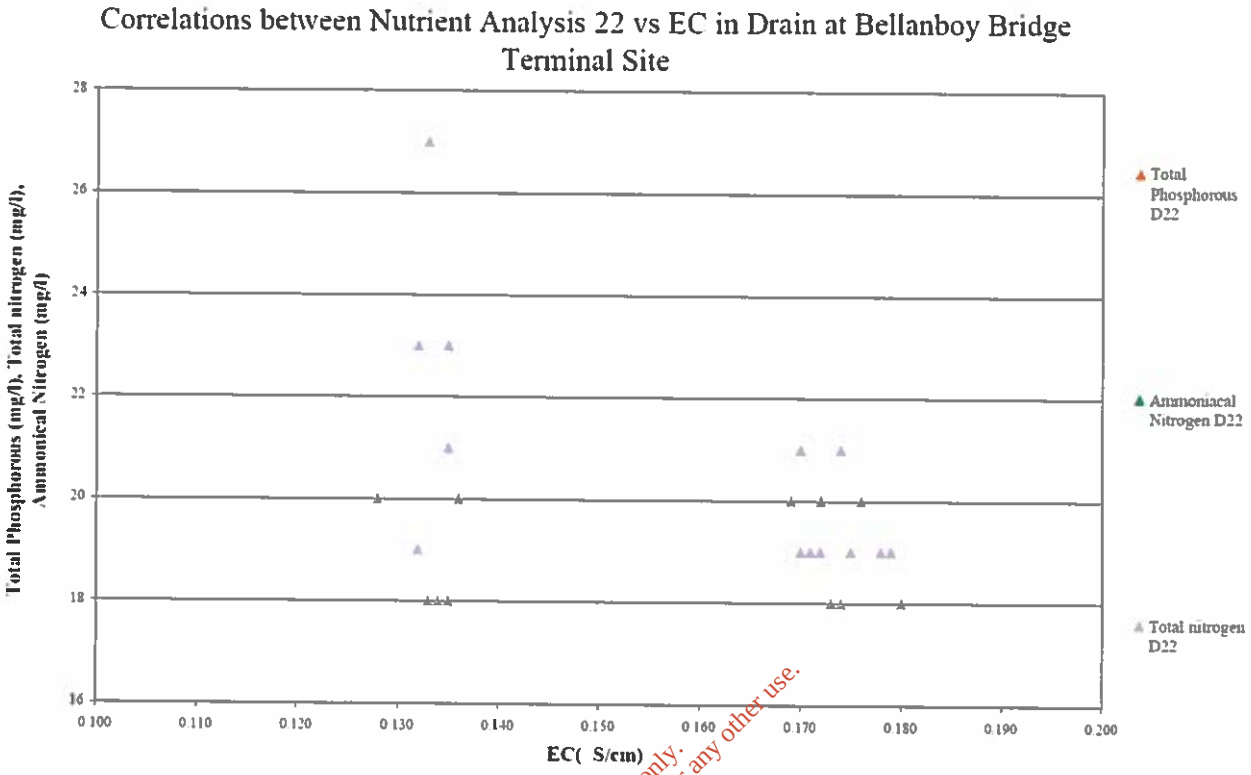


Figure3b

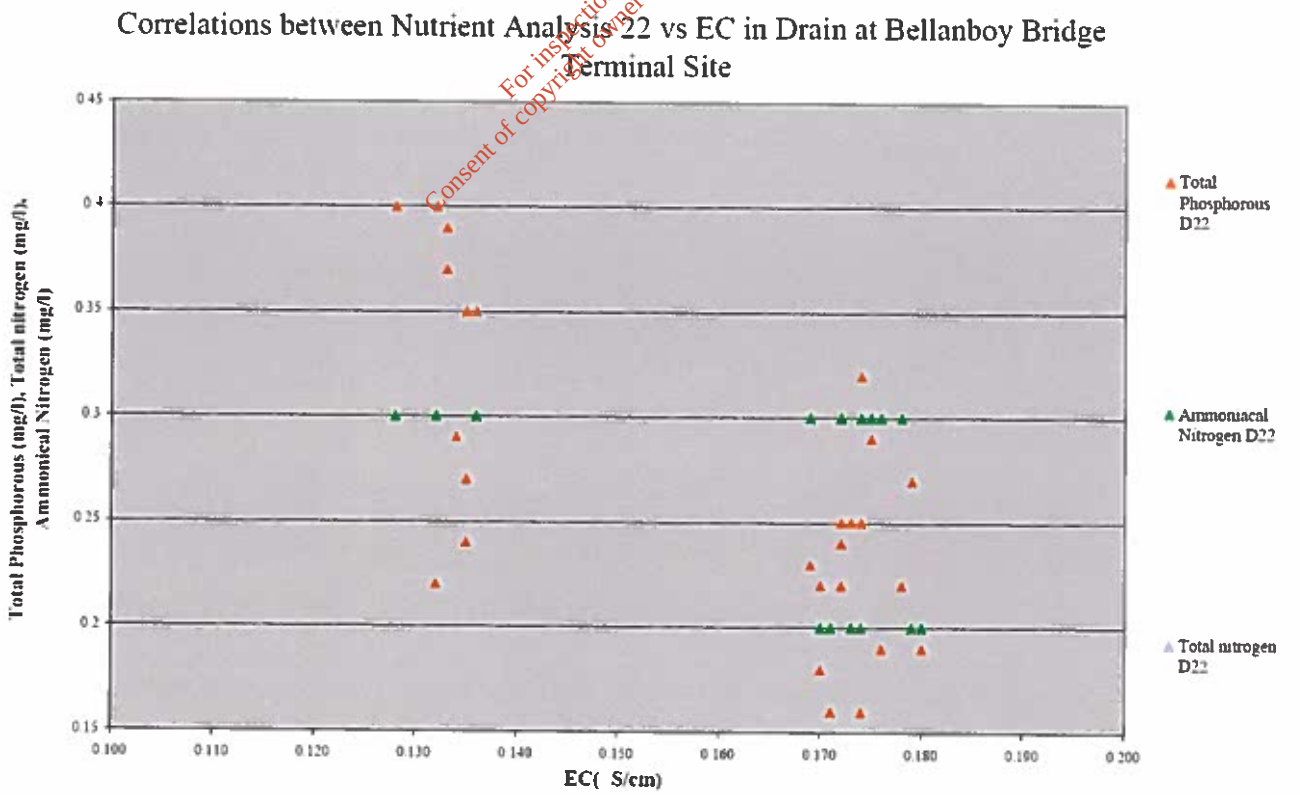


Figure 4

Summary of Water Level, Flow Data and Hydrochemical Data for May 2002
Response of Temperature, EC, pH and Turbidity to Flow at Weir 1 in Drain 16 at the Bellanaboy Terminal Site

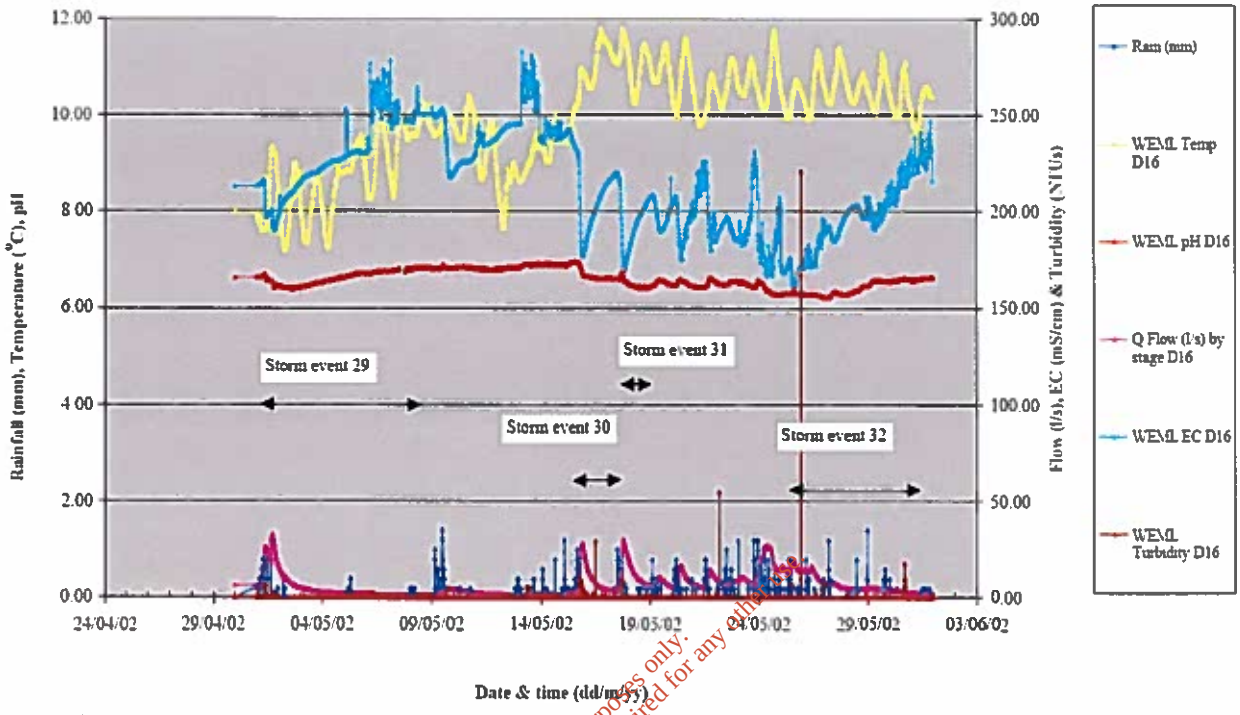


Figure 5

Correlations between Hydrochemical Analysis vs Flows in Drain 16 at Bellanboy Bridge Terminal Site

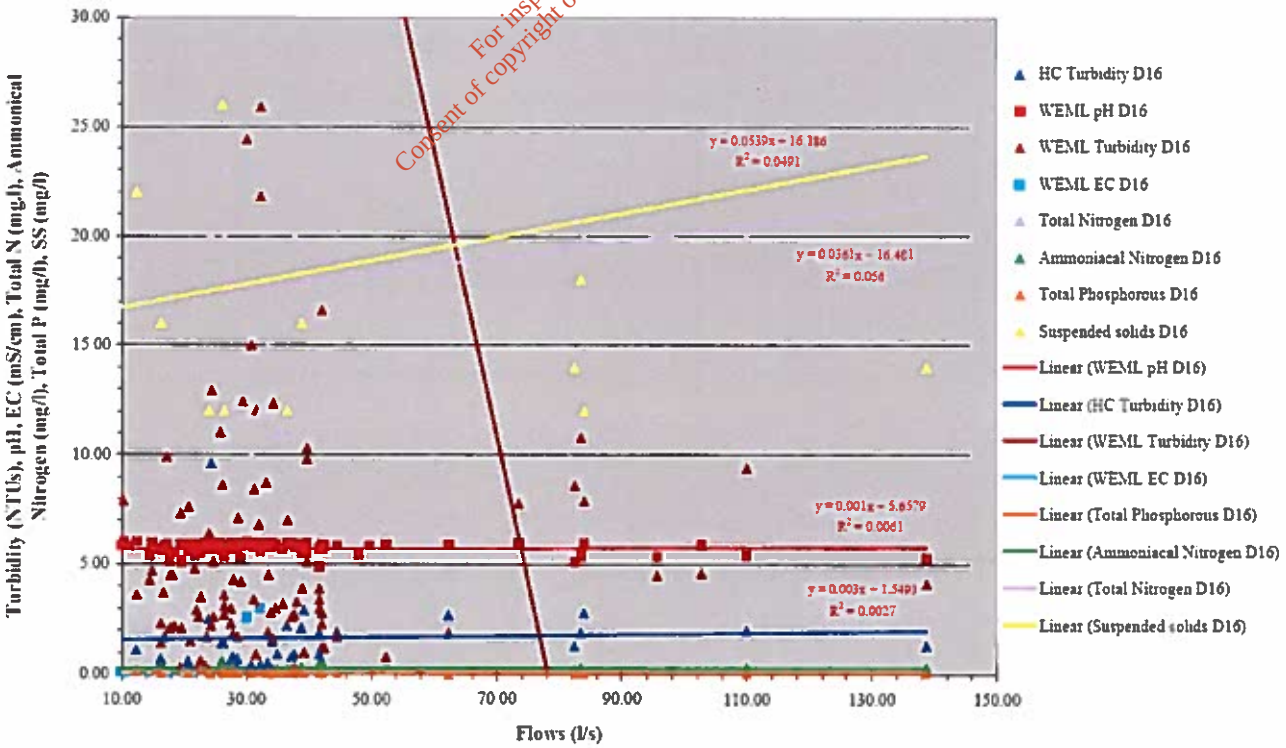


Table 2 Measured Monthly Data (MEL April 2002)

	Month	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	Year	2001	2001	2001	2001	2001	2002	2002	2002	2002
Meteorological Data		×	×	×	×	✓	✓	×	✓	✓
SURFACE WATER MONITORING (monthly)										
Weir 1 (D16)	Flow	×	×	×	×	✓	✓	✓	✓	✓
	Water level	×	×	×	×	✓	✓	✓	✓	✓
Weir 2 (D22)	Flow	×	×	×	×	✓	✓	✓	✓	✓
	Water level	×	×	×	×	✓	✓	✓	✓	✓
Weir 3 (D62)	Flow	×	×	×	×	✓	✓	✓	✓	✓
	Water level	×	×	×	×	✓	✓	✓	✓	✓
Turbidity		×	×	×	×	✓	✓	✓	✓	✓
Electrical Conductivity		×	×	×	×	✓	✓	✓	✓	✓
pH		×	×	×	×	✓	✓	✓	✓	✓
Temperature		×	×	×	×	✓	✓	✓	✓	✓
GROUNDWATER MONITORING (every 3 months from August 2001)										
Field Hydrochemical Monitoring										
	Electrical Conductivity	✓	×	×	✓	×	×	×	×	×
	pH	✓	×	×	✓	×	×	×	×	×
	Temperature	✓	×	×	✓	×	×	×	×	×
Water Level (every 3 months)		✓	×	×	✓	×	×	×	×	×
Analytical Hydrochemistry (biannually)		×	×	×	✓	×	×	×	×	×

	Month	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
	Year	2002	2002	2002	2002	2002	2002	2002	2002	2003	2003	2003
Meteorological Data		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SURFACE WATER MONITORING (monthly)			·									
Weir 1 (D16)	Flow	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Water level	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Weir 2 (D22)	Flow	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Water level	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Weir 3 (D62)	Flow	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Water level	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Turbidity		✓	×	✓	×	✓	✓	✓	✓	✓	✓	✓
Electrical Conductivity		✓	×	✓	×	✓	✓	✓	✓	✓	✓	✓
pH		✓	×	✓	×	✓	✓	✓	✓	✓	✓	✓
Temperature		✓	×	✓	×	✓	✓	✓	✓	✓	✓	✓
GROUNDWATER MONITORING (every 3 months from August 2001)												
Field Hydrochemical Monitoring												
	Electrical Conductivity	✓	×	×	×	✓	×	×	×	×	×	×
	pH	✓	×	×	×	✓	×	×	×	×	×	×
	Temperature	✓	×	×	×	✓	×	×	×	×	×	×
Water Level (every 3 months)		✓	×	×	×	✓	×	×	×	×	×	×
Analytical Hydrochemistry (biannually)		✓	×	×	×	×	×	×	×	×	×	×

16. *Proposals to deal with the storage of peat on site in the event of adverse weather conditions preventing sufficient de-watering of the peat to allow transportation to the deposition site.*

In the event of adverse weather conditions, the peat stored at the terminal site will be covered by waterproof sheeting. This is standard Bord na Mona practice and will ensure that free water can escape from the stored material, and prevent additional water being added.

