INTERNAL MEMORANDUM	
To:	The Board of the Agency
From:	Patrick Byrne (Oral Hearing Chairperson)
Date:	8TH OCTOBER 2009
RE:	**Report on Re-Opened Oral Hearing with regard to a Waste Licence Application by Fingal County Council, Register No. W0231-01.**

I am to refer to the letter addressed to me as chairperson to the oral hearing of objections in relation to the above referenced waste licence application, issue on your behalf, dated the 17th October 2008. Within that letter you requested that following receipt of the information requested from the Applicant and submissions received from other parties, I should re-open the oral hearing for the sole purpose of considering the further information and submissions.

In accordance with the provisions of Section 44 of the Waste Management Acts 1996 to 2008, I attach my report entitled 'Report on the Hydrogeological Risk Assessment, Submissions on the Assessment and Re-Opened Oral Hearing' for your consideration. This report is supplemental to our earlier report entitled 'Report on the Objections and Oral Hearing on the Proposed Decision of a Waste Licence Application'. Mr Kealan Reynolds and Mr Bruce Misstear, as per their letters of appointment from the Agency, assisted me during the course of the re-opened oral hearing and preparation of this report.

Signed:

Patrick Byrne
Chairperson

Report on the Hydrogeological Risk Assessment, Submissions on the Assessment And Re-Opened Oral Hearing (27th – 29th April 2009)

For

Fingal County Council
Nevitt
Lusk
Co. Dublin

Register No. W0231-01

October 2009

Report by: Patrick Byrne
Assisted by: Kealan Reynolds & Bruce Misstear

Acknowledgements

Kealan Reynolds, Bruce Misstear and I would like to acknowledge and thank all the administrative staff of the Environmental Licensing Programme who organised the re-opened oral hearing (27th – 29th April 2009), disseminated all the necessary information and carried out all the other tasks associated with the running of the re-opened oral hearing and preparation of this report.

I would like to note my sincere appreciation for the assistance provided by Mr Kealan Reynolds (Environmental Protection Agency) and Mr Bruce Misstear (Trinity College Dublin) who again acted as Assistant Chairmen at the re-opened oral hearing and assisted in the preparation of this report.

Finally I would like to thank the Applicant, Objection Parties and the local residents who attended and participated in the re-opened oral hearing, for their courtesy and contributions.

Table of Contents

Chapter 1 Introduction

1.1 Introduction and Background

Fingal County Council applied, in accordance with the Waste Management (Licensing) Regulations 2004, to the Environmental Protection Agency (Agency) on the 5th July 2006 for a Waste Licence for the development of a new engineered landfill facility and public recycling facility at Nevitt, Lusk, Co. Dublin. The principal activity proposed is the disposal of non-hazardous waste which will be placed in lined engineered cells. The design capacity of the proposed development is 9.4 million tonnes of waste. The waste licence application also includes remediation of an existing landfill within the site boundary of the proposed facility.

There were 108 valid submissions received by the Agency in relation to the waste licence application. The Agency issued a Proposed Decision (PD) on the 20th September 2007. The Agency subsequently received nine valid objections. Six of the objections included valid requests for an oral hearing.

The valid objections were received from the following individuals/parties:

- Mr Deaglan De Faoite, Baile Na Ridire, Lusk. Co. Dublin;
- Mr John and Mrs Mary White, John White Agricultural Contractor, Nevitt, Lusk, Co Dublin;
- Ms Margaret Heavey, Greenstar Ltd., Unit 6 Ballyogan Business Park, Ballyogan Road, Sandyford, Dublin 18;
- Mr Martin Kiely, Fingal County Council, PO Box 174, County Hall, Swords, Fingal, Co Dublin;
- Mr Shay Lunney and others, Nevitt, Lusk Action Group, Little Acre Cottage, Walshestown, County Dublin;
- Ms Jackie Keaney, Confederation of European Waste to Energy Plants (CEWEP) Ireland, PO Box 10285, Dublin 1;
- Mr Kevin T. Cullen, Sliding Rock, Blackglen Road, Sandyford, Dublin 18;
- Mr Ian McGrandles, TIROS Resources Limited, Armitage House, 10 Hatch Street Lower, Dublin 2; and
- Mr Trevor Sargent TD, Agriculture House, Kildare Street, Dublin 2.

The Agency received three submissions on the objections.

The Board of the Agency, following appraisal of the nature of the objections and requests for an oral hearing at a meeting of the Board of the Agency on the 13th November 2007, decided that an oral hearing of objections would be held. The Applicant and Objection Parties were notified of the decision to hold an oral hearing by letter on the 16th November 2007.

The Board of the Agency on the 29th January 2008 appointed Mr. Patrick Byrne to chair the oral hearing, and Mr. Kealan Reynolds and Mr. Bruce Misstear to act as assistants to the chair.

Mr Byrne, Mr Reynolds and Mr Misstear visited the site of the proposed facility and surrounding areas, including The Bog of the Ring, on the 20th February 2008.

The oral hearing was held in The Bracken Court Hotel, Bridge Street, Balbriggan, Co. Dublin. The oral hearing commenced at approximately 10:30 on the 3rd March 2008 and concluded on the 13th March 2008 (3rd – 7th and 10th – 13th March inclusive).

The Chair and Assistant Chairs prepared a report in July 2008 entitled *Report on the Objections and Oral Hearing on the Proposed Decision of a Waste Licence Application*, which was signed by the Chair on the 12th August 2008 and submitted to the Board of the Agency on the 21st August 2008. The Board of the Agency considered the report at a number of Board meetings (2nd/3rd September, 23rd September and 7th October 2008).

Following consideration of the report the Board of the Agency, in its letter of 17th October 2008, requested the Applicant to provide more information in respect of the environmental risk assessment. The Board requested the Applicant to: *'Provide a probabilistic quantitative risk assessment that evaluates the potential for leachate leakage/migration to groundwater below the proposed facility. This assessment shall, in particular, evaluate the predicted concentrations of List I or II substances (as defined in the EU Groundwater Directive 80/68/EC) likely to be present in any potential leachate leakage.*' A copy of the letter is included in Appendix A to this report.

The Agency issued a letter, dated the 17th October 2008 (copy included in Appendix A of this report), to all third parties who had participated in the waste licensing process, including those who made submission on the waste licence application, objectors to the proposed determination, participants at the oral hearing (held in March 2008) and statutory bodies, to which it attached the request issued to the Applicant.

The Agency also wrote to the Chairperson of the oral hearing, letter dated the 17th October 2008 (included in Appendix A of this report), identifying the information sought of the Applicant and stating that '*the Board of the Agency requests that you {chairperson}, following receipt of the information and submission, which will be forwarded to you in due course, reopen the oral hearing with the sole purpose of considering the further information and submissions referred to above'.*

The Applicant submitted a Hydrogeological Risk Assessment (HRA) report, received by the Agency on the 17th February 2009, a copy of which is included as Appendix B to this report. Following receipt of the HRA, the Agency circulated the HRA to third parties, letter dated 20th February 2009, and sought submissions in relation to the report on or before 20th March 2009 (a copy of letter from the Agency to third parties is included in Appendix A to this report).

The Agency received 10 submissions from third parties, copies of which are included in Appendix C to this report, as follows:

- Ms Gemma Larkin, Walshestown, Lusk, Fingal, Co Dublin;
- Cpt. Thomas A Larkin, Walshestown, Lusk, Fingal, Co Dublin;

- Mr Kevin T. Cullen, Sliding Rock, Blackglen Road, Sandyford, Dublin 18;
- Mr Declan White, Knightstown, Lusk, Co Dublin;
- Mr Patrick Boyle, on behalf of Nevitt Lusk Action Group, Hand's Lane, Rush, Co Dublin;
- Mr Dermot Sheridan, Jordanstown, Lusk, Co Dublin;
- Mr Shay Lunney, Little Acre Cottage, Walshestown, Lusk, Co Dublin;
- Mr Trevor Sargent TD, Department of Agriculture, Fisheries and Food;
- Ms Natalya Hunter Williams, Geological Survey of Ireland, Beggars Bush, Haddington Road, Dublin 4; and
- Mr Morgan Burke, Greenstar Limited, Fassaroe, Bray, Co Wicklow.

On the 2nd April 2009 the ten submissions received were circulated to the Applicant and all third parties. The covering letter noted that *'if you wish to make any further submissions either on the submissions enclosed or the Hydrogeological Risk Assessment Report itself, you may do so at the forthcoming oral hearing.'* The letter also notified all parties, in accordance with Article 30 of the Waste Management (Licensing) Regulations 2004, of the arrangements for the re-opening of the oral hearing. A copy of letter from the Agency to all parties is included in Appendix A to this report.

The re-opened oral hearing was held in The Bracken Court Hotel, Bridge Street, Balbriggan, Co. Dublin. The re-opened oral hearing commenced at approximately 10:30 on the 27th April 2009 and concluded on the 29th April 2009.

1.2 Scope of this Report

This report considers the Hydrogeological Risk Assessment (HRA), the submissions on the assessment and the presentations made at the re-opened oral hearing. The re-opened oral hearing was for the sole purpose of considering the HRA report including any submissions in relation to that report. This report is supplemental to our July 2008 report entitled *Report on the Objections and Oral Hearing on the Proposed Decision of a Waste Licence Application.*

This report has been completed in accordance with the requirements of the Waste Management Acts 1996 to 2008 and Waste Management (Licensing) Regulations 2004 to 2008.

1.3 Re-Opened Oral Hearing

The Chairperson re-opened the oral hearing at approximately 10:30 on the 27th April 2009. The Chairperson outlining the procedures to be followed during the re-opened oral hearing, identifying the parties present and indicating the proposed order of presentations.

Appendix D to this report provides a list of the individuals who made presentations during the course of the re-opened oral hearing including cross references to the Digitake recording. Appendix E includes a summary record of the re-opened oral hearing; the complete recording of the re-opened oral hearing is available as recorded

by 'Digitake'. The written presentations and witness statements provided to the re-opened oral hearing are included as Appendix F to this report.

1.4 Availability of Participants

Prior to commencement of the re-opened oral hearing the Agency received a letter from the Applicant on the 8th April 2009, in which the Applicant requested a deferment of the commencement of the re-opened oral hearing. The Applicant identified that their principal witnesses, Mr Graham and Mr Herlihy, would be unavailable on the dates proposed for the re-opened oral hearing. The Chair wrote back to the Applicant, letter dated the 9th April 2009 and, whilst acknowledging the difficulties the Applicant may have in relation to their principal witnesses, the Chair indicated that he did not propose to defer the re-opened oral-hearing.

Mr Graham and Mr Herlihy made themselves available as witnesses to the re-opened oral hearing on the 27th and 28th April but were unavailable on the 29th. Cross-examination of the Applicant's witness Mr Graham had to conclude at approximately 19:00 on the 28th April as Mr Graham had to excuse himself from the re-opened oral hearing for pre-arranged personal reasons.

Dr Ashley, witness for Nevitt Lusk Action Group (NLAG), was not available on the 27th or 29th April. However presentation of his witness statement and cross-examination was accommodated on the 28th.

Mr Mulcahy (legal council for Greenstar Ltd) was not in attendance on the 27th April. Based on a request from Greenstar Ltd cross-examination of the Applicant's witnesses by Greenstar Ltd was carried over from the 27th until the 28th as they wished to conduct the cross-examination through their legal council.

Mr White (NLAG) read the written evidence of Mr De Rossa MEP into the record, as Mr De Rossa was unable to attend at a time when the Chair could schedule his presentation.

1.5 Retirement of Witness

Mr Cullen presented his witness statement on the 27th April. Copies of Mr Cullen's witness statement were circulated to all parties just prior to the commencement of his presentation. Following completion of Mr Cullen's presentation the Applicant sought deferment of cross-examination of Mr Cullen on the basis of the extent of his presentation. The Chair agreed initially to defer cross-examination until after a coffee break and then until after Mr Boyle, for NLAG, presented his witness statement and was cross-examined. The Chair then, following representation by the Applicant, proposed to carry over the cross-examination of Mr Cullen until the 28th or 29th, depending on available time and scheduling of other witnesses. Mr Cullen's agreement to the deferral of his cross-examination was not expressly sought by the Chair but Mr Cullen did not object to the Chair's decision.

On the resumption of the oral hearing on the morning of 28th April, Mr Cullen read into the record a prepared statement within which he stated that the deferral of his cross-examination was to provide sufficient time for the Applicant to consider his

submission and prepare for cross-examination at a distant time in the hearing. Mr Cullen stated that the Chair did not defer to him with regard to this arrangement. Mr Cullen stated that it appeared to him that the re-opened oral hearing was being conducted in a manner which provided the Applicant with a distinct advantage over those without the technical resources. Mr Cullen stated that he was formally retiring from the hearing in protest over the manner in which the hearing was been conducted.

The Chair noted that the process for the re-opened oral hearing was to be as flexible as possible. The Chair also stated that he regretted that Mr Cullen considered that an injustice had been done by the Chair not insisting on cross-examination on the evening of Monday the 27th. The Chair offered to take cross-examination of Mr Cullen straightaway if that would assist Mr Cullen; however, Mr Cullen stated that his mind was made up and he had no intention of disrupting the hearing. Mr Cullen asked that it be put on record that the Chair carried out the hearing without any bias, but unfortunately it is a set of circumstances that emerged.

Mr Cullen's submission on the HRA, witness statement and presentation to the re-opened oral hearing were considered in preparation of this report. However cross-examination of the witness was not possible as the witness retired from the re-opened oral hearing.

1.6 Re-run of Model

During cross-examination of the Applicant's witnesses by Mr Mulcahy (for Greenstar Ltd), the Applicant offered to re-run the LandSim Model used in the Hydrogeological Risk Assessment (HRA). The model re-run was based on changing the ammonium half-life in the subsoil layer, 5-10 years in the HRA, to a more conservative figure. Mr Mulcahy, for Greenstar Ltd, expressed his dissatisfaction with the Applicant re-running the model and identified that re-running the model did not address all the issues raised in cross-examination of the Applicant's witness or additional issues raised in the Greenstar Ltd. witness statement (Dr Barnes and Mr Hall).

The Applicant undertook a re-run of the model, based on a half–life of 100 years for ammonium degradation, and the results of the model re-run were provided to the re-opened oral hearing (Document No. 9, Appendix F). Mr Graham, on behalf of the Applicant, provided a commentary on the results of the re-run of the model. Mr Graham provided points of clarification for the Assistant Chair and was cross-examined by Mr Boyle, NLAG, and Mr Mulcahy, Greenstar Ltd. Mr Graham had to leave the re-opened oral hearing prior to completion of Mr Mulcahy's cross-examination. Mr Mulcahy noted that this was unsatisfactory and that it was of Mr Graham's own making that had lead to the new information being necessary. Dr Barnes, expert witness for Greenstar Ltd., made a number of points in relation to the re-run of the model in supplementary evidence to the re-opened oral hearing on the following morning (29th April). Mr Mulcahy made reference to the re-run of the model in his closing statement.

Chapter 2 Hydrogeological Risk Assessment

2.1 Background

As noted in Section 1.2, this report is a supplement to our earlier report entitled *Report on the Objections and Oral Hearing on the Proposed Decision of a Waste Licence Application for Fingal County Council, Nevitt, Lusk, County Dublin*, dated July 2008. In Section 2.3 of that report, the hydrogeological evidence provided by the Applicant and the Objection Parties was considered under the following headings:

- **Geology**: including the evidence on superficial geology, rockhead elevation, bedrock geology and geological cross-sections;
- **Groundwater vulnerability**: including the evidence on subsoil thickness, subsoil permeability and groundwater recharge;
- **Aquifer classification**: including the evidence on the classification of the bedrock aquifer and whether the overlying gravels should be classified as a separate aquifer;
- **Protection of existing groundwater sources**: including the evidence on whether the proposed landfill lies within the zones of contribution to the Bog of the Ring wellfield or the existing horticultural wells;
- **Conceptual model and risk assessment**: including the evidence on the level of detail of the Applicant's conceptual model, the qualitative risk assessment, the Resource Protection Response rating and the need or otherwise for a groundwater model;
- **Future groundwater development potential**: including the evidence that a landfill at the proposed location would inhibit future groundwater development in the area.

Following consideration of this report, the Board of the Agency in its letter of 17th October 2008 requested the Applicant to provide more information in respect of the environmental risk assessment (a copy of letter from the Agency to the Applicant is included in Appendix A of this report). Specifically, the Board requested the Applicant to:

"Provide a probabilistic quantitative risk assessment that evaluates the potential for leachate leakage/migration to groundwater below the proposed facility. This assessment shall, in particular, evaluate the predicted concentrations of List I or II substances (as defined in the EU Groundwater Directive 80/68/EC) likely to be present in any potential leachate leakage. Predicted concentrations should be compared to relevant quality standards or background standards, for the relevant receptor, and a conclusion made as to the potential for, and significance of, any impact of the predicted leachate on groundwater chemical status. The assessment used should justify:

- *model software and any model inputs such as source term, declining source term, and retardation.*

- *predicted leakage losses and attenuation factors (e.g. dilution, dispersion, diffusion, sorption).*
- *receptors selected for assessment (such as aquifers, abstraction wells).*

The Applicant submitted its Hydrogeological Risk Assessment (HRA) report in February 2009, following which, as noted in Section 1.1 above, 10 submissions were received from Objection Parties in relation to the HRA.

The HRA, and the evidence provided at the re-opened oral hearing (27th, 28th and 29th April 2009) in relation to the HRA, is considered below under the following headings:

- Conceptual model;
- Choice of mathematical models;
- Modelling approach and data input;
- Receptors and compliance points;
- Model predictions.

In addition, several Objection Parties referred to local wells in the area and to the importance of the aquifer as a resource and the potential impact of the landfill on the local horticultural industry. Detailed evidence on these aspects was considered at the previous oral hearing, and relevant excerpts from our earlier report (*Report on the Objections and Oral Hearing on the Proposed Decision of a Waste Licence Application for Fingal County Council*) are included in Section 2.7 below.

2.2 Conceptual model

The Applicant's conceptual model for the site is described in Section 3.6 of Volume 5, Appendix H of the EIS and is summarised in Section 4 of the HRA and in Section 2 of the Applicant's witness statement (Document No. 1, Appendix F).

The geology of the proposed landfill site comprises glacial tills with sands and gravels, occurring either as lenses within the till or as more extensive horizon(s) overlying the Carboniferous limestone bedrock. The subsoil beneath the proposed landfill footprint is reported to be typically between 15 m and 25 m thick. The sand and gravel deposits vary from 'being absent to having a thickness of greater than 10 m beneath the low permeability clay' (Document No. 1, Appendix F).

The Carboniferous limestone aquifer at this site is classified by the Geological Survey of Ireland (GSI) as a locally important aquifer that is generally moderately productive ('Lm'). The gravels are not classified as a separate aquifer; rather, as confirmed by the GSI at the March 2008 oral hearing, they provide additional storage to the underlying bedrock aquifer.

The aquifer unit is described by the Applicant as being confined by the overlying low permeability clay. According to the Applicant, the 'saturation zone of the aquifer is located within the bedrock and sand and gravel deposits and does not include the overlying clay' (Document No.1, Appendix F). The Applicant frequently describes water within the till as being "perched", and states in the HRA (Section 4) that 'The perched water levels within the clay are generally higher than the potentiometric surface within the aquifer unit', implying a downward hydraulic gradient (except in

the north of the landfill footprint where artesian conditions exist, and where potentiometric levels 'are approximately 1 m above ground level and 1-2 m above the perched water level within the clay'.

In response to a question from Mr Mulcahy (for Greenstar Ltd), Mr Orsmond (for the Applicant) indicated that most of the boreholes in the clay subsoil were dry during drilling but that water percolated into the boreholes later. Ms Burden (for the Applicant) indicated that there were water strikes in three boreholes in the clay, she elaborated that a stabilised water level was subsequently recorded in all the subsoil boreholes. In response to a question from Mr Misstear, Ms Burden also indicated that the pore water pressure is less than atmospheric in the clay and at atmospheric in the sand lenses.

Several of the Objection Parties commented on the Applicant's conceptual model. Dr Barnes (for Greenstar, giving evidence jointly on behalf of himself and Mr Hall) indicated that the 'clay rich drift unit [the term Dr Barnes used for the subsoil, which was queried by Mr Flanagan for the Applicant] could be better interpreted as a leaky confining layer rather than containing a perched water table, or indeed isolated disconnected perched groundwater bodies' (Document No. 6, Appendix F). In support of this interpretation, Dr Barnes stated that the Applicant's data on water levels in the overburden 'strengthens our {Dr Barnes and Mr Hall} view that hydraulic head within the drift approximates, and is strongly influenced by, the aquifer piezometric surface' (Document No. 6, Appendix F).

In response to a question from Mr Misstear, Ms Burden indicated that the subsoil acts as an aquitard rather than an aquiclude. Mr Cullen, in his witness statement, argued that the water in the subsoil is groundwater and included borehole hydrographs in his witness statement in support of his argument that the clay subsoil and the bedrock are 'part of a single and continuous groundwater system' (Document No. 3, Appendix F). Mr Cullen, Mr Boyle and Dr Ashley (the latter two on behalf of the Nevitt Lusk Action Group (NLAG)) all took issue with the Applicant's use of the term "perched" to describe water in the subsoil, on the basis that this term is generally used to describe 'Unconfined ground water separated from an underlying main body of ground water by an unsaturated zone' (the US Geological Survey definition quoted by Dr Ashley in Document No. 4, Appendix F).

Several Objection Parties pointed out that lateral water flow in the subsoil was not allowed for in the Applicant's conceptual model and consequently that the risks to streams have not been properly assessed. Dr Ashley concluded that 'A major, and critical, defect is the failure to recognise the pathway whereby shallow groundwater could be contaminated by leachate leaking from the landfill and could then enter local streams, bypassing the compliance points that have been adopted' (Document No. 4, Appendix F). Mr Boyle (Document No. 2A, Appendix F) mentioned recharge of streams through saturated clay, and provided some photos (Document No. 2C, Appendix F) of a disused shallow well in a ditch located within the proposed landfill footprint. On the basis that lateral permeabilities often greatly exceed vertical permeabilities, Dr Barnes stated that 'the bulk of groundwater flow within the drift may be occurring laterally as opposed to the vertical direction assumed and modelled in the HRA'. He also indicated that the HRA does not discuss 'the associated

potential for provision of natural baseflow discharging from this unit to streams that exist to the north, south and east of the landfill' (Document No. 6, Appendix F).

The Applicant indicated that surface water features within the landfill footprint are 'drainage ditches and ephemeral streams which are shallow channels recharged by overland flow and interflow within subsoils' (Document No. 1, Appendix F). These streams 'have minimal flow which ceases in dry periods indicating that they do not receive a base flow from groundwater'. Two streams with deeper, incised channels, occur to the north of the landfill footprint and one of these is reported to contain exposures of bedrock. In both cases, the Applicant reported that the streams receive recharge from groundwater to the north-west (upgradient) of the proposed landfill. The Applicant indicated that 'The finished base of the landfill will be below both of these streams and no lateral pathways will exist' (Document No. 1, Appendix F).

Dr Ashley pointed out that the HRA does not address the risks from the existing landfill at the site (Document No. 4, Appendix F) and Dr Barnes queried whether contamination from this landfill would be drawn into the proposed underdrain (Document No. 6, Appendix F). Mr Mulcahy (in his closing statement) also mentioned that the HRA disregards the 'illegal' landfill.

Comment
The Applicant's use of the term "perched" to describe water in the subsoil does not seem to be entirely appropriate. As pointed out by a number of Objection Parties, the term is usually reserved for situations where an upper groundwater zone is separated from the main aquifer by an unsaturated zone. In this case, it is probable that the clayey subsoil beneath the permeable sand and gravel lenses is saturated, at least in the deeper parts. Mr Orsmond, in response to a question from Mr Boyle, noted that the clay had a typical moisture content of 15%, at 10 m depth. Mr Herilihy, in response to a question from Mr Misstear, indicated that the clay, lenses and underlying clay are saturated. In the modelling of the overburden as a vertical pathway, saturation was assumed (using both modelling tools), as confirmed by Mr Graham (for the Applicant), and as identified in the HRA Appendix E.1 Inputs & Outputs from LandSim Model – see Section 2.4 below. The issue as to whether water in the subsoil constitutes "groundwater" is considered in Section 2.5 below.

