BRIEF

I, Jerome Keohane was engaged by An Bord Pleanala as consultant Hydrogeologist/Hydrologist to advise the Inspector/Board on the likely impacts of the proposed development from the hydrogeology/hydrology perspectives, having regard to all aspects of the proposed developments including access tracks, foundations and turbines.

The brief provided to me by An Bord Pleanala, identified the following key responsibilities;

- Review and consider relevant documentation and observations submitted by the applicant, planning authority, prescribed bodies and third parties at all stages of the process, focussing particularly on the relevant sections of the environmental impacts statements (including any revisions to the EIS).
- Carry out site visits(s) if deemed necessary
- Set out and agree timescales with the Inspector.
- Liaise with the Inspector, and ecological consultant in relation to the oral hearing.
- Attend at the oral hearing
- Liaise with the ecological consultant in relation to potential or likely impacts of the proposed developments on groundwater dependent terrestrial ecosystems in the vicinity including Lough Croan Turlough SAC, due to potential or possible impacts on groundwater flows.
- Prepare and submit a report with reasoned conclusions on the hydrogeological/hydrological effects of both proposed developments including if relevant any cumulative impacts.

1. TASKS COMPLETED

In order to perform my brief, I undertook the following actions;

- Review of documentation, provided to me by An Bord Pleanala, in both hard copy and digital format.
- Development of preliminary overview and identification of items requiring clarification.
- Site visit on 04 May 2016, to carry out a general visual assessment of the topography and setting of the proposed development, and to inspect the location of each proposed turbine, and the routes of access roads. This was mainly carried out on foot, with vehicle access to expedite access.
- Attendance at Oral Hearing, Radisson Hotel, Athlone 09/10 June 2016.
- Preparation of report.

2. KEY QUESTIONS ADDRESSED IN ASSESSMENT

Having reviewed the documentation and undertaken the site visit, I consider the following questions need to be addressed as part of my assessment.

1. Was the issue of hydrological impact on the nature of the turloughs surrounding the proposed development, given appropriate importance from the outset by the

applicant and the consultative bodies, and did this have an effect on the nature and extent of the investigations undertaken?

2. Did the applicant and its advisors commission and undertake appropriate investigation and interpretation of the findings of these investigations to enable them to develop and present a robust conceptual model understanding of the hydrogeological and hydrological environment?

3. Does this conceptual model provide sufficient information to rule out any potential impacts on the integrity of Natura 2000 sites beyond all scientific doubt?

3. GENERALISED SETTING OF PROPOSED DEVELOPMENT

The site comprises approximately 58 Ha of undulating lowland hilly topography with two topographic high elevations at 118m O.D and 110m O.D respectively. The hills are locally steep in places. The land use generally comprises pasture which ranges from rough inaccessible heavily scrub vegetated strewn with boulders to improved grassland surrounded by dry stone walls.

The more elevated undulating topography of the proposed development is set within flatter topography through which tributaries of the River Suck pass. These lower areas also contain water features, some permanent and some seasonal.

Some of the seasonal features are identified as Turloughs and are afforded special protection under the Habitats Directive.

In addition there are other protected features which comprise grasslands, bog, lake, callows and eskers.

The geological setting of the site is dominated by Limestone, which is extensively karstified.

There is significant interaction between groundwater and surface water in this area.

Having walked the site, the site can be described as hummocky with significant variations in elevations and underfoot conditions over short distances. The Phase II site ground conditions appear to me to be dominated more by glacial deposits that Phase I and these deposits have blanketed the underlying karst landscape over most of the site. This suggests that groundwater dynamics may be more convoluted and respond slower to rainfall events than Phase I. I noted a number of significant outcrops of till with gravel in the area. I also observed a number of karst features (collapse /dolines) on and around the site confirming the underlying karst nature of the site.

The mapped source protection area of the Killeglan Springs encroaches onto the development site and includes Turbine 16 and part of the access road from T13 to T16.