17. *A detailed waste management plan setting out all wastes expected to be generated by the project both during construction and operation. The expected quantities of each waste type and their probable disposal routes.*

A response is provided overleaf..

1 Introduction

This section draws on and supplements Section 16 of Volume 1 of the EIS, addressing a number of the strategical aspects of waste management. Specifically, it addresses:

- The principles of waste management that will be applied by Shell;
- waste management practices to be applied to the different types of waste, and
- the estimated quantities, types and disposal options for waste that may be generated during construction and operation of the terminal.

It should be noted that in respect of some of the wastes arising as a result of terminal operations, the EIS submitted in support of the planning application has considered the worst case scenario. This is especially important when dealing with wastes that may arise due to the potential presence in the produced fluids of certain components, such as mercury. The EIS assumes that mercury will be removed from the gas, condensate and produced water streams by means of various filtration processes, and makes 'worst case' predictions with respect to quantities of waste generated. In table 3 the quantities presented are worst case estimates based on industry experience of similar reservoirs and are not actual or even likely quantities but are given to demonstrate the ability of the terminal facilities to deal with these wastes should they arise; see section 2 of the EIS for a more detailed discussion. It is not possible to give more accurate predictions of these types of wastes until after production start-up.

2 Principles of Waste Management

The following key principles will underpin Shell's approach to the management of all wastes arising:

- Compliance with Irish legislation with respect to waste management;
- specification of materials to minimise the impacts of waste disposal through selection of suitable materials with minimal environmental toxicity consistent with effective operational use;
- minimising arisings of waste, and
- maximising re-use on site where possible.

3 Waste Management Practices

These principles will be implemented by the construction contractor and by Shell as operator of the terminal. It will include the following practices:

- Segregation and the provision of safe storage facilities for the wastes arising on site pending their collection for disposal;
- appointment of competent staff to be responsible for the management of wastes;
- selection of minimum risk disposal methods (see tables below);
- selection of authorised and licensed waste contractors for transport and disposal;
- monitoring and checking of arisings and disposal, by reference to the retention of records and audits of contractors and Shell's own practices, and
- setting of reduction targets designed to further minimise wastes arising.

4 Waste Volumes

The following tables estimate the maximum quantities of wastes expected to be generated during construction and operation of the Terminal, and indicate the disposal routes for each waste type. For clarity they have been presented in the same format as that used for the IPC application which will be submitted to the Environmental Protection Agency. A precautionary approach has been taken in compiling the figures which are therefore likely to be an overestimate. The figures are based on start of construction in 2004. If there are delays, the project phasing will change but the overall principles will remain the same.

3.1 Non hazardous construction waste

The types of waste and disposal philosophy are discussed here. Table 1 presents a summary of this and provides approximate quantities and disposal routes. In addition peat will be removed form the terminal site and deposited for re-use at Srahmore, see Volume 1, Section 2 of the EIS. Table 4 of this response provides a more detailed description of material use and re-use as well as offsite disposal of surplus mineral soil. Such materials will be sent to a licensed facility where it is hoped they will be re-used as appropriate.

3.1.1 General compactable waste

This waste will comprise municipal waste and packaging arising from the construction operation and will include kitchen waste (excluding recyclable wastes such as cooking oil), office waste (excluding toner cartridges and the like which will be recycled) paper, cardboard and plastics arising from packaging. Where possible some segregation of these wastes will take place if recycling routes are identified in the local area (can, glass bottles, paper and board).

3.1.2 Chemical toilet waste

During the construction work the permanent sewage treatment system (Puraflo) will not be in place and so chemical toilets will be used. A licensed contractor will collect this waste on a regular basis and will dispose of it to an agreed licensed facility.

3.1.3 Cooking oil

The kitchen facility will be equipped with storage for used cooking oil. This will be collected by a licensed carrier and taken for recycling at a licensed facility.

3.1.4 General Construction Waste

These wastes offer a number of potentials for recovery and recycling. Examples of this include timber formwork (de-nailed), steel pile and rebar cutoffs, batteries, waste oil and solvents that can be recovered. Steel and other metals will be segregated for recycling and sold as scrap. Timber will be segregated and recycled. Other inert materials such as concrete products will be collected by a licensed contractor and disposed of to a local licensed landfill; examples of such local facilities are presented in table 1.

3.2 Hazardous Construction Waste

The types of waste and disposal philosophy are discussed here. Table 2 presents a summary of this and provides approximate quantities and disposal routes.

3.2.1 Oily waste

During the construction process a number of hazardous wastes will arise including oil contaminated Personnel Protective Equipment, oily rags, waste lubrication oil, brake fluid and various solvents. These wastes will be collected by a licensed waste carrier and sent to a hazardous waste transfer facility, examples of which are presented in Table 2. Currently there is no operational hazardous waste treatment facility in Ireland. All such wastes are sent overseas for treatment and disposal.

3.2.2 Clinical waste

Clinical wastes arising on a construction site tend to be those associated with first aid treatment on site. The arisings will be collected by a licensed contractor for delivery to a clinical waste incinerator.

3.3 Non hazardous operational waste

The operation of the terminal will result in small quantities of domestic and office waste associated with a workforce compliment of approximately 50 people in total using the site in a 24-hour period. All of the waste arisings will be handled in the same way as for non-hazardous construction waste. Recycling schemes for cans, bottles and paper and board are likely to be promoted on site subject to the presence of local recycling initiatives.

3.4 Hazardous operational waste

The range of potential hazardous wastes and likely volumes are presented in Table 3. This table also presents the likely disposal route from site i.e. via a licensed hazardous waste carrier to a licensed transfer facility. If there is no hazardous waste disposal facility in Ireland at the time of Terminal commissioning and operation these wastes will be sent overseas for treatment.

3.5 Other potential waste arisings

It is unlikely form our understanding of the operation that any other wastes will arise other than those discussed already. There is the possibility that during maintenance of equipment naturally occurring radioactive material (NORM) may be generated. This is a common event in gas transmission systems and procedures are well established to handle this scenario. In the unlikely event that this occurs, NORM would only be encountered in maintenance campaigns, typically once every three years starting in year three of terminal life. It is not expected that more than a few kilogrammes of NORM might be generated every three years.

In respect of possible NORM consignments, the developer will apply for a solid waste licence from the Radiological Protection Institute of Ireland (RPII), as required by the Radiological Protection Act, 1991 (ionising radiation) Order, 2000, S.I.No. 125 of 2000.

Staff responsible for maintenance work would be trained in the handling of NORM, and be equipped with appropriate personal protective equipment. Work with radiological sources would be covered by the terminal's work permit system. A compound for handling NORM would be established on-site, with NORM sealed in drums. This is in accordance with industry practice and with the requirements of the RPII implementing the Radiological Protection Act.

Table 1 Non-Hazardous Construction Waste

Waste	Description	Year	Volume (m^3)	Mass (tonnes)	Disposal
General compactable waste	Municipal waste, packaging	2004 2005 2006		26 178 85	Collected by a licensed contractor and disposed of to a local licensed facility such as: • Derrinumera, Newport (Grid. Ref. G 103 296) • Rathroeen, Ballina (Grid. Ref. G 123 323)
Chemical toilet waste		2004 2005 2006	234 1 603 761		Collected by a licensed contractor and disposed of to a licensed facility, such as the WWTW at Bangor.
Cooking oil	Vegetable based oil	2005	43		Collected by a licensed contractor and recycled off site.
General construction waste	Concrete products, timber formwork, steel pile and rebar cutoffs	2004 2005		100 200	Steel and other metals segregated and removed from site for recycling by an appropriate contractor. Timber segregated and recycled. Other inert materials collected by a licensed contractor and disposed of to a local licensed facility such as: • Derrinumera, Newport (Grid. Ref. G 103 296) • Rathroeen, Ballina (Grid. Ref. G 123 323)
Peat	Excavated peat	2004/5	450,000	495,000	Re-use in peat deposition site at Srahmore

Table 2 Hazardous Construction Waste

Waste	Description	Volume (m^3)	Mass (tonnes)	Disposal
Oily waste	Oil contaminated Personnel Protective Equipment, oily rags, lubrication oil		4.9/year	Removal by a licensed hazardous waste transport contractor to a licensed hazardous waste transfer station. • Minchem Chemicals Ltd • Sorundon Ltd. T/A Irish Environmental Services • Shannon Environmental Services • National Recycling and Environmental Protection Ltd.
Clinical waste	First aid waste	0.31/year		Removal by a licensed hazardous waste transport contractor to a licensed incinerator

Table 3 Hazardous Operational Waste

Waste	Description	Volume (m^3)	Mass (tonnes)	Frequency	Disposal
Aqueous filter cartridge type	Oil contaminated sand and inorganic salts	0.40	0.05	1 per annum	Removal by a licensed hazardous waste transport contractor to a licensed hazardous waste transfer station such as: • Minchem Chemicals Ltd • Sorundon Ltd. T/A Irish Environmental Services • Shannon Environmental Services • National Recycling and Environmental Protection Ltd.
Condensate filter cartridge type		0.27	0.05	Annual	
Odorisation package activated carbon	Oil contaminated anthracite	1.00	2.50	1 every 4 years	
Mercury removal bed	Oil contaminated absorbent containing traces of Hg	3.00	7.50	Every 3 years	
Export methanol filter cartridge type 2 no.	Oil contaminated sand and inorganic salts	0.01 each	0.05 each	Annual	
Product methanol filter cartridge type			0.05	Annual	
TPS or CPI sludge*		5.00	10.00	Every 3 years	
Produced water treatment sludge	Metals and inorganic salts	73	150.00	Annual	
Produced water treatment cartridge type	Oil contaminated salts	2	4	1 per annum	
Scale inhibitor drums/IBC		2		Annual	
Corrosion inhibitor drums		2		Annual	
Contaminated heating medium	Contaminated tri-ethylene glycol	30.00	28.56	Every 10 years	
Methanol still reboiler scale	Inorganic salts and sand with slight oil contamination	4.80	12.00	Every 3 years	
Tankage and/or vessel sludge	Oil contaminated sand and inorganic salts	50.00	100.00	Every 3 years	
Methanol reboiler tubes	Carbon steel with oil contaminated sand and inorganic salts		7.00	Every 6 years	
Methanol still valve trays			1.00	Every 3 years	
Chemical waste	Spent chemicals used in laboratory	5	4.5	Annual	
Clinical waste		0.03		Annual	
*The inlet filter separator will be periodically washed out and the waste water sent to the TPS/CPI.					

Estimate of Earthworks Volumes Showing Off Site deposition

Construction site location	Deposition Location: On Site – Cut (m3)		Fill (m3)			Off Site – Bord na Mona Srahmore	Off Site – Other Permitted Reclamation Site	Comments
	Peat	Mineral Soil / Rock	Mineral Soil / Rock	Imported Fill	Imported Concrete	Peat m3	Surplus / Unsuitable Mineral Soil m3	
Terminal Footprint Cut and Fill	408,000	184,000	178,000			408,000	6,000	
Main Access Road				5,750				
Eastern Access Road to Terminal Footprint	2,500			750		2,500		
Admin. Building Access Road				2,750				
Emergency Access Road			8,000	2,750			-8,000	Negative Figure Shown here is as suitable fill material is reused at this location and the emergency access road lies outside the parameters of the Terminal Footprint Earthworks Volumes Model e.g. Foundation Risings / Road Cuts at grade in Terminal will most likely be Suitable materials
Settlement Ponds Access Road				3,600				
Admin. Building Car Park				2,100	1,250			
Admin. Building				3,500	1,250			
Temporary Construction Facilities				10,000				
Gabions				12,300				
Peat Loading Bay and Haul Roads				4,500				KEY
Settlement Ponds	6,500					6,500		Unsuitable (peat)
Terminal Footprint Dressing		20,000		20,000			20,000	Suitable
Drainage				10,000				Unsuitable /reuseable
Foundations		15,000			15,000		15,000	
Total	417,000	219,000	186,000	78,000	17,500	417,000	33,000	
Contingency on Peat Volume						33,000		
Total Off Site Deposition						450,000		

18. *Figures 12.1 to 12.4 at a size sufficient to show all noise sensitive receptors and to allow their individual numbering.*

Figures 12.1 to 12.4 are provided at A3 size .

