1.0 Qualifications and Experience

1.1 My name is Eileen McCarthy and I am the managing director of QMEC Environmental Ltd (QMEC). QMEC is an independent, Irish owned environmental consultancy that specialises in eco-hydrological and eco-hydrogeological impact and risk assessments.

1.2 I hold a Bachelor of Science Degree in Earth Science from University College Cork and a Master of Science Degree in Hydrogeology from University College London. Currently as part of continued professional development I am completing part-time Doctorate Studies in Wetland Hydrology at Trinity College Dublin, and also a part-time Diploma in Field Ecology at University College Cork. I am a member of the International Association of Hydrogeologists (IAH) and also a member of the Chartered Institution of Water and Environmental Management (CIWEM).

1.3 My area of expertise is in wetland hydrology and hydrogeology (*i.e.* eco-hydrology), with particular emphasis on peatland habitats in Ireland (*i.e.* fens, raised bogs and blanket bogs). I have 10 years experience in environmental consultancy, having contributed to technical reports for a large number of Environmental Impact Statements (more than 50 in number). These reports were completed for a range of developments that include: wind farms, road schemes, pipelines, gas terminals and extractive industries (mines, sand and gravel pits, and quarries). 90% of these studies involved the assessment of direct and indirect impacts on peatland environments. Regionally, I have completed nine (9 no.) of these peatland studies in Co. Mayo.

2.0 Objective and Background of My Evidence

2.1 My evidence provides an overview of the assessments of the eco-hydrology of designated peatlands within the Glenamoy Bog Complex cSAC and non-designated EU Annex 1 intact blanket bog that occur along and near the pipeline route. This includes a characterisation of the existing hydrological regime and the potential impacts on it, represented by the pipeline. Appropriate mitigation measures are detailed in relation to these potential hydrological impacts. In addition, this evidence also addresses third party submissions relative to my area of expertise.

2.2 Eco-hydrology is an interdisciplinary science that treats and describes the dependency between hydrological flows and ecological systems. Eco-hydrology refers to the 'surface' component, while eco-hydrogeology refers to the "subsurface" component. For simplicity the rest of this statement refers to both disciplines as 'eco-hydrology'.

2.3 Blanket bog habitats of variable quality, variable ecological value, both designated and non-designated occur along the proposed pipeline route. The habitats are addressed in a separate statement on Terrestrial Ecology, and in Chapter 12 of Volume 1 of the EIS.

2.4 These peatland habitats are located within Rossport Commonage between approximately Ch. 87.55 and Ch. 88.35. Non-designated Annex 1 "intact" blanket bog habitat also occurs adjacent to the pipeline route at two other locations, namely Aghoos (Ch. 90.20 to 90.39) and Bellagelly (Ch. 91.00 to 91.23). These study sites have also been considered in my assessment.

2.5 The eco-hydrological impact assessment is provided in full in Appendix M6 of Volume 2 of the EIS. The main components of this study are summarised in Chapter 15 of Volume 1 of the EIS.

2.6 An EIS Addendum Report has also been submitted to this hearing. Appendix C of this report presents up to date technical work that has been completed. This includes more recent and

ongoing baseline monitoring to establish temporal trends in the hydro-environment along the pipeline route. I will now present the information contained in this report.

3.0 Assessment Methodology

3.1 As part of the baseline characterisation of the eco-hydrological regime along the pipeline route, the following phased investigations and assessments were undertaken:

a) A desk study of site geology, geomorphology, hydrology and hydrogeology was undertaken. This took into account the habitat assessment and available geomorphological data from the geotechnical assessments.
b) Several site walkover surveys were undertaken between July 2008 and January 2009 allowing for direct field measurement of surface water chemistry, evaluation of local topographical relief, mapping of surface water features, and determination of likely groundwater flow patterns.
c) Detailed site investigations and an ongoing survey programme have also been undertaken to provide site-specific data on geology, hydrology and hydrogeology. These include installation of boreholes and nested piezometer couples at representative points in order to determine hydraulic gradients and groundwater flow direction.
d) Based on the results of the site investigations and the survey programmes, and knowledge of analogous peatland habitats, a Conceptual Hydrological Model (CHM) was developed. This model was subsequently substantiated by further data collection as presented in Appendix C of the EIS Addendum Report.
e) Based on the conceptual understanding of the hydrological controls, all eco-hydrological impacts were identified.
f) Mitigation measures were developed to avoid, reduce or remedy the adverse eco-hydrological impacts identified.
g) Residual impacts for the proposed development were evaluated.
h) A monitoring programme for ongoing baseline, construction period and post construction impact evaluation was outlined. The purpose of this monitoring programme is to allow ongoing evaluation of eco-hydrological trends prior to and resulting from construction of the pipeline.