According to the GSI information, the majority of the proposed development lies within the Suck Groundwater Body. However a small portion around Turbines 17, 18 and 19 lies in the adjacent Funshinagh groundwater body. The site will be potentially hydraulically connected to any groundwater features, within the groundwater body, situated in a down gradient

direction from the site. Accordingly it is considered that each portion of the site will be hydraulically connected to different groundwater dependent protected sites and Turloughs. The Ryan Hanley report of 2010 mapped the majority of the site in the Ballyglass catchment. Using this mapped catchment together with flow following topography, the following assessment of connectivity with protected sites and turloughs is proposed;

EUROPEAN SITE	PHASE I	PHASE II (1-16)	PHASE II (17,18.19)
	PL20-244346	Pl20-244347	Pl20-244347
GROUNDWATER BODY	SUCK	SUCK	FUNSHINAGH
SPA			
Four Roads Turlough	Y	N	N
Lough Croan Turlough	Y	N	N
River Suck Callows	Y	Y	N
Lough Ree	N	N	Y/N
Middle Shannon Callows	N	N	N
SAC			
Lough Ree	N	N	Y/N
Lisduff Turlough	Y/N	N	N
Four Roads Turlough	Y	N	N
Lough Croan Turlough	Y	N	N
Lough Funshinagh	N	N	Y
Killeglan Grassland	N	Y	N
Ballynamona Bog/Corkip Lough	N	N	Y
Castlesampson Esker	N	N	Y
River Shannon Callows	N	N	Y
Turloughs			
Lough Croan	Y	N	N
Four Roads	Y	N	N
Lough Feakle	N	Y	Y
Corkip Lough	N	N	Y
Dysart (Thomas Street)	Y	N	N
Cuilleenirwan	Y	N	N
Along Ballinglass Canal/River	Y	Y	N

ASSESSMENT OF CONNECTIVITY OF PROPOSED SITES WITH EUROPEAN SITES AND TURLOUGHS based on mapped groundwater bodies, topography and assessment of groundwater flow directions.

Y : suggests connectivity on basis of available information

N: suggests no connectivity on basis of available information

Y/N: Uncertain

It should be appreciated that the nature and extent of the connection needs to be understood to fully assess the potential impact and this can only be established by investigation. The efficacy of the investigative process undertaken by the applicant in this regard is assessed below.

4. ANALYSIS OF KEY QUESTIONS

Q1 *was the issue of hydrological impact on the nature of the turloughs surrounding the proposed development, given appropriate importance from the outset by the applicant and the consultative bodies?*

In considering this issue, I have reviewed the documentation and listened to the evidence and arguments offered at the Oral Hearing.

Chronological review of planning process to date.

The setting of the proposed development in the context of the karst was identified and acknowledged at an early stage by the applicant and is mentioned in the EIS.

It is stated in Chapter 9 (Soils and Geology) (section 9.7) of the EIS that no turbines are located close to the surface expression of any karst features.

Chapter 10 (Hydrogeology), confirms the karst nature of the bedrock, but does not specifically provide an assessment of impacts on Turloughs.

It is stated that since the turbine bases are shallow, that any interference with the groundwater flow regime is extremely unlikely and that the potential impacts of (i) alteration in recharge patterns (ii) creation of preferential pathways are of minor significance and would create negligible residual impact.

I however, could find no site specific evidence to support these conclusions. I am assuming that this is then taken to imply that consequent consideration of impacts on turloughs is not warranted.

In Chapter 11 Hydrology, the distance between Feacle Lough and the proposed turbine locations is “deemed sufficient as to eliminate the risk of any interaction or impact”. At this stage it appears to me that the applicant considered the Turloughs remote from the proposed development by nature of distance and predicted negligible impacts arising from activities related to the proposed development.

The Natura Impact Statement (July 2011) submitted by the applicant focussed on birds and concluded that “ on the basis of bird surveys undertaken , that there would be no direct or indirect impacts on any of the Natura 2000 sites listed within 15km of the wind farm.

It appears that initial observations by the Department of Arts, Heritage and the Gaeltacht (9th August 2011) were more focussed on the impact on birds connected with the protected habitats than maintenance of the hydrological integrity of the site. During the Oral hearing Dr. Tierney explained that this related to the bias of the experts who prepared the observations and that hydrology/hydrogeology was not mentioned because NPWS did not have a hydrology/hydrogeology expert in-house.