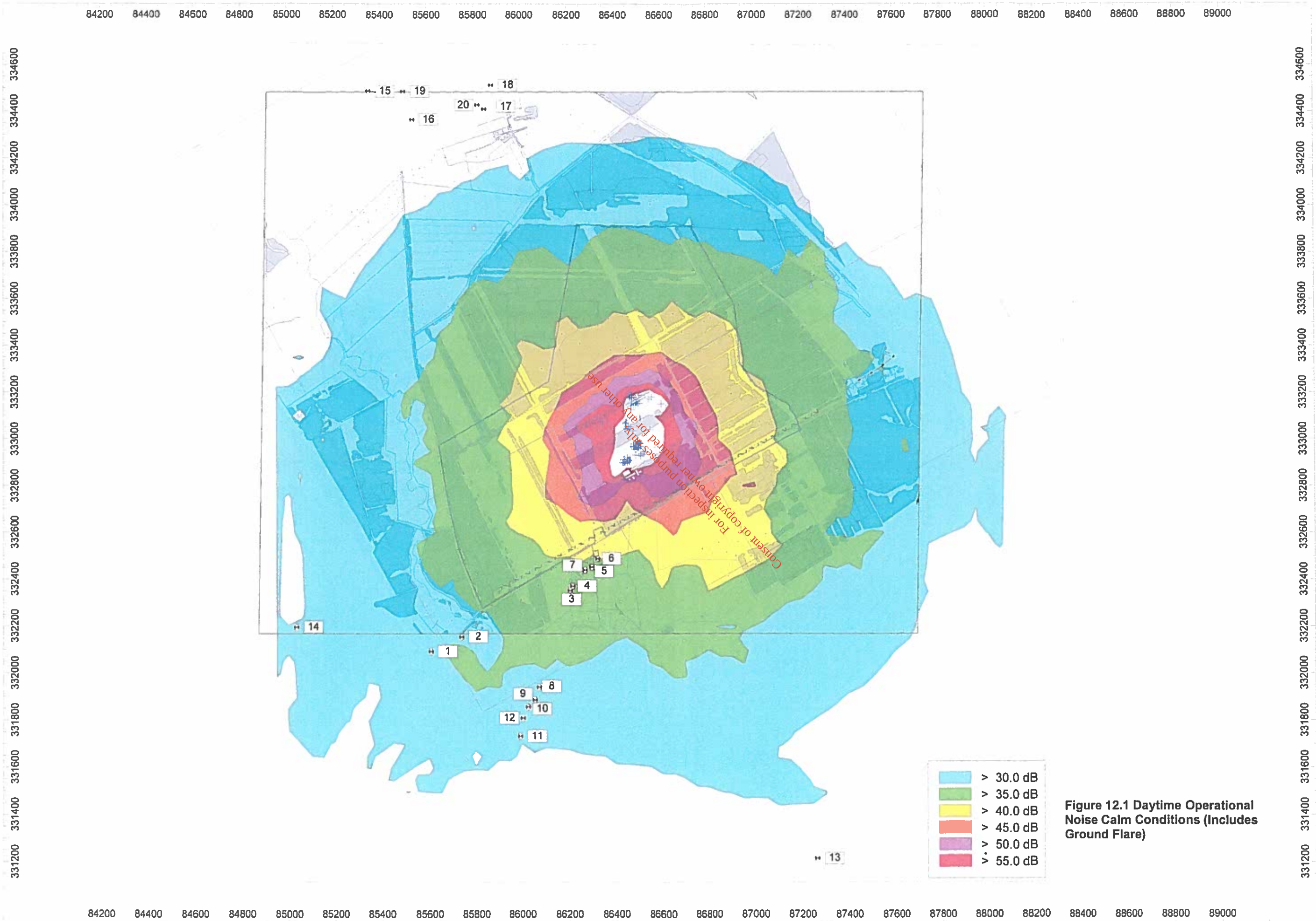


Figure 12.1 Daytime Operational Noise Calm Conditions (Includes Ground Flare)

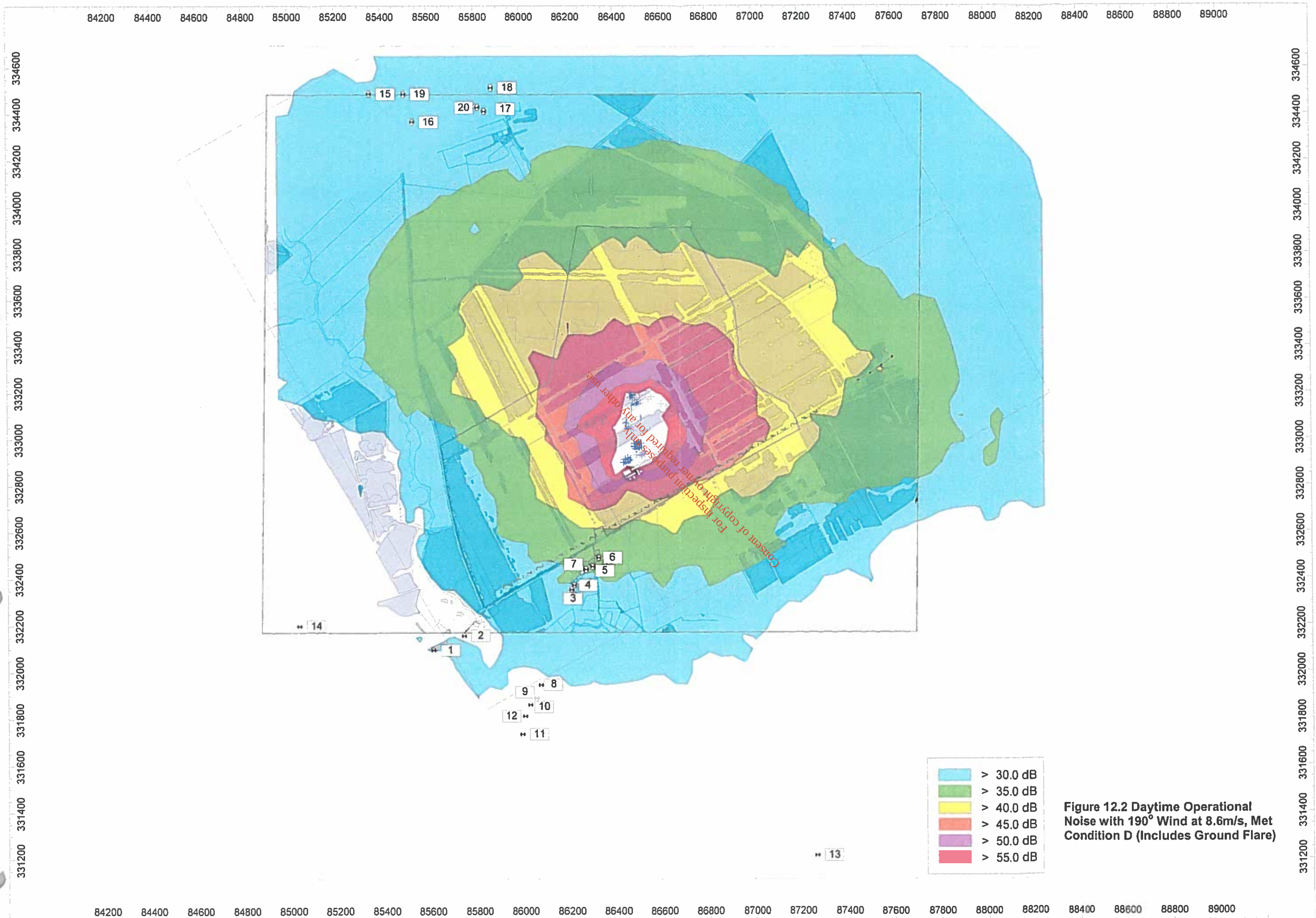


Figure 12.2 Daytime Operational Noise with 190° Wind at 8.6m/s, Met Condition D (Includes Ground Flare)