Based on the data available, the more permeable deposits that occur within the clayey subsoil do not appear to be continuous, which will limit their potential for allowing lateral migration of any leachate that might escape from a landfill. However, the presence of an engineered drainage blanket beneath the proposed landfill, if continuous, would increase the likelihood of lateral flows. At the re-opened oral hearing, Mr O'Toole (for the Applicant) commented that the proposal was to install a drainage blanket where required, although the proposed decision, as issued by the Agency on the 20th September 2007, required a continuous drainage blanket (which the Applicant addressed in their objection to the proposed decision and at the oral hearing, in March 2008). This issue was considered in Section 3.5 of our July 2008 report, which concluded that the provision of a drainage blanket beneath the entire site was not necessary and would most likely cause engineering difficulties.

Water levels recorded within the subsoil boreholes appear to show a broadly similar pattern to those in the deeper bedrock/gravel boreholes, with a fall in elevation from

northwest to southeast. The water level in the subsoil is generally higher than the potentiometric surface in the bedrock/gravel aquifer, indicating a downward hydraulic gradient. It seems likely that saturation levels in the deeper subsoil would be influenced by the underlying bedrock/gravel aquifer.

2.3 Choice of mathematical models

The HRA was undertaken using two quantitative risk assessment tools: *LandSim Version 2.5* and the *Contaminant fluxes from hydraulic containment landfills spreadsheet v1.0*. Both pieces of software were developed for the Environment Agency of England and Wales, for use in hydrogeological risk assessments of landfills. The LandSim model was produced by Golder Associates (UK) Limited, and members of this company provided a witness statement on behalf of Greenstar Ltd at the re-opened oral hearing.

LandSim is a probabilistic model which uses the Monte Carlo simulation technique to select randomly from a pre-defined range of possible input values to create parameters for use in model calculations. It can be used to predict leakage of leachate through an engineered barrier under different conditions, and subsequent migration of the contaminants through different geological pathways. The geological pathways that can be specified in the model are: an unsaturated zone; a low permeability vertical pathway; and an aquifer pathway. The processes of advection, dispersion, biodegradation and retardation can be allowed for in each pathway. LandSim can be used to model the different phases of a landfill lifecycle. In this instance, it was used to predict leachate concentrations and elevations during the operational phase of the site and to estimate advective fluxes from the landfill when leachate heads are predicted to exceed groundwater levels in the surrounding subsoil and the potentiometric surface in the aquifer unit.

The Applicant used the *Contaminant fluxes from hydraulic containment landfills spreadsheet v1.0* to simulate contaminant transport by diffusion, which is the transport process that would occur when there is an inward hydraulic gradient into the landfill. The diffusion model, which will be referred to hereafter as the Hydraulic Containment Model (HCM), is described in the Environment Agency of England and Wales 2004 report *Contaminant fluxes from hydraulic containment landfills: a review*. The Applicant's consultants modified the spreadsheet by adding "@Risk" software to enable a range of input parameters to be specified and hence to enable the model to provide a probabilistic assessment.

The two models were applied separately since, as pointed out by the Applicant, 'they use assumptions which are mutually exclusive' (Document No. 1, Appendix F). Several of the Objection Parties commented on the choice of models. Dr Ashley concluded that: 'The HRA uses two software tools which are designed for mutually exclusive scenarios. Both tools are quite incapable of simulating the complex geography, hydrogeology and phased landfill development plan' (Document No. 4, Appendix F). Dr Barnes commented that 'It is not obvious how this transient LandSim model simulates any or several of the four conceptual model scenarios presented in the HRA on Figure 006, which describes the site as being hydraulically contained during the Operational Phase and leaking on the basis of an outward differential head across the liner in the Post Management Phase' (Document No. 6,

Appendix F). In their summary evidence (Document No. 13, Appendix F), the NLAG stated that the HRA 'used inappropriate computer modelling tools'.

In his submission on the HRA (see Appendix C of this report), received on the 19th March 2009, Mr Cullen referred to the fact that the Agency had requested (in 2006) a numerical modelling study to be undertaken by the Applicant, but he noted that the Applicant had not done so, leading to 'a considerable waste of public monies in the interim'. Mr Shortt (Document No. 5, Appendix F) also referred to the Agency's 2006 request to the Applicant to carry out a numerical modelling study, whilst Dr Barnes indicated that 'Had that modelling been undertaken as requested, it would have provided an opportunity to fully investigate and understand the site including the conceptual understanding of the development area' (Document No. 6, Appendix F), a point reiterated by Mr Mulcahy in his closing statement.

Dr Ashley and Dr Barnes argued that LandSim is not suitable for situations where the landfill base is below the water table. The Applicant argued that the proposed landfill does not represent a sub-water table landfill (Document No. 1, Appendix F).

In relation to the HCM, Dr Ashley concluded that this is 'an appropriate tool for the proposed scenario, but it is designed for scoping studies only, not for the "*detailed quantitative probabilistic risk assessment*" requested by the Agency' (Document No. 4, Appendix F).

Following a request for information from Mr Misstear, Mr O'Toole (for the Applicant) gave two examples of where LandSim had previously been applied in support of a waste licence application in the Republic of Ireland: at Ballynacarrick Landfill Site in Co. Donegal (Register No. W0024-03), and at Meenaboll Landfill Site, also in Co. Donegal, (Register No. W0215-01).

Comment
LandSim is widely used for carrying out hydrogeological risk assessments of landfills in England and Wales. It is one of the risk assessment tools referred to in the Environment Agency's 2003 document *Hydrogeological Risk Assessments for Landfills*. Modelling of leachate emissions from landfills has not been carried out routinely in Ireland, although LandSim has been applied at a number of sites previously, including the two examples in County Donegal noted by Mr O'Toole, and also at the Annaskinnan Residual Landfill in Co Westmeath. We are unaware of the HCM having been applied previously to a landfill risk assessment in Ireland.

In the case of Ballynacarrick Co. Donegal (Register No. W0024-03) LandSim was used to model the existing dilute and disperse landfill and a proposed lined landfill extension; at Meenaboll, Co. Donegal (Register No. W0215-01) LandSim was used to model a proposed lined landfill; at Annaskinnan, Co Westmeath (Register No. W0153-01) LandSim was used to model a proposed lined landfill.

As pointed out by the Applicant and by a number of Objection Parties, LandSim can only be used to simulate contaminant migration where leachate levels within the landfill are at a higher elevation than water levels outside the landfill. Whilst this situation is less likely to occur during the operational phase of the proposed landfill - due to active leachate removal and maintenance of a leachate head of 1 m - a positive

outward hydraulic gradient is more likely during the post management phase. LandSim is considered to be an appropriate tool for the situation where the landfill is not hydraulically contained.

The HCM was developed specifically for the situation where a landfill is hydraulically contained, and therefore would appear to be an appropriate tool for the period(s) when there is an inward hydraulic gradient to the landfill, which is the expected situation during the operational phase of the proposed landfill. Also, we note that the amended HCM tool (which includes the software for producing probabilistic predictions, '@Risk') has not been validated, although we also note that the Environment Agency document *Hydrogeological Risk Assessment for Landfills* identifies the use of proprietary spreadsheets and software packages including '@Risk'.

Ideally, it would have been desirable to apply a single model, one that could simulate advective and diffusive fluxes at different stages of the landfill's lifecycle. However, we are not aware of such a model being available as an 'off the shelf' software package; rather, such a model would be very complex to develop and would be difficult to validate. Therefore, the use of two separate modelling tools is considered reasonable in this case. The modelling approach using the two models, and the data inputs, are considered in Section 2.4 below.

The Environment Agency of England and Wales 2003 document *Hydrogeological Risk Assessments for Landfills* describes "simple" and "complex" risk assessment. It is clear in the Hydrogeological Risk Assessment for Landfills that even a simple risk assessment should be quantitative: 'Simple risk assessments should consist of simple quantitative calculations, typically analytical solutions solved in a deterministic fashion using conservative input parameters, assumptions and methods.' Simple risk assessments will generally be applicable 'in less sensitive locations where the risk screening and prioritisation have not identified any receptors that would be particularly susceptible to the consequences of leachate pollution. Where there is uncertainty regarding any of the source, pathway and receptor terms, undefined groundwater patterns including the potential for fissure/conduit flow or long-term liner integrity, and a robust decision cannot be made using conservative inputs, methods and assumptions, then a complex risk assessment should be carried out'. The Applicant has indicated that the HRA constitutes a complex risk assessment as per the Environment Agency's 2003 manual (see the Executive Summary of the HRA). Within the Environment Agency's manual, the use of LandSim incorporating worst-case (generic) assumptions is regarded as a simple risk assessment, whereas its application with site-specific data is regarded as complex risk assessment (Table 3.3). Again, the application of proprietary spreadsheets in a stochastic fashion using software packages such as '@Risk' would be a complex risk assessment where it relies on site-specific data. In the worked example of a complex risk assessment in Appendix 11 of the Environment Agency's manual, site specific data include geochemical properties that control retardation of key pollutants. In this respect, the Applicant's HRA is less than a full complex risk assessment (the data input parameters include site specific data for certain parameters, including fraction of organic carbon values, but other parameters such as partition coefficients are based on literature values). We would add, however, that the request to the Applicant from the

Agency for a hydrogeological risk assessment did not refer to simple or complex risk assessment.

Regarding the Agency's 2006 request to the Applicant for a numerical groundwater model, it should be noted that the purpose of the Inspector's request was for such a model 'to determine (a) the impact on the groundwater flows at the proposed landfill area of the additional abstraction wells along the indicated area of land [south of Decoy Bridge along a zone that is roughly parallel to the M1], and (b) the combined zone of contribution for the existing Bog of the Ring abstraction system and the theoretical new abstraction wells'. That request was not for a model to provide a quantitative probabilistic risk assessment that evaluates the potential for leachate leakage/migration to groundwater below the proposed facility. Section 2.3.6 Future Groundwater Development Potential of our July 2008 report includes consideration of this issue in greater detail, and excerpts from that report are included in Section 2.7 of this supplementary report.

2.4 Modelling approach and data inputs

The modelling approach and data input parameters are described in Section 5 of the HRA. Further details of the data inputs are given in the appendices to that report. Site specific data used in the modelling include the engineering details for the landfill and the hydraulic characteristics of the subsoil and aquifer. Information on waste characteristics, biodegradation rates, retardation rates, subsoil and bedrock porosity values were obtained from literature sources, including the LandSim manual.

According to the HRA, the contaminant pathways and processes modelled were: direct leakage through the HDPE landfill liner; advective transport through the engineered mineral liner, clay subsoil and aquifer unit; diffusive transport through the mineral liner and clay subsoil (using the HCM); a vertical pathway comprising 10 m of in-situ clay subsoil; a horizontal pathway comprising the aquifer unit (sand and gravel and limestone bedrock); dilution of leachate by infiltrating rainfall during and after management of the site, and dilution within the aquifer unit; retardation processes within the mineral liner, vertical pathway and aquifer unit; dispersion within the vertical pathway and aquifer unit (LandSim only); degradation of contaminants within leachate and within the vertical pathway and aquifer unit.

Issues raised at the re-opened oral hearing included the modelling timescale; the modelling in relation to the phasing of the landfill construction, management and post management; leachate breakout; leachate recirculation; contaminant attenuation; aquifer dilution. The further issue of whether the clayey subsoil represents a pathway or a receptor will be considered in Section 2.5 below.

The timescale for the HRA modelling predictions was 20,000 years according to evidence presented by the Applicant. Tables 6.1, 6.2 and 6.3 in Section 6 of the HRA summarise LandSim predictions for 30, 60 and 20,000 years after the start of filling and Section 6.3 of the HRA indicates that the predicted concentrations for the HCM are at 20,000 years (and graphs in Appendix E2 show predictions to 100,000 years).

Mr Cullen highlighted the uncertainties involved in making predictions over a period of 20,000 years, illustrating his argument with the enormous changes in climate and

human development that have occurred over the past 20,000 years. (He also pointed out that the HCM predictions in Appendix E2 of the HRA extend the timeframe to 100,000 years). Mr Flanagan, in his closing statement, claimed that the 20,000 year modelled lifetime is not a user-defined figure in LandSim. Dr Ashley described the time factor for the risk assessment as 'problematic', and concluded that 'Most accidental damage, leachate control problems and other high risk events are likely to occur during the construction phase' (Document No. 4, Appendix F).

Both Dr Ashley and Dr Barnes noted that the modelling did not take account of the detailed phasing of landfill construction, operation, management and aftercare. Dr Barnes argued that the modelling should have taken account of the engineering controls during the lifecycle of each cell.

Mr Mulcahy and Dr Barnes queried whether surface breakout had been allowed for in the modelling, and hence whether contaminant mass was being removed from the model to surface water. Mr Graham, for the Applicant, confirmed that there is a prediction of break-out, but that the model continues to predict emissions from the site through the lining system. Mr O'Toole (also for the Applicant) stated that break-out is a theoretical situation in the future, no different to any landfill: however, no operator could walk away until there is no risk to the environment and until passive controls are considered adequate. Mr O'Toole also noted that the agreement of the Agency is necessary prior to closure and surrender programmes.

Dr Barnes pointed out that the model assumes that leachate removed from the landfill is treated before being recirculated back into the landfill, at a rate of 100 m^3/day. Mr Graham confirmed that the default setting in LandSim does assume leachate treatment. He added that they did run the model without the recirculation option being active, but this is not reported in the HRA. Mr Mulcahy queried why the Applicant had not produced the results of the model run without the recirculation option. Mr Graham said that recirculation is proposed, and that the model is limited as to how this is represented. He explained that selecting the option of leachate recirculation allowed the appropriate leachate heads to be calculated.

Dr Barnes criticised the assumption of ammonium biodegradation within the low permeability clays that form the vertical pathway, as the necessary supply of oxygen is unlikely to be present. In response, the Applicant's consultants re-ran the LandSim model during the re-opened oral hearing, using an ammonium half life of 100 years compared to a range of 5 to 10 years in the HRA (the results of the new simulation were presented as Document No. 9, Appendix F, and are referred to in Section 2.6 below). Dr Barnes also indicated that 'We would, as a minimum, expect to see laboratory derived Kd [partition coefficient] values for the List 1 metals' (Document No. 6, Appendix F).

Within the aquifer pathway, Dr Barnes pointed out that the fraction of organic carbon, and 'on occasion the partition coefficient values used', were higher than in the overlying clays, which seemed unlikely. Moreover, Dr Barnes put forward calculations suggesting that the aquifer dilution rates applied by the Applicant were too high. He concluded that 'The models are certainly not considered to be conservative as reported' (Document No. 6, Appendix F).

Comment
The Objection Parties, notably Dr Barnes, identified issues with some of the model input parameters, such as ammonium biodegradation, indicating that the HRA is not conservative in every respect. The LandSim manual states that 'It cannot be over emphasised that the use of the biodegradation function should be used with caution, and a realistic judgement made as to whether the conditions in each of the pathways are likely to be favourable for biodegradation'. During the oral hearing, the LandSim model was re-run using a longer half-life for ammonium biodegradation in the vertical pathway (100 years compared to 5-10 years in the HRA), therefore producing more conservative predictions.

Again, the assumption within the LandSim model that leachate would be treated prior to recirculation would not apply in this case, although we note that recirculation of leachate was allowed for in order to simulate leachate heads more reasonably.

Although some of the model input parameters could have been varied to be more conservative, the adoption of two modelling approaches (LandSim and the HCM) to simulate the two "extreme" scenarios of advection and hydraulic containment, occurring over the very long time periods modelled (20,000 years), should provide generally conservative predictions. As pointed out in Section 2.3, ideally it would have been desirable to apply a single model to simulate all the stages in the projected landfill lifecycle, but such a model would have been very complex to develop and difficult to validate.

2.5 Receptors and compliance points

There was considerable discussion at the re-opened oral hearing about whether the water in the clay subsoil is groundwater, and whether the subsoil is a receptor as well as a pathway.

The Applicant quoted the definition of groundwater included in the Groundwater Directive 80/68/EEC and the Water Framework Directive 2000/60/EC: '"groundwater" means all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil. According to the Applicant 'water within the subsoils does not form a continuous "saturation zone" beneath the landfill and therefore is not considered to meet the definition of groundwater within the directive' (Document No. 1, Appendix F).

The Applicant argued that water in the clay subsoil acts as a pathway, and hence that the proposed landfill 'does not pose the potential to contravene the EU Groundwater Directive by permitting the release of List 1 Substances directly to groundwater' (Document No. 1, Appendix F). If any leakage from the landfill does occur, the Applicant argues that this would be an "indirect discharge" according to the Groundwater Directive, as it would have to percolate through the subsoil before it reaches the groundwater.

For the HRA, the Applicant chose two compliance points for the predictive modelling: a) the base of the vertical pathway prior to dilution (for List I substances) and b) groundwater within the aquifer unit 100 m down hydraulic gradient of the proposed waste footprint (for List II substances). This second compliance point within

the aquifer unit is based on a monitoring borehole located within the application boundary directly down gradient (southeast) of the landfill footprint (ER12). The Applicant indicated (in Section 5.2.5 of the HRA) that this compliance point is closer to the landfill than the nearest groundwater user (Thomas Kerrigan), which is approximately 800 m south of the proposed landfill, adding that Kerrigan's well is 'located across gradient rather than directly down gradient', so adopting the compliance point at 100 m down gradient is 'a conservative assumption which will be protective of users of groundwater within the aquifer unit'.

Dr Ashley argued that 'EU legislation (the Groundwater and Water Framework Directives) essentially include all water below ground level in the definition of groundwater' (Document No. 4, Appendix F). Therefore, he argued that the Applicant's choice of compliance point at the top of the aquifer is incorrect, and that the compliance point for List I substances should be immediately below the landfill liner. Dr Ashley added that streams in the vicinity of the landfill should also be included as a receptor, 'because contaminated groundwater could reach them without first passing by either of the other two receptors'.

Dr Barnes also referred to the definition of groundwater in the EU directives, noting that discharge of List I substances to groundwater is prohibited. He commented that 'We have seen no justification to support the fact that the 'perched' water table as it is described within the drift' does not meet the EU definition of groundwater, and therefore 'that List I substances can be legitimately discharged to this water' (Document No. 6, Appendix F). Like Dr Ashley, Dr Barnes referred to potential pathways to perimeter streams which had not been modelled. In his cross-examination of Dr Barnes, Mr Flanagan pointed out that the Agency letter of 17th October 2008 refers to impact of leachate on groundwater chemical status and the letter mentions aquifers as examples of receptors selected for assessment. He suggested that the Agency is mainly concerned about the impact of the landfill on groundwater chemical status in the aquifer beneath the landfill. Dr Barnes noted that the Agency letter refers to the potential for leachate migration to the groundwater below the proposed facility.

In response to a query from Mr Misstear relating to the use of models in similar situations elsewhere, Dr Barnes indicated that he had examples of where the compliance point was chosen very close to the base of the lining system.

Mr Boyle questioned the use of the term "perched" to describe water in the clay subsoils, and argued that, if unsaturated conditions do not exist below this "perched" water, then the compliance point would be groundwater immediately below the landfill (Document No. 2A, Appendix F). The NLAG closing statement also referred to the compliance point, stating that 'It should have been located at the water table in the clay or, in the case of below-water table conditions, directly below the engineered drainage layer' (Document No. 13, Appendix F).

Mr Cullen pointed out differences between the wording of the Agency's request in the letter of 17th October 2008, and the interpretation of this wording by the Applicant in the HRA, noting that the former referred to an evaluation of the potential for leachate migration to groundwater below the proposed facility, whereas the latter referred to migration to 'groundwater within the aquifer unit beneath the site' (Document No. 3, Appendix F). Mr Cullen quoted the definition of groundwater included in the

Environmental Protection Agency's 2006 *Draft Manual on Landfill Site Selection*: 'Water below the earth's surface, either stored in aquifers, in "perched" conditions above layers of impermeable soils, or in the unsaturated (vadose) zone above the aquifer'. Mr Cullen then went on to argue that water in the clay subsoil is groundwater and that the first compliance point should be immediately below the liner system (he specifically referred to relocating the first compliance point to 'the position of the regional water table at BSA4'). Mr Cullen also proposed that the clay subsoil is an aquifer according to the definition of aquifer contained in the Protection of Groundwater Regulations 1999 (S.I. 41 of 1999).

Mr Flanagan, in his closing statement, said that the Agency should be consistent in its decision making, and referred to Knockharley and Ballynagran landfills, where he indicated that similar hydrogeological conditions applied.

Several Objection Parties referred to the potential impacts of a landfill on local wells in the area, including Mr Boyle (Document No. 2A, Appendix F), Mr White (Document No. 10, Appendix F), Ms Larkin (Document No. 11, Appendix F) and Mr Lunney (Document No. 12, Appendix F). Mr De Rossa (MEP) referred to the impacts on the potential use of the groundwater resources in the area (Document No. 7, Appendix F). This aspect is discussed in Section 2.7 below.

Comment
The issue of whether water in the clay subsoil at the proposed landfill site should be regarded as groundwater has potential implications regarding the selection of appropriate compliance points.

There are many definitions of groundwater in the scientific literature. The majority of these refer to groundwater as water in the zone of saturation below the water table. Three examples from groundwater text books are quoted below:

- 'The term groundwater is usually reserved for the subsurface water that occurs beneath the water table in soils and geologic formations that are fully saturated' (Freeze and Cherry, *Groundwater*, 1979).
- 'The water contained in interconnected pores located below the water table in an unconfined aquifer or located in a confined aquifer' (Fetter, *Applied Hydrogeology*, 2001).
- 'All water that occurs naturally below the Earth's surface is called sub-surface water, whether it occurs in the saturated or unsaturated zones…….. Water in the saturated zone, that is to say below the water table, is called ground water or groundwater' (Price, *Introducing Groundwater*, 1996).

Thus a distinction is generally made in the scientific literature between groundwater and sub-surface water.

The definition of groundwater used in the Environment Agency of England and Wales document *Hydrogeological Risk Assessments for Landfills* (2003) is the same as that given by the EU Groundwater Directive and the Water Framework Directive i.e. 'all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil'. That document defines the saturation zone as 'The zone in which the voids of the rock or soil are filled with water at a pressure

greater than atmospheric. The water table is the top of the saturation zone in an unconfined groundwater system'. This interpretation of groundwater appears to be consistent with the text book definitions quoted above. However, as pointed out by Mr Cullen, the Environmental Protection Agency's *Draft Manual on Landfill Site Selection* does include a broader definition of groundwater, one that seems to encompass all sub-surface water. We would add that this manual is still at a draft stage.

The UK Technical Advisory Group (UKTAG) on the Water Framework Directive has considered the issue of whether water in low permeability deposits should be considered as groundwater. The group concluded: 'UKTAG does not consider pore water in low permeability deposits to be groundwater. The concept of the zone of saturation is not relevant in these deposits as it is usually not feasible (to) define a water table where lateral percolation is impeded' (UKTAG *Application of Groundwater Standards to Regulation*, Working Paper Version 11b(iii) v14 final, 2008). They note that the 'properties and the function of low permeability materials are recognised in existing European legislation, such as the Landfill Directive, where these materials can be used as geological barriers to support engineering measures for groundwater protection'. As to what constitutes a low permeability material, UKTAG state that this is difficult to define and conclude that a site-specific judgement may be needed.

The subsoil beneath the proposed landfill site mainly comprises low permeability clay and thus could fall within the UKTAG interpretation that its pore water is not groundwater. We would concur with the UKTAG opinion that pore water in low permeability deposits should not be considered groundwater. On the other hand, the subsoil beneath the proposed facility does include some more permeable sandy or gravelly lenses which are saturated and where the pore water pressure is likely to be atmospheric, thereby satisfying the criteria for being regarded as groundwater. Indeed, the Applicant's HRA mentions that 'perched groundwater is present within the clay subsoils' (Page i of the HRA). Moreover, as acknowledged by the Applicant's witnesses during questioning, the clay itself is also likely to be saturated at depth. Although Ms Burden suggested that the pore water pressure in the clay is at less than atmospheric pressure, we feel it likely that the pore water pressure in the deeper clay, especially where it directly overlies the confined (or semi-confined) bedrock and sand and gravel aquifer unit, is likely to be above atmospheric pressure. Therefore, it can be argued that water in the clay subsoil, or some of it at least, falls within the definition of groundwater contained in the European directives.