Observations made by appellants (August 2011) raise the issue of hydrology/hydrogeology in the context of possible impact on construction (Burke and Long), and with regard to turloughs (Brown) who states "that an appropriate level of detail was not evident in the site assessments to establish beyond reasonable scientific doubt that the proposed development will not result in adverse effects on the integrity of the surrounding Natura 2000 sites and Annex 1 habitats".

The request for further information from Roscommon County Council did raise general issues regarding hydrology/hydrogeology.

- Item 2 related to a request to clarify the existing drainage network on and around the site, and requested substantiated information to ensure that there would not be any negative impact upon the Killeglan springs source protection area.
- Item 3 requested that all proposed mitigation measures to ensure the protection of groundwater and to ensure the safe and stable construction of turbine foundations should be explored and submitted.

The Applicant submitted a response to these items in a document dated June 2012 stating that there is essentially no existing drainage network on the site with all incident rainfall going to groundwater, they describe the proposed drainage system and they describe the proposed measures to mitigate any impact on the groundwater environment and state that these will be conservative, rigorous and robust and will ensure that there is no negative impact upon Killeglan Springs, private wells, watercourses or groundwater. There was no direct reference to Turlough habitats.

The applicants also submitted an accompanying report to inform the Appropriate Assessment process (June 2012). In the screening section it is acknowledged that there is hydrological connectivity between the proposed development site and the Lough Croan, Four Roads Turlough and Lough Funshinagh, and state that due to the uncertainty of the indirect impacts that the site will be need to be assessed further. It is stated that "a detailed pre-construction geotechnical investigation will be required to more accurately assess the impact (if any) on turlough habitats within the study area in the local context and mitigation measures for the protection of groundwater are provided in the current assessment to reduce the likelihood of impacts on this habitat within the context of the designated Natura 2000 sites occurring within the same groundwater body". It is further stated that "adherence to the Environmental Management system together with implementation of mitigation measures, would ensure that there would be no indirect impact on the turlough habitat".

On 17th August 2012 Roscommon County Council decided to grant permission subject to 30 conditions, The conditions did not specifically mention the turloughs or SAC's, but reiterated in condition 4, the requirement to implement all environmental, construction and ecological mitigation measures set out in the EIS and further information response and the requirement for an environmental monitoring programme for the construction phase of the development in condition 7.

In their appeal to an Bord Pleanala, the Wind Turbine Action Group stated that "the applicant had failed to adequately describe the general landscape character of the area or to address the site specific and relevant geological and hydrological characteristics in the context of hydrology/hydrogeology, that no data was presented to show the development would have no significant impact upon the receiving karst environment" and added that "the

interaction between nearby natura sites and the karst landscape is difficult to understand and that any interference with existing flow paths within the karst may give rise to significant consequences in respect of the recharge of turloughs in the surrounding nearby landscape".

A submission from the Department of Arts, Heritage and the Gaeltacht of September 2012 focussed more on birds, that on the hydrology/hydrogeological aspects of the turloughs.

In the response to the appeals (September 2012), the applicant stated that potential interaction between karst hydrogeology of the site, groundwater pollution and recharge of turloughs and consequent impacts on ecology and Natura 2000 sites was not a matter raised by the Department. They state that Roscommon County Council did not express any concerns. They state that a comprehensive suite of mitigation measures was proposed, which was accepted by Roscommon County Council. They further stated their intention to undertake more detailed investigations post consent and argue that is normal practice in the case of virtually all construction projects.

In a further response the appellants again raised the issue of the interconnectivity between karst landscapes and Natura 2000 sites.

The Inspectors report of February 2013 referred to an absence of information on the interaction between the karst landscape and the nearby turloughs and the Inspector stated she was not satisfied that the applicant had demonstrated that the proposed development will not adversely impact on groundwater flowpaths within the karst landscape or indirectly therefore the groundwater regime of the designated wetland habitats.

The Board of An Bord Pleanala considered the subject of hydrology and the potential for adverse impact by the proposed development on groundwater quality and flow in the karst. The Board was satisfied taking into account the information supplied by the applicant including resistivity test data submitted to the planning authority with the application that subject to normal good construction practice, turbine foundations can be developed at this location without significant impacts on the hydrology or hydrogeology of the area. The Board overruled the Inspectors recommendation and granted permission.