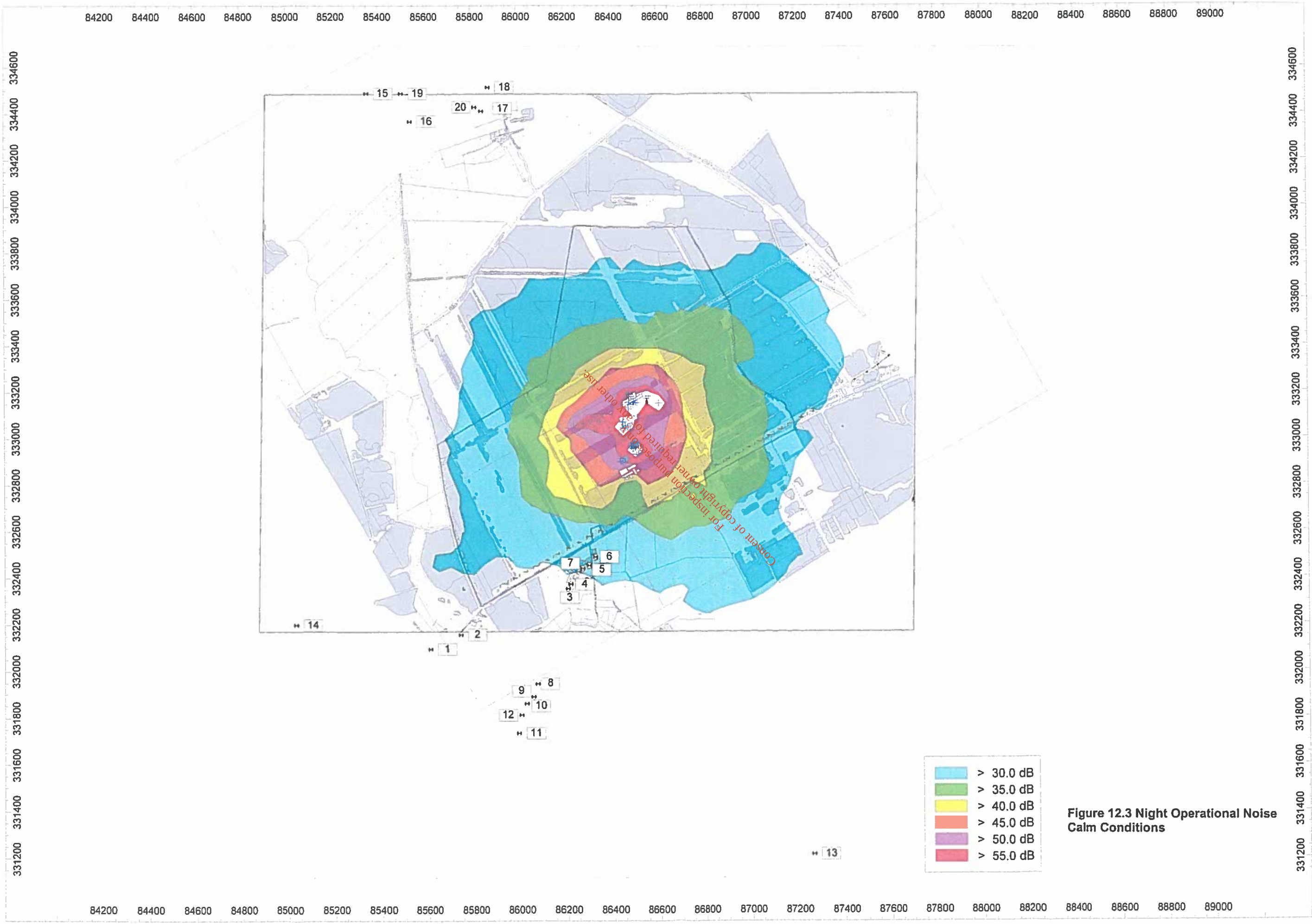


Figure 12.3 Night Operational Noise Calm Conditions

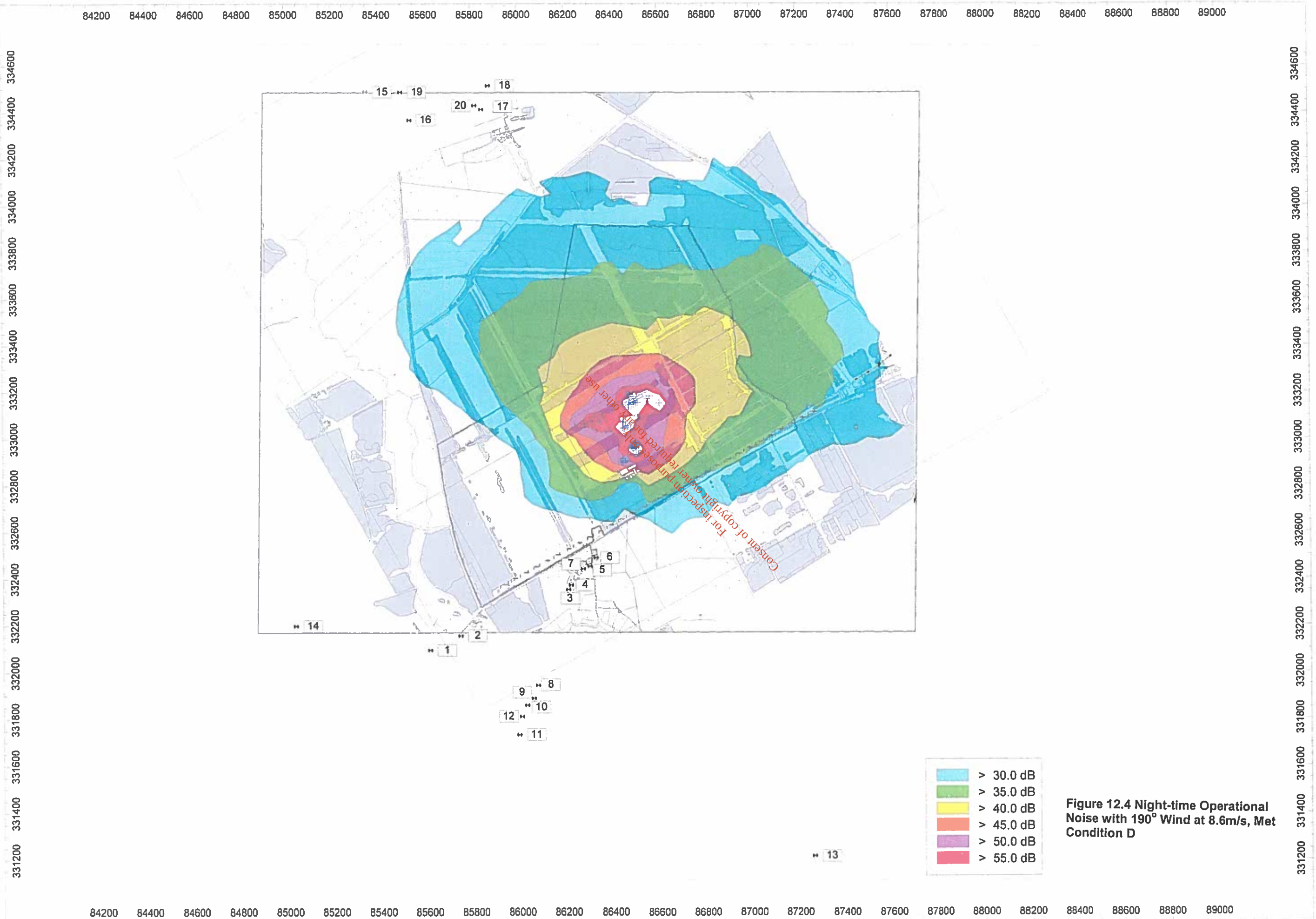
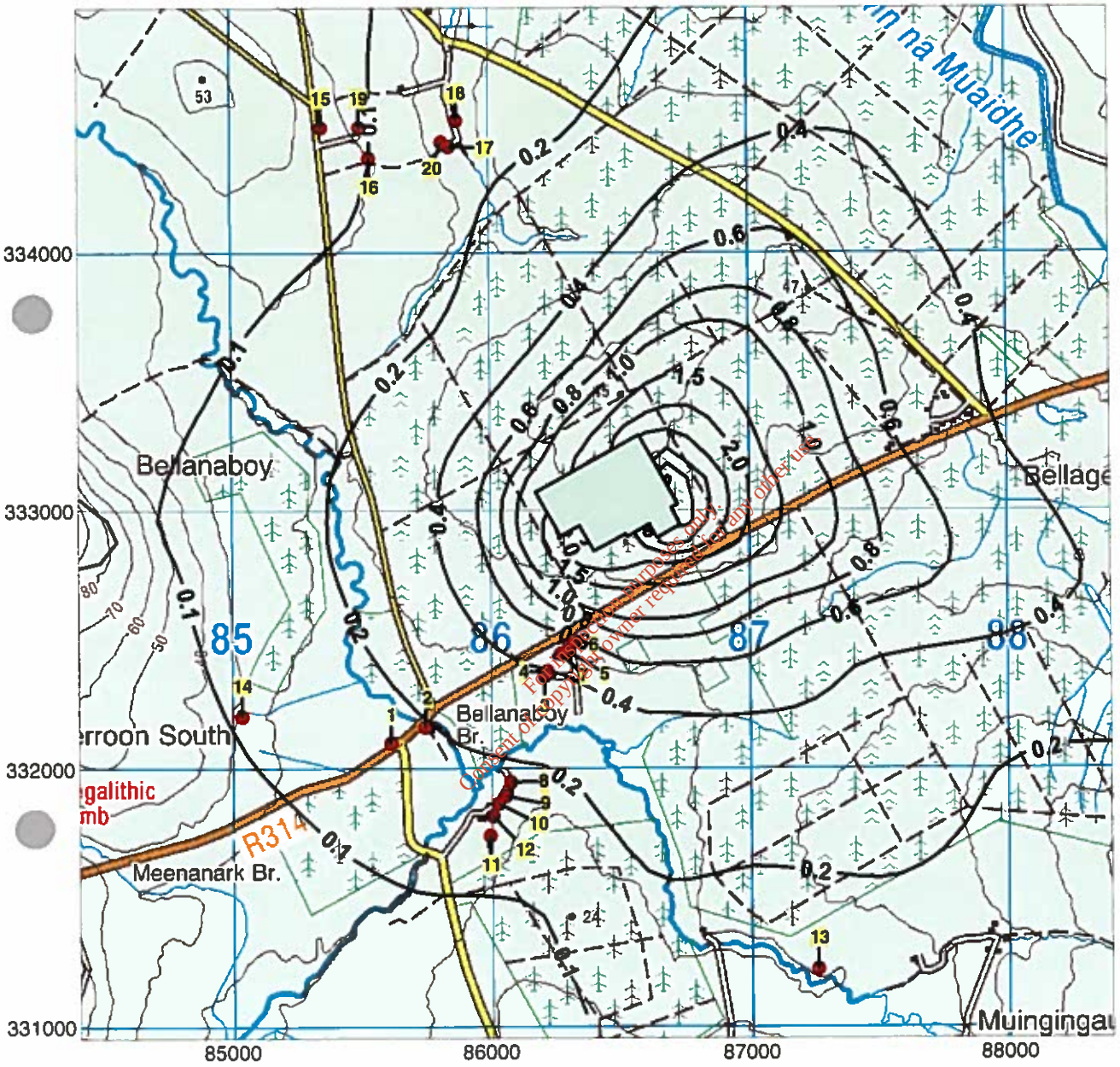


Figure 12.4 Night-time Operational Noise with 190° Wind at 8.6m/s, Met Condition D

19. *Figure 11.3 Concentration Contour at a size sufficient to allow the individual numbering of the nearby houses.*

Figure 11.3 is provided on the following page.

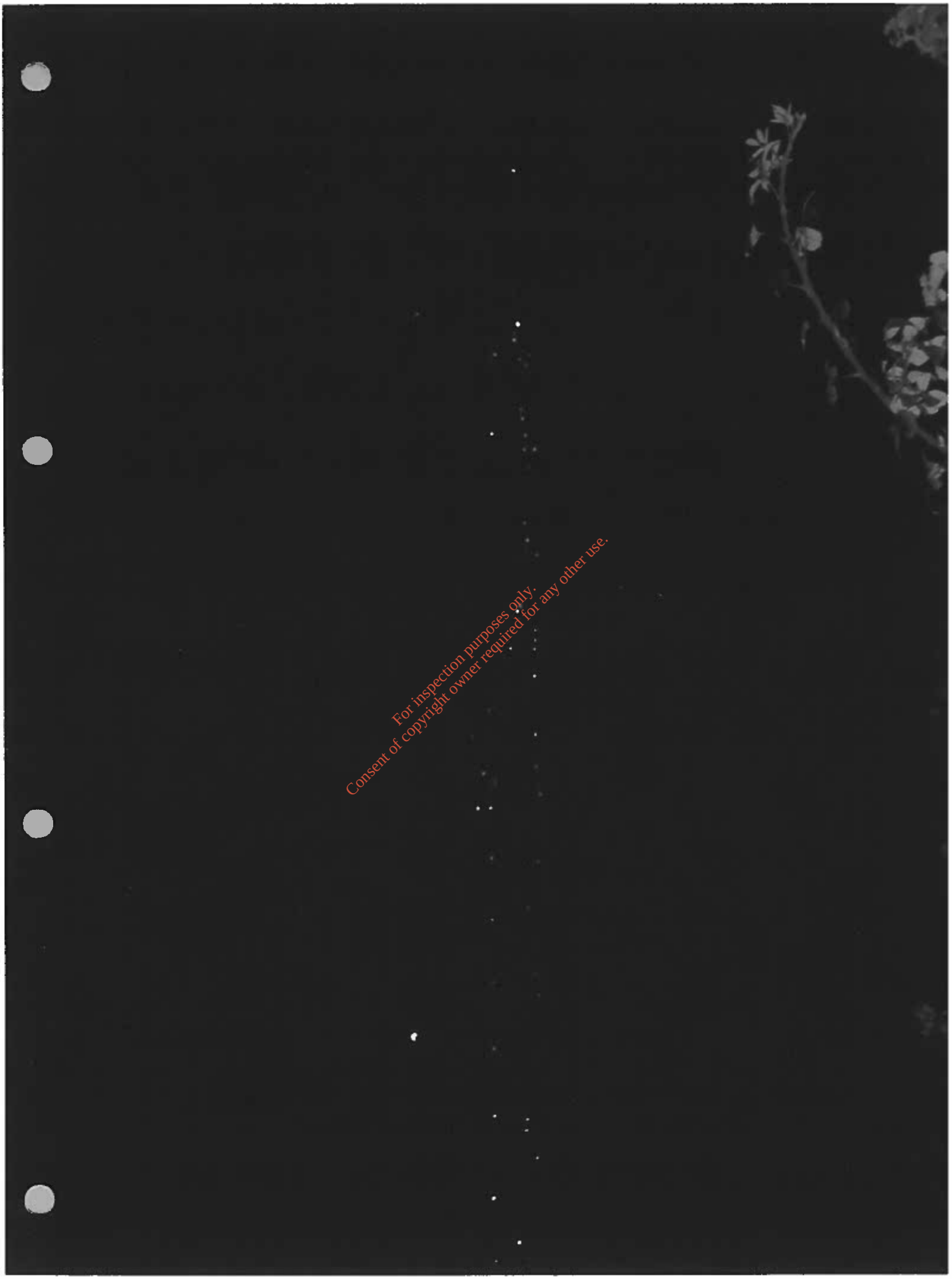
Figure 11.3 Concentration Contour of Annual Average NOx as NO_2 Concentrations Arising from Process Contributions from the Terminal



(1999 Meteorological data. Air Quality Standard is 40µg/m³ for the protection of health and 30 µg/m³ for the protection of ecosystems)

20. *Plates 13.1 and 13.2 reproduced at improved resolution on A4 size photographic paper.*

Plates 13.1 and 13.2 are provided at A4 size.



1. *Additional water quality samples including physico-chemical analyses of these water samples as a baseline for establishing existing water quality (Please note that three of the six water quality samples at Srahmore were taken as drainage maintenance works were being carried out on the main watercourse through the site and would not be representative of baseline conditions).*

Additional water quality samples were obtained on the 6th January 2004 and the 19th February 2004, see Table 1, from the 6 No. surface water sampling points established during the baseline assessment.

The surface water surveys undertaken on the 6th January and 19th February 2004 augment the surface water survey undertaken on the 29th October 2003, which was included in Section 9.3.2 of Volume 2 of the EIS. The samples taken on the 29th October 2003 were taken during a prolonged period of heavy rainfall and also while drainage maintenance works were being carried out at the site.

The samples taken on the 6th January and 19th February 2004 would be considered to be more representative of baseline condition, as no site activities were being undertaken by Bord na Móna during these surveys.

All water quality data is included in Table 1. The locations of the 6 No. sampling points are shown on Figure 9.1 of Volume 2 of the EIS.

As stated in Section 9.3.2 of Volume 2 of the EIS, Bord na Móna were undertaking remedial works along the Main Drain through the Srahmore site. These works would have affected the surface water chemistry downstream of the site. The surface water sampling survey of October 2003 was preceded by a period of rainfall, which would also likely impact upon the surface water chemistry, as a result of overland run-off to the surface water channels.

The surface water sampling surveys of January and February 2004 were undertaken on days of low precipitation, however as the surveys were undertaken during winter months, intermittent rainfalls would have been common prior to both sampling surveys. No site works were being undertaken on the watercourses during the January and February sampling surveys such as those that affected the existing baseline conditions taken in October.

The most recent results, Table 1, show some noticeable differences in water chemistry from the October survey, however in general the water chemistry reflects the geological environment in which the water comes in contact prior to discharging to the marine environment at Tullaghan Bay.

- The Biochemical Oxygen Demand (BOD) of the February 2004 samples is consistently lower than the samples taken in October 2003, as displayed in Table 1 (Samples were not analysed for BOD during the January survey).

  The Chemical Oxygen Demand (COD) is elevated for all sampling surveys, however this is not unexpected due to the presence of large tracts of land covered with organic rich peat. Peat is chemically active and biologically inert, therefore resulting in elevated COD and low BOD.

- The conductivity is relatively stable and would be considered low in comparison to waters elsewhere in Ireland. The alkalinity and hardness of the water is also low. The low concentration of conductivity, alkalinity and hardness is considered natural and due to the geology of the region.

- The total solids concentration is composed of the dissolved solid concentration and suspended solid concentration. The dissolved solid concentration is a factor of the

mineralisation of the water and is analysed by evaporating the water and determining the concentration of solids remaining.

Activities associated with the proposed deposition of peat will not affect the dissolved solid concentration. The suspended solid concentration could be impacted by sediment-laden run-off, however the drainage infrastructure proposed in Volume 2 of the EIS, Section 9.7, is designed to mitigate this risk.

The total solid concentration varies with sample location and the time the samples were obtained. This variation is most likely due to the suspended solid concentration of the samples, however it is also a factor of mineralisation.

The suspended solid concentration is the concentration of material that would settle out of water in still water conditions. The total suspended solid concentration is significantly lower in both the January and February sampling surveys, in comparison to the October 2003 survey. The suspended solid concentration in February was consistently below the detection limit of the laboratory. This reinforces the view that the suspended solid concentration of the October 2003 survey was not representative of the baseline conditions, due to the drainage maintenance works occurring at that time.

- The ammoniacal nitrogen concentration is locally elevated; see Table 1 below, however the elevated concentration of ammonia appears to be a natural phenomenon in peat rich environments.

- The Nitrate concentrations are generally lower than are found in other regions of Ireland and the Nitrite concentration is slightly higher than would be found elsewhere in Ireland. Naturally occurring ammonia is a feature of peat rich environments. A high watertable (i.e. close to the surface) is a characteristic of such environments, therefore there is very little free oxygen in the material and Nitrogen is reduced to Ammonia rather than oxidised to Nitrate, as occurs in other environments where free draining soils exist.