The Groundwater Directive (80/68/EEC) requires that List I substances are prevented from entering groundwater, and that the introduction of List II substances is limited so as to avoid pollution. The Directive distinguishes between direct and indirect discharges: direct discharges are 'the introduction into groundwater of substances in Lists I or II without percolation through the ground or subsoil', whereas indirect discharges are 'the introduction into groundwater of substances in Lists I or II after percolation through the ground or subsoil'.

The more recent Water Framework Directive (2000/60/EC) and Groundwater Daughter Directive (2006/118/EC), which will come fully into force prior to repeal of Council Directive 80/68/EEC in December 2013, require that hazardous substances

are prevented from entering groundwater, and that inputs of non-hazardous substances into groundwater are limited so as to ensure that such inputs do not cause deterioration [in status] or significant and sustained upward trends in the concentrations of pollutants in groundwater.

A discussion of direct and indirect inputs to groundwater, and of potential compliance points in relation to the Groundwater Daughter Directive, is contained in the European Communities 2007 document '*Common Implementation Strategy for the Water Framework Directive (2000/60/EC), Guidance Document No 17: Guidance on preventing or limiting direct and indirect inputs in the context of the Groundwater Directive 2006/118/EC*'. It makes clear that the term input in the Water Framework Directive/Groundwater Daughter Directive is 'distinctly different from discharge (used in the 80/68/EEC Directive) in that it covers all pollutants that enter groundwater, and is not restricted to deliberate disposals'. Four different "points of compliance", or POC, are identified in the document: POC 0 is located at the base of the source in the unsaturated zone; POC 1 is located at the point of input into the groundwater; POC 2 is located hydraulically down gradient from the input, in between POC 1 and a receptor; POC 3 is used to monitor the impact at the receptor. For landfills, the document states that POC 0 should be situated 'at the interface between the engineered barrier if present, and the subsoil'. The purpose of POC 0 'is to assess if a pollutant release takes place, what the pollutants are, and whether the groundwater could be affected'. For planned new activities, the document notes that hazardous substances must not be introduced into groundwater and therefore that 'all proposals involving hazardous substances should be assessed at POC 1 (at the Water Table)'. For activities involving non-hazardous substances, the document states that compliance 'should be assessed at POC 3 depending on the receptor' and that 'compliance values at POC 2 should be derived with reference to the characteristics of the aquifer, the contaminants, the processes in the soil and the groundwater, thereby ensuring compliance at POC 3'.

This European guidance document does not appear to address the issue of whether water within low permeability subsoil is groundwater. However, it does include the following example: 'water within discontinuous river terrace gravel deposits or perched water in a peat deposit above a boulder clay are both groundwater, and inputs of pollutants have to be prevented or limited to ensure that pollution of any receptors does not occur'. But the water *within* the boulder clay in that example is not mentioned.

The Environmental Protection Agency's 2006 *Draft Manual on Landfill Site Selection* does not refer explicitly to compliance points. It does make clear, however, that site selection should have regard to the *Groundwater Protection Responses for Landfills*, a copy of which is included in Appendix A of the Environmental Protection Agency site selection document. The *Responses* relate to the national Groundwater Protection Schemes published by the Department of the Environment and Local Government, Environmental Protection Agency and Geological Survey of Ireland in 1999. The permeability and thickness of the subsoil overlying an aquifer are the main basis for determining groundwater vulnerability and, in general terms, the *Responses* matrix shows landfills as being acceptable where vulnerability is low and where the aquifer is of poor or local importance. (The relationship of the proposed landfill at Nevitt to the *Groundwater Protection Scheme* criteria was discussed in detail during the 2008

oral hearing, and is considered in our July 2008 report (*Report on the Objections and Oral Hearing on the Proposed Decision of a Waste Licence Application for Fingal County Council*). That a low permeability subsoil is a potential pathway rather than a receptor seems to underpin the *Groundwater Protection Schemes* document.

The Environment Agency of England and Wales document *Hydrogeological Risk Assessments for Landfills* (2003) indicates that the receptor for modelling of potential discharges of List I substances should be the groundwater at the point of entry of the discharge. This is to ensure that no List I substances enter groundwater. The more recent UKTAG (2008) document - whilst noting that compliance points for preventing inputs of hazardous substances should be assessed in the immediate vicinity of the input - adds that 'the prevent objective is inappropriate for pore waters falling outwith the definition of groundwater' which, as noted above, would include pore waters within low permeability deposits. They do note, however, that groundwater can occur in geological strata that do not meet the definition of a groundwater body (e.g. 'a small or discontinuous volume of groundwater within a deposit overlying a recognised aquifer') and such groundwater 'requires protection under the "prevent and limit objective" and may act as a pathway for transmitting pollutants to receptors such as ecosystems or to adjacent groundwater bodies'.

For List II substances, the Environment Agency document *Hydrogeological Risk Assessments for Landfills* (2003) states that 'Regard to dilution and attenuation processes immediately around the landfill is normally acceptable for List II substances, where a change in water quality may be permitted as a result of the discharge, but pollution must be prevented'. The document goes on to indicate that the 'compliance point for List II substances will be monitoring boreholes adjacent to the landfill'. The UKTAG document describes a range of potential compliance points for limiting the input of non-hazardous substances. These potential compliance points include the receptor (such as the chemical status of the groundwater body, or an aquatic ecosystem) or an intermediate point along the geological pathway between the source and receptor.

The European Common Implementation Strategy Guidance Document No. 17, referred to above, discusses the so-called *de minimus* exemptions of the existing and new Groundwater directives. This provision in the two directives was referred to by Mr Flanagan in his cross-examination of Dr Barnes, and also in his closing statement. In Directive 2006/118/EC, Article 6(3) refers to inputs of pollutants that are 'considered by the competent authorities to be of a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater' (the current Directive 1980/68/EEC refers to discharges containing 'substances in Lists I or II in a quantity and concentration so small……'). The document states that the *de minimus* provision may apply to residual insignificant inputs from landfills: 'In the course of time a small flux of contaminants into groundwater may occur, but if the impact is assessed as being insignificant (e.g. by modelling) and validated through monitoring, then the exemption applies'.

As noted above, Mr Flanagan referred to the previous Agency decisions on waste licence applications at Knockharley, County Meath, Register No. W0146-01, and Ballynagran, County Wicklow, Register No. W0165-01, and said that the Agency should be consistent in its decision making. The Inspector's report for Knockharley

(W0146-01) refers to an overburden of low permeability glacial till, overlying a 'poor aquifer'. In relation to Ballynagran (W0165-01), the Inspector's report refers to an overburden of glacial till and lenses of sand and gravel, overlying an aquifer classified as poor (Pl) and locally important (Ll). It is our understanding, from reading the Inspectors' reports, that the overburden was not regarded as a receptor.

Turning to the issue of what constitutes an aquifer, the following are examples of definitions given in scientific publications:

- 'An aquifer is best defined as a saturated permeable geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients' (Freeze and Cherry, *Groundwater*, 1979).
- An aquifer, according to Fetter is 'Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs'(Fetter, *Applied Hydrogeology*, 2001).
- 'Layers of rock sufficiently porous to store water *and* permeable enough to allow water to flow through them in economic quantities are called aquifers' (Price, *Introducing Groundwater*, 1996).

The Protection of Groundwater Regulations 1999 (S.I. 41 of 1999), as referred to by Mr Cullen, defines aquifer as 'any stratum or combination of strata that stores or transmits groundwater', which does not appear to be consistent with the text book definitions cited above. The definition of aquifer in the Water Framework Directive is 'a subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater.' This definition does appear to be consistent with the textbook definitions. We would add that, under the Water Framework Directive, the management unit for groundwater is the 'groundwater body', which is defined as 'a distinct volume of groundwater within an aquifer or aquifers'.

2.6 Model predictions

The results of the modelling are described in Section 6 of the HRA. The results are presented for the 95th percentile outcome of the model. In written evidence at the re-opened oral hearing, the Applicant summarised the results by stating that chloride and potassium are the only contaminants which, over the modelled lifetime of 20,000 years, may record detectable concentrations 'within groundwater beneath the site'. Chloride and potassium are both List II substances. As noted in Section 2.5 above, the Applicant selected the top of the bedrock/gravel aquifer unit beneath the subsoil as the first receptor and compliance point for List I substances, and selected a point 100 m down gradient of the proposed waste footprint as the compliance point for List II substances. The HRA noted that cadmium is the only List I substance to record breakthrough at the compliance point within the modelled period, adding that the predicted 95th percentile concentration (of 1.14×10^{-5} mg/l) is 'not detectable with current laboratory methods'.

As described in Section 2.4 above, Dr Barnes (for Greenstar) criticised the assumption made in the HRA regarding biodegradation of ammonium in the subsoil, and the LandSim model was re-run by the Applicant's consultants during the re-opened oral

hearing using a different input value for ammonium biodegradation in the vertical pathway (half life of 100 years compared to 5-10 years in the HRA). The results were presented as Document No. 9, Appendix F. The 95th percentile showed a peak value of 0.11 mg/l which, according to Mr Graham, is within the interim value for groundwater of 0.15 mg/l for ammonium included in the Environmental Protection Agency's 2001 document *Towards setting guideline values for the protection of groundwater in Ireland*. Mr Herlihy indicated that the standard for drinking water is 0.3 mg/l. Dr Barnes commented that these results show a significant increase in breakthrough concentrations and, if the biodegradation in the vertical pathway had been turned off, the ammonium level would exceed the Maximum Admissible Concentration. He added that Golder Associates do not routinely allow for ammonium biodegradation in such modelling.

Other issues that were raised by Dr Barnes in relation to the model results, and which have been considered in the earlier sections of this document, include, *inter alia*: the possibility of leachate breakout through the landfill cap following termination of leachate head control; the potential for advective flow in the underdrain towards perimeter streams; the model assumption of treatment of leachate prior to recirculation; the 'unrealistically high' dilution potential generated by the model (Document No. 6, Appendix F).

In commenting on the conclusions of the Applicant's risk assessment, Dr Ashley stated that no attempt is made to assess the validity of the conclusions in the context of the 'great simplifications that have been made in the conceptual model of the site and its future development' or in the context of 'the discrepancy between the conceptual model as defined and the conceptual model that underlies both [modelling] tools' (Document No. 4, Appendix F). He also pointed out that the HRA did not cover remediation of the former landfill. As noted earlier, Dr Ashley and other Objection Parties, including Mr Cullen, highlighted the uncertainties involved with such a long modelling timeframe.

In his letter of 19th March 2009, Mr Dermot Sheridan commented on the probabilistic modelling approach adopted by the Applicant. He indicated that, according to the Groundwater Daughter Directive (2006/118/EC), there is a requirement to assess the chemical status of groundwater bodies with respect to pesticides, but that the HRA contains no information on pesticides. He suggested that pesticides could be present in the landfill (in non-hazardous waste products and produce treated with biocides).

Mr Trevor Sargent TD (in a commentary attached to his letter dated 20th March 2009), noted that the Applicant's HRA concluded that the predicted escape of low levels of cadmium and chloride from the landfill will pose no significant risk to groundwater; however, he pointed out that there is already evidence that groundwater is impacted by human activities despite the low vulnerability classification in the study area (quoting a paper co-authored by one of the Applicant's witnesses). Mr Sargent also raised the issues of seismic activity and climate change (notably the possible increase in frequency of extreme weather events) which had not been taken account of in the HRA. The Applicant responded (in Document No. 1, Appendix F) that the fault zone east of the site is inactive, and therefore that seismic activity was not considered a significant factor. Regarding climate change, the Applicant indicated that an increase

in severe weather events will mainly affect surface water drainage, which 'will be designed with such events in mind'.

Comment
The modelling generally predicts that contaminant breakthrough will not occur at the compliance points chosen, i.e. the aquifer beneath the site (for List I substances) and a point within the aquifer 100 m down gradient of the proposed waste footprint (for List II substances). However, the revised run of the LandSim model for the ammonium ion does illustrate that the model predictions are sensitive to the assumptions made (since the predicted peak concentration increased by several orders of magnitude, from 5.02×10^{-8} mg/l in the HRA, to 0.11 mg/l for the run with reduced allowance for biodegradation). Notwithstanding this sensitivity, and given the conservative nature of many (albeit not all) of the assumptions in the modelling, the results suggest that a landfill at the proposed location is unlikely to lead to pollution of the aquifer beneath the site. Based on the results available, we consider the *de minimus* provision of the Groundwater directives is applicable i.e. that discharges of substances in Lists I or II are likely to be in a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater. In our opinion, therefore, the main issue is whether the receiving groundwater is the aquifer beneath the site or the water within the subsoil below the landfill liner, as discussed under Section 2.5 above.

2.7 Importance of aquifer

Several of the Objection Parties referred to the importance of the aquifer and to the existing wells in the area, including Mr Cullen (Document No. 3, Appendix F), Mr De Rossa (Document No. 7, Appendix F), Mr White (Document No. 10, Appendix F) and Ms Larkin (Document No. 11, Appendix F). However, no substantive new evidence was provided and, in any case, the sole purpose of the re-opened oral hearing was to consider the HRA.

Detailed evidence on the implications of the landfill proposal on the existing groundwater sources and on the future groundwater development potential in the area was presented at the oral hearing in March 2008. Relevant excerpts from the commentary in our July 2008 report are included below. The July 2008 report also considered other hydrogeological issues discussed at the oral hearing in 2008, including the evidence on geology, aquifer classification and groundwater vulnerability.

2.7.1 Protection of existing groundwater sources

Considering first the implications of the proposed development with respect to the Bog of the Ring wellfield, the evidence available indicates that the groundwater divide lies north of the proposed development and that the zone of contribution of the wellfield does not extend beneath the proposed landfill footprint. The exact position of the groundwater divide is not certain (it appears to lie approximately 500 m north of the proposed landfill footprint) and additional monitoring boreholes would be required to establish this position with greater accuracy. We consider it unlikely that the position of the divide would differ between the bedrock aquifer and the overlying gravel layer: for example, the Applicant's May 2007 submission suggests the heads

are generally similar and therefore the two formations are likely to be in hydraulic continuity.

From the evidence provided by the Applicant, an increase in abstraction from the Bog of the Ring wellfield is unlikely, so any movement of the groundwater divide in the future would be more likely to occur as a response to variations in recharge. In particular, it is possible that the wellfield ZOC {zone of contribution} *and hence the divide could move further southwards if there were a prolonged drought (and existing levels of abstraction were maintained); although the exact extent of such movement is not known, it seems unlikely that the divide would move sufficiently far south so as to encompass the proposed landfill footprint within the wellfield ZOC. Nevertheless, in the event that the landfill is permitted to proceed, it is recommended that additional monitoring boreholes should be installed in the vicinity of the groundwater divide to establish its position with greater accuracy and to monitor any changes in its position over time. Groundwater quality should also be monitored in this area.*

Turning to the private (mainly horticultural) wells, it can be inferred from the groundwater level contour maps provided by the Applicant that Moore's well and Thorn's well are highly unlikely to be hydraulically down gradient of the landfill footprint. With respect to Kerrigan's well, the groundwater level map for 6th December 2006, contained in the Applicant's Article 14 submission of January 2007, includes Kerrigan's well (earlier maps did not) and, as such, the water level contours extend further south than those on previous maps. Although the contouring suggests that Kerrigan's well is not down gradient of the proposed landfill footprint, we consider that there is insufficient groundwater level data available south of the landfill footprint to be able to assess, with confidence, flow directions in the vicinity of Kerrigan's well and wells further to the south.

2.7.2 Future groundwater development potential

It is clear from the evidence available that there is little scope for increasing the abstraction significantly from the existing Bog of the Ring wellfield located north of the proposed facility site. As noted above {in Section 2.3.4 of the July 2008 report} *we consider it unlikely that the ZOC of the Bog of the Ring wellfield will extend sufficiently far south in the future so as to encompass the proposed landfill site (but groundwater level monitoring would be required to confirm this in the event that the landfill development proceeds).*

From the information available, it is likely that there are potentially exploitable groundwater resources in the vicinity of the proposed facility, notably to the east (on the fault line extending south from Decoy Bridge) and possibly also to the south. Additional investigations would be required both to quantify the resource and to assess the extent of the ZOCs of any future wellfields (such investigations would require the collection of additional field data on aquifer properties and groundwater levels to the east and south of the proposed facility, plus the construction of a numerical groundwater model to help predict the effects of potential abstractions). However, even in the absence of this additional information, we consider that the construction of a

landfill would inhibit future groundwater development to the east and also possibly to the south of the proposed site, in that, in line with the precautionary principle, a responsible water supply provider is unlikely to locate a new wellfield where there would be a large landfill site within its potential zone of contribution (ZOC)……

The Applicant has made it clear that Fingal County Council is not proposing to develop new wellfields in the area. Nevertheless, the impacts of a landfill on other potential users of groundwater should also be considered; for example, the development of new horticultural wells. Again, following the precautionary principle, we would not regard it as good practice to install new industrial or private wells where there is a large landfill site within their ZOCs, even if the risk of groundwater pollution is small. In our opinion, therefore, the landfill, if it is to proceed, could inhibit some future groundwater development in the area. There is insufficient information available to determine the extent of the aquifer area that might be 'sterilised' by a landfill development.

Chapter 3 Conclusions and Recommendations

The evidence provided at the March 2008 oral hearing was considered in our earlier report entitled *Report on the Objections and Oral Hearing on the Proposed Decision of a Waste Licence Application for Fingal County Council, Nevitt, Lusk, County Dublin,* dated July 2008. That report pointed out that the hydrogeological risk assessment in the Environmental Impact Statement was entirely qualitative, and the only quantitative component was included in an Article 14 submission in which leakage losses through a composite landfill liner were calculated, together with the estimated dilution factor should this leakage reach the groundwater in the aquifer beneath the site. Whilst we concluded that it was unlikely that a landfill at this proposed location would lead to deterioration in groundwater quality, based on the information available we could not conclude with confidence that no pollution would occur. More specifically, we could not conclude with confidence that the discharge to groundwater of List I or List II substances (as per the Groundwater Directive) would be in a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater. On that basis, we recommended that a licence should not be granted for the proposed facility. We also indicated that the effect of the proposed facility on the groundwater development potential in the area, and the presence of an existing landfill at the site, were other key issues that should be taken into account by the Board in reaching a final decision on the proposed facility.

Following consideration of the report by the Board of the Agency, the Board requested the Applicant to provide more information in respect of the environmental risk assessment (a copy of the letter from the Agency to the Applicant, dated 17th October 2008, is included in Appendix A of this report). The letter requested the Applicant to: '*Provide a probabilistic quantitative risk assessment that evaluates the potential for leachate leakage/migration to groundwater below the proposed facility. This assessment shall, in particular, evaluate the predicted concentrations of List I or II substances (as defined in the EU Groundwater Directive 80/68/EC) likely to be present in any potential leachate leakage.*'

The re-opened oral hearing held in April 2009 was for the sole purpose of considering the Hydrogeological Risk Assessment (HRA) provided by the Applicant in response to the Agency's request, and the submissions received from the Objection Parties in relation to the HRA. The HRA, the submissions on the HRA and the evidence provided at the re-opened hearing are reviewed in Chapter 2 of this report.

The Applicant undertook the HRA using two quantitative risk assessment tools, *LandSim Version 2.5* and *Contaminant Fluxes from hydraulic containment landfills spreadsheet v1.0* (referred to in this report as the Hydraulic Containment Model (HCM)). Landsim was used to predict leachate concentrations and elevations during the operational phase of the proposed landfill, and to estimate advective fluxes from the landfill when leachate heads are predicted to exceed water levels in the surrounding subsoil and the potentiometric surface in the aquifer unit. The HCM model is designed to simulate contaminant transport by diffusion, which is the transport process that would occur when there is an inward hydraulic gradient into the landfill. Ideally, it would have been desirable if a single model could have been

applied, one that could simulate advective and diffusive fluxes at different stages of the landfill's lifecycle. However, we are not aware of such a model being available as an 'off the shelf' software package. In our view, such a model would be very complex to develop and would be difficult to validate. Therefore, the use of two separate modelling tools is considered reasonable in this case.

The Objection Parties identified issues with some of the model input parameters, such as ammonium biodegradation and the assumption of leachate treatment prior to re-circulation, indicating that the HRA is not fully conservative in its assumptions. Although some of the model input parameters could have been varied to be more conservative, the adoption of two modelling approaches (LandSim and the HCM) to simulate the two "extreme" scenarios of advection and hydraulic containment, occurring over the very long time periods modelled (20,000 years), should provide generally conservative predictions.

The modelling generally predicted that contaminant breakthrough will not occur at the compliance points chosen, which were the aquifer directly beneath the proposed landfill (for List I substances) and a point within the aquifer 100 m down gradient of the proposed waste footprint (for List II substances). However, a revised run of the LandSim model during the oral hearing that included a reduced allowance for ammonium biodegradation in the vertical pathway, did illustrate that the model predictions are sensitive to the assumptions made. Notwithstanding this sensitivity, and given the conservative nature of many (albeit not all) of the assumptions in the modelling, the results suggest that a landfill at the proposed location is unlikely to lead to pollution of the aquifer beneath the site. Based on the results available, we consider the *de minimus* provision of the Groundwater directives is applicable i.e. that discharges of substances in Lists I or II are likely to be in a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater.

An issue discussed in detail at the re-opened oral hearing is whether the receiving groundwater is water in the aquifer beneath the site or water within the subsoil directly below the landfill liner (see Section 2.5 for a detailed account of this issue). We concur with the view of the UK Technical Advisory Group (UKTAG) on the Water Framework Directive (as expressed in their document: *Application of Groundwater Standards to Regulation*, Working Paper Version 11b(iii) v14 final, 2008) that pore water in low permeability deposits should not be considered as groundwater. As the UKTAG document points out: 'properties and the function of low permeability materials are recognised in existing European legislation, such as the Landfill Directive, where these materials can be used as geological barriers to support engineering measures for groundwater protection'. Moreover, the assumption that a low permeability subsoil is a potential pathway rather than a receptor seems to underpin the *Groundwater Protection Schemes* document produced by the Department of the Environment and Local Government, the Environmental Protection Agency and the Geological Survey of Ireland. This guidance document is widely used in Ireland for the screening of potentially polluting developments, including landfills.

However, as explained in Section 2.5, it can be argued that water in the clay subsoil, or some of it at least (especially the water contained within more permeable sand or gravel lenses), falls within the definition of groundwater contained in the European

directives (Groundwater Directive, Water Framework Directive and Groundwater Daughter Directive). If those arguments are accepted, then the HRA would be inadequate, as it does not include predictions for a compliance point immediately below the landfill liner.

Another issue relating to potential receptors, which is considered in Section 2.2, is whether the local streams would be at risk from landfill leachate migrating laterally through the subsoil: several Objection Parties pointed out that lateral water flow in the subsoil was not allowed for in the Applicant's conceptual model and consequently argued that the risks to streams have not been properly assessed. Based on the data available, the more permeable deposits that occur within the clayey subsoil do not appear to be continuous, which will limit their potential for allowing lateral migration of any leachate that might escape from a landfill. Therefore, we consider that the local streams are not likely to be impacted by lateral movement of leachate below the proposed landfill footprint. However, the presence of an engineered drainage blanket beneath the proposed landfill, if continuous, would increase the likelihood of lateral flows. This issue was considered in Section 3.5 of our July 2008 report, which concluded that the provision of a drainage blanket beneath the entire site was not necessary and would most likely cause engineering difficulties.

If the Board accepts our view that the water in the clay subsoil should not be considered a receptor, and that the risk of pollution to the underlying aquifer or to local streams is low then, as indicated in our July 2008 report, the effect of the proposed facility on the groundwater development potential in the area, and the presence of an existing landfill at the site, are other important issues that should be taken into account by the Board when reaching its final decision on whether or not to grant a licence to the proposed facility.

The locally important aquifer which underlies the proposed facility and the surrounding area is used as a source of public water supply from the Bog of the Ring wellfield, located to the north of the proposed facility, and by private wells, several of which are used in the horticultural industry, located mainly to the east and south of the proposed facility. It is clear from the evidence provided to the March 2008 oral hearing that there is little scope for significantly increasing the abstraction from the Bog of the Ring wellfield and we consider it unlikely that the zone of contribution ('catchment') of this wellfield will extend sufficiently far south in the future so as to encompass the proposed facility site. (Nevertheless we recommend, in our July 2008 report, that groundwater level monitoring should be carried out to confirm this, in the event that the proposed facility is granted a waste licence).