4.0 Development of a Conceptual Hydrological Model

4.1 The detailed findings of this study are contained in Appendix M6 of Volume 2 of the EIS and Appendix C of the EIS Addendum Report are summarised below.

4.2 Landuse Activity:

- Landuse use activity has degraded the hydrological regime, both at the margins and across the surface of the sections of the route that traverse the Glenamoy Bog Complex cSAC and non-designated EU Annex 1 intact blanket bog. Specifically, activities such as turf cutting and overgrazing have degraded and damaged the functioning of the natural hydrology. These existing landuses are having an ongoing negative impact on the hydrological regime that sustains the intact blanket bog habitat present. Recent activity has also included significant degradation by use of a sausage machine on the intact blanket bog at Bellagelly, which had been avoided by the pipeline route.

4.3 Geology:

- Lowland blanket peat is present across the study site, ranging from 0.25 to 5.4m in depth.
- Within Glenamoy Bog Complex cSAC locally, peat depths ranging from 4 to 5.4m occur between Ch. 88.00 and 88.20.

- Outside of the cSAC, peats depths between 3 and 4m are encountered between Ch. 87.00 and 87.35 and between Ch. 86.20 and 86.50.
- Shallow depths of peat occur at several locations that are generally coincident with areas of cutover bog and associated trackways into the bog.
- Peat was logged and characterised in the deeper parts of the site. It is characterised by "firm to soft with depth, dark brown, humified with long to medium fibre content". It was generally recorded as damp to wet, but notably not very wet within the peat profile.
- In general mineral subsoil occurs below the peat along the pipeline route. Within Rossport Commonage, the mineral subsoils are characterised as "firm to very stiff, grey, slightly to very sandy SILT". Where shallow mineral subsoils were encountered immediately below the peat, they were generally 'dry'.
- Bedrock along the pipeline route is mapped as the Broad Haven Formation (BN). This is psammitic schist. Direct investigation of bedrock geology indicates that the local geology is characterised by "light green, medium to coarse grained Schist". The upper bedrock was recorded as being 'dry'.

4.4 Hydrology:

- The pipeline route within Rossport Commonage is located close to the topographic divide separating two surface water catchments. These have been labelled A & B on Figure C of Appendix M6 of Volume 2 of the EIS. Surface water in catchment B drains to the north. Surface water in catchment A drains to the south towards Sruwaddacon Bay. (Slide 1).
- Three natural watercourses have been identified within Rossport Commonage. These have been labelled D1, D2 and D3 on Figure C of Appendix M6 of Volume 2 of the EIS. These watercourses will not be crossed by the proposed pipeline route.
- The pipeline will cross two distinct man-made drains at Ch. 86.40 and 86.82. These are associated with access tracks within the cutover areas of the bog.
- Two bog pool complexes have been identified during the course of the study.
    - The first is a large bog pool complex located within the Glenamoy Bog Complex cSAC. These pools are located approximately >250m east-southeast of the propose pipeline route at Ch. 88.10. Both the pipeline and the bog pools are located along the same catchment watershed divide.
    - A separate localised system of bog pools is present south of the proposed route at Ch.87.26 in the non-designated section of the Commonage (Figure D of Appendix M6 of Volume 2 of the EIS). The pipeline is routed to the north of the larger pools. However a few small surface pools lie within the temporary working area.
    - These bog pools are 'perched' systems and are entirely dependent on rainfall for their water supply.
- Two flushes have been identified and surveyed within Glenamoy Bog Complex cSAC. Characterisation of these is included within the EIS Addendum Report (Appendix C). Flush 1 is located at approximately 200m northeast of the pipeline route at approximately Ch. 87.80. Flush 2 is located at approximately 210m east-northeast of the pipeline route at approximately Ch. 88.10. (Slide 2).
- A survey and site-specific tests (Appendix C of the EIS Addendum Report) indicate that the source of water flow to these flushes is primarily derived from near surface flow. Surface water catchments to these flushes have been delineated. The catchment to Flush 2 will not be intercepted by the proposed pipeline route. However, the pipeline route does intercept the upper part of the catchment to Flush 1. (Slide 3).
- The construction of the pipeline has the potential to affect the surface water catchment to Flush 1. This impact is associated with the construction phase only as reinstatement will restore the water supply over the whole catchment. Measures are proposed during construction to maintain the water supply from the upslope catchment to the flush. It is noted that the natural hydrology of this area has been impaired by landuse as stated above.