- The sulphate concentration is slightly lower than normal background levels and the chloride concentration is slightly elevated above normal background levels, however the concentrations recorded are considered to be representative of the existing surface water baseline conditions in this region.

The presence of faecal coliforms and total coliforms in the surface water, Table 1, is not considered to be due to human factors. The presence of microbes in the surface water is considered to be due to vegetative decay and fauna activity within the surface water catchments. There is no apparent human source for the microbes at the particular sampling points.

Table 1. Comparison of Surface Water Chemistry

Parameter	Units	SW1			SW2			SW3		
		10/29/03	1/6/04	2/19/04	10/29/03	1/6/04	2/19/04	10/29/03	1/6/04	2/19/04
pH		6.42	7	7.64	6.74	6.7	7.37	6.37	6.6	7.29
Conductivity	uS/cm	225		255	210		360	274		368
Dissolved Oxygen	mg/l	8.3		9.1	7.6		8.7	8.2		9.2
BOD	mg/l	6		<2	5		<2	3		<2
COD	mg/l	436	37	27	617	251	21	433	224	22
Total Solids	mg/l	632	268	172	249	192	233	556	174	238
Total Suspended Solids	mg/l	116	8	<10	172	132	<10	92	111	<10
Total Organic Carbon	mg/l	26		14	25		13	22		11
Total Hardness	mg/l	46		70	46		136	44		164
Total Alkalinity	mg/l	30		70	30		160	20		130
Ammoniacal Nitrogen	mg/l	39	0.08	1	1	0.18	1.2	1.2	0.2	0.9
Nitrate	mg/l	2.8		2	2.1		1.5	3		8.8
Nitrite	mg/l	0.11		2.04	0.14		1.52	0.12		8.75
Sulphate	mg/l	23		8	31		8	32		8
Chloride	mg/l	32		39	32		39	31		40
Total Coliforms	cfu/100ml	1120		14000	2160		7000	3040		2000
Faecal Coliforms	cfu/100ml	1140		2000	2496		212	576		192

2. *Reconcile the fact that the EIS states that settlement pond S5-2 is operating efficiently in lowering the sediment loading of run-off at that location, a total solids figure of 475mg/l, (this figure itself appears high) when the level of total solids recorded in water samples taken from the main drain when drainage maintenance work was being carried out (249-632mg/l).*

The efficiency of settlement pond S5-2 is determined by analysing the concentration of suspended solids at the outfall point of the pond. It is not appropriate to use total solids to determine its efficiency.

The total solids concentration is composed of the dissolved solid concentration and suspended solid concentration. The dissolved solid concentration is a factor of the mineralisation of the water and is analysed by evaporating the water and determining the concentration of solids remaining. The suspended solid concentration is the concentration of material that would settle out of water in still water conditions.

Reference to the water chemistry data included in Table 1 below, with specific reference to the water chemistry for SW6 on the 29th October 2003, the total solid concentration at the outfall of settlement pond S5-2 is 103mg/l. The suspended solid concentration at the outfall point is 33mg/l.

[Note: The total solid concentration quoted in the question above is the total solid concentration for SW5, which is located downstream of the Srahmore site, on the Munhin River.]

Activities associated with the proposed peat deposition of peat will not affect the dissolved solid concentration. The suspended solid concentration could be impacted by sediment laden run-off, however the drainage infrastructure proposed in Volume 2 of the EIS, Section 9.7, is designed to mitigate this risk. The concentration of suspended solids at the outfall of settlement pond S5-2 is significantly lower than the suspended solid concentration elsewhere within the Srahmore site on the 29th October 2003. For this reason the statement was made in Volume 2 of the EIS (Section 9.3.2) that settlement pond S5-2 was operating efficiently.

It should be noted that the samples taken on the 29th October 2003 were taken following a period of prolonged rainfall. Subsequent surface water sampling, taken on 6th January and 19th February 2004, see Table 1, indicate that the suspended solid concentration at sampling points on the Munhin River and at the outfall point of settlement pond S5-2 are significantly lower than previously recorded on the 29th October 2003.

With respect to sampling points SW2 and SW3, the monitoring points are located on the Main Drain through the Srahmore site. The water collected in this drain is treated downstream of SW3 and prior to outfall to the Munhin River in stilling ponds. As detailed in the drainage design proposed for the peat deposition area (Ref. Volume 2 of EIS, Section 9.7) it is proposed to construct new settlement lagoons to treat all water prior to outfall to the Main Drain. This will further augment the treatment arrangement of surface water.

Table 1. Comparison of Surface Water Chemistry

Parameter	Units	SW1			SW2			SW3		
		10/29/03	1/6/04	2/19/04	10/29/03	1/6/04	2/19/04	10/29/03	1/6/04	2/19/04
pH		6.42	7	7.64	6.74	6.7	7.37	6.37	6.6	7.29
Conductivity	uS/cm	225		255	210		360	274		368
Dissolved Oxygen	mg/l	8.3		9.1	7.6		8.7	8.2		9.2
BOD	mg/l	6		<2	5		<2	3		<2
COD	mg/l	436	37	27	617	251	21	433	224	22
Total Solids	mg/l	632	268	172	249	192	233	556	174	238
Total Suspended Solids	mg/l	116	8	<10	172	132	<10	92	111	<10
Total Organic Carbon	mg/l	26		14	25		13	22		11
Total Hardness	mg/l	46		70	46		136	44		164
Total Alkalinity	mg/l	30		70	30		160	20		130
Ammoniacal Nitrogen	mg/l	39	0.08	1	1	0.18	1.2	1.2	0.2	0.9
Nitrate	mg/l	2.8		2	2.1		1.5	3		8.8
Nitrite	mg/l	0.11		2.04	0.14		1.52	0.12		8.75
Sulphate	mg/l	23		8	31		8	32		8
Chloride	mg/l	32		39	32		39	31		40
Total Coliforms	cfu/100ml	1120		14000	2160		7000	3040		2000
Faecal Coliforms	cfu/100ml	1140		2000	2496		212	576		192

3. *Indicate whether the level of Total ammoniacal Nitrogen (which already appears high in the water samples taken) will increase with the introduction of peat from Bellagelly South and whether it will impact on marine waters in Tullaghan Bay pNHA and Blacksod Bay/Broadhaven SPA downstream of the proposed development. Details shall include proposals to mitigate any adverse effect.*

Drainage effluent form industrial peatlands, where the peat has been drained and is being 'worked' thus facilitating greater oxidation than would occur in virgin peatlands, typically register higher Nitrogen levels than from virgin peatlands. Studies have shown, however, that this elevation is much lower in western blanket peatlands than from those in the Midlands.

It is not expected that the level of Ammoniacal Nitrogen will increase with the introduction of peat to the Srahmore site from Bellagelly South. The reason for this is that naturally occurring ammonia is a feature of peat rich environments. High watertables are characteristic of such environments, therefore there is very little free oxygen in the material and Nitrogen is reduced to Ammonia rather than oxidised to Nitrate, as would happen in other environments where free draining soils exist.

The initial process of depositing the peat from the terminal site could constitute a 'working' of peat not too dissimilar to that which occurs during typical industrial peat harvesting processes. The peat from Bellanaboy being wetter than peat being harvested industrially will result in less oxidation, and therefore less ammoniacal Nitrogen release. As a result of this activity the levels of nitrogen in the discharge waters should be at the worst similar to current levels, as the deposition site is still an active peat harvesting area.

Once the deposition phase is complete and the stabilisation phase commences, bringing with it a widespread and flourishing growth of Soft Rush - Juncus effusus, it is expected that the amount of Nitrogen in the run-off will reduce to levels typical of a cutaway, or indeed ultimately to the even lower levels associated with peatlands in their natural state.

The surface water analyses, in Table 1 below, highlight a number of points of interest.

a) The ammonia levels on the 29th October 2003, Table 1, are generally significantly elevated, with the exception of SW6 (where the level was below the detection limit of the laboratory).

SW6 is at the outfall point of settlement pond S5-2. This suggests that the ammonia concentration is reduced following retention in the settlement ponds due to the settlement of suspended peat solids.

b) The drainage design for the peat deposition area, as detailed in Section 9.7, Volume 2 of the EIS, proposes to construct a number of settlement ponds to treat all the run-off water from the site. This will thus have the affect of reducing the ammonia concentration, as the suspended peat solids are settled out of the water before it is released to the receiving environment.

This will treat the run-off water at source and therefore will not result in adverse impacts in marine environments downstream.

c) The samples obtained on the 29th October 2003 were preceded by heavy and prolonged rainfall. This would have resulted in sustained run-off to surface water channels across the catchment.

Sampling point SW4 is upstream of all activities associated with Bord na Móna and also exhibits elevated ammonia concentrations, which suggests that ammonia in the surface water is not restricted to the Srahmore site.

The drainage infrastructure has been designed using an extreme rainfall event and will provide adequate settlement, during the extreme rainfall event and more than adequate settlement at other times, to allow a lowering of suspended solids in the water captured within the peat deposition site.

There will be no significant change to the marine water in Tullaghan Bay pNHA and Blacksod/Broadhaven SPA downstream of the site as a result of the peat deposition within the site. Regular monitoring of the outfall quality will be undertaken throughout the lifetime of activities within the site and during the aftercare period to determine the quality of the water discharged from the site. The quality of the outfall will be such that it will cause no adverse impacts downstream.

Table 1. Comparison of Surface Water Chemistry

Parameter	Units	SW1			SW2			SW3		
		10/29/03	1/6/04	2/19/04	10/29/03	1/6/04	2/19/04	10/29/03	1/6/04	2/19/04
pH		6.42	7	7.64	6.74	6.7	7.37	6.37	6.6	7.29
Conductivity	uS/cm	225		255	210		360	274		368
Dissolved Oxygen	mg/l	8.3		9.1	7.6		8.7	8.2		9.2
BOD	mg/l	6		<2	5		<2	3		<2
COD	mg/l	436	37	27	617	251	21	433	224	22
Total Solids	mg/l	632	268	172	249	192	233	556	174	238
Total Suspended Solids	mg/l	116	8	<10	172	132	<10	92	111	<10
Total Organic Carbon	mg/l	26		14	25		13	22		11
Total Hardness	mg/l	46		70	46		136	44		164
Total Alkalinity	mg/l	30		70	30		160	20		130
Ammoniacal Nitrogen	mg/l	39	0.08	1	1	0.18	1.2	1.2	0.2	0.9
Nitrate	mg/l	2.8		2	2.1		1.5	3		8.8
Nitrite	mg/l	0.11		2.04	0.14		1.52	0.12		8.75
Sulphate	mg/l	23		8	31		8	32		8
Chloride	mg/l	32		39	32		39	31		40
Total Coliforms	cfu/100ml	1120		14000	2160		7000	3040		2000
Faecal Coliforms	cfu/100ml	1140		2000	2496		212	576		192

4. *A map showing noise sensitive receptors and indicating existing and predicted noise levels at those sites by means of noise contours.*

Alan Saunders Associates undertook the noise survey and predictions for the original EIS and were therefore retained to undertake the additional works requested in this item. Due to the large area involved in the proposed peat deposition process, sample noise propagation calculations have been used to predict noise levels at representative sensitive receptors. It is not practical to issue representative predicted noise contours due to the mobility of numerous mobile plant items around the large site area.

The noise predictive report, prepared by Alan Saunders Associates, is presented below.

Operational Noise Emissions from the Peat Depository Site

Additional noise emissions calculations have been undertaken to provide more detailed indications of the noise levels to which individual properties are likely to be exposed during the course of the peat deposition process.

Section 12.4.2, Volume 2 of the EIS stated that *"The peat distribution and grading process, therefore, involving tracked mobile plant and vehicles, is estimated to result in typical average (L_{Aeq}) noise levels about 65 dB(A) at 100m from each of the operations concerned. Worst case levels at the receptor locations have been calculated to fall within 55 to 60 dB(A), depending on the proximity of the closest working approach to a given receptor."*

These predictive calculations were based on a relatively simple model to assist with the generality of the above statement and ensuring compliance with British Standard BS5228. The calculations accounted only for geometric dispersion with no meteorological, ground effects, or topographical screening. BS5228 states that the omission of air absorption is roughly equivalent to the assumption that adverse noise propagation conditions occur in all directions (i.e. all receptors are downwind).

It is understood that the request for further information in this respect is seeking a definitive noise level prediction at specific receptor locations for an assumed operational scenario.

The detailed noise propagation model which has been compiled to address this request is based on the assumptions below:

- Deposition activity in zone 2 (close to both dwellings on the R313 and at the R313/L1206 junction)
- Three sensitive receptor locations as identified during site visit denoted A, B and C (as shown on Figure 1)
- Three cases
  1. no losses (to correlate with simple model);
  2. propagation losses to ISO 9613;
  3. as (2) with adverse wind towards receptors.

On site plant numbers and noise data as below:

ES activities	No. + comments	Source	Ref.	Description	Lw dB(A)	kW
Delivery Lorry arrive/depart	400 deliveries/day.	BS5228; P1	C.7 121	Lorry arrival	98	-
Delivery lorry unload/tip	400 deliveries/day.	BS5228; P1	C.7 122	Lorry Unloading	112	-
Front end industrial loader	2	BS5228; P1	C.3 3	Wheeled Loader	102	52
Excavator moving / shaping	11	BS5228; P 1	C.3 38	Tracked Excav	111	65
Bulldozers spreading	7	BS5228; P 1	C.3 66	Dozer	112	48

Tractor inc Haku trailer	20	ASA		Generic Tractor	108	
Wheel Wash	1	ASA		Wheel wash	93	

The results of these calculations are tabulated below. They put the generalised worst case assumptions shown in Volume 2 of the EIS into the context of specific predicted receptor exposure levels.

	Receptor A	**Receptor B**	**Receptor C**
Case 1 (no losses, as simplistic BS5228 calc)	58.8	58.0	54.5
Case 2 (ISO9613 air & ground absorption, no wind)	47.8	46.3	42.4
Case 3 (ISO9613 & adverse wind)	49.9	49.0	45.2

The calculation results show how at the distances involved, the pessimistic BS5228 assumptions present an over-estimate of the maximum noise level to which dwellings might be exposed, and that during the majority of meteorological conditions noise levels will in fact be considerably lower.