From the information available, it is likely that there are potentially exploitable groundwater resources in the vicinity of the proposed facility, notably to the east and possibly also to the south. Additional investigations would be required both to quantify the resource and to assess the extent of the zones of contribution of any future wellfields. However, even in the absence of this additional information, and notwithstanding the findings of the Applicant's HRA that the landfill will not result in deterioration of groundwater quality in the aquifer beneath the site, we consider that the construction of a landfill would inhibit future groundwater development to the east and also possibly to the south of the proposed site, in that, in line with a precautionary approach, a responsible water supply provider is unlikely to locate a new wellfield

where there would be a large landfill site within its potential zone of contribution. The Applicant has made it clear that Fingal County Council is not proposing to develop new wellfields in the area. Nevertheless, the impacts of a landfill on other potential users of groundwater should also be considered; for example, the development of new horticultural wells. Again, following a precautionary approach, we would not regard it as good practice to install new industrial or private wells where there is a large landfill site within their zones of contribution, even if the risk of groundwater pollution is low. In our opinion, therefore, the landfill, if it is developed, could inhibit some future groundwater development in the area. However, there is insufficient information available to determine the extent of the aquifer area that might be "sterilised" by the proposed facility.

The Applicant identified, as part of their waste licence application, that there is an existing landfill within the site boundary of the proposed facility. There was significant discussion at the March 2008 oral hearing in relation to the scale and nature of the waste within the existing landfill and the completeness of the risk assessment submitted by the Applicant. The PD included a requirement to remediate the existing landfill by excavation, remediation and restoration. The Applicant acknowledged that they are prepared to undertake the requirements of the PD in respect of the existing landfill. If a waste licence is granted for the proposed facility, our recommendation in relation to this existing landfill is to include additional conditions to manage and control its excavation, remediation and restoration. If a waste licence is not granted for the proposed facility, the holder of the waste is responsible for the waste within the existing landfill and shall undertake remediation of the existing landfill as necessary.

If the Board decides to grant a waste licence for the proposed facility, then specific recommendations on licence conditions are included in Section 4.2 of our July 2008 report.

Signed: _____ Date: 8th Oct 2009

Appendix A

Correspondence from the Agency

- Letter from the Agency to the Applicant, 17th October 2008
- Letter from the Agency to Third Parties, 17th October 2008
- Letter from the Agency to the Chairperson, 17th October 2008
- Letter from the Agency to Third Parties, 20th February 2009
- Letter from the Agency to all Parties, 2nd April 2009

applicant.

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Headquarters, PO Box 3000
Johnstown Castle Estate
County Wexford, Ireland

Ceanncheathrú, Bosca Poist 3000
Eastát Chaisleán Bhaile Shéáin
Contae Loch Garman, Éire

T: +353 53 916 0600
F: +353 53 916 0699
E: info@epa.ie
W: www.epa.ie

LoCall: 1890 33 55 99

Mr P J Howell
Director of Services Env. Economic & Social Dev.
Fingal County Council
P.O. Box 174
Fingal County Council
Main Street Swords, County Dublin
REF: Nevitt, Fingal Landfill

17 October 2008 W0231-01

re: Notice pursuant to Articles 24 & 25 of the Waste Management (Licensing) Regulations, 2004, in respect of an application to the Agency for a waste licence by Fingal County Council for a facility at Fingal Landfill, Nevitt, Lusk, County Dublin.

Dear Mr Howell

I am to refer to your application for a waste licence referenced above. Having regard to the requirements of Council Directive 99/31/EC on the landfill of waste and Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances, the Board considers that further information is required to ensure the proper determination of this matter. You are requested to prepare and submit further information in relation to the environmental risk assessment for the facility that was submitted in relation to the application. This information shall deal in particular with the following matters: -

Provide a probabilistic quantitative risk assessment that evaluates the potential for leachate leakage/migration to groundwater below the proposed facility. This assessment shall, in particular, evaluate the predicted concentrations of List I or II substances (as defined in the EU Groundwater Directive 80/68/EC) likely to be present in any potential leachate leakage. Predicted concentrations should be compared to relevant quality standards or background standards, for the relevant receptor, and a conclusion made as to the potential for, and significance of, any impact of the predicted leachate on groundwater chemical status. The assessment used should justify:-

- model software and any model inputs such as source term, declining source term, and retardation.
- predicted leakage losses and attenuations factors (e.g. dilution, dispersion, diffusion, sorption).
- receptors selected for assessment (such as aquifers, abstraction wells).

With a view to ensuring that there is no undue delay in the processing of this application you are requested to advise the Agency as soon as possible of the programme necessary to obtain the necessary information and likely date for submission to Agency. In any event you should inform the Agency of the likely date for submission of the information no later than one month from date of this letter.

The information should be submitted as follows, the original, one hard copy and two electronic copies.

I am also to advise that the information will be circulated to all parties and all, including yourself, will be given an opportunity to make a written submission regarding the information. All parties to the objection, including yourself, will be circulated with a copy of all submissions received. The Board of the Agency considers that the best way to deal with this matter and to give consideration to the further information and submissions is to reopen the oral hearing for the sole purpose of considering same.

Please note that the application's register number is W0231-01. It is important that all correspondence in relation to this matter is directed to Administration, Licensing Unit, Office of Climate, Licensing & Resource Use, Environmental Protection Agency, Headquarters, PO Box 3000, Johnstown Castle Estate, County Wexford quoting the register number and this letter.

Yours sincerely

Mr. Patrick Nolan
Programme Manager
Office of Climate, Licensing & Resource Use

Encl.

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Headquarters, PO Box 3000
Johnstown Castle Estate
County Wexford, Ireland

Ceanncheathrú, Bosca Poist 3000
Eastát Chaisleán Bhaile Sheáin
Contae Loch Garman, Éire

T: +353 53 916 0600
F: +353 53 916 0699
E: info@epa.ie
W: www.epa.ie

LoCall: 1890 33 55 99

Mr. Shay Lunney and others
On behalf of the Nevitt, Lusk Action Group
Little Acre Cottage
Walshestown
County Dublin

17 October 2008 Reg No. W0231-01

re: Notice pursuant to Articles 24 & 25 of the Waste Management (Licensing) Regulations, 2004, in respect of an application to the Agency for a waste licence by Fingal County Council for a facility at Fingal Landfill, Nevitt, Lusk, County Dublin.

Dear Mr. Lunney and others,

I am to refer to the above waste licence application and to advise you that the Agency has requested further information from the applicant and I attach a copy of the letter to the applicant requesting the necessary information for your information.

As pointed out in the attached letter, this information is specifically required to address and satisfy the requirements of Council Directive 99/31/EC on the landfill of waste and Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances.

This further information will be sent to you and all other third party objectors as soon as possible following receipt by the Agency. The Board of the Agency considers that the best way to deal with this matter and to give consideration to the further information and submissions is to reopen the oral hearing for the sole purpose of considering same. You will be given an opportunity to make a written submission on the information received prior to the reopening of the hearing. All submissions received prior to the hearing will be circulated to all parties including yourself and you will be given an opportunity to make a submission on them.

Please note that the application's register number is W0231-01 It is important that all correspondence in relation to this matter is directed to Administration, *Licensing Unit, Office of Climate, Licensing & Resource Use, Environmental Protection Agency, Headquarters, PO Box 3000, Johnstown Castle Estate, County Wexford* quoting the register number and this letter.

Yours sincerely,

Mr. Patrick J. Nolan
Programme Manager
Office of Climate, Licensing & Resource Use

Encl.

Chair

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Headquarters, PO Box 3000
Johnstown Castle Estate
County Wexford, Ireland
Ceannceathrú, Bosca Poist 3000
Eastát Chaisleán Bhaile Sheáin
Contae Loch Garman, Éire
T: +353 53 916 0600
F: +353 53 916 0699
E: info@epa.ie
W: www.epa.ie
Lo-Call: 1890 33 55 99

Mr. Patrick Byrne
Office of Climate, Licensing and Resource Use
Environmental Protection Agency
Regional Inspectorate
Mc Cumiskey House
Richview
Clonskeagh Road
Dublin 14.

17 October 2008

RE: Oral hearing of objections to proposed decision on waste licence application (Reg. No. W0231-01) from Fingal County Council for a facility at Fingal Landfill, Nevitt, Lusk, County Dublin.

Dear Mr. Byrne

I am writing to you in your capacity as chairperson to the oral hearing of objections in relation to the above referenced waste licence application. The Board of the Agency has asked me to inform you that they are of the view that more information should be obtained from the applicant in respect of the environmental risk assessment that was submitted in support of the application. This information should deal in particular with the following: -

Provide a probabilistic quantitative risk assessment that evaluates the potential for leachate leakage/migration to groundwater below the proposed facility. This assessment shall, in particular, evaluate the predicted concentrations of List I or II substances (as defined in the EU Groundwater Directive 80/68/EC) likely to be present in any potential leachate leakage. Predicted concentrations should be compared to relevant quality standards or background standards, for the relevant receptor, and a conclusion made as to the potential for, and significance of, any impact of the predicted leachate on groundwater chemical status. The assessment used should justify:-

- *model software and any model inputs such as source term, declining source term, and retardation.*
- *predicted leakage losses and attenuations factors (e.g. dilution, dispersion, diffusion, sorption).*
- *receptors selected for assessment (such as aquifers, abstraction wells).*

This information is specifically required to address and satisfy the requirements of Council Directive 99/31/EC on the landfill of waste and Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances.

The Agency is writing to the Applicant requesting this further information in writing and will communicate with you on its receipt and furnish a copy to you. All third party objectors will be circulated with a copy of the further information and advised that they can make a written submission on it prior to the reopening of the oral hearing. The Agency will forward a copy of all submissions received to each of the third party objectors and advise them that they can make a submission on them at the reopened oral hearing. I attach a copy of letters that have been issued to the applicant and third party objectors for your information. The Board of the Agency requests that you, following receipt of the information and submissions, which will be forwarded to you in due course, reopen the oral hearing for the sole purpose of considering the further information and submissions referred to above.

All third party objectors will be notified of the reopening of the oral hearing in due course when details of the date, time and venue have been finalised with you and your assistants.

Yours sincerely

Mr. Patrick J. Nolan
Programme Manager
Office of Climate, Licensing & Resource Use

Encl.

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Headquarters, PO Box 3000
Johnstown Castle Estate
County Wexford, Ireland

Ceanncheathrú, Bosca Poist 3000
Eastát Chaisleán Bhaile Sheáin
Contae Loch Garman, Eire

T: +353 53 916 0600
F: +353 53 916 0699
E: info@epa.ie
W: www.epa.ie

LoCall: 1890 33 55 99

Mr Shay Lunney
On behalf of the Nevitt Lusk Action Group
Nevitt Lusk Action Group
Windfield
Nevitt
Lusk
County Dublin

20 February, 2009

W0231-01

re: Notice pursuant to Articles 24 & 25 of the Waste Management (Licensing) Regulations, 2004, in respect of an application to the Agency for a waste licence by Fingal County Council for a facility at Fingal Landfill, Nevitt, Lusk, County Dublin.

Dear Mr Lunney,

I refer to the Agency's letter to you of 17 October 2008 in relation to the above.

Please find enclosed the information that was submitted to the Agency on 17 February 2009, entitled '*Fingal Landfill Project – Hydrogeological Risk Assessment*'. Any submissions you may have on this document should be returned in writing to the Agency no later than **20 March 2009.**

Please use the register number of the Waste Licence, W0231-01, in any future communication. All correspondence should be addressed to the Licensing Unit, Office of Climate, Licensing & Resource Use, Environmental Protection Agency, P.O. 3000, Johnstown Castle Estate, County Wexford.

Yours sincerely,

N. Keavey

Noeleen Keavey
Programme Officer
Office of Climate, Licensing & Resource Use

Encl.

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Headquarters, PO Box 3000
Johnstown Castle Estate
County Wexford, Ireland

Ceanncheathrú, Bosca Poist 3000
Eastát Chaisleán Bhaile Sheáin
Contae Loch Garman, Éire

T: +353 53 916 0600
F: +353 53 916 0699
E: info@epa.ie
W: www.epa.ie
LoCall: 1890 33 55 99

Ms Gemma Larkin
Walshestown
Lusk
Fingal
County Dublin

2 April, 2009 W0231-01

re: Notice pursuant to Article 24 & 25 of the Waste Management (Licensing) Regulations, 2004, in respect of an application to the Agency for a waste licence by Fingal County Council for a facility at Fingal Landfill, Nevitt, Lusk, County Dublin.

Dear Ms Larkin,

I refer to the Agency's letter to you on 20th February 2009 in relation to the above notification.

I am to advise that the Agency received a total number of ten (10) submissions in relation to the Hydrogeological Risk Assessment Report circulated to you and all other parties. The submissions are now enclosed for your consideration. If you wish to make any further submissions either on the submissions enclosed or the Hydrogeological Risk Assessment Report itself, you may do so at the forthcoming Oral Hearing. It should be noted that the Oral Hearing is being re-opened for the sole purpose of considering the Risk Assessment Report including any submissions in relation to same.

No further submissions should be made to the Agency at this stage.

Therefore, I am notifying you, in accordance with Article 30 of the Regulations, of the arrangements for the re-opening of the Oral Hearing, as follows:

Venue:	**Bracken Court Hotel (Martello Suite)** **Bridge Street** **Balbriggan** **County Dublin**
Commencing on:	**Monday 27th April 2009 at 10.30 am**

In order to ensure the smooth running of the hearing, you should note the following:

- ✓ Please ensure that you have adequate copies of any submissions (in this case c.20 copies) made for all other parties to examine and comment on during the course of the hearing.
- ✓ If you are intending to use equipment such as overhead projector or dvd player, in presenting your submission, you should notify the chairperson as soon as possible. In any event the onus is on the submitter to have this equipment at the venue for the hearing.

Yours sincerely,

N. Keavey

Noeleen Keavey
Programme Officer
Office of Climate, Licensing & Resource Use

Encl.

Appendix B

Hydrogeological Risk Assessment, February 2009

Fingal Landfill Project
(Available on the Environmental Protection Agency website, www.epa.ie)

Appendix C

Submissions on Hydrogeological Risk Assessment

(Available on the Environmental Protection Agency website, www.epa.ie)

Ms Gemma Larkin, Walshestown, Lusk, Fingal, Co Dublin;
Cpt. Thomas A Larkin, Walshestown, Lusk, Fingal, Co Dublin;
Mr Kevin T. Cullen, Sliding Rock, Blackglen Road, Sandyford, Dublin 18;
Mr Declan White, Knightstown, Lusk, Co Dublin;
Mr Patrick Boyle, on behalf of Nevitt Lusk Action Group, Hand's Lane, Rush, Co Dublin;
Mr Dermot Sheridan, Jordanstown, Lusk, Co Dublin;
Mr Shay Lunney, Little Acre Cottage, Walshestown, Lusk, Co Dublin;
Mr Trevor Sargent TD, Department of Agriculture, Fisheries and Food;
Ms Natalya Hunter Williams, Geological Survey of Ireland, Beggars Bush, Haddington Road, Dublin 4; and
Mr Morgan Burke, Greenstar Limited, Fassaroe, Bray, Co Wicklow.

Appendix D

Order of Appearance (Re-opened Oral Hearing 2009)

Date	Order of Witness/Testimony	Time	Oral Hearing Document No.	Oral Hearing Digitake Record Reference
27/04/09	Mr Herlihy (Applicant)	11:30	1	E, F, G, H, J, K, L, M, N, O, P, R & S
	Mr Cullen	14:35	3	S, T, U, V, W, X, AA,
	Mr Boyle (NLAG)	16:05	2A, 2B & 2C	AA, BB, CC, DD, EE
28/04/09				
	Mr Cullen	9:00		A, B, C
	Dr Ashley (NLAG)	9:30	4	D, E & F
	Mr Shortt (NLAG)	9:50	5	F
	Mr Herlihy (Applicant)	10:10		H, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, AA, BB, CC, DD, EE, FF, GG
	Dr Ashley (NLAG)	15:10		GG, HH, JJ, & KK
	Dr Barnes (Greenstar)	16:20	6	LL, MM, NN, OO, PP, QQ,
	Mr Graham (Applicant)	18:10	9	WW, XX, YY, ZZ, AAA & BBB
29/04/09				
	Dr Barnes (Greenstar)	9:00		A, B, C, D, E, F, G, H, J, K, L, M, & N
	Mr White (NLAG)	11:30		P, Q, & R
	Ms Larkin (NLAG)	11:50		R, S & T
	Mr White (read in Mr De Rossa's statement)	12:15		T, U
	Mr Lunney (NLAG)	12:30		V & W
	Closing Statements			
	Mr Mulcahy (Greenstar Ltd)			Y, Z, & AA
	Mr Boyle (NLAG)			AA
	Mr Flanagan (Applicant)			BB, CC, DD, EE, FF & GG

Appendix E

Summary Record of the Re-opened Oral Hearing

Table of Contents

Introduction

The following is a summary record of the proceedings of the re-opened oral hearing into Reg No. W0231-01, Fingal County Council waste licence application. The re-opened oral hearing had the sole purpose of providing for consideration of the Hydrogeological Risk Assessment (HRA) prepared by the Applicant based on a request from the EPA, letter dated 17 October 2008. This summary does not purport to be a complete transcript of all that was said and the reader is referred to the Digitake recording for the complete record. The Chair and Assistant Chairs have listened to the recording and used it as an aide memoir during the preparation of this record and the report on the re-opened oral hearing.

Appendix D Order of Appearance is provided to facilitate locating the presentations within the recording.

The re-opened oral hearing commenced at 10:30am on Monday the 27th April 2009.

Procedural Issues

The Chair introduced himself and the Assistant Chairs. The Chair then outlined the purpose of the re-opened oral hearing and outlined the recording being undertaken by Digitake.

The Chair then sought confirmation of which Parties, who had made submissions on the Applicant's HRA, were present. The Chair provided the opportunity for other parties who had not made a submission on the HRA to identify themselves if they wished to make an oral presentation to the re-opened oral hearing and a running order of appearance was outlined subject to agreed changes during the course of the re-opened oral hearing.

The following individuals, who did make a written submission on the Applicant's HRA, did not provide a presentations/submissions during the re-opened oral hearing:

- Capt. Thomas A Larkin, Walshestown, Lusk, Fingal, Co Dublin;
- Mr Dermot Sheridan, Jordanstown, Lusk, Co Dublin;
- Mr Trevor Sargent TD, Department of Agriculture, Fisheries and Food;
- Ms Natalya Hunter Williams, Geological Survey of Ireland, Beggars Bush, Haddington Road, Dublin 4.

The Chair identified that the written submissions received by the Agency in relation to the HRA, including those received from parties who did not provide a presentation/submission to the re-opened oral hearing, would be fully considered.

Mr De Rossa submitted a written statement to the re-opened oral hearing, as he was not available to make the presentation himself. Mr White read the statement into the record.

Witness No. 1 Mr Herlihy

Mr Herlihy, for the Applicant, read into the record a joint witness statement (Document No. 1 Appendix F) on behalf of himself, Ms Louise Burden, Mr Richard Graham, Mr Wyatt Orsmond and Mr Larry O'Toole (All of RPS Consulting).

Mr Herlihy provided a summary of the experience and qualifications of each of the joint witnesses. Mr. Herlihy then provided further details under the following headings:

- Overview of Risk Assessment;
- Conceptual Model;
- Geology;
- Hydrogeology; and
- 3rd Party Submissions.

In relation to the 3rd Party Submissions Mr Herlihy addressed the following issues: Hydrogeological Conceptual Model, Definition of Groundwater, Drainage Blanket, Interaction between Groundwater and Surface Water, Compliance Points used in the HRA, Selection of Risk Assessment Tools, Seismic Activity and Climate Change, Risks to Horticultural Industry and Resource Potential of Aquifer. Attached to the witness statement are the letter from the EPA to the Applicant, dated the 17th October 2008, and maps of Bedrock Contour Levels with Water Levels in Clay, dated October 2005 and March 2006.

Cross-examination of Mr Herlihy and other contributors to the Applicant Witness Statement

Mr Flanagan, for the Applicant, asked if the information followed on from the information in the EIS, supporting documentation and baseline data.

Mr Herlihy confirmed that it did follow on from the EIS.

Mr Boyle, NLAG, in reference to the two maps provided in the witness statement asked if a contour map of water levels in the clay could be provided. Mr Boyle questioned how the Applicant could assert that there is no continuity when there are no boreholes between the boreholes presented, in addition he identified that the water level in the clay is shown in the Applicant's section drawing. Mr Boyle asked for clarification in relation to whether the Applicant was claiming the landfill was completely underlain by perched groundwater or not completely underlain by perched groundwater. Mr Boyle asked if it was the case that for all boreholes into shallow clay you identified water, and there were no dry boreholes.

Mr Herlihy stated that they did not contour the water levels in the clay because they do not believe the water levels form a continuous aquifer unit. The water levels represent spot levels in stand pipes. Ms Burden stated that the line shown in Figure 6 of the risk assessment report is an indicative line to illustrate the difference in water levels within clay in relation to other aspects of the site, the line is not intended to indicate a continuous perched water table. Ms Burden stated that the perched water is

localised and stated that there were 15 no. boreholes into the clay within the landfill footprint, of which 3 recorded distinct water strikes.

Mr Boyle asked if the drainage blanket would supply water to areas where there was no existing groundwater. Mr Boyle asked if the drainage would not be continuous. Mr Boyle asked if a drainage blanket was required everywhere water was encountered in boreholes. Mr Boyle quoted the following from the Environment Agency Hydrogeological Risk Assessment for Landfills '*need to match effort and resources in evaluating potential risks to the magnitude of environmental damage that could result from each hazard*' and therefore highlighted that the Applicant should match risk to damage and asked where is there an evaluation of the risk of an accident and evaluation of risk on the horticultural sector or anyone else. Mr Boyle stated that you cannot screen out risk and you must ameliorate the plan to take account of the risks. Mr Boyle claimed that there was no consideration of the dire consequences on groundwater and that the Applicant has not said what the plan is for such an eventuality. Mr Boyle highlighted the horticultural sector's dependence on groundwater and surface water. He asked where in the proposal are there design considerations to ensure an impact on groundwater and surface water could not occur.

Mr Herlihy stated that a drainage blanket would only be installed where necessary and water would be pumped out, as necessary.

Mr O'Toole stated that the Applicant only proposed to install a drainage blanket where necessary. He acknowledged that the proposed determination, issued by the Agency, required a drainage blanket under the entire site but identified that the Applicant objected to this. Mr O'Toole stated that many sites require drainage blankets; however, this site does not have significant volumes of water and therefore a drainage blanket is only necessary in some areas.

Ms Burden stated that the risk assessment process takes account of the magnitude of consequences and likelihood of consequences. The risk screening process was completed by use of the Geological Survey of Ireland (GSI) Risk Matrix which takes account of risk and probability. The screening process gave an 'R1' classification (lowest risk). Ms Burden stated that the assessment undertaken is a worst case scenario and based on seeing if contaminant levels would exceed standards at the compliance points. The concentrations do not exceed the standards, therefore there is no need for further consideration of consequences. The landfill is protected by engineering and low permeability clay.

Mr Boyle identified that the EPA letter to the Applicant refers to '*receptors selected for assessment (such as aquifers, abstraction wells)*' and he identified that the nearest abstraction well is Thorn's. He claimed that the Applicant did not assess the abstraction wells. Mr Boyle asked if the Applicant had considered among other things draw down from Mr Kerrigan's well, and claimed that the well was below the level of groundwater under the proposed landfill. Mr Boyle identified that Mr Kerrigan's well is significant and draw down may be significant and that the zone of contribution may extend under the landfill; however, data are not available. Mr Boyle asked what the impact would be of running the well continuously.

Ms Burden stated that the risk assessment looked at impact on the primary receptor, groundwater, and this includes secondary receptors including wells.

Mr Herlihy stated that Mr Kerrigan's well has been shown to be cross gradient and that the extent of abstraction was c.6 m^3/day for vegetable washing. Mr Herlihy stated that the risk assessment considered the impacts to the overall groundwater body and that has concluded that they are imperceptible and as such any potential impacts to other receptors located downgradient are also going to be imperceptible.