4.5 Hydrogeology:

- The underlying bedrock is mapped by the Geological Survey of Ireland as a "poor aquifer". Due to the low permeability characteristics of the overlying mineral subsoils and peat, and limited recharge, the underlying bedrock is not a controlling factor in supporting the hydrological functioning of the blanket bog along the pipeline route.
- In-situ tests of the peat and the underlying mineral subsoils (Appendix C of the EIS Addendum Report) indicate that these strata are characterised by very low permeability. This is a normal precursor for blanket peat formation.
- Peat is generally characterised as an aquitard with very little water movement. However, the peat may be divided into two layers, the lower catotelm unit, and the upper acrotelm unit. (Slide 4).
- The acrotelm is the upper aerobic layer in peat bogs that contains the living plant material and poorly humified plant remains. It tends to have higher permeabilities than the underlying 'catotelm' layer, and the water level fluctuates more rapidly in response to rainfall.
- The catotelm is the lower saturated anaerobic layer that comprises more humified peat. Permeability is generally lower and decreases with depth. The degree of humification generally increases with depth.
- The peat along the pipeline route was generally found to conform to this simple two-layer hydrological model.
- Water level monitoring data (Appendix C of the EIS Addendum Report) confirms that groundwater gradients were observed to be generally downwards within the peat profile.
- With very low permeabilities, the peat remains saturated most of the time and the majority of the rainfall runs off as near surface flow. This runoff is controlled by the macro-scale topographical relief.
- Deeper levels of peat show slower responses to rainfall events and indicate restricted water movement at depths below 0.5m.
- Direct measurements of hydraulic conductivity (Appendix C of the EIS Addendum Report) confirm decreasing permeabilities with depth. This implies that there is reduced potential for water movement at depth.
- This ties in with observations in the field where catotelm peat and underlying mineral subsoils were observed to be 'dry'.
- Electrical conductivity measurements (Appendix C of the EIS Addendum Report) gradually increase with depth within the peat profile. This data supports our understanding of the groundwater regime in terms of the potential for water movement and an overall downward vertical gradient. The data also indicates that the study sites coastal location plays a significant part in the slightly higher electrical conductivity values within the profile. The nutrient levels in the peat profile are derived in part from the body of the peat, but also from sea spray which is carrying airbourne nutrients to the blanket bog.
- In areas of cutover blanket bog and eroding blanket bog, the simple two layer hydrological model will not apply due to desiccation or removal of the acrotelm and catotelm layers by drainage, landuse and/or peat cutting, such as along the margins of Rossport Commonage.

5.0 Potential Impacts

5.1 The potential impacts of the proposed development are outlined in detail in Appendix M6 of Volume 2 of the EIS. In addition, reference is made to the Appendix C of the EIS Addendum Report for evaluation of potential impacts on the flushes located north of the pipeline route.

5.2 It is proposed to construct the gas pipeline within the body of a stone road. The road construction could have the potential to create rapid vertical drainage and increased longitudinal or lateral flows. This potential for impact requires mitigation by design and this is dealt with below.

5.3 Based on the understanding of the hydrological controls within Rossport Commonage by way of the Conceptual Hydrological Model it is clear that the predominant hydrological flows occur within the upper 0.5m of peat, *i.e.* within the acrotelm layer. The assessed low permeabilities for mineral soils, catotelm peat and bedrock confirm low flows within those horizons. In short it is a classical hydrological regime of blanket peat.

5.4 As a result of this understanding proposed mitigation measures are focused on maintaining and protecting existing near surface flows, thereby preventing the stone road from becoming a longitudinal or lateral drain.

5.5 Flush 1 is the only flush that has a potential to be impacted by the pipeline construction as all its water comes from near surface water and the pipeline intercepts some of its water supply. This impact will only occur during the construction phase.

5.6 The large complex of bog pools located within the cSAC to the northeast of the pipeline route will not be impacted upon. The pipeline route is in a separate catchment to the bog pools, therefore they will not be subject to any impact.

5.7 In the non-designated section of the Commonage, the large pools will be avoided. The small, discrete pools within the temporary working area will be subject to impact during construction. The habitat status of these pools is addressed in the Statement on Terrestrial Ecology.

5.8 Potential impacts on water chemistry during the construction phase have been assessment. These potential impacts arise from the risk of fuel spillage from mobile plant and storage areas.

5.9 Other impacts assessed for the construction phase include potential for increased runoff siltation, and possible erosion of adjacent peatland habitats.

5.10 For the operation phase, the change in ground composition for the stone road construction has the potential to impact on groundwater chemistry within an acidic blanket bog environment.