We can conclude that the noise impact of the proposed site activities will be no worse than indicated in the EIS, and on the basis of more detailed calculations should be considerably less onerous.

Legend:

- DOMESTIC DWELLING
- BANGOR GARDA STATION
- DERELICT BUILDING
- AGRICULTURAL BUILDINGS/WORKSHOPS/STABLES
- SPORTS GROUND FACILITIES
- BANGOR WATER SUPPLY RESERVOIR
- BANGOR WASTE WATER TREATMENT PLANT
- 500m OFFSET FROM SITE BOUNDARY

NOTE:

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OS Sheet No. 18 & 26 Co. Mayo

All levels relate to Ordinance Datum at Malin Head

Noise Receptor A

Noise Receptor B

Noise Receptor C

Shell E&P Ireland Limited

BORD NA MÓNA

Project:

PEAT
DEPOSITION AREA

Drawing Title:

DWELLING AND INFRASTRUCTURE
LOCATION

Scale: 1:8000 @ A3

Drawn by	Checked by	Date
MC	CM	MARCH 2004

ENGINEER IN CHARGE: SEAN FINLAY

TES
CONSULTING ENGINEERS

Drawing No.

FIGURE 1

Rev.

5. *Figure 6.1 Habitats Map*

Section 6.1, Volume 2 of the EIS, which deals with the terrestrial ecology of the Srahmore site, makes reference to Figure 6.1 (Habitats Map for Srahmore Peat Deposition Site). This figure was inadvertently omitted during the compilation of the EIS. A copy of Figure 6.1 is attached.

Munhin Bridge

Area 4

Area 5

Area 6

Area 7

Legend:

- A. Cutover Bog Complex
- B. Atlantic Blanket Bog Remnant
- C. Degraded Atlantic Blanket Bog
- D. Drainage Channel Complex
- E. Railway Complex
- F. Forestry Complex

NOTE:

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OS Sheet No 18 & 26 Co. Mayo

All levels relate to Ordnance Datum at Malin Head

Rev	Revisions	date	init

Applicant: Shell E&P Ireland Limited

Operator: BORD NA MÓNA

Project:
CORRIB FIELD DEVELOPMENT
SRAHMORE PEAT DEPOSITION SITE

Drawing Title:
HABITATS MAP
FOR SRAHMORE PEAT DEPOSITION SITE

Scale 1:5000

Drawn by	Checked by	Date
Mary O' Sullivan	Damien Grehan	DECEMBER 2003

ENGINEER IN CHARGE: SEAN FINLAY

TES CONSULTING ENGINEERS

Drawing No.
FIGURE 6.1

Rev.

6. *Proposals to deal with excess water seepage from stockpiled peat.*

The peat from Bellanaboy Terminal Site will be unloaded from the transport vehicles and stockpiled on the reception area prior to final movement and placement in the peat deposition area. Drawing No. 1169/01/212 in Volume 2 of the EIS shows the layout of the peat reception area.

The reception area will be constructed as a fully bunded concrete slab, and will be laid to falls to ensure that any water collected on it, by means of seepage from the peat of from runoff, will fall towards the centre of the reception slab.

The centre of the slab will be formed at falls such that all water is directed towards the concrete sump chamber to allow primary settlement of sediment. The concrete sump chamber is located behind the administration building. This chamber will be designed such that it may be cleaned by means of a mechanical excavator.

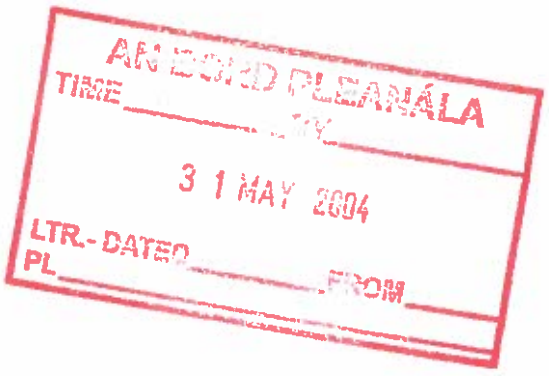
From the concrete sump chamber the water will be diverted through a grit trap then an oil interceptor and the settlement lagoon at the south of Area 5, before it outfalls to the receiving environment.

For full details of proposals to deal with water seepage and surface run-off from stockpiled peat in the reception area at Srahmore, Mayo County Council are directed to Drawing No. 1169/01/212 of Volume 2 of the EIS and Drawing No. 1169/01/436 of the Planning Application Drawings , and Section 3.6.3 and Section 10.7, Volume 2 of the EIS.

7. *An assessment of the impact of mineral soil being overlain on the existing peat soil.*

There is no intention to import mineral soil to the Srahmore site. The only material that Bord na Móna will accept at the reception area is peat. The volume of material to be imported to the Srahmore site is documented in the Waste Management Plan for the Terminal site (see response to Item 17, Volume I above).

In support of the proposal to accept up to 450,000m^3 of peat to the cutover industrial peatland at Srahmore, Bord na Móna undertook an investigation into the handling of raw peat, which includes details of relevant field trials and outlines comparable activities undertaken by Bord na Móna in the past. A copy of this report is attached.



BORD NA MÓNA DOCUMENT AMENDMENT RECORD

Client	Shell E&P Ireland Ltd.
Project	Corrib Project
Title	Investigation into Handling of Raw Peat

REVISION NO.	DATE	PREPARED BY	CHECKED BY	REMARKS
0	2/3/04	BH	PF	Submitted to EPA in support of Waste Licence application
1	10/3/04	BH	PF	Amended to include results of Field Trial on peat from Shell's Bellanaboy Site

INVESTIGATION INTO HANDLING OF RAW PEAT

1 INTRODUCTION

This paper has been prepared in support of the proposal to remove 450,000 cubic metres of in situ peat from the Shell Gas Terminal Site at Bellanaboy, transport and deposit this peat on Bord na Móna's cutover industrial peatland at Srahmore [1].

It provides relevant background on the moisture content of peat, describes the proposed peat handling method, reports on relevant field trials and outlines comparable activities undertaken by Bord na Móna in the past.

2 MOISTURE CONTENT OF PEAT AND ITS HANDLEABILITY

Raw peat consists of a mixture of decomposed vegetation solids and water. Typically the wetness of a peat bog is described in terms of the moisture content. The moisture content is the percentage (by weight) of the water contained in the sample. This value is arrived at by taking a sample of known weight and evaporating off the water content in an oven at 105°C. The weight change is noted and the moisture content calculated [2].

An undrained virgin bog typically has a moisture content of 93-95% [3]. When drainage is provided the moisture content can be reduced to 87-91%. In the past the Bellanaboy site was a research station for the AFT and has had an extensive drainage system for at least 40 years. Due to this drainage system, the Bellanaboy bog cannot be considered to be in a virgin state.

The inherent viscous nature of peat means that its moisture content needs to be in the 94%-98% range in order to facilitate being pumped: i.e. huge amounts of water relative to the amount of solid content need to be present [4]. In such a state the peat could be said to be "slurry". Slurry is defined as a thin mixture of a liquid, especially water, and any of several finely divided substances. Under such a definition the Bellanaboy site peat would hardly qualify. Firstly, the peat contains fibrous material knitting it together. The flora of the Bellanaboy bog site differs from the Bord na Móna bogs of the midlands since it contains Soft Rush (*Juncus effusus*) which grows particularly long roots helping to bind the material together more [1].

Secondly, pulverised peat can be formed into blocks and maintain its shape readily at moisture contents above 91% [3]. The peat extracted in Bellanaboy will not be pulverised but extracted whole in large scoops. The moisture content will be well below 91% so there is simply not enough water present for the peat to form slurry. Furthermore even at high moisture contents peat has a relatively high shear strength owing to the fibrous nature of its constituent material even when highly decomposed [5] .

After restoring the drainage system at Bellanaboy, the excavated peat will be "Windrowed" in order to reduce its moisture content to the required level for spreading, typically 82-87%. At this level of moisture content the peat is quite cohesive and capable of retaining its consistency through multiple rehandlings. Windrowing is the term used for the stacking of

peat in piles for the purpose of air-drying. Excavated and windrowed peat undergoes a number of different phases of drying. In the initial phase (~ 8 days) the free water within the peat drains away rapidly and the most effective drying occurs during this time [6]. Depending on the prevailing weather conditions such windrowing could lower the moisture content of the peat to approximately 80% over 8 days, but would typically achieve 82-87%. Thereafter drying slows as the moisture released has to migrate from within the peat particles to the outside surface. Research has shown that a reduction of 4-5% in moisture content can increase the ultimate shear strength of the peat by a factor of 2 or 3 [7]. This improves the handleability of the peat.

3 PEAT HANDLING METHOD

During the peat removal at the Bellanaboy site the peat will be excavated in large scoops using an excavator piled into Windrows. Each Windrow will be left for eight days to remove any excess free water. The peat will then be loaded onto lorries for road haulage to the Srahmore Peat Deposition Site.

At the peat reception area the road trucks will unload the peat onto a concrete hardstand area. The peat will then be loaded using two front-end industrial loaders into low ground bearing pressure trailers (Haku trailers) (See Figure 1). The Haku trailers will travel along internal roadways which will be constructed on raised areas of the bog known as high fields and empty the peat by tipping to the side as shown in Figure 2.

Figure 1 Haku trailer carrying milled peat

Figure 2 Haku trailer on internal temporary road side tipping onto sides of high fields.

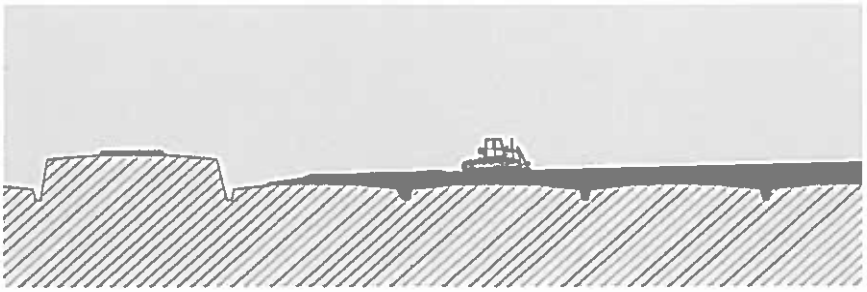


Figure 3 Material spread over low fields and compacted with dozers.

Excavators will remove the peat from the high fields to the low field. The peat will then be bulldozed towards the centre of the area between the two high fields creating a cambered surface with the highest point in the centre sloping back towards drains close to the high fields as shown in Figure 3. The height of deposited peat will generally be of the order of 1.4m to 1.8m above the existing ground levels at the highest point in the centre, with a fall of approx. 1:200 towards the high fields.

It is proposed that 4000m^3 of peat per day will be handled in this manor. To test the feasibility of this proposed handling method two industrial scale trials were carried out.

4 INDUSTRIAL FIELD TRIALS

Two separate industrial trials were carried out. The first trial proved the feasibility of handling the required quantity of peat. The second trial concentrated on the quality of the peat post handling.

4.1 Quantitative Test

A quantitative test was conducted at Ballydermot on 22 & 23 October 2003 into the feasibility of spreading peat using different methods. The tests involved excavating raw peat from the edge of a production peatland near the Ballydermot workshop and loading into each of the three transport methods being tested. From visual inspection the raw peat was similar to that viewed in inspection pits at the Bellanaboy site. The material was then carried to the Ballydermot Workshop site (an approximate distance of 1 kilometre). At this location the load was emptied.

This test was primarily concerned with loading, unloading, dispersing and safety issues and was carried out under the supervision of two Bord Na Mona Engineers. The results were favourable. The Haku trailer system was proven for loading/unloading bog peat.

4.2 Qualitative Test (Oweninny)

A trial was carried out on the 27th November 2003 at Oweninny Works. This trial was designed to test the quality of blanket peat typical of North-West Mayo, peat post handling, and prove it would not degrade into liquid slurry.

During the trail the peat was:

- Extracted from a wet spot of undrained virgin bog using an excavator
- Loaded into a Haku Trailer
- Driven hard for 3 miles on a rough and bumpy pot-holed road
- Unloaded onto the ground

- Handled 6 times further using an excavator

As can be seen the peat maintains its shape both after tipping and additional handling (Figure 4). This proved that the peat does no readily degrade into liquid slurry due to handling.

The November trial represented the worst case scenario for the following reasons:

- The trial was carried out in November which is wetter than and outside the proposed handling season
- The virgin raw bog is wetter than the Bellanaboy site peat
- The Bellanaboy peat has long soft rush root providing better binding
- The peat will be transported on national routes or on purpose built temporary bog roads and will therefore not experience such rough quality of the roads

Figure 4 Peat Solid after Transport and Additional Handling

4.3 Qualitative Test (Bellanaboy-Bangor)

A trial was carried out from 4th to 9th March 2004 at Shell's Bellanaboy site and at Bord na Móna's Bangor yard. This trial was designed to test the quality of the Bellanaboy peat post handling and prove it would not degrade into liquid slurry.

During the trail the peat was:

- Extracted using a tracked excavator from three different trial pits deemed to be generally representative of the peat to be removed to Srahmore
- Loaded into a tracked dumper, transported to the side of the site access road and tipped into a pile to simulate a windrow
- Allowed to stand for 4-5 days to shed any free water and avail of any air-drying
- Re-loaded into an 8-wheeler truck for onward road-transport
- Transported by road along the proposed haul route to the proposed entrance to Srahmore and onwards to the existing Bord na Móna hard-stand yard at Bangor, a total of 18 kilometers
- Unloaded onto the hardstand yard
- Re-loaded into the truck and returned to the Bellanaboy site and re-tipped into windrows allowing for comparison between transported and un-transported peat

Figure 5 Excavation & Loading of Peat into Tracked Dumper

Figure 5 shows the peat being excavated from a trial pit and being loaded onto the tracked dumper. As can be seen the peat contains fibrous material knitting it together. As stated earlier the flora of the Bellanaboy bog site differs from the Bord na Móna bogs of the midlands in that it contains Soft Rush (*Juncus effusus*) which grows particularly long roots that help to bind the material together more.