Mr Boyle stated that there are no boreholes between ER10 and Mr Kerrigan's well, therefore the contours are assumed. Mr Boyle identified that the water level in ER10 normally is recorded as c.38 mOD, however in June and September 2005 the water level was c. 32 mOD (EIS Volume 5 H & I): Mr Boyle asked whether irrigation from Mr Kerrigan's well could have caused the decrease.

Mr Herlihy confirmed that the water level in ER10 was depressed in June and September 2005 compared with July and August.

Mr Boyle identified that it is stated in the HRA that there is '*low permeability sandy gravely clay*' which indicates that this is present everywhere yet there are gravel lenses. Mr Boyle asked what would happen when no rainfall is entering clay beneath the landfill, will it dry out, what is the percentage of moisture in the clay and would it crack.

Ms Burden stated that the majority of clay is classified as 'sandy gravely clay' but also layers of silt and lens of gravel.

Mr Graham stated that recharge to the site will be reduced when landfill is constructed; however, drying of the clay is not expected due to low permeability.

Mr Orsmond identified that in Section 4.3.3 of the EIS there is a graph of moisture contents ranging from 10-20%, and approximately 15% at a depth of 10 m. As the clay beneath the liner is protected by the liner it will not dry out and it is expected to remain at c.15% moisture.

Mr Boyle identified that the geophysics, presented by the Applicant in their EIS, indicates a possible fault line continuing from north to south and in the general direction of Mr Kerrigan's well. Mr Boyle asked why the Applicant didn't investigate this possible fault line or gravels. Mr Boyle referred the Applicant to the groundwater contour maps which have a drawing together of the contour lines in the southern part of the site on the western perimeter and asked could drawing together of the contour lines be due to the possible fault zone under the site. Mr Boyle, in relation to the engineering control measures, identified that the drainage layer may be necessary to avoid base heave. He asked if such an event would result in lifting of the liner or clays. Mr Boyle asked if 10 m of clay is removed, would the Applicant be likely to hit springs.

Mr Herlihy stated that they consider that they have investigated the site extensively and more than adequately. Mr Herlihy stated that the pump tests indicate moderate

transmissivity across the site increasing towards the mapped fault zone to the east of the landfill.

Mr Flanagan stated that he considered that the questions were issues addressed at the previous oral hearing and that the purpose of this re-opened oral hearing was for a sole purpose. Mr Herlihy stated that the risk assessment considered all variability across the site.

Mr O'Toole stated that base heave or uplift is possible where significant quantities of water accumulate below the liner system and can uplift the liner due to inadequate ballast. A drainage layer allows pumping of water temporarily. Mr Herlihy stated that there are greater than 10 m of low permeability clay below the base of the landfill.

Mr Shortt, NLAG, identified that he had a fundamental problem with the process and with the interjection by Mr Flanagan in relation to Mr Boyle's questions. Since the last oral hearing there has been an An Bord Pleanala oral hearing, and he stated that it is clear that the Applicant has not provided accurate information on geology, hydrogeology or the true water supply. Mr. Shortt submitted that there were no current accurate maps provided to the re-opened oral hearing, therefore he stated that Mr Boyle was correct to challenge RPS (consultants for the Applicant). There are many flaws in the data and no true data. Mr Boyle and others have proven categorically that data are incorrect. Mr Shortt claimed that to make sound decisions you need good data, therefore continuation of the re-opened oral hearing is deplorable as we don't have good data. True risk assessment should look at all catastrophes. The use of a spreadsheet is not a validated method. Mr Shortt asked for someone with leadership to halt the process.

Mr Flanagan stated that the Applicant and others were present to discuss the report requested by the EPA. It is for the EPA to consider the report and points made. Mr Flanagan noted that due process should be followed and that the statement by Mr Shortt was inopportune, as it was supposed to be cross-examination of witnesses.

The Chair stated that all parties would have an opportunity to make statements to the hearing and witness statements would be subject to cross-examination.

Hearing adjourned from 1.17pm until 2.20pm

NLAG sought permission to have the Applicant's witnesses cross examined by Dr Ashley, their expert witness, on Tuesday morning (28th April) as he would only be arriving at the re-opened oral hearing that morning.

Ms Heavey, for Greenstar Ltd., also requested permission to undertake their cross-examination of the Applicant's witnesses on Tuesday morning, through their legal council, who was not present on Monday 27th.

The Chair agreed to defer the cross-examination of the Applicant witnesses. Therefore, an opportunity to cross examine the Applicant's witnesses was provided to Mr Cullen and other members of NLAG. Mr Cullen indicated that he had no questions.

Ms Larkin, NLAG, asked for clarification in relation to who was to complete the risk assessment and who then would adjudicate on it. Ms Larkin also questioned whether the EPA and An Bord Pleanala should jointly look at the risk.

The Chair stated that the risk assessment was to be completed by the Applicant, as per the letter from the EPA to the Applicant dated the 17 October 2008. The Chair confirmed that the Chair and Assistant Chairs would prepare a report on the re-opened oral hearing, including recommendations and submit it to the Board of the Agency for them to make a final decision. The Chair clarified the role of the Chair and Assistant Chairs in relation to the waste licence application process.

Mr White, NLAG, asked if Dr Graham was aware of the definition of groundwater in the EPA Manual 2006, Mr Cullen confirmed that the manual was the {Draft for Consultation} Site Selection Manual published by the EPA. Mr White asked Ms Burden how many monitoring wells, identified in the witness statement, are in clay and how many of the water levels in clay represent the regional water table and therefore what is the regional water table level?

Mr Herlihy stated that they did not have a copy of the EPA manual in front of them but they took it to be similar to the definition in the Water Framework Directive (WFD) and Groundwater Directive.

Ms Burden stated that those boreholes that were marked in pink on the maps attached to the Applicant witness statement (Document No.1, Appendix F), submitted at the re-opened oral hearing, and have a number associated with them are in clay. Ms Burden identified 27 wells in clay. Ms Burden stated that the water levels in clay do not represent the regional watertable. Ms Burden stated that the potentiometric surface represents the water level in the aquifer beneath the site.

Further cross-examination of the Applicant's witnesses was adjourned until Tuesday morning (28th April).

Witness No. 2 Mr Cullen

Mr Cullen read into the record his witness statement (Document No. 3 Appendix F). Mr Cullen identified that his objection to the proposed landfill is based upon his assertion that the landfill footprint overlies an important groundwater resource contained in the underlying extensive sand and gravel deposits and limestone bedrock. Mr Cullen stated that it appears to him that the location of the landfill is directly contrary to the principle of sustainability. Mr Cullen stated that he believes that the Applicant's documentation that accompanied the waste licence application and EIS failed to adequately describe the extent of the underlying resource. Mr Cullen's statement provided detailed information under the following headings:

- Present Request for Further Information;
- Modelling Timeframe;
- Appreciating a Twenty Thousand Year Timeframe;
- Climatic Change to the 22nd Millennium;
- Population of Ireland in 20,000 Years;
- Agency's Request;
- Council Directive 80/68/EEC of 17th December 1979;
- Perched Water Table;
- Perched Water Table Above the Regional Water Table;
- Unsaturated Zone between the Perched Water Table and the Regional Water Table;
- Perched Water Table being Hydraulically Disconnected from the Regional Water Table;
- Relative Position of Landfill Base in relation to the Regional Water Table;
- EPA Definition of Groundwater;
- Compliance with the Groundwater Directive and Protection of Groundwater Regulations (SI 41 of 1999);
- Risk to Local Drainage Network;
- Drainage Layer;
- Extension of Modelling Timeframe to 100,000 years; and
- Conclusions.

Mr Cullen's conclusions are that the Applicant has plainly refused to address the Agency's October 17th 2008 request. Mr Cullen stated that the Agency could now refuse the waste licence application on grounds of sustainability. Alternatively the Agency must request the Applicant to make another submission that directly addresses the core issue of the Agency's request of October 17th 2008. Any further request by the Agency must also direct the Applicant to:

- correct the conceptual model regarding the perched water table in the overburden;
- relocate the 1st compliance point to the position of the regional water table as identified in BSA4;
- relocate the 2nd compliance point some distance downgradient of BSA4;

- consider potential impacts of leachate migration on the drainage network down gradient of BSA4;
- furnish the numerical model and revised geological map which were also sought by the Agency as far back as late 2006, but which were never delivered by the Applicant;
- present a water table map with summer and winter levels using the 25 monitoring wells located in the clay overburden;
- present a water table and piezometric map indicating the impact of the drainage layer on the summer water table levels away from the footprint, and in both the overburden and underlying gravel bedrock aquifers; and
- report on the impact of the drainage layer on flows within the local drainage network and on groundwater levels at the nearby Bog of the Ring abstraction.

The Chair proposed an adjournment for coffee of 20 minutes after which cross-examination of Mr Cullen would take place. Mr Flanagan was the only party who indicated that they had questions for cross-examination of Mr Cullen.

Mr Flanagan identified that Mr Cullen's submission on the HRA was 2 pages whereas his submission to the re-opened oral hearing was 18 pages and some of the issues raised go beyond Mr Cullen's submission of March 2009. Therefore, Mr Flanagan asked for some time to prepare for cross-examination. Mr Flanagan also noted that he would seek to rebut some of Mr Cullen's statements.

The Chair proposed to hear the statement of evidence of Mr Boyle, NLAG, prior to returning to cross-examination of Mr Cullen.

Ms Larkin, NLAG, stated that she was concerned by Mr Flanagan's statement that he may address some of Mr. Cullen's evidence by means of a rebuttal rather than cross-examination and that this would not be fair process.

The Chair identified that all parties would have an opportunity to cross examine witnesses and make closing statements. The Chair noted that there would inevitably be different points of view between the Applicant and other parties and it would be for the Chair and Assistant Chairs to draw-out a conclusion and recommendation from the information presented. The Chair noted that as much time as was possible would be afforded to all parties for cross-examination.

Mr Flanagan stated that he considered that no amount of cross-examination would address all the points raised by Mr Cullen, but that he would be guided by the Chair in relation to cross-examination.

The Chair, in response to a question raised by Mr Cullen in his evidence, stated that there was no correspondence between the EPA and the Applicant in relation to clarification of the Agency request dated the 17th October 2008. The Chair identified that there was correspondence between the Applicant and Agency in relation to the submission dates.

Mr Flanagan also noted for Mr Cullen that there was no further request for information following submission of the HRA.

Witness No. 3 Mr Boyle

Mr Boyle, NLAG, read into the record his witness statement (Document No. 2A, 2B & 2C Appendix F). Mr Boyle identified that his submission is a comment on the HRA and the comments focus principally on the lateral movement of groundwater in the saturated clay zone. Mr Boyle's statement is presented under the following headings:

- Perched Groundwater;
- Saturated Zone;
- Recharge of Surface Streams;
- Chemical Analysis of Stream Water;
- Recharge of Down Gradient Bedrock Aquifer; and
- Local Wells.

Mr Boyle included a number of maps and data with his statement, including documents entitled as Lateral Flow in Saturated Clay, Map of Surface Elevation, Depth to Bedrock Contour Map, Extent of Gravel Deposits Underlying Low Permeability Superficial Deposits, Geotechnical Core Log Record (BSC4), Groundwater Contours Bedrock 24th June 2005, Groundwater Contours Bedrock 18th August 2005, and Groundwater Contour Maps (indicating location of Thorn's, Moore's and Kerrigan's Wells). In addition, Mr Boyle presented a summary table of boreholes installed as part of the investigations and photographs of a well adjacent to a stream within the landfill site boundary.

Mr Boyle stated in conclusion that the HRA failed to recognise and assess the risk of polluting streams, the risk of down gradient pollution of the bedrock aquifer, and the threat to local horticultural wells.

Cross-examination of Mr Boyle

Mr Flanagan indicated that he did not have any formal questions for Mr Boyle.

Mr Herlihy asked if Mr Boyle had been able to establish the depth of the well identified in his evidence.

Mr Boyle stated that access was limited and that Mr White was unable to measure the depth.

There were no further questions of cross-examination for Mr Boyle.

The Chair asked if Mr Flanagan was in a position to cross examine Mr Cullen.

Mr Flanagan stated that he had identified 17 points raised by Mr Cullen and that he hoped to discuss these points with his technical expert prior to Tuesday morning and therefore possibly limit the number of questions to be posed to Mr Cullen. Mr

Flanagan identified that he could pose a number of non technical points but would rather address all his cross-examination together.

The Chair noted that cross-examination of the Applicant witnesses was being deferred until Tuesday and that it may be more appropriate to do likewise for cross-examination of Mr Cullen. Mr. Cullen did not raise any objection to this proposed course of action.

The Chair outlined that the proposed programme for Tuesday, on the basis that Dr Ashley and Mr Graham would only be available for Tuesday, was for Dr Ashley to present his witness statement at 9:00, followed by resumption of cross-examination of the Applicant's witnesses, followed by cross-examination of Dr Ashley, followed by cross-examination of Mr Cullen. The Chair also requested that Greenstar and other parties due to make presentations should have them circulated as soon as possible.

Mr Flanagan reiterated that technical briefs of evidence should be circulated as soon as possible. Mr Flanagan also noted that he hoped not to have to renew his request for an adjournment, due to unavailability of his witnesses.

Ms Heavey, Greenstar, agreed to provide their brief of evidence on Tuesday morning; however she noted that her expert witnesses were not present.

Hearing adjourned from 4.52pm until 9am Tuesday morning 28th April

Tuesday 28th April 2009 – Hearing opened at 9:00am

Mr Cullen identified that he wished to make a statement prior to the continuation of the re-opened oral hearing.

Mr Cullen identified that the Agency had invited him to make further submissions to the re-opened oral hearing, and he noted that yesterday the Chair outlined how proceedings were to proceed. The Applicant's witnesses were to make their submission followed by cross-examination and then other parties were to make their submissions and then be available for cross-examination. Mr. Cullen stated that the Chair indicated that parties who had difficulty attending the hearing would be accommodated and that cross-examination of witnesses could be made at a later date in the hearing. The Applicant identified no difficulty with the proposal.

Mr. Cullen identified that the Applicant proceeded to make a detailed submission. On completion of evidence Mr Boyle was asked to cross examine the Applicant: despite Mr Boyle's lack of technical knowledge, he did not benefit from a break in the hearing. Mr Cullen noted that after lunch the Chair invited him to make his submission and he was available for cross-examination thereafter. After completion of Mr Cullen's evidence the Chair adjourned the hearing for a coffee break and for the Applicant to consider Mr Cullen's submission. On recommencing after coffee, rather than proceed with cross-examination the Chair instead invited Mr Boyle to make his submission and thereafter proceeded to close the hearing earlier than previously indicated.

Mr Cullen added that in conversation with the Chair and the Applicant the record will show the reason for closing the hearing early was to provide sufficient time for the Applicant to consider Mr Cullen's submission and prepare for cross-examination at a distant time in the hearing. Mr Cullen claimed the record would also show that the Chair did not defer to Mr Cullen with regard to this arrangement. Mr Cullen stated that it appeared to him that the re-opened oral hearing was being conducted in a manner which provided the Applicant with a distinct advantage over those without the technical resources.

Mr Cullen stated that he now formally retires from the hearing in protest over the manner the hearing is been conducted.

The Chair acknowledged that the process as outlined was that after submissions were made there would be cross-examination; however, the Chair noted that on the first day parties would have a disadvantage as papers would not be circulated prior to evidence being heard. The Chair noted that it had been stated that proceedings would be as flexible as possible for all parties, in particular allowing cross-examination of the Applicant's witnesses by Dr Ashley for NLAG and legal council for Greenstar on Tuesday morning. No party was forced to cross examine the Applicant immediately. The Chair expressed his regret at Mr Cullen leaving the hearing. The Chair further expressed that his preference was for Mr Cullen to remain at the hearing for cross-examination.

Mr Cullen stated that he had no wish to embarrass the Chair or colleagues but it was just the manner of how it evolved. Mr Cullen stated that the Applicant had indicated

that they may not have technical questions but would deal with points by rebuttal; therefore, withdrawal from the hearing would not disenfranchise the Applicant. Mr Cullen outlined that on this side of the house {objection parties} there is limited technical expertise whereas on the far side {Applicant} there is ample expertise and it is just unfortunate that he gave his evidence on Monday afternoon and, with all considered reasonableness, that Mr Flanagan could have completed cross-examination on Monday afternoon. Mr Cullen stated that he considered it to be unbalanced.

The Chair noted that when arrangements for the carry over of cross-examination by Dr Ashley and Greenstar were provided for, Mr Cullen didn't ask for his cross-examination of the Applicant to be deferred. The Chair added that any such request would have been considered.

Mr Cullen considered that carry over of cross-examination was provided for where there were difficulties. However, in his mind there was no difficulty for the Applicant to initiate cross-examination, therefore he considered it unbalanced. The programme proposed for today (Tuesday) was for cross-examination of the Applicant's witnesses and cross-examination of Mr Cullen's evidence would be later on Tuesday or Wednesday.

The Chair outlined that he would be willing to accommodate cross-examination of Mr Cullen immediately (Tuesday morning), if that was satisfactory for Mr Cullen.

Mr Cullen stated that his mind was made up earlier that morning (Tuesday) and he had no intention of disrupting the hearing.

The Chair noted that the process was to be as flexible as possible, and that there seemed to be reasonable agreement to changes proposed, and he therefore regretted if Mr Cullen believed that the Chair did him any injustice by not insisting on cross-examination yesterday afternoon (Monday).

Mr Cullen asked that he put on record that the Chair carried out the hearing without any bias but unfortunately it is a set of circumstances that emerged and he {Mr Cullen} felt that carrying on would copper-fasten that to his disadvantage. Mr Cullen noted that the hearing was carried out in a professional and efficient manner.

The Chair stated again that he would rather Mr Cullen remain for cross-examination and that it was the Chair's intention to facilitate all parties and to be as fair as possible.

Mr Cullen noted that while the Chair was trying to be fair it worked out to his disadvantage - he had made himself available yesterday afternoon but the Applicant chose not to cross examine.

Mr Flanagan stated that by inference from Mr Cullen, that this is the Applicant's fault. He noted that yesterday, (Monday,) he had stated that he had some questions that could be asked. It was not engineered on behalf of the Applicant. Mr Flanagan indicated that he regretted that Mr Cullen felt as outlined.

Mr Cullen finally said that in no way was the situation engineered, it just happened and placed him at a disadvantage and that can't be changed.

Mr Cullen departed from the re-opened oral hearing.

Witness No. 4 Dr Ashley

Dr Ashley, for NLAG, read into the record his witness statement (Document No. 4 Appendix F). In addition to Dr Ashley's witness statement he provided a copy of a letter he had sent to Mr Shortt, dated the 19th November 2008 (Document No. 4A Appendix F). Dr Ashley referred to this letter within his witness statement. Dr Ashley identified that he had provided evidence to An Bord Pleanala oral hearings and to the EPA oral hearing, and that this witness statement is a review of the Fingal Landfill Project HRA. Dr Ashley's witness statement provided additional information under the following headings:

- Conceptual Model;
- LandSim Modelling;
- Contaminant Fluxes Spreadsheet;
- Conclusions of the Risk Assessment;
- Former Landfill;
- Appraisal of Overall Approach and Methodology; and
- Conclusions.

Dr Ashley's conclusions were as follows:

- The conceptual model employed in the Applicant HRA is incorrect in a number of aspects, and is excessively simplistic. No attempt has been made to agree a conceptual model with the other experts considering this case;
- A major, and critical, defect is the failure of the HRA is to recognise the pathway whereby shallow groundwater could be contaminated by leachate leaking from the landfill and could then enter local streams, bypassing the compliance points that have been adopted;
- The HRA uses two software tools which are designed for mutually exclusive scenarios. Both tools are quite incapable of simulating the complex geography, hydrogeology and phased landfill development plan;
- The HRA has incorrectly used LandSim as a tool, it is not suitable for scenarios where the landfill base is below the water table. Insufficient information is given to justify the choice of parameters chosen for its application;
- The contaminant fluxes spreadsheet is an appropriate tool for the proposed scenario, but it is designed for scoping studies only, not for the 'detailed quantitative probabilistic risk assessment' proposed by the Applicant. It also effectively simulates only one process – diffusion. The Applicant has modified the spreadsheet by adding its own probabilistic tool (no validation of this modification has been provided) but this only partly addresses the concern;

- The time factor for the risk assessment is problematic; long term results are given for 20,000 years, which assumes that the site will be managed, if needed, to maintain low leachate levels for this period, which is unrealistic. Most accidental damage, leachate control problems and other high risk events are likely to occur during the construction phase. The risk assessment does not appear to model the construction programme in this period, other than providing results after 30 years of operation;
- No attempt has been made to assess the risks from the existing old landfill site, either on its own, or in combination with the new one;
- No attempt is made to comment on or assess the validity of the HRA conclusions in the context of how well the conceptual model employed matches the conceptual model that underlies the risk assessment tools; and
- The HRA is apparently incompatible with the EPA's own requirements, and is actually not in accordance with the UK Environment Agency's guidance that the HRA purports to follow. It is clearly not compliant with EU legislation with respect to definitions of groundwater and therefore of compliance points, and may not be compliant with EU environmental assessment legislation concerning the old landfill and cumulative effects.

Dr Ashley concluded that in his opinion the HRA is quite inadequate as a basis for understanding the real contamination risks that could arise from the proposed landfill.

Witness No. 5 Mr Shortt

Mr Shortt read into the record his witness statement (Document No. 5 Appendix F). Mr Shortt identified that he is a resident facing eviction of his family and neighbours and he wished to express their concern at the process they are being subjected to and the inadequacy of the data presented on which to make a sound judgement. Mr Shortt stated that had it not been for the hard work of the NLAG, the proposed project would have proceeded unchallenged. Mr. Shortt said that decisions should be based on sound data appropriate to carry out a comprehensive cumulative assessment of this project. Mr Shortt claimed that this process has been allowed to fumble on without clear leadership from the reviewing authorities, which he outlined in the following three points:

- November 16 2006: The EPA requested, under Article 14(2)(b)(ii) of the Waste Management (Licensing) Regulations, the Applicant to carry out a Modflow numerical modelling study. In the opinion of the NLAG, the request was not met and the continued absence of this information is fundamentally unacceptable and contradictory;
- October 17 2008: the EPA asked the Applicant to provide a probabilistic quantitative risk assessment that evaluates the potential for leachate leakage/mitigation to groundwater below the proposed facility. The report submitted by the Applicant substantially fails to answer the question. The Applicant was previously advised that LandSim was not appropriate for the conditions; and
- We don't know the scale of the water resource, we don't know the scale or contents of the illegal dump, there is no definite clear picture of the underlying geology or hydrogeology and there is no comprehensive risk assessment of the

cumulative risk to the underlying groundwater. Mr Shortt stated that it is obvious that the Applicant is trying to gain permission without providing the necessary body of knowledge. Mr. Shortt called on the EPA to stand up to their moral responsibility and immediately refuse this flawed application.

Cross-examination of Mr Herlihy and other contributors to the Applicant's Witness Statement

Dr Ashley indicated that he had no questions for the Applicant.

Mr Mulcahy (Greenstar), asked who had carried out the modelling, and who had decided on the model tools to use. Mr Mulcahy asked under what circumstances of landfill is LandSim an appropriate model, what conditions of landfill would have to operate for LandSim to be valid, and whether LandSim is appropriate for hydraulically contained or non-contained landfills. Where are the different conditions that apply over the lifetime of the proposed site set out in the HRA? When do the scenarios in Figure 5 of the HRA apply? Were both models used for the entire lifetime of the proposed site and therefore are both models used at times when they are inappropriate?

Mr Graham responded that he carried out the modelling; however, the team assembled by the Applicant decided upon the tools. Mr Graham acknowledged that there were two models used, LandSim and the Environment Agency (EA) model. LandSim is a tool for modelling lifetime performance of waste in an engineered cell and the effect of leachate and its potential impact on the environment. For LandSim to operate, there needs to be a clear conceptual understanding of the site and engineering practices and of the properties of the waste. The LandSim model is used to predict advective fluxes and the Applicant used the EA model to model fluxes under hydraulic containment.

Mr Herlihy added that Section 5.1 of the HRA report explains why they used two models.

Mr Graham identified that it is correct to say that LandSim is for situations where the landfill is not hydraulically contained and the EA model is used where it is hydraulically contained. Mr Graham identified that Figure 5 of the HRA describes the different scenarios; the models represent the worst case scenario based on both processes operating separately over the entire lifecycle of the site.