The decision was challenged in the High Court and a number of affidavits were sworn and submitted in relation to hydrology and hydrogeology (Long, Johnston, Burke). The appellants highlighted the lack of investigation undertaken in relation to Turloughs and (Johnston) stated that "specific investigation of the supporting hydrogeology of the Turloughs is required, and that the EIS had taken only a generalised view since no observational data (other than geophysics) had been collected". He states further that "in karst of this type, that increasing distance from a discharge point is no guarantee of protection".

In a response to Professor Johnston's affidavit, Waterwise reiterated the intention "to prepare a through conceptual model at the post consent detailed design stage", and described the suite of proposed mitigation measures which they state will avert any adverse impacts on groundwater or risk to the groundwater regime around the sites.

Justice Finlay Geoghegan stated in her judgement 25/7/2014, that she considered that the Board had not lawfully conducted an appropriate assessment in accordance with Article 6(3) of the Habitats directive capable of upholding its determination.

In a submission by O'Connell Clarke Solicitors on behalf of Ted Kelly, they refer to the judgement of Ms. Justice Finlay Geoghegan whom they reference stating that "appropriate assessment will only arise where the screening process has determined that there is a likelihood of significant effects, that the Appropriate Assessment must (i) by examination and analysis identify all aspects of the development which could affect the conservation objectives of a European site, and must (ii) contain complete, precise and definitive findings and conclusion and must not have lacunae or gaps considering the best scientific knowledge in the field and after the Competent Authority decides that no reasonable scientific doubt remains as to the absence of identified potential effects".

The Applicant responded in May 2015, stating that they, "the Applicant is of the view that the extensive material submitted during the course of the planning appeal constituted the best scientific evidence in the field and was entirely appropriate to enable the Board to reach complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the proposed development". The applicant also states that, "the mitigation measures proposed in the information submitted by the applicant, and captured in the conditions of consent, are extremely detailed and comprehensive and fully exclude the possibility of any impact on hydrogeology or recharge patterns arising from the proposed development. As a consequence there is no reasonable scientific doubt as to the absence of impacts on a European site". And "where there is uncertainty in relation to whether there was a possible indirect hydrogeological link between the development and a European site, the applicant has assumed the presence of such links and assessed the proposed development on this basis".

In a submission by The Department of Arts Heritage and the Gaeltacht in May 2015, they state that for habitats such as turloughs, maintenance or restoration of habitat condition requires maintenance or restoration of groundwater and hydrological dynamics.

A submission by Kavanagh Burke 19/10/2015 on behalf of Ted Kelly commented on the size of cavity encountered in the rotary borehole RC-T8, which they state confirms the extent of active karstification that underlies the site which is a significant factor in the hydrological dynamics in the area, yet no reference is made to it by the applicant

In a further submission (October 2015) the applicant states that "the conclusions of the original Inspectors report have been superseded by a suite of detailed further information, subsequently submitted by the applicant, which fully removes all of the concerns raised" . I presume that in the context of hydrology and hydrogeology that this relates to the Jennings O'Donovan report submitted in May 2015, which is further discussed below.

Professor Johnston in the Oral hearing gave evidence that groundwater is the driver of turloughs and that the turlough ecology depends on the frequency and duration of flooding and stated that if the recharge of groundwater to the turloughs is impeded it will have an effect on the turloughs. He also stated that "no serious investigation of the measured response of turloughs to rainfall had been undertaken and that this is a major gap". He stated that "conventional borehole led investigation can be uncertain in karst areas, so that measurement of the response of turloughs water levels to rainfall, together with the use of a hydraulic model can give information on the extent and response of the turlough catchment to rainfall events".

Professor Johnston stated, in response to questioning, that the type of investigation proposed by Jennings O'Donovan would not satisfy his reservations in respect to the most appropriate form of investigation to determine the effects on turloughs.

This was reiterated by Rose Burke, who stated that the proposed investigations outlined by Jennings O'Donovan would inform the proposed construction solution for the foundation bases, but would not address the impacts on Turloughs.

Prof Johnston's stated that possible impacts on Turloughs would be either related to quality or quantity. In terms of quality he stated that disturbance of the ground for bases and roadways would possibly alter the recharge regime and could allow ingress of nutrients (Phosphorous and Nitrogen), which could make their way to the turloughs. He also felt that any change to flow regime by grouting/blocking conduits could alter the frequency and duration of flooding. He gave some examples where changes in landuse had created impacts on the nature of Turloughs. He felt that the two key issues to investigate, were (i) determine the catchment area to the turlough and (ii) determine the response of the turlough to rainfall regime.