Figure 6 Windrow of Newly Excavated Peat

Figure 6 shows the peat standing in the "windrow" soon afterwards. As can be seen the peat has maintained its shape and consistency at this point. Figure 7 presents the peat after 4 days of windrowing during the rather poor drying conditions (minimal evaporation) prevailing at that time. Free water can be seen draining away and the peat can still be seen to maintain its consistency. The loading of the peat into a truck similar to those proposed for the project and its condition in the truck after 18km journey, is shown in Figure 8. The picture in Figure 9 shows the condition of the peat after transport and tipping.

Figure 7 Windrows of 4 Day Old Peat showing Free Water

Figure 8 **Loading Windrowed Peat into 8 Wheeler Truck & Its Condition after 18km Journey**

Figure 9 **Peat being Tipped in Bord na Móna's Bangor Yard**

Finally, having been reloaded and transported back to Bellanaboy, the peat was tipped beside the unmoved remains of the earlier windrow. A comparison of the relative condition of the two peats is evident in Figure 10.

This shows that the Bellanaboy peat is not slurry, does not degrade into liquid slurry when handled and is therefore readily handleable by the proposed method.

Figure 10 **Comparison between Moved & Unmoved Peat from the Same Windrow**

5 HISTORICAL COMPARISONS

Historically Bord Na Móna has had ample experience of bulldozing and spreading large amounts of raw peat in the past. This is most evident where sod peat bogs were converted to milled peat bogs. In the production of sod peat the machinery sits on an area of high bog and takes a progressive vertical cut along the bank leaving a cutover area in its wake at some 2m lower level (Figure 11). Many of these sod peat banks have been bulldozed to allow for more productive milled peat extraction.

Figure 11 Machinery Cutting Sod Peat on High Peat Bank

5.1 Derrylea Case Study

Derrylea, outside Portarlington is one such site where a sod peat bog was converted into a milled peat bog 5-7 years ago. This involved the bulldozing of over 1.4m m^3 of raw peat. Here however only half of the site was bulldozed. This allowed for comparison between the state of the bog before and after conversion.

The original high bank and lower bank (Figure 12) and the bulldozed version (Figure 13) differ only in topography. In both cases strong vegetation has grown back over the exposed bog soil. Figure 12 shows an approximate two metre stepup between the cutover area and the intact high bog bank. Figure 13 indicates an area where the original high bank has been levelled and graded towards the main drain shown in the centre of the picture. This process was repeated for ten other such banks. Clearly, this involved managed movement of substantial amounts (>1.4 m m^3). There have been no stability issues with the bog in the five years since.

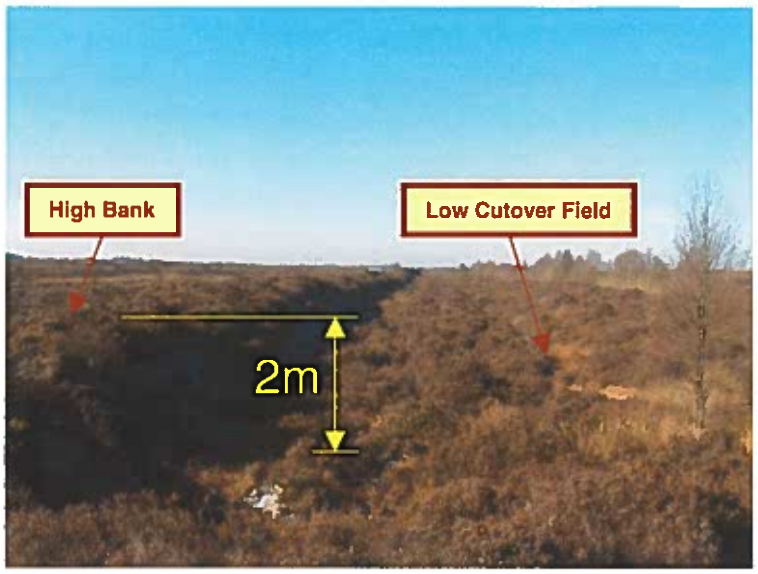


Figure 12 **Derrylea Bog showing original high bank (left) and low bank (right)**

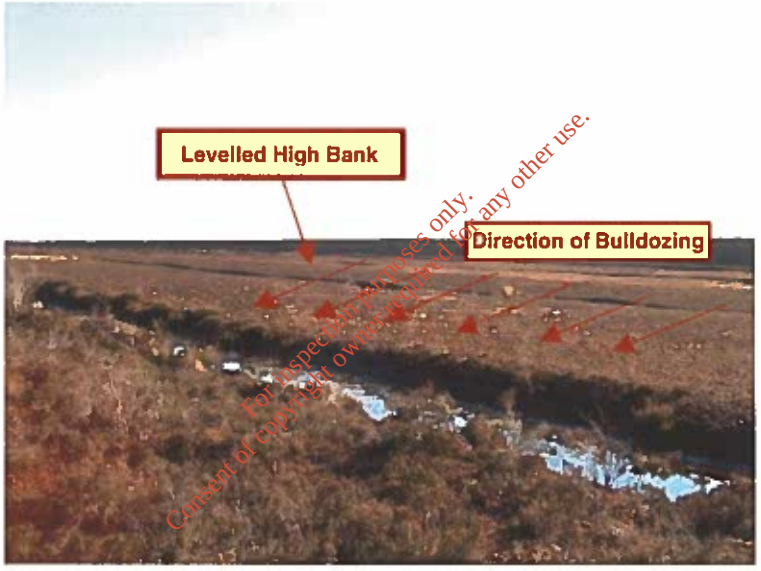


Figure 13 **Derrylea Bog showing bulldozed high bank**

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[1] Corrib Gas Field Development - Enviromental Impact Statement
[2] "Coal – Determination of Moisture in the Analysis Sample",(1983), ISO 331
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[5] HEATHWAITE, A.L., GOTTLICH, KH., (1993), *"Mires – Process, Exploitation and Conservation"*. John Wiley & Sons, ISBN 0-471-93353-8 pp.200-202.
[6] DALTON, J, (1954), *"Air Drying of Peat"*. Proc. Int. Peat Sym. Section 3C pp.1-22.
[7] SOLOPOV, S.G., VOLAROVICH, M.P., KORCHUNOV, S.S., TSUPROV, S.A., MOGILEVSKII, I.I., ABAKUMOV, O.N., (1968), *"Physical and Mechanical Properties of Peat"*. Proc. 3rd Int. Peat Congress pp.155-156.

Other Matters.

1. *Please submit an assessment of the cumulative effects of (a) the gas terminal (b) the deposition site and (c) the haul route.*

An assessment of the cumulative effects from the above three elements of the Corrib Terminal development is provided.

P03/3343

CORRIB GAS FIELD DEVELOPMENT

Prepared in respect of the proposed Bellanaboy Bridge Gas Terminal and associated Srahmore Peat Deposition Site

RESPONSE TO REQUEST FOR FURTHER INFORMATION 17/02/04

Other Matters 01
CUMULATIVE IMPACTS

Shell E&P Ireland Limited

March 2004

RSK ENSR GENERAL NOTES

Project No:	P40036/10
Title:	Corrib Gas Field Response to request for Further Information 17/02/04 Other Matters 01 - Cumulative Impacts
Client:	Shell E&P Ireland Limited
Issue Date:	Rev01 March 2004
Issuing Office:	Hemel Hempstead

Authorised by:	*Janet Swan*	Project Manager	Date:	*04/03/04*
Authorised by:	*David Taylor*	Project QA Rep	Date:	*04/03/04*

TABLE OF CONTENTS

1 Introduction

In order to construct the Bellanaboy Bridge Natural Gas Terminal it will be necessary to excavate up to 450,000m^3 of peat from the site. It is proposed that this peat is transported by public road (R313, R314, L1204) from the terminal site to a deposition site on a cutover peatland at Srahmore, Bangor. Some upgrading of the L1204 is required to make it suitable for construction traffic, including peat haulage.

This report addresses the cumulative impacts that may result from upgrading of the haul road, removal of peat from the Terminal site and deposition at the Srahmore site, and construction of the Terminal. It expands on the information supplied in Volumes 1 & 2 of the Environmental Impact Statement (EIS) that have been submitted in respect of the proposed Bellanaboy Bridge Gas Terminal and the associated Srahmore Peat Deposition Site. Within these documents, Section 18 of Volume 1 addresses cumulative impacts in the context of the terminal development and Section 17 of Volume 2 addresses cumulative impacts in the context of the Srahmore deposition site. This report should be read in conjunction with these sections. Upgrading of the L1204 will be undertaken by Mayo County Council who have provided a description of the proposed road upgrade works (Section 2).

Figure 1 shows the relative works programmes for the three elements of the Corrib project that are the subject of this assessment. For each element a lighter shade denotes less intense activity. Figure 2 shows the relative locations of each element.

Figure 1 Works Programme

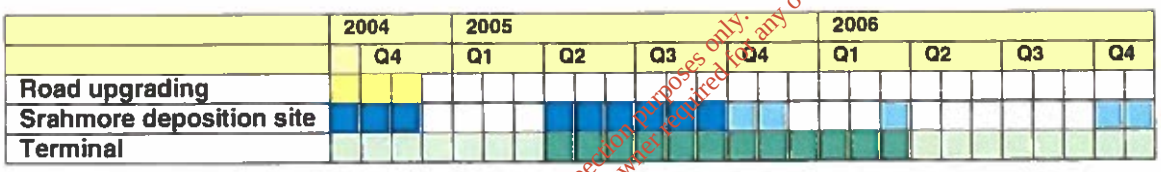
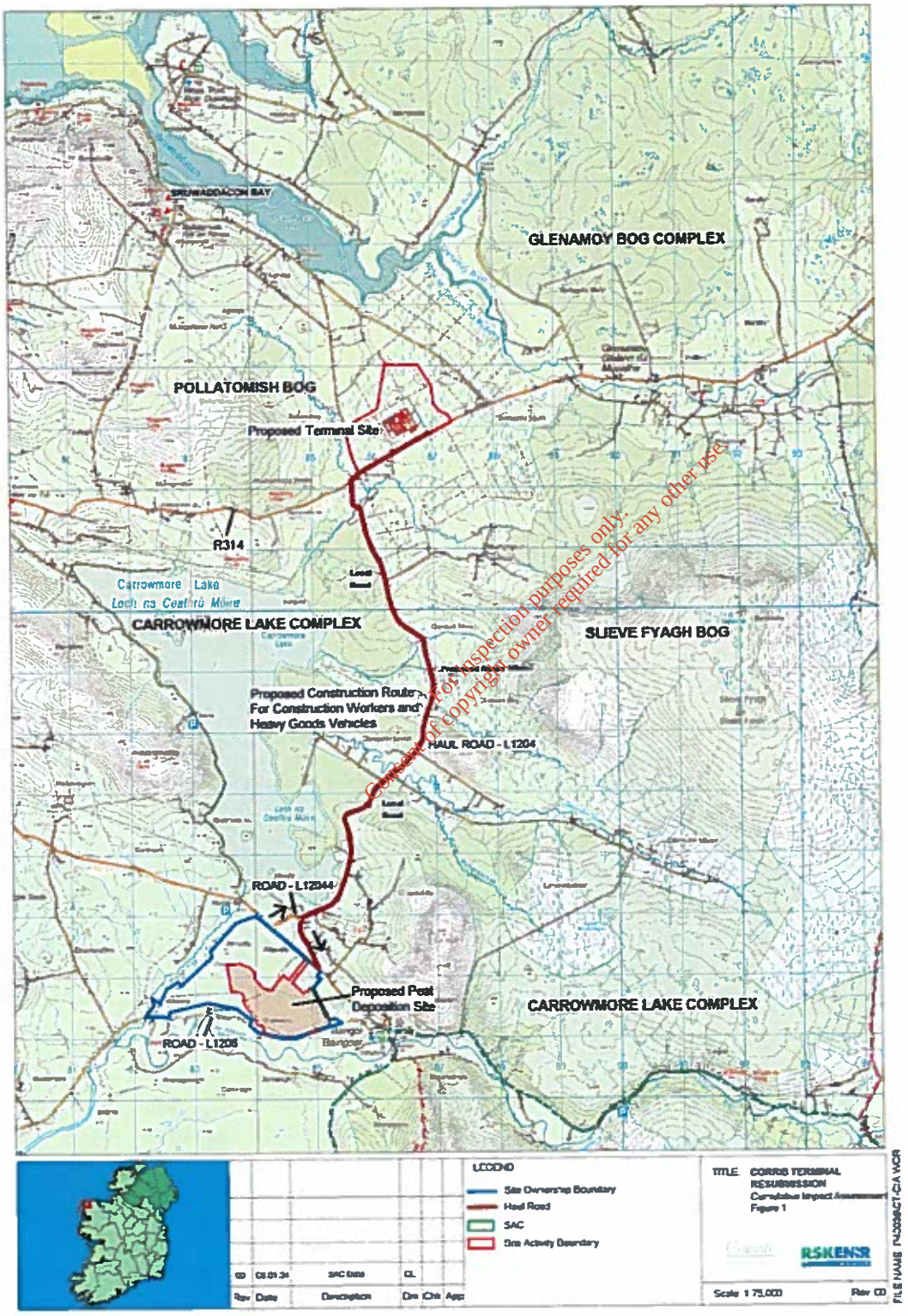


Figure 2 Relative Locations of the Terminal, Haul Road and Peat Depository Sites



2 Road Upgrade Works

The road ugrading works that are proposed for the L1204 are of the same nature as those undertaken routinely by Mayo County Council as they maintain and upgrade the road network. It may therefore be assumed that the people of Mayo have a broad familiarity with the construction process for this type of work.

During upgrading, transport of materials to the working section will be along the section which has not yet been improved, to avoid the haulage of material over the new surface. The operation is expected to commence at the Bellanaboy Terminal end and work towards the Srahmore deposition site.