Mr Herlihy identified that the Applicant had to use two mutually exclusive models for two extremes (diffusion and advection).

Mr Mulcahy continued by asking where is it shown that the Applicant modelled the worst case scenario and he asked had the Applicant a concept of how the landfill will develop and when will it be hydraulically contained or not. Why was it not modelled as it was intended to develop and apply modelling tools as appropriate? What factors will define if the landfill is hydraulically contained? If the aquifer unit is 10 m below the base of the landfill how will the potentiometric surface affect hydraulic containment?

Ms Burden responded that there is a spectrum of transport mechanisms, and therefore the Applicant has modelled the two extremes (diffusion and advection) across the entire site. There would be a combination of transport mechanisms operating laterally and temporally across the site during the lifetime of the site, in order to undertake the risk assessment they have looked at the two extremes.

Mr Herlihy identified that Figure 5 (of the HRA) shows where advection and diffusion, and a combination of both, occur; each of the models used only allow for advection or diffusion. Scenarios 1 and 2 of Figure 5 (of the HRA) apply when leachate levels are managed and scenarios 3 and 4 when leachate is unmanaged. Hydraulic containment is influenced by water levels in clays, potentiometric head and leachate levels.

Mr Mulcahy asked if the raw data for the models were existing data and were assumptions made for the modelling based on the data? Mr Mulcahy noted that the quality of the model is dependent on the quality of data and assumptions. Mr Mulcahy asked if the boreholes were the principal data, and how many boreholes were in the landfill footprint.

Ms Burden clarified that existing data, as presented in the EIS, were used and assumptions were made based on the data. She stated that the Applicant believes the data are robust and that the assumptions are conservative. Ms Burden confirmed that there are approximately 42 boreholes within the landfill footprint and the data presented in the witness statement includes boreholes in clay sub-soils and shallow bedrock.

Mr Mulcahy asked how many boreholes in clay were dry, and is there a difference between dry when drilled and thereafter, and if it is significant that the boreholes were dry during drilling. Mr. Mulcahy asked that the term 'water strike' be explained and is it unusual for such to occur in clay. Mr. Mulcahy noted that all standpipes in clay have water present. Mr Mulcahy noted that one of the assumptions made by the Applicant is that there are discrete lenses in the clay; he asked how would the water from the discrete lenses behave over a period of time. Mr. Mulcahy asked if the clay is sufficiently permeable for recharge and why is there a response in deep clay. And he added was it the case that rainfall seeps down to lenses and stops, and in the deep clay water rises from the aquifer? Mr. Mulcahy asked was BSA3a dry when drilled, and noted for information that the log indicates that there was no water strike. Mr. Mulcahy asked is it the case that the water in the aquifer is under pressure and therefore there is greater pressure moving water up than down.

Mr Orsmond stated that most boreholes into clay were dry when drilled. When boreholes were drilled, circumstances were recorded and logged, standpipes installed and levels of water recorded thereafter.

Mr Herlihy stated that the water in the standpipes was not considered significant.

Mr Orsmond confirmed that in glacial till you may have lenses and these lenses hold water which may seep into standpipes.

Ms Burden confirmed that water was present in all boreholes but was not significant.

Mr Herlihy stated that based on the behaviour of glacial tills in Ireland, and at the site, the Applicant believes there are lenses. Based on hydrographs, the water levels in the shallow clay do respond to rainfall, however most of the shallow clay will be excavated to construct the landfill. Borehole BSA3a, which has a base at 16-17 m, may be influenced by the piezometric head of the aquifer below. Where a borehole is close to an aquifer, which is confined, the pressure of water in the aquifer can influence it. BSA3a was dry when drilled but there is an installation at the base of the borehole which may be influenced by pressure from the aquifer below. The assumption was that water in shallow boreholes was from one or more lenses.

Mr Mulcahy asked if the model was based on the soil below the landfill and above the aquifer unit being unsaturated, and did the HRA only assess the risk to water in the bedrock aquifer?

Mr Graham clarified that the model takes account of moisture in lenses and finer material.

Mr Herlihy clarified that they have accounted for two spectrums, advective flow by LandSim and diffusive flow by the EA model (subsoil saturated). Mr Herlihy referred to the Agency request for an assessment (letter dated 17th October 2008) and also made reference to a number of definitions in Article 2 of the WFD, including No.s 11, 12, 19 and 25.

Hearing adjourned from 10.55am until 11.23am

The Chair indicated that Mr De Rossa MEP had a statement that he wished to have included in the record, but that he was not available to make his presentation later in the day or the following day. The Chair suggested that Mr De Rossa's statement be read into the record by a member of the NLAG at a later stage in the re-opened oral hearing as there were time pressures in relation to cross-examination of other witnesses today {Tuesday}.

Mr De Rossa stated that he accepted the suggestion and the written statement was accepted as Document No. 7 (Appendix F).

Cross-examination of Mr Herlihy and other contributors to the Applicant Witness Statement

Mr Mulcahy asked for clarification in relation to the saturation of the clay, the fact that the Applicant does not refer to the saturated clay as a saturation zone and the basis for the Applicant's evidence that the water in soil does not form a continuous saturation zone and is not groundwater. In addition Mr Mulcahy asked how clays became saturated.

Mr Graham clarified that the clays are modelled as saturated, based on the assumption that the clay is saturated with respect to the pore fraction being full of water, i.e. void space full of water.

Ms Burden made a distinction between 'saturated' and 'saturation zone'. The clay is not considered to be an aquifer and water level in clay is not a water table.

Mr Herlihy clarified that the saturation zone is in the aquifer, whilst water is bound in the clay and water is released from the lenses. Saturation of the clay has occurred over long periods of time.

Mr Graham clarified that the risk assessment considers that the clay is saturated in the entire pathway beneath the site.

Mr Mulcahy asked if the saturation of the clay reflected the piezometric head and if there is any correlation between the water level in clay and the piezometric head. Mr Mulcahy asked if the variability in water level could be due to the variability in soil permeability.

Mr Herlihy responded that in the deeper clays the confined aquifer affects saturation, whereas in the shallow clay the saturation is affected by rainfall; he referred to Figures 3A, 3B and 3C (of the HRA) to identify different water levels which are as a result of the low permeability clay. The water level in the shallow clay is 2-3 m above the piezometric head and the water in the shallow clay is from lenses within the clay. Mr Herlihy contended that there is an obvious disconnect.

Mr Mulcahy identified that there is a line included in Figure 6 of the HRA which shows water level in clay. He asked if this implies a connect between the various levels in clay, and asked are the lenses disconnected, and should the label 'clay groundwater level' mean a connected groundwater level where it did not previously exist. Mr Mulcahy queried if it was curious or coincidence that the levels in the clay wells enable the drawing of a line, particularly if the lenses are discrete and not connected and asked would it not have been likely to have at least one dry borehole.

Ms Burden noted that the line drawn on Figure 6 of the HRA represented the stabilised level in the clay standpipes and does not represent a perched water table across the site.

Mr Herlihy identified that the line is continuous for the model and if a drainage blanket were to be installed water would enter the blanket. When the site is excavated it will in effect be connecting the lenses. The pathways and groundwater levels are discussed in Section 4.2.3 of the HRA.

Mr Orsmond claimed that presence of water in boreholes represents the heterogeneity of the clay.

Mr Mulcahy asked where is there evidence of a disconnect rather than one body of water. He asked how are the pump tests indicative in any way and how does transmissivity link to the lenses the Applicant says are in the clay. Mr Mulcahy asked if there was any reaction to pump tests in BSA3a.

Ms Burden indicated that the 'water in clay' and 'pump tests' were discussed in the EIA process and the EIS, and that the data used in the HRA considered the relationship between clay and bedrock.

Mr Herlihy identified that the pump tests give details of the transmissivity in the bedrock which are essential for the model. Mr Herlihy acknowledged that there was a response to pump tests at BSA3a.

Mr Mulcahy identified the definition of 'saturation zone' in the EPA Landfill Monitoring Manual, 2nd Edition, Paragraph 5.1, '*The saturated zone is the subsurface zone in which all interstices are filled with water*', and asked if the clays fit this definition. He asked if the clay was a pathway or a receptor. Mr Mulcahy also asked what was the basis for considering that water in clay is not groundwater and stated that he considered that the Applicant was not asked to evaluate impact on the groundwater body.

Mr Herlihy responded that they do not accept that the water in clay represents a continuous zone: there is only the water released from the lenses where the permeability is higher. The model assumes that the clay is saturated. Mr Herlihy stated that there is a fundamental disagreement between the Applicant and Mr Mulcahy with regard to clay - the Applicant contends that the clay is a pathway and the bedrock aquifer is the receptor. Mr Herlihy reiterated that they do not consider clay to be an aquifer and groundwater in clay is not a groundwater body.

Mr Mulcahy indicated that a key aspect of the risk assessment is the output; evidence suggests break-out and asked what is the effect of break-out on other emissions from landfill such as the effect of reduced emissions from leakage. Mr. Mulcahy also asked if break-out would result in under-reporting of contaminant escape to ground. Mr Mulcahy asked whether the model accounts for break-out when calculating leakage, and doesn't the model assume that leachate that breaks-out is treated?

Mr Graham confirmed that there is a prediction of break-out. After operation and management of the site, the model continues to predict emissions from the site through the liner after break-out. Calculations of fluxes from site are a function of the water balance and fundamentally the head of leachate. Once break-out occurs, the leachate head becomes fixed.

Mr O'Toole stated that break-out is a theoretical situation in the future, and is no different to any landfill. He added that no operator could walk away until there is no risk to the environment and passive controls are considered adequate, and he noted that Agency agreement would be necessary for closure and surrender programmes.

Mr Graham identified that break-out of leachate is a worst-case scenario and is unlikely to occur.

Mr Mulcahy referred to Appendix E.1, Inputs and Outputs of the HRA and in particular page 4, 'Infiltration Information'. He enquired what is being referred to as 'leachate recirculated and treated'? Mr Mulcahy asked for clarification of the values used in the model, their relevance and is recirculation of treated effluent common.

Mr O'Toole outlined the principle of leachate recirculation and treatment, the value of leachate recirculation and that the proposal is to recirculate raw leachate and treat the balance in the waste water treatment plant.

Mr Graham identified the range of values used in the model, and confirmed that recirculation of 100 m^3/day is as provided by the landfill engineers.

Hearing adjourned from 1.10pm until 2.20pm.

Cross-examination of Mr Herlihy and other contributors to the Applicant Witness Statement (continued)

Mr Mulcahy identified that his outstanding question from before lunch related to leachate treatment and recirculation. Mr Mulcahy explained that his understanding was that recirculation of 100 m^3/day of treated leachate removes that leachate from the environment being assessed, and therefore is significant. If there was recirculation with no treatment there would be no impact on calculations in the model. Mr Mulcahy asked why was leachate recirculation and treatment included in model if it is only proposing to re-circulate untreated leachate. Mr Mulcahy asked what the leakage figures would be under the circumstances he suggested, and would leakage be vastly in excess of what the model predicted where leachate is recirculated after treatment. Mr Mulcahy asked how was it conservative to include recirculation and treatment.

Mr Graham responded that LandSim provides for recirculation and this links to hydraulics of the site. It is not considered to have a significant impact on calculations whether recirculated leachate has been treated or not, the effect of recirculation is limited in the long term due to the very slow rate of contaminant removal. Recirculation has an effect on the water balance and there is no provision in LandSim for recirculation of untreated leachate.

Mr O'Toole clarified that recirculation will be up to 100 m^3/day but production of leachate is 2-3 times higher. Mr Graham identified that leakage figures were not to hand as they are calculated within the model. Recirculation in the LandSim model allows for some additional degradation compared to if there was no recirculation; however, degradation is over 100s if not 1000s of years. The model's assessment of hydraulics associated with recirculation and leachate migration are considered within the model.

Mr Mulcahy referred to Appendix E.1, page 2 of 10 of the HRA in relation to contaminant half-lives and particularly the value for ammonium of 5-10 years and asked for the source of the figure. Mr Mulcahy provided page 28 of the Environment Agency Report Review of Ammonium Attenuation in Soils and Groundwater (Document No. 8, Appendix F). Mr Mulcahy asked what processes would cause ammonium to bio-degrade and have a half-life; would the process be nitrification and would the process require the presence of oxygen and if so where would there be a source of oxygen. Mr Mulcahy stated that it is not appropriate to have bio-degradation, as ammonium does not fall out as the assessment presents.

Mr Graham acknowledged that the half-life in the assessment is taken from the aerobic degradation column of the document identified by Mr Mulcahy and referenced in the HRA (see Document No. 8, Appendix F). The pathway has limited

oxygen and the value used could be re-assessed and therefore they could re-run the model to evaluate the sensitivity of the value.

The Chair asked the Applicant to estimate the time necessary to re-run the model as suggested.

Mr Graham suggested that a re-run could be completed within 30-45 minutes.

Mr Mulcahy asked if in the absence of nitrification/biodegradation would dilution be the only attenuation method and would chloride and ammonium have similar dilution characteristics. Mr Mulcahy suggested that prior to reaching the limestone aquifer the only process occurring is retardation which only slows movement. Mr Mulcahy used the example of chloride which, based on the model, has a dilution of about 60 times (9850 mg/l on escape from landfill and 165mg/l at the compliance point). If similar dilution were used for ammonium, the resulting figure would be 60mg/l (based on 3590mg/l at escape from landfill): this is 200 times the drinking water limit. Mr Mulcahy stated that it may be premature for the Chair to inform the Applicant what they need to do to adequately inform the Chair and Agency. Mr Mulcahy claimed that you can't simply re-run to address ammonium: the Applicant should take account of all other issues with the model, including leachate recirculation and reassess the compliance point used in the model.

Mr Graham identified that dilution would be modelled in the absence of biodegradation but also processes such as cation exchange would occur. Mr Graham claimed that the limestone aquifer would be aerobic therefore the process of biodegradation would be present, and that as ammonium is a List II substance the compliance point is in the aquifer down gradient of the landfill. Mr Graham identified two principal differences between ammonium and chloride: the ammonium species will be subjected to retardation in the pathway whereas chloride is considered as a conservative un-retarded element; and secondly you would need to take account of biodegradation along the aquifer pathway for ammonium whereas chloride does not degrade. Therefore chloride is not directly applicable when calculating dilution factors between species. The model runs on probabilistic values, therefore a direct comparison of dilution factors is not appropriate.

Mr Flanagan, for the Applicant, offered to give further evidence in relation to the model and an explanation of the Applicant's interpretation of the Agency letter.

Clarifications for Mr Herlihy and other contributors to the Applicant Witness Statement

Mr Misstear sought clarification in relation to pore water volumes and associated pressures in the overburden. Mr. Misstear said he understood, based on evidence, that it is assumed that the pore water saturation levels vary in shallow tills in response to the seasons. Mr. Misstear asked what is the Applicant's concept of the degree of saturation in clay, the lenses and the underlying clay? Is it the Applicants conceptual model that it is all saturated? Mr Misstear asked what the concept of pore water pressure in overburden is in relation to atmospheric pressure and was it the Applicant's contention that water in clay is being held at below atmospheric pressure by suction but where you have a sand lens it is at atmospheric pressure? Mr Misstear

asked is it the concept that the measured levels in clay are above the potentiometric surface of the aquifer and is there potential for downward movement? He asked does the overburden act as a confining layer (aquiclude) or a semi-confining layer (aquitard)? Mr Misstear identified that in relation to Figure 6 of the HRA where Mr Mulcahy asked about the cause of hydraulic containment, was it due to water in clay or to the potentiometric surface in the underlying aquifer. If Mr Misstear understood the Applicant correctly, they said it was both and Mr Misstear asked the Applicant to reflect on this. Mr Misstear stated that based on what the Applicant said, both models assumed that the clay mineral layer and overburden are saturated. Mr Misstear identified that in Figures 3a, 3b and 3c of the HRA, it appears that there is a glitch with the dates on the x axes: and asked could the Applicant confirm the dates. In relation to ammonium did the model assess ion exchange in the overburden? Mr Misstear asked if the Applicant could refer to examples of where LandSim has been used in situations similar to the proposed landfill.

Mr Herilihy confirmed that it is the Applicants concept that it {clay, lenses and underlying clay} is saturated. Ms Burden noted that where they are not seeing seepage it is below atmospheric pressure. Ms Burden agreed with Mr Misstear's statements re pressure in clay and lenses and movement of water downward. Ms Burden identified the overburden as an aquitard.

Mr Herlihy identified that hydraulic containment is where water flows in from the clay to the liner. He suggested that there was perhaps some misinterpretation when we have a potentiometric surface higher than the resting water level, the water level will equilibrate in the clay or around the liner, in order to have a downward migration you have to have diffusion rather than advection because you would be going against the gradient. There is not hydraulic containment because of the potentiometric surface.

Mr Graham acknowledged that the clay mineral layer and overburden are considered to be saturated in the models.

Ms Burden confirmed that the correct dates in Figures 3a, 3b and 3c are 2005 to 2008 and copies of Figures 3a, 3b and 3c could be reprinted.

Mr Graham confirmed that the model did not consider ion exchange: earlier versions of LandSim did consider ion exchange but the function was removed to make the model more conservative. Mr Herlihy identified that they could in due course identify other sites where LandSim was used.

The Chair noted that they would defer a decision in relation to re-running the model until after the evening coffee break.

Cross-examination of Dr Ashley, NLAG[1]

Mr Flanagan identified the concerns expressed by Dr Ashley, then asked if Dr Ashley was familiar with the Landfill Directive and identified that the proposed landfill is in accordance with the engineering requirements of the Landfill Directive and site

[1] Note: :On the Digitake recording 'GG' to 'KK' Dr Ashley is mistakenly listed as Mr Larry O'Toole.

design manual published by the EPA. Mr Flanagan asked if Dr Ashley's principal concern was groundwater and the potential effect of the landfill on receiving water. Mr Flanagan asked if the requirements of the Landfill Directive are to protect water and he claimed that the Groundwater Directive deals with discharges to water, and the Landfill Directive imposes technical requirements. Mr Flanagan referred to the technical specifications in the Landfill Directive for an engineered landfill, Annex 1 of the Directive. He suggested that in the context of Paragraph 3.4 of Annex I of the Landfill Directive did Dr Ashley take into account the Groundwater Directive in the context of the technical requirements specified in the Landfill Directive. Mr Flanagan asked if Dr Ashley recalled Mr Cullen's evidence at previous oral hearings that he has never encountered an engineered landfill which has caused difficulty to groundwater.

Mr Flanagan quoted from Article 2 of the Groundwater Directive (80/68/EEC) and asked if Dr Ashley was aware that the Groundwater Directive was prior to the Landfill Directive and was transposed into national legislation in 1999. The Irish regulations effectively refer to discharges to sewer; the Landfill Directive imposes requirements and obliges an Applicant to have regard to the Groundwater Directive in the context of Paragraph 3.4 of Annex 1 of the Landfill Directive.

Mr Flanagan identified that the WFD was introduced in 2000 and it has at its core the protection of groundwater resources for human consumption and where it might affect eco-systems. Mr Flanagan quoted the first three points in the preamble of the Groundwater {Daughter} Directive (2006/118/EC). Mr Flanagan put it to Dr Ashley that the Groundwater Directive is to protect groundwater resources and the HRA looking at the impact on the aquifer is appropriate as the groundwater resource would be the bedrock aquifer. Mr Flanagan referred to the wording of the EPA letter to the Applicant, particularly 'protection of groundwater against pollution' and 'groundwater chemical status'. Mr Flanagan suggested that the Agency letter referred to the chemical status of the groundwater body on the basis that good groundwater status is defined in Article 25 of the WFD and refers to a body of groundwater. Mr Flanagan identified that the EPA letter refers to 'receptors' and identified the definitions of aquifer and body of groundwater as per the WFD. He also suggested that clay is not an aquifer and noted that evidence was previously given that the Applicant does not plan to abstract water from the area.

Dr Ashley responded that assessment of the engineering has not been part of his work. His concern has been the water environment generally. Dr Ashley acknowledged that the Landfill Directive imposes technical requirements. Dr Ashley stated that he did not recall Mr Cullen's statements in relation to engineered landfills, but he could identify engineered landfills that have caused problems.

Dr Ashley considered that the WFD referred to the protection of the water environment generally; groundwater is included in the WFD; and resource should be considered in the broader sense including effects on eco-systems. Dr Ashley clarified that his questioning of the HRA was in relation to compliance points, definition of groundwater and cumulative effects. He considered that the HRA would only be an appropriate assessment if the receptor was the bedrock aquifer, but he stated that EU legislation requires you to look at more than the bedrock aquifer. Dr Ashley accepted that clay was not an aquifer.

Clarifications for Dr Ashley

Mr Misstear identified that the point of compliance had been discussed and asked if Dr Ashley was aware of a situation where the point of compliance had been taken to be within the glacial till.

Dr Ashley identified that he had not been directly involved in a similar situation in glacial till. However, in a case of a large engineered landfill on fractured mudstone overlying a major aquifer, the point of compliance was in the mudstone immediately beneath the base of the landfill.

The Chair noted that Dr Ashley referred to a letter he had sent to Mr Shortt, dated the 19th November 2008. The Chair asked if Dr Ashley could make a copy of the letter available to the hearing.

Dr Ashley confirmed that he had a copy of the letter and would make it available (Document 4A, Appendix F).

Hearing adjourned from 3.55pm until 4:20pm.

The Chair identified that the proposed re-run of the model to address the half-life of ammonium would be accepted as additional information from the Applicant. Cross-examination of the Applicant would be provided for on receipt of the re-run model.

Mr Mulcahy noted that the evidence of Dr Barnes may result in the Chair feeling that there may be other aspects of the model that the Chair may wish the Applicant to address and that the Chair should not be limited to offers by the Applicant.

Witness No. 6 Dr Barnes

Dr Barnes, for Greenstar Ltd., read into the record the joint witness statement of Dr Barnes and Mr Hall (Document No. 6, Appendix F). Dr Barnes provided an overview of both his qualifications and experiences and those of Mr Hall.

Dr Barnes presented his witness statement under the following headings:

- Nature of Objection
- Conceptual Model
    - Pathways
    - Receptors
    - Consideration of Landfill Development
    - Summary Comments on Conceptual Model
- Modelling
    - LandSim
        - Lifecycle phases
        - Landfill hydraulics
        - Leachate treatment
        - Contaminant transport

        - Aquifer dilution
    - SC0310 Hydraulic Containment Model
    - Summary of comments on Modelling

Dr Barnes's conclusions included the following:

- The baseline hydrogeological conditions in relation to groundwater in the drift (i.e. glacial tills) and its interaction with perimeter streams and the underlying aquifer in particular appear to be poorly understood;
- The only receptor modelled is groundwater within the underlying Gravel/Bedrock aquifer. No consideration has been given to identifying potential pathways to perimeter streams, or the release of contaminants to the groundwater table present in the drift. Justification is needed as to why this groundwater in the drift should not be protected as specified in the Groundwater Directive;
- The conceptual understanding presented of how the landfill will operate throughout its entire lifetime is considered inaccurate, inadequate, and has been poorly transposed and therefore poorly represented in the software selected;
- Key contaminant parameters are considered grossly optimistic and inaccurate. Site-specific justification has not been provided for identified selections. The models are certainly not considered to be conservative as reported;
- The dilution potential being generated by the model from the input information is considered to be unrealistically high. This would benefit from a proper assessment;
- The leachate treatment technology approach used in the LandSim model is considered significant in relation to the output results. Only scant details of the leachate treatment technology, its operation and integration into the management plan for the site are included in the submission, and not in sufficient detail to allow its adequacy to be determined; and
- A demonstration that the development can comply with the requirements of the Groundwater Directive throughout its entire lifecycle has not been provided.

Dr Barnes concluded that the HRA is fundamentally flawed, and the conceptual understanding upon which the modelling is based is inaccurate and inadequate. Dr Barnes and Mr Hall believe that the outputs are not conservative, the use of LandSim during key stages of the lifecycle is not appropriate and the overall results are misleading.

Mr Mulcahy sought the following clarification from Dr Barnes prior to cross-examination: he identified that Dr Barnes referred to leachate treatment as being significant, and asked would it be of significance if, based on Mr O'Toole's evidence, it is not intended to treat the leachate prior to recirculation?