Mr Kenny on behalf of the applicants suggested that Prof Johnston's main thesis was that "the applicant had not done testing to determine the interrelationship between the site, the groundwater and the turloughs". He stated that his clients approach has been to assume a relationship between the ground and the turloughs. He suggested that undertaking the form of investigation proposed by Prof. Johnston would only confirm or deny something that had always been assumed.

Prof Johnston responded saying that whilst a connection can be assumed, the nature of the connection must be evaluated.

Mr. Kenny suggested to Prof Johnston, that once a connection is assumed, if the proposed development does not interfere with this connection, then no impact will arise.

Prof Johnston argued that the construction of the (mitigated) bases and roadways will interfere with the groundwater.

Mr Kenny suggested that taking into account the investigations including the resistivity testing and the boreholes, that there was enough information before the Board to allow the Board to determine if a foundation solution can be found to ensure that there is no adverse interaction with the karst layer and no sediment or pollution is allowed from the construction or operation into the Turloughs.

Prof Johnston responded that it is a fundamental requirement to investigate the nature of the connection and not just assume that there will be no impact.

Mr Kenny proposed an additional condition (should consent be granted) that his client would be prepared to accept, that no turbines would be built over an active karst feature. Prof Johnston responded that it would be a difficult condition to achieve and he would need to see a detailed methodology of how it could be achieved before he would accept it.

Mr. Kenny read out the statement from the Board, and its satisfaction in respect to the previous decision, mentioning the extra data from the Jennings O Donovan report together with an additional condition that his client would accept. He suggested that given the current understanding there is no basis to show any integrity impact on the Turloughs.

Prof. Johnston cautioned, highlighting the difference between the application of mitigation measures to protect the immediate groundwater underlying bases and roadways and the effect that these mitigated structures might have on the Turloughs.

CONSIDERATION OF THE ISSUE

It appears to me that the importance of the hydrological status of the Turlough habitats has evolved with time in the process. It was not identified by the Department at the planning stage, and this possibly informed the reaction of the applicant and Roscommon County Council. The initial NIS submitted by the applicant did not address it.

The Department representative at the Oral Hearing, Dr David Tierney explained that the Department did not have hydrological expertise in house, which would explain the perceived bias towards birds.

I suspect that engagement by the appellants of experts in this area raised the profile of the issue.

The Inspector and the Board (although they reached different conclusions) identified it as a key issue and it was considered in detail at the judicial review. The Judge examined the process (Appropriate Assessment) for assessing the possible impacts on the Turloughs and identified the constraints in respect of the burden of proof required in terms of scientific certainty.

In subsequent submissions to the Board, the issue has been highlighted by the Appellants, and the Department (May 2015) has acknowledged its importance.

The applicant has argued that they have always accepted a linkage exists between the site and the Turloughs, that potential impacts will be negligible once the mitigation measures are in place, that sufficient information has been provided to allow the Board to make a determination and that further post consent investigation will provide a more comprehensive conceptual model to allow a more comprehensive impact assessment to be undertaken. I include my assessment of the linkages based on topography and interpreted flow direction at the start of this report.

Prof. Johnston who appeared on behalf of the appellants at the Oral hearing argued that selection of mitigation measures to prevent direct impact on the groundwater underlying the site, is different to the assessment of the impact these mitigated structures might have on the groundwater recharge mechanisms to Turloughs and that the investigations and proposed investigations were not designed to address this difference. He said it was a fundamental requirement to investigate the nature of the connection and reliance on assuming that there is a connection and this connection will not be interfered with is not sufficient. He recommended measurement of water levels in turloughs in response to rainfall events and the mapping of catchments to the turloughs.

The key potential impacts on Turloughs will be related to changes to the quantity or quality of groundwater recharge that can either, change the frequency and extent of flooding (quantity) or introduce nutrients that might lead to changes in the flora of a turlough (quality). Whilst I accept that these are the main potential impacts, the key question is how significant these impacts might be and this can only be determined by an appropriate investigation.