6.0 Mitigation Measures

6.1 In order to mitigate the potential impacts identified, a series of mitigation measures have been detailed in Appendix M6 of Volume 2 of the EIS and in Appendix C of the EIS Addendum Report to this hearing.

6.2 The mitigation measures will be aimed to maintain the principal hydrological flows within the blanket bog complex, i.e. principally the flows within the acrotelm (upper 0.5m). The reinstated turve surface will be contoured such that the existing surface water flow will be maintained.

6.3 In respect of Flush 1, in which there is a potential loss of some catchment contribution, mitigation measures will be undertaken to ensure water supply from the upslope surface water catchment is maintained to Flush 1 during construction. Long term drainage pathways to the flush will be preserved by the construction reinstatement.

6.4 In terms of the access tracks crossing the pipeline route, mitigation measures are directed at restoring the baseline situation after construction is completed.

6.5 The risk of the pipeline acting as a drainage pathway will be mitigated by construction of peat plugs at a maximum frequency of 50m intervals along the route. These plugs will prevent lateral sub-surface flow. The construction design will ensure the maintenance of saturation conditions within the pipeline route, while at the same time maintaining the natural near surface flows within the acrotelm.

6.6 The potential impacts on water chemistry will be mitigated by the following measures.

- Construction drainage will be put in place to intercept and attenuate runoff siltation prior to outfall. Where practical, upslope water flow will be transferred across the construction area, in order to maintain the existing hydrological regime.
- During the construction phase, appropriate locations will be designated for storage of fuel and other construction materials within the temporary working area. With the exception of the turves, no sidecasting, storage or stockpiling will be undertaken within the Glenamoy Box Complex cSAC or on EU Annex 1 habitat.
- An Environmental Management Plan will be implemented for the construction phase. This plan will contain emergency response procedures to remediate any accidental spills, should these occur.
- The material sourced for the construction of the stone road will be composed of similar chemistry material to that which is currently underlying the peat profile, specifically a siliceous source (i.e. non-carbonate) with a slightly acidic pH.
- During the construction phase, potential runoff erosion will be mitigated by drainage control measures. The proposed turve reinstatement will mitigate the potential for runoff erosion during the operation phase.

6.6 Concerns have been expressed as to the viability of proposed mitigation measures at Rossport Commonage in the light of apparent damage incurred at another blanket bog site at Upper Glencullin, in which a stone road and gas pipeline were emplaced.

6.7 Through observations made on Upper Glencullin, improvements to the construction technique have been made to limit the hydrological impacts of pipeline construction at Rossport Commonage. These include:

- The pipeline will be constructed within the stone road.
- To mitigate under drainage, a 0.5m impedance layer of peat will remain in-situ to prevent vertical drainage from the base of the stone road.
- The proposed turve reinstatement detail is designed to restore the existing hydrological regime. Turves will be stored in single layers on bog mats within the temporary working area. Following construction of the pipeline, a regulation layer of peat will be placed over the stone road. Then peat turves will be replaced in a patchwork array. Minor gaps between adjacent turves will be packed by hand.
- Turves will also be used to construct slightly elevated and contoured linear transverse ‘wings’. These will be coincident with the location of peat plugs within the stone road. The transverse ‘wing’ will form a barrier for longitudinal flow of surface water along the edge of the reinstated turve surface. These barriers will force surface water to flow across the reinstated area at regular intervals, thereby restoring the baseline pathways.

6.8 Finally, it is important to note that no upwelling of groundwater occurs in Rossport Commonage along or adjacent to the pipeline route. This is why no groundwater fed flushes occur along the pipeline route.

7.0 Conclusion

7.1 Inspector, the purpose of my statement was to provide an overview of the assessments of the eco-hydrology of 'protected' peatland habitats along and near the proposed pipeline route. The study and assessment of potential impact on designated peatlands within the Glenamoy Bog Complex cSAC and non-designated EU Annex 1 intact blanket bog is a central component to the Environmental Impact Assessment. As the eco-hydrogeologist engaged for this project, I can categorically state that a robust impact assessment has been completed. It is my technical opinion that no significant impact will occur on the Glenamoy Bog Complex cSAC or the other non-cSAC Annex 1 habitats along the pipeline route and therefore the integrity of the cSAC will be maintained. As a result, it can be stated beyond a scientific doubt, that the integrity of these sites or habitats will not be adversely affected.

7.2 The eco-hydrological investigations have established that while impaired by previous landuse, the bog still functions in a typical blanket bog hydrological regime. The predominant water supply is rainwater and the gradients are vertically downwards. This results in predominant flows being close to the topographic surface across the bog. Mitigation measures have been designed to conserve this regime.

7.3 Inspector, that concludes my witness statement.