Dr Barnes responded that the model assumes that it you activate the leachate recirculation function you would pump out leachate, treat it and pump back in clean water, essentially flushing out contaminants. Dr Barnes stated based on his estimated calculation at a recirculation rate of 100 m^3/day and a chloride level in the leachate of 5000 mg/l, you could remove 50,000 kg of chloride per day for 60 years when the site

is active, therefore this contaminant load is not going to ground but to a leachate treatment system. If the leachate is not being treated prior to recirculation this will have a significant impact compared with what is considered in the model.

Mr Flanagan asked that he might have some time, possibly 15 minutes, to prepare for cross-examination on the basis that the evidence was only made available late Tuesday morning.

The Chair agreed to adjourn for 15 minutes.

On return the Chair asked for an update on witness availability and also the progress with the re-run of the model, as offered by the Applicant.

Mr Flanagan indicated that the results of the re-run of the model were being printed. Mr Flanagan identified that Mr Graham would be available until approximately 19:00 and thereafter would not be available for two weeks for personal reasons, Mr Herlihy has difficulty attending on Wednesday and Thursday, and Mr Orsmond has difficulty attending on Wednesday.

Dr Ashley identified that a re-run of the model as proposed would not address all the issues raised, and he indicated that he had to leave that evening. Mr Boyle, NLAG, wanted to have recorded that LandSim was identified as not been capable of simulating the situation at the site and he wished to record his concern at the use of the model.

Mr Mulcahy indicated that his witnesses were available. He identified that he would question the validity of the re-run of the model, would require time to consider the output from the re-run, would need to consider the electronic file, and the information relied upon.

Mr Flanagan stated that the output from re-run of the model had been completed and suggested that Mr Graham could comment on the new information for the benefit of all parties (Document 9, Appendix F)

Additional Evidence of Mr Graham

Mr Graham provided additional commentary on the output from the re-run of the LandSim model (Document 9, Appendix F). Mr Graham identified that time is presented in years on the x-axis and concentration of modelled substances in the aquifer in mg/l on the y-axis; the three traces presented are for the 95%ile, 90%ile and 50%ile values. Mr Graham identified that the only alteration is the half-life of ammonium, which the Applicant has revised to 100 years: the Applicant considers this very conservative based on the action of processes other than those dependent on aerobic conditions/processes, such as cation exchange. At the 95%ile the maximum predicted concentration is 0.11 mg/l which can be compared with the interim value for groundwater of 0.15 mg/l, therefore this is considered an acceptable release after 1000 years, beyond which there will be a slow and gradual decline. In addition, the model is conservative based on the concentration of ammonium in the leachate which is higher than the leachate likely from landfills in the future.

Clarifications for Mr Graham

Mr Misstear asked if the half-life of 100 years is a composite half-life to include a variety of processes including bio-degradation and ion exchange. Mr Misstear asked was there any attenuation assumed in the overburden and what attenuation was in the horizontal pathway in addition to dilution. Mr Misstear identified that the re-run model result (Document 9, Appendix F) presents the 95%ile maximum as 0.11mg/l which you compared to a groundwater compliance standard of 0.15 mg/l: Mr Misstear asked for clarification of the standard. Mr Misstear identified that the graph shows a peak after about 1000 years and then a decline and a constant value from approximately 4000 years at around 0.03 mg/l, and he asked what is the source of the residual figure. Mr Misstear asked if one chooses the option for recirculation of leachate in the model, does that assume that the leachate is treated prior to recirculation? Mr Misstear asked if the model had been run with the recirculation option turned off and was such a result presented in the HRA?

Mr Graham confirmed the half-life was a composite half-life. The only change from the HRA report was the change of the half-life to 100 years in the vertical pathway, the attenuation in the horizontal pathway remains at 5-10 years.

Mr Herlihy identified that the standard of 0.15 mg/l is an interim standard taken from the EPA Interim Report entitled Towards Setting Guideline Values for Protection of Groundwater in Ireland. The drinking water standard is 0.3 mg/l.

Mr Graham identified that the 95%ile is the upper percentile of likelihood and therefore does not represent the more likely return to zero reference point. In LandSim the residual concentration in steady state is a result of the probabilistic calculations and does not represent a permanent release of contaminants; for the 50%ile scenario the line flattens out at closer to zero. The model is highly conservative in its presentation. The model is set-up so that it assumes leachate is treated before recirculation. The model was run with the recirculation of leachate turned off but the results of such are not presented in the HRA. Mr Graham identified that the results of the model with the leachate recirculation option turned off are not as significant as other parties have suggested.

Cross-examination of Mr Graham and Other Applicant Witnesses

Mr Boyle, for NLAG, asked if ammonia degrades in soil or are we only talking about dilution? Mr Boyle asked how long does it take for ammonia to degrade to a safe level. Mr Boyle questioned the suitability of LandSim for the situation where there is an inward water pressure. Mr Boyle identified that the model does not assess lateral movement and therefore does not consider a compliance point 100 m down gradient within the clay. The flow laterally in the subsoil may be 10-100 times greater than in the vertical pathway and therefore the contaminants would reach streams: Mr Boyle asked when would this occur? Mr Boyle identified that he read of the phenomenon of pooling, where the horizontal component of the waste reaches the surface and asked if leachate could reach the surface down gradient of the landfill, and asked what is to prevent pooling? Mr Boyle identified that the whole exercise assumes that ammonia moves down through soil, and to say that it does not leak removes the purpose of the

exercise, and he stated that there are no calculations to show that pooling will not occur.

Mr Graham identified that ammonia degrades as well as being diluted. The model results indicate that ammonium is at a safe value for the entire life cycle of the proposed landfill. The LandSim assessment is taken for the advective scenario. Within the Applicant's conceptualisation the two models have validity for the site, and the vertical pathway is considered saturated beneath the site.

Ms Burden reiterated that the only change to the model has been the half-life - the conceptual model is as discussed at length before. The Applicant has run the model to protect the primary receptor, which is considered to be groundwater; therefore secondary receptors, such as streams, are protected.

Mr O'Toole identified that with the combination of a composite liner and a low permeability clay the 'pooling' effect is not anticipated. During the management stage the maximum head of leachate is 1 m, and the post management stage can only occur when the landfill no longer poses a risk to the environment and is subject to the agreement of the Agency.

Mr Mulcahy identified that it was quite unsatisfactory to present a re-run of the model. Mr Mulcahy identified that Mr Graham had confirmed that the model had been run with the recirculation of leachate turned on and off, and asked why then rely on the wrong model run. Mr. Mulcahy suggested that it was the Applicant's opinion that the conservative approach was to factor in a mitigation or dilution effect rather than disregard an effect that was insignificant. Mr Mulcahy asked why did the Applicant model treatment of leachate, when there was an option not to include recirculation. Mr Mulcahy identified that it was Mr Graham's evidence that LandSim is appropriate at some stages and the diffusion model is appropriate at other times, and asked would it be correct that LandSim is relevant to early stages of landfill, if relevant at all.

Mr Graham responded that it was not the wrong model as the Applicant is anticipating recirculation and they are limited in how this can be handled by LandSim. Removal of recirculation did not have a significant effect on the life cycle of the landfill modelled. Mr Graham identified that recirculation is proposed for the landfill and the point in dispute is with regard to whether the leachate is treated before recirculation or not. The model allows for recirculation but there is no option to turn treatment on or off, and to include recirculation allows for assessment of the hydraulics associated with recirculation. Mr Graham identified that LandSim is used for the overall assessment of the life cycle of the site. During the operational phase leachate head controls are in place and advective flow from the site is unlikely. While there is management control the leachate head is suppressed to less than 1 m, and there is little likelihood of LandSim representing that scenario. Mr Graham identified that the Applicant has modelled advective flux because of the potential in the later life of the site when leachate heads are expected to rise; they are accounting for advective fluxes in addition to diffusion fluxes from the site. By using the two models the Applicant is being completely pessimistic.

Mr Herlihy referred to Figure 5 of the HRA, and identified that Scenarios 1 and 2 are the conditions during the leachate management stage. The pathway is through defects in the liner but beyond that it is expected that the water level in clay will be higher than leachate levels in the cells. Therefore, the only mechanism for contaminants to escape through the mineral liner is by diffusion, which is not covered by LandSim.

Mr Graham noted that for the diffusion model a half-life is not an input parameter.

Mr Flanagan indicated that Mr Graham had to leave, as indicated earlier. Mr Graham apologised that he could not remain.

Mr Mulcahy had at this point not finished his cross-examination and was asked by the Chair if he wanted to continue his cross-examination of the Applicant's remaining witnesses who may be able to address his questions in Mr Graham's absence. The Chair also noted that many of the points may have been included in Dr Barnes's evidence to the hearing, and points can be raised in Mr Mulcahy's closing statement.

Mr Mulcahy indicated that Dr Barnes may provide a written response to the additional information provided by the Applicant or he may address it in his closing statement. Mr Mulcahy noted that it was unsatisfactory and that it is of Mr Graham's own making that has lead to the new information being necessary.

Hearing adjourned at 7.17pm until 09:00 Wednesday morning.

Wednesday 29th April 2009 – Hearing opened at 9.05am

The Chair outlined the programme for Wednesday as follows: Cross-examination of Dr Barnes, witness statement of Mr De Rossa to be read into record, and witness statements of Ms Larkin, Mr White and Mr Lunney to be presented. Thereafter closing statements would be taken.

Additional Evidence of Dr Barnes

Prior to cross-examination of Dr Barnes, Mr Mulcahy put a number of points to Dr Barnes for comment in relation to the additional information provided by the Applicant on Tuesday evening.

Mr Mulcahy asked Dr Barnes if the re-modelling addresses the concerns expressed in his evidence as presented yesterday. Mr Mulcahy asked for a comment on the 100 year half-life used by the Applicant. Mr Mulcahy identified that Mr Graham had referred to cation exchange and other processes which he claimed justify the 100 year half-life, and asked Dr Barnes to comment. Mr Mulcahy also asked if there are other processes not accounted for in LandSim and was there justification for a 100 year half-life. Mr Mulcahy asked would Dr Barnes have allowed a 100 year half-life or a different half life.

Dr Barnes identified a significant increase in breakthrough that he claimed demonstrates that the model is sensitive to degradation of ammonium - the increase is of two orders of magnitude even where a half-life of 100 years is included. The use of a half-life of 100 years reduces the concentration at breakthrough below what would be predicted if no half-life was included. The use of a degradation rate in the aquifer is a subject that may require some discussion. Dr Barnes identified that he thought the half-life should be turned off or justified. If there is oxygen present it needs to be justified. The persistence of a contaminant at the receptor is reduced when you assume oxygen is present, however at the centre of the plume there is no oxygen so no reduction in peak concentration. LandSim previously allowed for cation exchange, but it was a simplistic assumption that no ammonium was released until all the cation exchange capacity was used up; however, it is known that cation exchange is reversible, therefore the process is allowed for in the partition co-efficient or retardation and is therefore already accounted for in the model. There are no other processes to justify a 100 year half-life. Dr Barnes stated that they {Golder Associates} do not allow for ammonium biodegradation routinely and certainly not for new sites.

Clarification for Dr Barnes

Mr Misstear enquired, for clarification, if cation exchange was provided for in the retardation coefficient and was retardation included in the vertical pathway?

Dr Barnes identified that the model included retardation in the aquifer, which was something highlighted in his own evidence that he is dubious about, particularly retardation in a limestone bedrock. However, it does not have a huge implication for

the outputs but retardation is less justifiable in bedrock and gravel than in clay. Retardation in the vertical pathway is provided for in the model and the numbers are realistic.

Cross-examination of Dr Barnes

Mr Flanagan noted Dr Barnes's experience and asked if he was familiar with the Landfill Directive, Environmental Impact Assessment legislation, Waste Management Acts and the licensing process. He stated that the Waste Management Act gave effect to the Landfill Directive and the Groundwater Directive. He asked if based on {Dr Barnes's} regular use of LandSim are all the input data available in the HRA appendix? Mr Flanagan stated that while there may be dispute about interpretation of the Agency letter, the HRA provides significant information, and is used to predict results at the compliance point in the aquifer. Mr Flanagan asked if Dr Barnes could have run LandSim based on the information in the Appendix of the HRA and in so doing, could he have used alternative compliance points and presented such information to the Agency?

Dr Barnes confirmed that he had a broad understanding of legislation and processes referred to. He acknowledged that he had all of the EIS available to him and had read the sections relevant to hydrogeology. Dr Barnes acknowledged that all inputs are in the Appendix of the HRA; however, the HRA is the Applicant's interpretation of the conceptual model. Mr Mulcahy noted that the request from the Agency was made to the Applicant. Dr Barnes identified that he could have constructed the model based on the input data.

Mr Flanagan asked Dr. Barnes which Groundwater Directive was referred to on page 2 of his statement of evidence. Mr Flanagan stated that the Groundwater Directive has the purpose of protecting groundwater resources and refers to groundwater as a natural resource and groundwater as bodies of drinking water and future use must be protected and therefore the overall context is protection of groundwater resources.

Dr Barnes identified his reference, on page 2 of his witness statement, as being to the Groundwater Directive of 1980. He identified that he considers the Directive just refers to resource and he interprets it as groundwater. The key purpose of the Groundwater Directive is in relation to what is an acceptable discharge. He takes groundwater to mean as defined in the Groundwater Directive.

Mr Flanagan read Article 2 of the Groundwater Directive of 2006 and asked if Dr Barnes was aware of that quote and was he aware of definitions in the WFD. Mr Flanagan identified that the WFD is the over-arching Directive for looking at water in the future. In the WFD good chemical status is in relation to a body of groundwater. Mr Flanagan referred to the EPA letter and in particular reference to groundwater chemical status, which based on definitions in the WFD, refers to chemical status in the water resource i.e. water in the aquifer. Mr Flanagan identified the definitions in the WFD for 'good groundwater chemical status', 'body of groundwater', and 'aquifer'; therefore, he stated that the Agency were concerned with chemical status of a body of groundwater in an aquifer. Mr Flanagan asked that if Dr Barnes were to accept the interpretation put forward, would the assessment adequately address the Agency letter? Mr Flanagan asked Dr Barnes to explain his suggestion in his witness

statement that an assumption is made that List I substances can be discharged to groundwater. Mr Flanagan asked if he could have interpreted the information from the data provided in the appendices of the HRA without re-running the model.

Dr Barnes acknowledged that he was aware of Article 2 and broadly aware of the WFD. Dr Barnes stated that he considered that the EPA letter refers to groundwater chemical status and he would interpret the Agency letter as referring to groundwater. Dr Barnes stated that the Agency letter refers to groundwater below the facility and it is open to the Applicant to justify their interpretation. Dr Barnes stated that there are problems with the assessment and therefore he considers it does not address all receptors including streams. Dr Barnes identified that the receptor has been adopted to be at the bottom of the clay-rich drift and as List I substances were present at this point, even if below a standard, the risk is increased that they would be at a higher concentration at the top of the drift. Dr Barnes identified that he did not re-run the model, but had asked for electronic copies of model. Therefore his evidence is based on his experience.

Mr Flanagan referred to terms used by Dr Barnes in his evidence including 'shallow drift', 'shallow groundwater system', 'groundwater in drift', 'shallow overburden', 'shallow drift', and 'groundwater flow in drift' and sought clarification as to what is meant by 'drift' which is used repeatedly.

Dr Barnes stated that he was conscious that gravel could be interpreted as drift, and 'shallow drift' means material above gravel. If gravel is part of the aquifer it could be considered as part of the aquifer body or as drift. The aquifer unit incorporates some of the drift. The use of the word drift was to distinguish that gravel is not bedrock.

Mr Flanagan identified that Dr Barnes's evidence refers to a number of boreholes, and he identified HR9 to the east of the motorway (Figure 8 of Appendix H), which is a gravel monitoring well. Mr Flanagan stated that it is a fundamental assumption that gravel provides additional storage for the aquifer. The HRA, page 5, identified sand and gravel as additional storage and clays as non-aquifer. The conceptual model in the HRA refers to water level in sand and gravel as similar to the water level in bedrock and forms a single aquifer unit. ASA2, as referred to in Dr Barne's evidence, is also in gravel. Mr Flanagan stated, therefore, in terms of Dr. Barnes's analysis, there is a need to be careful to distinguish between gravel and clay. Dr. Barnes's analysis could cause confusion and he could have used other terms. Mr Flanagan asked what was Dr Barnes referring to as a 'leaky confining layer'. Mr Flanagan stated that the Applicant has acknowledged that the sand and gravel provides additional storage. At HR9 the Applicant has acknowledged a significant depth of gravel and has only taken the clay to be the protective layer which is considered to be the conservative approach. Mr Flanagan asked why Dr. Barnes refers to the water in the clay as groundwater bodies when that has a specific definition?

Dr Barnes stated that he didn't agree with Mr Flanagan's analysis which was misleading: both the boreholes identified bottomed in clay and Dr Barnes suggested that there are examples of boreholes where there is gravel at an elevation within the clay. The 'confining leaky clay' is the material above the bedrock which provides additional storage. Dr Barnes stated that he was comfortable with his interpretation and it shows that the hydraulic head can be transferred to a higher level. HR9 is not

the only borehole where there is gravel in the clay. Dr Barnes stated that there is water in the shallow clay-rich drift and he interprets it as groundwater as per the Groundwater Directive. Dr Barnes stated that he interprets the clay rich drift to be a leaky confining layer which is saturated.

Mr Flanagan noted that Dr Barnes stated that he is unaware of any sites where there is a discharge of List I substances authorised to what he refers to as a groundwater table, and Mr Flanagan asked what this means and is this based on a continuous water table. Mr Flanagan identified a scenario which he indicated represented a Greenstar facility and asked if Dr Barnes was familiar with the Greenstar facilities. Mr Flanagan referred to details from the EIS prepared for Knockharley (Greenstar facility) and also the Ballynagran (Greenstar Facility) which he described as similar to the proposed facility. Mr Flanagan asked if Dr Barnes should have familiarised himself with the Greenstar facilities as they are a competitor and operate a number of facilities and it would have informed him of the regulatory approach. Mr Flanagan asked if there should be a consistent approach by the regulator and identified his issue with accusations that the application is inconsistent and flawed. Mr Flanagan identified that the low permeability clay layer is in addition to the requirements of the Landfill Directive and there is a similar situation at the Knockharley Greenstar facility.

Dr Barnes responded that the water table could be laterally continuous. Dr Barnes confirmed that he is not aware of the Greenstar facilities. His work for Greenstar has been limited to this proposed facility and therefore he does not know the details about the facilities mentioned by Mr Flanagan.

Mr Mulcahy noted that there were no inconsistencies identified with Dr Barnes evidence.

Dr Barnes acknowledged that consistency and compliance with legislation are necessary measures for a regulator.

Mr Flanagan referred to Dr Barnes's use of 'groundwater bodies' in relation to water in clays which Mr Flanagan indicated, based on WFD, is not a groundwater body. Mr Flanagan asked if there was a conflict within Dr Barnes's evidence between stating that he was not aware of authorised discharges of List I substances to water yet he had identified sub water table landfills. Mr Flanagan asked if reference to sand and gravel in ASA2 and HR9 is incorrect.

Dr Barnes identified that his statement about groundwater bodies was not in the context of the WFD. The gravel over bedrock acts as one unit, there is also gravel in clay. Dr Barnes confirmed that he is aware of sub water table landfills.

Mr Flanagan identified that technical requirements for landfills are in Annex I of the Landfill Directive, including protection of soil and water. The Groundwater Directive is referred to in paragraph 3.4 of Annex I of the Landfill Directive and protection of groundwater is built into technical specifications. The HRA is a tool to assist the decision maker. Mr Flanagan identified a number of conditions in the proposed determination in relation to groundwater and the control of discharges to groundwater and monitoring of groundwater and therefore considered that these address compliance in the proposed determination. The Groundwater Directive of 1980

provides an exemption in Article 2 and the 2006 Directive provides an exemption in Article 6, the exemptions may be used if there is monitoring of bodies of groundwater. Mr Flanagan asked what was the meaning of the reference to 'groundwater in drift' in the conclusion of evidence, and questioned if it means clay.

Dr Barnes accepted that there is a connection between engineering and protection of groundwater. He identified that he was not familiar with the proposed determination as he focused on the HRA. He understood the conditions of the proposed determination referred to by Mr Flanagan as good practice and it is a legislative requirement. The drift means the shallow clay-rich fraction.

Mr Misstear sought a clarification from Mr Flanagan in relation to one of his questions in relation to the suggestion that Dr Barnes had enough information for him to re-run the model if he so chose: Mr Misstear asked Mr Flanagan to clarify that he was not also implying that information in HRA provides results at alternative compliance points.

Mr Flanagan identified that he was referring to there being sufficient data for Dr Barnes to re-run the model.

Mr Boyle, NLAG, identified that Dr Barnes's evidence suggests that lateral movement can be 10-100 times greater than vertical movement and asked if that is possible at this site and would it happen in saturated and highly permeable layers. Mr Boyle asked did Dr Barnes seek a contour map and would the distance travelled laterally be proportionate to vertical movement. Mr Boyle identified the topography in the south east corner of the site and asked would water flow in the same direction as topography. Mr Boyle asked was it possible for water to move laterally between GR5 and BRC4, 300-400 m, along a topographic gradient of 14 m in the same time it may take to travel 4 m vertically. Mr Boyle identified that southeast of the landfill the clay depth decreases to less than 5 m and at BRC4 the groundwater level is at 0.5 m below the ground surface, Mr Boyle asked if the saturated water in the shallow drift may be in direct contact with the aquifer.

Dr Barnes identified that it is possible to have lateral flow 10-100 times greater than vertically; saturated flow would be encouraged to be lateral. The request for a contour map was for the water levels in the clay-rich drift to be presented. The water level in the shallow soils approximates with the deeper systems and so shows a significant degree of continuity. The gradient and permeability would be proportional. His concern is that the level of groundwater is likely to be above the streams and if there is an under-drain any gravel lens could link the under drain and the stream. Seepage favours lateral movement rather than vertical movement and flows often follow topography. A gradient of greater than 10 m is a reasonable gradient. The system is likely to be saturated close to the surface and at that level expected to have some connection and discharge to streams. Dr Barnes noted that he thinks there is a high level of continuity across the site.

Ms Larkin asked for Dr Barnes's opinion in relation to the model suitability for the site, has there been adequate testing of the model, is it possible to cost the development of the facility, and is there any allowance for failure of the liner?

Dr Barnes responded that there is a problem in the conceptual model, the site setting is not guaranteed to be below the water level, leading to two models being run, one to look at leakage and the other hydraulic containment and the model does not take account of how the facility will operate. LandSim is only used when dewatering is taking place from the site. For a site of this size there should be additional testing for transmissivity and degradation. LandSim provides for degradation of the liner.

Clarifications for Dr Barnes

Mr. Misstear suggested that it appeared that Dr. Barnes was making the point that because there is a partition co-efficient in the vertical pathway, that it already accounts for ion exchange and including half-life is double accounting. Therefore does retardation account for ion exchange? Mr. Misstear asked that, based on Dr Barnes's experience, did he ever see the LandSim model used in a similar situation to this site i.e. in glacial till over an aquifer and was the diffusion model used for the post closure phase? Mr. Misstear asked that of the sites that Dr. Barnes is familiar with, was he aware of a compliance point being chosen in the till? In those cases would a diffusion model or LandSim have been used for the risk assessment?

Dr Barnes identified that ion exchange and degradation are two very different processes. Degradation includes nitrification that he feels is not justified in clay and ion exchange is in model as retardation. Where there is site-specific data you can convert ion exchange to a Kd value. The retardation values used by the Applicant are creditable published values. Dr Barnes considered that he had dealt with some similar situations but they would have been based on hydraulic containment conceptual understanding. LandSim would be used for the early operation phases. Diffusion model is most suitable if you can demonstrate hydraulic containment. Dr Barnes stated that he had plenty of examples where the compliance point was chosen very close to the base of the lining system. Site design should be to protect the receptors.

Hearing adjourned from 10.55am until 11:20am.

Mr Flanagan identified that he had technical issues that he wished to respond to, in particular issues that arose in relation to Mr Cullen's evidence on the basis that Mr Cullen was not available for cross-examination. He identified that there would be about twelve points and they would be presented by Ms Burden.

Mr Mulcahy indicated that he assumed they would not relate to the evidence of Dr Barnes as he was available for cross-examination, but Mr Mulcahy sought to reserve his position.