In summary I would suggest that the Applicant feels they have undertaken adequate investigations (Geophysics, trial pits and boreholes) to inform the Board in making its determination and they intend undertaking further investigation to re-inforce their view of no impact on the Turloughs, whereas the Appellants feel that the applicants have focussed on mitigating impacts created by the construction of the scheme at the expense of assessing what impacts these mitigated structures will have on the Turloughs.

I am satisfied that the Department and the Applicant have modified their approach to the impact on turloughs through the process and have more recently in the process, taken it more seriously. The appellants and their experts have consistently argued that the issue has not been adequately investigated by the applicant.

I am of the opinion that the investigation process undertaken by the applicant has not addressed the onerous constraints that apply when considering an appropriate assessment of impact on turlough habitat.

With regard to the Killeglan Springs source protection area. There is only slight encroachment of the proposed development into the source protection area. This together with the proposed mitigation measures would in my opinion present no significant risk to the quality of the source.

Q2. *Did the applicant and its advisors commission and undertake appropriate investigation and interpretation of the findings of these investigations to enable them to develop and present a robust conceptual model understanding of the hydrogeological and hydrological environment?*

To assess this question, I have examined the investigations undertaken to date, and considered their findings and the interpretation drawn by the Applicant from the findings. I also posed a series of questions to the experts retained by the applicants at the Oral Hearing.

Chronological review of Ground Investigation process to date.

I am satisfied that the desk study undertake in relation to this process, did adequately identify the hydrogeological and hydrological setting of the proposed development.

Only 7 trial pits were excavated in April 2011. When asked at the oral hearing why only 7 trial pits were excavated, Waterwise stated that by this stage the Geophysics was done, and a decision was taken to excavate only enough trial pits as needed to augment the geophysical interpretation. Waterwise also stated that a detailed post consent investigation was planned.

The maximum depth of the trial pits was 0.95m, which suggests that the excavator was unable to penetrate the subsoils. The inference I draw from this is that the excavator was not of a suitable size.

When questioned about the resistivity surveying undertaken, Dr Hodgson explained that interpretation can be subjective, and that his interpretation erred on the side of caution, when indicating shallow rock.

He accepted that the interpretation was at variance with the findings from boreholes (RC-T3, RC-T8, RC-T19) drilled in 2015 and stated that these findings would suggest the need to re-interpret the geophysical profiles, but that this would only be done as part of the post-consent investigation.

When asked why no standpipes were installed in boreholes drilled in 2015 to measure groundwater levels, Mr. Kiely on behalf of the applicants stated there was no specific reason why this was not done, even though a standpipe had been installed on Phase I with a recommendation that water levels be measured over a prolonged period.

No specific hydrogeological investigation has been undertaken on the site, although Waterwise did draw conclusions from observations, resistivity testing and trial pit excavation. I questioned Waterwise during the oral hearing on their conceptual understanding of the hydrological/hydrogeological environment.

I felt in reading the documentation that the water balance presented was over simplistic suggesting simply that all 100% of effective rainfall became groundwater recharge without any detailed description of the recharge mechanisms and flow dynamics and discharge mechanisms. I considered it important to understand the different mechanisms through which rainfall entered the ground and thereafter passed through the ground, the interactions with turloughs and the discharge mechanisms from the aquifer.

Having walked the site, I have formed the impression that there is sufficient variability in conditions and permeability across the site to have warranted a more extensive assessment and description of drainage conditions.

Ms Ibbotson stated that the absence of surface water features suggested the 100% recharge. She stated that the recharge mechanisms were either through point features (dolines) or diffuse. She indicated that the aquifer discharges to the River Suck, via a variety of mechanisms. In my view it was too generalised a water balance without any specific elements or quantities being identified.

I noted that Waterwise had referenced Goodwillies (1992) study on Turloughs and his estimation of the size of the catchment contributing to the Lough Feacle Turlough of 210Ha. I was interested to determine if Waterwise had attempted to map this catchment. Ms. Ibbotson stated that they did not have enough site specific data to do this, however they worked on the assumption that the site was connected to the Turlough and she reiterated that the final questions would be answered as part of the post consent investigation, whereby boreholes and geophysics would be used to identify karst features (if any) under each turbine and if any were found and posed a potential residual risk the turbine may be removed.