The initial works will include the cutting back of verges, the excavation and removal of edge peat and its replacement with imported stone. Where required, roadside drainage works will also be carried out at this time.

The formation will be graded where necessary and the paving machine will then begin to lay down the new surface. This paver will be continuously fed with foam mix, and typically a fleet of up to 20 trucks will be deployed to haul material to the working section. Temporary lay-bys and turning areas will be provided at intervals to facilitate this materials flow. In some instances these improvement works are carried out in stages involving half carriageway widths, but it is likely that the L1204 will be undertaken as a full width operation.

Each day, the section which has been paved with foam mix will be sealed; the bitumen sprayer and gritting machines will therefore follow the foam mix paving operation at an appropriate time of the working day. Sealing is also a continuous operation.

In summary, this element of enabling works essentially involves an intense road improvement operation, that will progress at approximately 1 km per week along the L1204, and will be fed by a fleet hauling road making materials to the working section.

3 Traffic Flows

The potential for cumulative impacts from the three elements of the Terminal development (namely the Terminal site at Bellanaboy Bridge, the haul route and the Peat Deposition site at Srahmore) relate primarily to traffic movements, particularly along the L1204 which will be used as the haul road. Traffic movements may cause nuisance to people, could affect water and habitat quality and could disturb animals. These issues are discussed below.

3.1 Existing Traffic Flows

Existing traffic flows on the local roads are given in Volume 1 of the EIS and reproduced below in Table 1. The figures for the R313 were recorded at a time when peat harvesting operations by Bord na Mona were not in progress at their Srahmore site.

Table 1 Peak hourly traffic counts

Location	Predominant Traffic Type	Peak Hourly Count - morning	Peak Hourly Count - evening
R314 Westwards from Terminal gate		11	44
L1204	Residents living in houses located off this road	19	27
R313 crossing	Wide range including cars, HGV, buses, quarry traffic, light industrial	118	142

3.2 Construction Traffic Flows

A detailed Transport Management Plan (see accompanying volume) has been prepared which addresses traffic flows relating to all elements of the Corrib project, namely:

- Upgrading the local roads (responsibility = Mayo County Council);
- Construction of the Srahmore peat deposition site (responsibility = Bord na Mona);
- Construction of the gas terminal, including enabling works and peat haulage (responsibility = Shell);
- Construction of the gas import pipeline (responsibility = Shell);
- Construction of the Mayo to Galway pipeline (responsibility = Bord Gas Eireann).

Construction activities will be managed to ensure that project-related truck movements do not exceed 400 vehicles per day (Figure 3) and car/van movements do not exceed 300 vehicles/day (Figure 4).

Figure 3 Daily Average Truck Movements

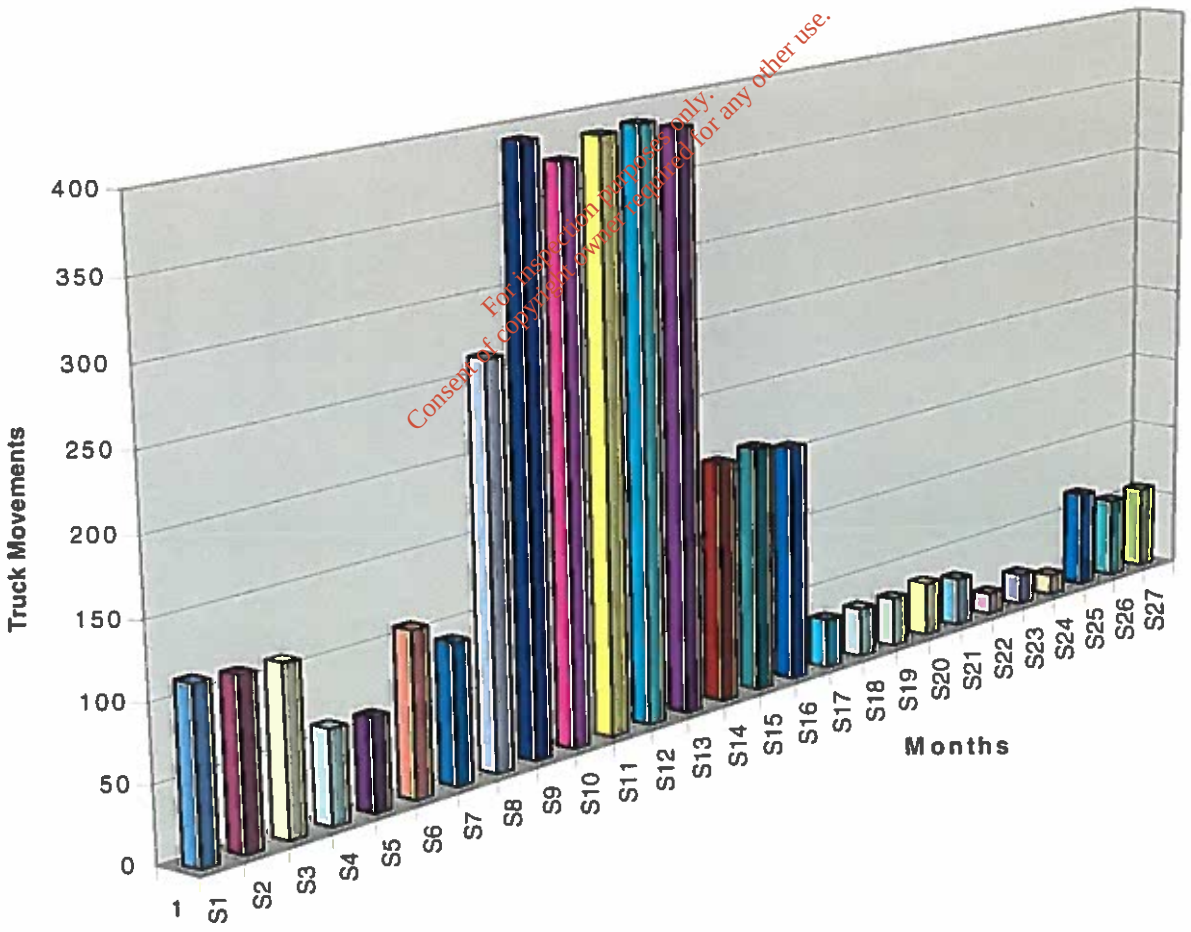
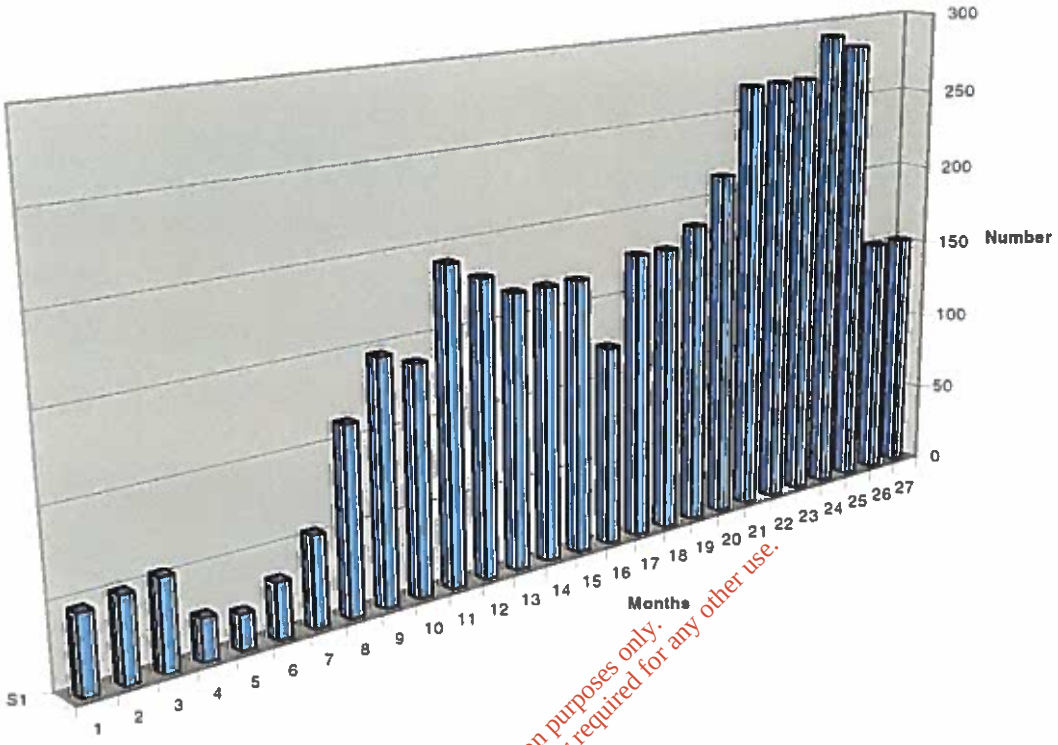


Figure 4 Daily Average Car and Van Movements



4 Potential Cumulative Impacts and Mitigation Measures

As discussed in Volumes 1 and 2 of the EIS, the combined works associated with the Terminal development have the potential to affect local residents, tourists, wildlife, water quality and the Carrowmore Lake complex. There may also be minor cumulative impacts in terms of archaeology, visual impact, aggregate resources and waste disposal sites. Potential cumulative impacts on all these receptors are further discussed in this section together with relevant mitigation measures.

4.1 Human Beings

4.1.1 Journey Time

Drivers using the L1204 will experience some delays to their journeys during the works period. This is likely to be most acute during the upgrading works (approximately 3 months) and while the peat is being transferred from the Terminal to the Srahmore site (approximately 6 months). During the road upgrading, access will be restricted around the working section but Mayo County Council will adopt suitable traffic management measures to facilitate the flow of local, emergency and construction traffic. Local residents will be kept informed of the works programme.

4.1.2 Noise

Increased noise levels will be experienced in the vicinity of the works. Vehicle noise will be most intense at the Srahmore and Terminal sites; this has been taken into account in the noise assessments presented in Section 12 of Volumes 1 and 2 of the EIS. During the road upgrading works, noise from the delivery trucks and paving machines will be typical of that volume of HGVs. The working section will progress steadily over the 11 km in the same number of weeks so no single dwelling will be subject to noise from this activity for more than a few days.

4.1.3 Air Quality

As discussed in Section 11 of Volumes 1 and 2 of the EIS, vehicles and machinery will release exhaust fumes into the air. Emissions will include releases of oxides of nitrogen, carbon monoxide, sulphur dioxide, benzene and

PM_{10}. Vehicles will also potentially generate dust, including PM_{10}, in the event of passing over dry, unpaved surfaces. There will therefore be a minor degradation of air quality along the roads used by the construction traffic but the air quality will still be good in comparison to that of roads through nearby villages and towns.

Emissions from the bitumen spraying operation are standard with such work and represent no particular hazard in the open unconfined working area.

4.2 Water Quality and Fisheries

During construction there will be an increased risk of contaminating local watercourses and Carrowmore Lake, either through sediment run off or fuel/chemical spillage. The road upgrading will require some widening of the road, but this activity will be confined to the eastern side away from the lake. A new stone filled edge will be constructed as part of the ugrading works, which will absorb and attenuate road runoff during the surfacing operation. No additional bridges or culverts are required.

Any upgrading of bridges and culverts will be undertaken in close consultation with the North West Regional Fisheries Board (NWRFB) to ensure that risk to aquatic fauna is minimised. The project is committed to stringent pollution prevention measures that are detailed in Sections 3 and 9 of Volumes 1 & 2 of the EIS, and are considered sufficient to address any cumulative impact.

4.3 Carrowmore Lake Complex cSAC

The widening of sections of the L1204 will encroach slightly on the Carrowmore Lake Complex candidate Special Area of Conservation (SAC). However, the areas concerned are characterised by shallow peat which is degraded in ecological terms. Some areas have been quarried in the past and, during recent years, there has been an upsurge of housing development along the roadside.

The National Parks and Wildlife Service and Mayo County Council have reviewed the sections and agreed specific locations where widening is acceptable. No widening will be allowed outside these locations.

4.4 Greenland White-fronted Geese

Carrowmore Lake cSAC supports a number of bird species which are of international conservation significance and are listed on Annex I of the European Birds Directive. As discussed in Section 6 of Volume 1 of the EIS, during October, Greenland White-fronted Geese arrive to feed around the lake and in some nearby fields, some of which are close to the proposed haul route at Glenturk More. They are resident in the area until late February.

Peak use of the haul road is expected to be between April and September (Figures 1 and 3) during which time, Greenland White-fronted Geese are not in residence. Other activities will extend beyond this period. However, ilt has been observed that Greeland White-fronted Geese feeding within 500m of the Coillte clear felling operations near Glenturk do not react to loud trucks or mechanical noises. It is therefore considered very unlikely that this species will be adversely affected by the construction traffic.

The feeding grounds for the geese are to the west of the L1204 and will not therefore be affected by road widening.

4.5 Archaeology and Cultural Heritage

The cumulative impact on the archaeological resource will be additive rather than synergistic. The pooled knowledge gained from investigation of each of the development sites will enhance synergistically the understanding of the local area.

4.6 Landscape and Visual

Upgrading of the haul road together with construction activities at the terminal site and deposition site will increase the area of disturbance to the local landscape (Section 13 of Volume 1 of the EIS). This impact will be temporary, as the terminal site will be landscaped and the deposition site reinstated. Landscape disturbance is significantly reduced by using an existing road for the haul route rather than constructing a new, dedicated route.

4.7 Aggregates and Wastes

During construction there will be an accelerated depletion of local aggregate resources and filling of waste disposal sites. As explained in Section 18 of Volume 1 of the EIS) the total quantities of aggregate used and waste disposed by each element of the project will be additive, but is not expected to cause a strain on these resources. Forward planning and effective communication with the aggregate and waste site managers will pre-empt any problems.

5 Monitoring

It is not proposed that any monitoring will be undertaken specifically for cumulative impacts. However, monitoring will be undertaken, where required, for the individual phases of the Bellanaboy Bridge gas terminal and the Srahmore peat deposition site.