In the context of construction issues, which were addressed by Mr. Kiely of Jennings O'Donovan, I wished to enquire about the extent of site specific data that was collected to inform the designs. Mr. Kiely outlined the typical detail of road construction and how they would engineer the roadways to as close as possible greenfield conditions. I enquired if information on current permeability would be required and Mr. Kiely stated it would and that this data would be collected in the post-consent investigation.

In relation to the proximity of the Roadstone quarry to the site, Ms Ibbotson stated that a better understanding of the interaction between groundwater on the site and the quarry would be forthcoming once boreholes with standpipes are drilled particularly in the region closest to the Quarry as part of the post consent investigations.

Professor Johnston on behalf of the Apellants having heard my questioning of the applicants experts commented that there appeared to be inconsistencies and anomalies in the data presented suggesting a lack of knowledge of the hydrogeological regime, which would be an essential part of assessing the impact on turloughs.

Mr. Kenny in summing up his experts evidence, suggested that perhaps in light of the findings from the boreholes, that the original conceptual model was too conservative.

CONSIDERATION OF THE ISSUE

The impression I take from the evidence presented at the Oral hearing is that the applicant considers that they have upto now presented a worse case conceptual model, based on few data, and that they intend to tune this model with a comprehensive post construction investigation. The inference being that any revised model will be less conservative.

I feel however, that the current lack of information, the very generalised conceptual model, and the lack of site specific data undermines this position.

I also feel that the understanding by the applicant of the recharge to groundwater mechanisms is quite generalised. The absence of site specific permeability testing, the lack of a comprehensive spatial understanding of the extent of point source and diffuse recharge across the site and the lack of measurement of groundwater and turlough responses to rainfall events are all significant deficits in the information required to properly assess impacts. Without this level of fundamental understanding, it seems to me that the determination of how construction (including proposed mitigation measures) of bases and access roadways will affect groundwater recharge, cannot be reliably informed.

I am concerned that the Resistivity geophysics, which was augmented by a trial pit investigation of only 7 pits excavated to a maximum depth of only 0.95m is not accurate in light of the information from three boreholes (RC-T3, RC-T8 and RC-T19) drilled in 2015. The resistivity data was referenced by Roscommon County Council and the Board as a significant pillar of their approval.

In the context of assessing the impact on turloughs, the burden of proof does require the presentation of complete, precise and definitive findings that represents the best scientific knowledge in the field.

I am not convinced that assumption of a worst case scenario together with a suite of proposed mitigation measures that can be applied as required meets this requirement.

The suggestion that there is a need for a comprehensive post consent investigation to produce a comprehensive conceptual model and to more accurately assess the impact (if any) on turlough habitats within the study area suggests that the current model is not comprehensive and as such cannot be relied upon to make any definitive assessment of impacts.

Q3 *Does this conceptual model provide sufficient information to rule out any potential impacts on the integrity of Natura 2000 sites beyond all scientific doubt?*

I am satisfied that the applicant has the experience and can retain the necessary professional expertise to construct and operate this windfarm. I am also satisfied that on a site not hydraulically connected to Natura 2000 sites, that the proposed type of mitigation measures augmented by a post consent investigation and construction and environmental management plan to the scale outlined by Jennings O'Donovan would provide adequate protection to the groundwater immediately beneath the site.

I am not satisfied, however, that this level of confidence can be extended to the protection of the preservation of Turlough Habitat without the presentation of more complete, precise and definitive findings that represents the best scientific knowledge in the field as required by the Appropriate Assessment process as I understand it. To date, I am not satisfied that the nature and extent of investigation that has been undertaken in respect of this proposed development meets the standard and consistency required to generate such findings.

With some modification (along the lines outlined by Professor Johnston), the proposed investigation has the potential to generate such findings, however on the basis of my understanding of the requirement that "no reasonable scientific doubt remains as to the absence of the identified potential effects", I am not satisfied the present understanding of the hydrological/hydrogeological environment can eliminate that doubt. The key deficits that I see in the information provided are; The absence of site specific permeability testing, the lack of a comprehensive spatial understanding of the extent of point source and diffuse recharge across the site and the lack of measurement of groundwater and turlough responses to rainfall events.