The Chair noted that the Applicant could put forward an additional witness but there would have to be cross-examination of the evidence and that a paper of the evidence should be circulated for all parties.

Mr Flanagan committed to updating the hearing as soon as he could.

Witness No. 7 Mr White

Mr White read into the record his witness statement (Document No. 10 Appendix F). Mr White identified that in his view the EPA are trying to put a landfill into a perfectly good water supply and a clean food production aquifer. He identified that the horticultural industry depends on the water supply. Mr White noted that everyone has to accept responsibility for their decisions and asked for detailed technical responses from all EPA staff involved in the proposed decision. Mr White identified that a percentage of drinking water quality in Ireland is contaminated. He then provided details of the scale of the Nevitt resource including horticultural wells in the area and identified that the Applicant confirmed that 1.5 million litres of water per day flows under the site. Mr White pointed out that the Applicant has submitted a number of revisions of bedrock and gravel maps and he noted that a number of witnesses do not agree with the maps presented. Mr White posed a number of questions for the Chair and Assistant Chairs in relation to the information submitted to date, the information sought by the Agency and the appropriateness of information provided.

Mr White attached to his statement copies of water analyses (two sample results) that were referred to by Mr Boyle in his witness statement.

Witness No. 8 Ms Larkin

Ms Larkin read into the record her witness statement (Document No. 11, Appendix F). Ms Larkin highlighted that this is oral hearing No. 5 and the local residents find themselves at a significant disadvantage again. Ms Larkin asked what is going on and asked 'did the Council think that a report could be flung together with any old information'? Ms Larkin questioned why they should show the inadequacies of the HRA and stated that they have listened to objectors and professionals highlighting the insufficiency of the information used to compile the assessment, the inaccurate information used, the unsuitability of the model, misleading conclusions and mis-interpretation. After four oral hearings the site is a completely different site, from a geological and hydrogeological aspect, to that presented in the EIS. Ms Larkin referred to a letter (copy attached to witness statement) from the European Commission to the Permanent Representative of Ireland to the EU in relation to Petition 295/2005 on the Nevitt landfill project.

Ms Larkin identified that the GSI suggested further testing be carried out. A potential public water source has been identified, yet none of the investigations have been done and none of the inadequacies have been rectified. Ms Larkin referred to responses provided by the Applicant to questions posed at the An Bord Pleanala oral hearing. Ms Larkin identified that Council Directive 99/31/EC requires the Applicant to identify the cost of developing the site and how it is to be financed and she questioned how this could be done as the methodology for preventing pollution has not been identified. In the present economic climate, is it affordable and who is the operator?

Ms Larkin stated that the risk assessment does not address risk to rivers, streams, private wells or Rogerstown Estuary. Ms Larkin stated that the response from the Applicant is inadequate and asked that the application be rejected. Ms Larkin presented a list of what she considered the HRA failed to contain. The list included the following: a national groundwater map, an aquifer map of Fingal, an adequate assessment of the aquifer, the aquifer's output capacity, the aquifer as a future water source, loss of leachate from landfill, mis-use of the precautionary principle, no assessment of horticultural industry, justification for the landfill below the water table, archaeology, ownership of the groundwater, inaccurate EIS, location relative to airport, breach of the WFD, proximity to groundwater supplies, and the issue of nuisance.

Ms Larkin questioned the 'system' where two different agencies, EPA and An Bord Pleanala, are deliberating on an infrastructural project such as this landfill. In particular she identified that the areas of 'risk' and 'need' are been considered by the EPA and An Bord Pleanala.

Witness No. 9 Mr White (Mr De Rossa's Statement)

Mr White read into the record the written statement provided to the re-opened oral hearing by Mr De Rossa, MEP (Document No. 7, Appendix F). Mr De Rossa attended the re-opened oral hearing on Tuesday the 28th April 2009; however, as there was a full schedule Mr De Rossa was asked to submit his written statement of evidence and, subject to his agreement, have the statement read into the record by a member of the NLAG. Mr De Rossa was agreeable to this suggestion on the basis that he could not attend the hearing at another time.

Mr De Rossa's statement identified that Ireland is facing the European Court on a range of environmental cases, and in addition the Commission has expressed concern that Ireland has not properly transposed 10 of the 20 articles of the Landfill Directive. There may therefore be question marks in the future over permissions or licences granted based on defective national laws. The statement notes that the Petitions Committee sent Mr Hammerstein to the oral hearing in 2008 and notes that Mr De Rossa is pleased that the EPA has re-opened the issue. Mr De Rossa's statement notes that organisations such as Fingal Co Co will seek to progress what they see as critical infrastructure: the EPA's primary role in this instance is to protect the citizen's fundamental right to a clean environment and not simply to mitigate the worst effects of a proposal.

The statement notes that Mr De Rossa is struck by the fact that the EPA's proposed decision is reliant on the expertise of Fingal Co Co to rebut objections. The HRA is the work of the Applicant. The statement notes that Mr De Rossa's scepticism concerning the proposed dump has been sharpened by the way in which the Co Co dealt with the presence of the aquifer. He indicated that what we now know about the underground reservoir of water is entirely due to the work done by citizens affected by the proposal: leachate can escape for up to 100 years and the dump will operate until 2040. The statement notes that Mr De Rossa is convinced that if the size and importance of the aquifer had been admitted at an early stage this site would have been ruled out as an option. Whatever about the adequacy of the hydrogeological

assessment Mr De Rossa suggested that the fact an assessment has had to be undertaken calls into question all the assumptions underpinning the entire proposal.

Mr De Rossa notes that he has never come across a public authority deliberately proposing to neutralise a valuable and irreplaceable water source. The statement includes an excerpt from a letter from the European Commission to the Permanent Representative of Ireland.

The statement notes that the proposal will render a water source unusable while at the same time there is a proposal to pipe water from the west of Ireland to Dublin. Mr De Rossa urged that the proposal to grant a licence for this dump be withdrawn for the following reasons: cannot accept assurances and promises from the Applicant; must be a review of the assumptions; newly elected Fingal Co Co should be given an opportunity to review the project; there is an economic, social and environmental crisis; climate change; and the imminent availability of incineration.

Witness No. 10 Mr Lunney

Mr Lunney read into the record his written statement (Document No. 12, Appendix F). Mr Lunney stated that in his opinion there is a certain irony in the HRA because it is almost 5 years since the EIS was issued. The EIS was completely flawed. Between 2004-2009 the NLAG have brought a mountain of factual evidence to the table along with evidence of other parties. Mr Lunney asked how much of this evidence has been considered in the HRA - none in his opinion. Mr Lunney identified that the Applicant has had to reproduce numerous maps and data that bore no resemblance to those in the EIS and that there are a number of non-technical summaries all bearing different information.

Mr Lunney presented a list of points which he considered the Agency should reflect on: was the horticultural industry given adequate consideration; recommendation of Agency not to use water to the east of the site; are the Agency aware that the vast majority of fresh food supplies are over the aquifer and down-gradient of the site; why has Agency not insisted on a regional well report; why has the Agency not insisted on an independent study of the site; why is the Agency proceeding to debate this latest report; are the Agency aware of the critical importance of access to clean groundwater; other engineered landfills are failing miserably; why has GSI recommendation been ignored; why was mod-flow not required; why has the Council ignored the RPS strategic water report for the Dublin area; and the presence of an illegal landfill.

Mr Lunney stated that since 2004 the community has had one door after another closed in its face, therefore they took the case to the European Parliament where there is an active petition and Mr Hammerstein attended the last hearing and provided evidence. Mr Lunney noted that Mr Cullen walked out of the hearing as a result of what Mr Lunney claimed was a barrage of bias and favouritism towards the Council by the Agency. Mr Lunney then presented, as a number of bullet points, reasons why the proposal would have been binned in 2004/5 in any other developed country.

Mr Lunney attached the Judgement of the Court in case C-215-06 between the Commission of the European Communities v Ireland.

Hearing adjourned from 12.45pm until 2.05pm.

Closing Statements

Mr Mulcahy, Greenstar Limited

Mr Mulcahy indicated that this was his second closing statement to the oral hearing and there has been no ruling in relation to the first closing statement and that he stands over the first statement. Mr Mulcahy identified that the reason we are here is because the Applicant has proposed an extremely large landfill at the proposed site and in order to do so they require planning permission and a waste licence. The burden is on the Applicant to prove its case that the proposed development is in the interest of proper planning and sustainable development and to prove that they can carry out the construction, development and operation without causing environmental pollution, infringing on Irish regulations and European directives. It is for the Applicant to prove that its models, assumptions and outputs are robust and conservative: any suggestion that the other parties should carry out modelling to disprove the Applicant's case is inappropriate.

Mr Mulcahy noted that Greenstar are present as they are a developer of landfills and supporter of the technology but are seeking to achieve consistency in the planning and regulatory regime. Greenstar want to ensure that the 'illegal' landfill is addressed in a consistent manner. In relation to this hearing it is not clear how a hydrogeological assessment can be carried out while disregarding the 'illegal' landfill or proposals for its remediation.

Mr Mulcahy identified that the Agency requested further information from the Applicant and therefore made the decision to re-open the hearing. This has occurred because the Applicant has not provided enough information for the Agency to make a decision. The Agency previously sought a 'Modflow' model under Article 14 of the regulations, the Applicant declined to provide the model on the basis that they considered it was unnecessary. Mr Mulcahy noted that they had made a legal submission in relation to this and expected the Agency to rule on it in due course. Mr Mulcahy claimed that the refusal to provide the 'Modflow' model has at least led to this request for further information and the re-opened oral hearing.

Mr Mulcahy claimed that the Applicant has belatedly acknowledged that this is a hydrogeologically complex site and that many of the arguments put forward by other parties in relation to the presence or otherwise of gravels, aquifer, and groundwater resource have been accepted by the Applicant. The understanding is very different to that presented at the start of the process.

Mr Mulcahy identified that the assumptions and inputs are crucial to the success of the model, as confirmed by Mr Graham (witness for the Applicant). Had the Applicant carried out a Modflow model they would have established an understanding of the complex hydrogeology beneath the site. In the absence of that understanding the Applicant has developed a conceptual model after design which is wholly confused. It is not clear to the Applicant when the site will be hydraulically contained, when an under drain will be required and how leachate will be managed. In such circumstances the Applicant had to take two mutually exclusive models and

hope that some useful information would be derived. The Applicant did not have a hydrogeological understanding to develop a conceptual model to allow a proper model. The Applicant did not deem it necessary to get new information or undertake further investigations.

Mr Mulcahy claimed that in addition to the Applicant's misconceived conceptual model and the manner in which they set out to comply with the Agency request, the error is compounded by the way in which they interpreted their task. The Applicant has chosen to model outputs to one receptor, aquifer unit as they describe it. Mr Mulcahy identified that it is their submission that there are other receptors including groundwater in the underlying clays and adjoining streams. Failure to consider these receptors, or those other than the aquifer, is significant because they failed to comply with the Agency request and it means that the Applicant was unable to show that the proposal complies with the Groundwater Directive. Mr Mulcahy claimed that since any discharge of Annex I and II {List I and II of the Annex of the Groundwater Directive (80/68/EEC)} substance to groundwater is prohibited a model should have considered any groundwater likely to be impacted. The Agency letter references the Groundwater Directive rather than the Water Framework Directive, and groundwater is defined in Article 1(2) of the Directive.

Mr Mulcahy identified that the Applicant acknowledged that the clay is saturated but failed to acknowledge that it is a saturated zone. Mr Mulcahy claimed that the Applicant offered no rationale and that the description of the clay provided by the Applicant is similar to the definition of a saturated zone in the Landfill Monitoring Manual.

Mr Mulcahy claimed that Mr Flanagan, for the Applicant, in cross-examination of Dr Ashley and Dr Barnes, sought to impose a purposive interpretation of the Groundwater Directive. The wording of the Groundwater Directive is clear and while the Applicant may take issue with how restrictive the Groundwater Directive is, the Applicant cannot reinterpret the directive. There is no doubt the Groundwater Directive imposes significant obligations on the Agency and developers who wish to discharge Annex I and II substances {List I and II}.

Mr Mulcahy noted that Ireland and the Agency have been successfully prosecuted by the EC for licensing landfill in circumstances where there was failure by the Irish Authorities to prevent the discharge of Annex I and II substances {List I and II} to groundwater (Case C – 248/05).

Mr Mulcahy identified that Dr Barnes raised significant issues with the model including the modelling tools, modelling of leachate break-out, leachate treatment, degradation of ammonium and dilution rates applied. The errors identified, some of which have been acknowledged by the Applicant, would have led to a significant underestimation of the impact of the development on the environment. The Applicant has been given several opportunities to get this right and the Applicant has made a number of changes to the information initially submitted. There have been a number of requests for information by the Agency and this is the second oral hearing. Mr Mulcahy reiterated that the Applicant still hasn't developed a clear conceptual model, they haven't demonstrated compliance with the Groundwater Directive and haven't answered the request made by the Agency. In the circumstances it is time to say no to

the proposal rather than give another chance to remedy difficulties which continue to undermine any possible hope that it could secure planning permission.

Mr Boyle, Nevitt Lusk Action Group (NLAG)

Mr Boyle presented a closing statement on behalf of the NLAG, based on his written statement (Document No. 13, Appendix F). Mr Boyle stated that the NLAG wished to make the following final observations based on the most significant issues arising from the evidence presented by the hydrogeological experts at the re-opened oral hearing:

- The HRA used inappropriate modelling tools;
- The Applicant's assertion that the groundwater in the tills is discontinuous and perched is incorrect. Instead it constitutes a saturated body of clay overlying and hydraulically connected to the gravel/bedrock aquifer;
- The compliance point selected for List I substances was incorrect. It should have been located at the water table in the clay or, in the case of below-water table conditions, directly below the engineered drainage layer;
- Lateral movement of groundwater in the saturated tills below the liner could be up to 100 times greater than the vertical component;
- Arising from the above the shortest pathway through the clays to the aquifer is in a south-easterly direction where the depth of clay overburden reduces, e.g. at BRC4 some 500 m down gradient the depth of clay is only 5 m. Groundwater in the clays therefore could potentially reach this point in half the time taken to travel through 10 m in a vertical direction;
- For the same reason there is a real threat of pollution to surface streams. At some period in the future there is a possibility of malfunction in the passive water control system and consequential overspill of leachate through the capping;
- No assessment of possible pooling of leachate from beneath the bund due to high leachate levels was undertaken; and
- No measurements of the cones of depression and zones of contribution of nearby horticultural wells were carried out in the screening process in order to eliminate possible risk of pollution.

Mr Flanagan, Fingal County Council

Mr Flanagan stated that he is taking it that the Landfill Directive, Groundwater Directives 1980 and 2006 and the Water Framework Directives were read. In relation to the Agency request, dated 17th October 2008, he identified that the letter should be read in its entirety; however, he noted that he relied on the use of the following words within the letter '*relevant receptor*', '*groundwater chemical status*' and '*receptors selected for assessment (such as aquifers, abstraction wells)*'. He identified that '*groundwater chemical status*' has a meaning within the Water Framework Directive; he also identified a number of other definitions under Article 2 of the Water Framework Directive. Mr Flanagan identified that '*environmental objectives*' are referred to in Article 4 of the Water Framework Directive, and groundwater is

specifically referred to in Article 4(1)(b). He identified that Annex 2, subparagraph 2 of the Water Framework Directive also refers to groundwater. Based on the above, the Applicant identified the compliance point in the HRA.

Mr Flanagan then identified the relationships between different directives, in particular he identified Annex 1 subparagraph 3 of the Landfill Directive in relation to '*protection of soil and water*' and subparagraph 3.4 which references the Groundwater Directive. Mr Flanagan noted that there is a particular legislative framework in the Waste Management Acts and the Landfill Directive because of the words used in the Landfill Directive and he quoted the following from the directive: '*on the basis of an assessment of environmental risks taking into account, in particular Directive 80/68/EEC*'.

Mr Flanagan identified that the authorised body looking at the remedial measures will consider first the fact that disposal of waste at this proposed facility is not a dilute and disperse situation, unlike the one in the judgement referred to by Mr Mulcahy (C248-05). Because the proposed landfill is engineered it could never be considered a direct discharge. The Groundwater Directive envisages an authorisation process, the 1999 Groundwater Regulations (S.I. No. 41 of 1999) appear to recognise the Landfill Directive as it refers to the application for a waste licence. Mr Flanagan identified that there is an exemption included under Article 2(6) of the Groundwater Directive and Article 6 of the 2006 Groundwater Directive envisages the situation where one can grant a discharge where there is monitoring. Mr Flanagan claimed that the Agency has addressed this in terms of a monitoring regime.

Mr Flanagan identified that they have presented their case at this and previous oral hearings and reached decisions in relation to the status of the water in clay and they maintain there is no continuity. They believe the description provided in relation to zone of saturation and water in clay will be readily understood and therefore there is no direct discharge to groundwater. Mr Flanagan identified that the Agency's proposed determination referred to 'perched groundwater' and 'groundwater' and he considered that the Agency had made a distinction.

Mr Flanagan identified that Mr Mulcahy refers to consistency of approach and therefore Mr Flanagan invited the Board and Chair to review licences granted Register no.s 146-01, Knockharley, and 165-01, Ballynagran. He also invited the Board and Chair to look at the EIS, inspectors' reports and the assessment of the applications. He stated that the application made by Fingal County Council is entirely consistent with the approach taken with those applications and that similar hydrogeological situations apply and waste licences were granted.

Mr Flanagan referred to the GSI classification of the aquifer and what they identified as not an aquifer. He stated that he has placed particular emphasis on groundwater resource, and in terms of whatever resource there is the Applicant's evidence is that it is in 'poor' status in relation to abstraction. Mr Flanagan claimed that the statement in Mr De Rossa's evidence is quite alarming and without scientific standing, when it refers to neutralising of a valuable and irreplaceable water resource.

Mr Flanagan claimed that there has been much made of the implications of water in clays as groundwater at this oral hearing. He claimed that such an approach hasn't

been made up until now. Mr Flanagan invited the Chair to review Mr Mulcahy's closing statement from the last oral hearing, particularly paragraphs 41-45. Mr Flanagan claimed that the key concern that had been raised was in relation to groundwater resource. He claimed that the concern about a groundwater resource has been addressed. Mr Flanagan claimed that there was confederacy between Mr Cullen, Greenstar and to some extent Dr Ashley in relation to the issue at the re-opened oral hearing. Mr Flanagan noted that Mr Cullen did not make himself available for cross-examination at the last An Bord Pleanala oral hearing.

Mr Flanagan claimed that Dr Ashley has accepted that there is not an aquifer in the clay. In relation to consistency and to Mr Cullen's evidence to this oral hearing, he quoted from the submissions made by Mr Cullen since September 2006 up to his closing statement to the oral hearing in 2008, which refer to 'productive aquifer', 'groundwater resource', 'groundwater in bedrock' etc. Mr Flanagan claimed that Mr Cullen seemed to change direction at the re-opened oral hearing, which undermined Mr Cullen's own submissions to date and asked that Mr Cullen's submission to the re-opened oral hearing should be taken with the greatest of caution.

In response to Mr Cullen's submission, the Applicant does not agree that the subsoil, sand and gravel deposits and bedrock form a single continuous water body. They do not agree that the levels in the clay standpipes represents a regional water table. Evidence is that water was not generally encountered in subsoil during drilling, and the stabilised levels in standpipes show a vertical difference between the level in clay and the potentiometric surface. The hydrographs from clusters of boreholes in different strata clearly show a separation between different strata. Response to recharge and response of water levels within the clay to pumping tests were considered in the EIS. The water levels in the clay could not represent a regional water table. The regional water table is represented by the potentiometric surface in the confined aquifer. Mr Flanagan stated that the Applicant accepts that groundwater in and around the sand and gravel deposits will record similar groundwater levels to the potentiometric surface of the aquifer unit. Mr Flanagan stated that the Applicant does not accept that the water in the clay should be considered an aquifer. Mr Flanagan stated that the modelled lifetime is not user defined, and that results can be presented for any defined timeframe over the total timeframe.

Mr Flanagan noted that revised versions of Figures 3a, 3b and 3c from the HRA were submitted to the re-opened oral hearing (Document no. 14, Appendix F) with the dates included on the x-axis.

Mr Flanagan identified that the modelling exercise has been done and should form part of the totality of information collated for the purpose of reporting and forming recommendations from this hearing. Mr Flanagan stated that the EIS and technical appendices particularly H and J have recognised the characteristics of the site and maintains that this is an appropriate assessment of the hydrogeological conditions. Mr Flanagan stated that it has never been the case that the Applicant has not acknowledged the existence of the clay tills; it has never been the case that the Applicant has not acknowledged the existence of sand and gravel above the aquifer providing additional storage as a single aquifer unit; and the Applicant has modelled on that basis. Mr Flanagan stated that the Applicant has complied with the Agency request and the evidence affirms it to be appropriate and the compliance points are

appropriate, and the HRA forms appropriate additional information for the decision making process.

Mr O'Toole indicated, in response to an earlier request from Mr Misstear, that he had been able to identify with colleagues two sites where LandSim had been used in Ireland: the examples were Ballynacarrick Landfill Site and Meenaboll Landfill Site in Co Donegal.

Mr Flanagan concluded that it is an issue for interpretation in relation to 'zone of saturation' which is within the definition of groundwater. There is a difference of opinion and one is entitled to have regard to the true purpose and objectives of the Groundwater Directives 1980 and 2006 and the Water Framework Directive. Mr Flanagan referred to two cases (HMIL Limited v Minister for Agriculture (unreported judgement of 8th February 1996) and Wicklow County Council v Fenton (2002)) that support the purposive approach. Therefore Mr Flanagan claimed that one is entitled to look at the objectives of those directives and that is the way that any ambiguity should be interpreted. Mr Flanagan reiterated his interpretation of the true purpose of the directives to give protection to the groundwater resource.

The Chair clarified that the document referred to by Mr Flanagan during his closing statement, and which was submitted as evidence, is a point of clarification sought by Mr Misstear earlier in the re-opened oral hearing, as three graphs in the HRA had incorrect date formats on the x-axis. (Document No. 14 Appendix F of this report). The information provided by Mr O'Toole was also in relation to a clarification sought by Mr Misstear, similar to a clarification sought from Dr Barnes. The Chair identified that the details in relation to the two sites identified by Mr O'Toole are available to the Agency and the Chair would not be seeking further clarification from the Applicant.

Mr Mulcahy stated that, somewhat unusually, he was seeking a right to reply to matters raised in Mr Flanagan's closing statement. Mr Mulcahy stated that Mr O'Toole, admittedly in response to a request from Mr Misstear, provided new information. Mr Mulcahy noted that a similar request was made of Dr Barnes. He identified that Dr Barnes was asked if he was aware of other sites where a compliance point was other than in an aquifer and similarly to Mr O'Toole, Dr Barnes could provide a list of such sites if that would be of assistance to the inspectorate and could forward the list to the Applicant as well.

Mr Mulcahy noted that Mr Flanagan had chosen to launch an attack on Mr Cullen in his absence, and that that is a matter for Mr Cullen, but Mr Flanagan has also dragged Greenstar and Dr Ashley into the attack accusing the parties of being part of some confiding, to the extent that he has therefore questioned the independence of Dr Barnes and the objectivity of the evidence he has given. Mr Mulcahy asked that Mr Flanagan confirm that he is not questioning the independence of Dr Barnes. Mr Mulcahy also took the opportunity to confirm that Mr Cullen is not working for Greenstar. Mr Mulcahy stated that the hearing should not close without Dr Barnes's evidence being accepted.

Mr Flanagan stated that he raised the point in the context of answers given by Dr Barnes in cross-examination: Dr Barnes is retained by Greenstar, he has given a brief

of evidence and despite looking at over 100 landfills he has not looked in any detail at the landfills applied for by Greenstar on which decisions have been made. Mr Flanagan stated that his point was in relation to consistency and therefore invited the Chair to look at these applications and decisions; he does not consider that Dr Barnes sought to mislead. Mr Flanagan noted that Greenstar are looking for consistency: when you look at the Knockarley and Ballynagran sites the hydrogeology is similar to the proposed site and therefore he asked that Dr Barnes evidence be looked at in light of the similarities. Mr Flanagan noted that he does not suggest that Dr Barnes has done anything other than give his views based on the information he looked at.

Mr Boyle identified that the additional graphs provided by the Applicant were new information and sought clarification in relation to the details within the graphs.

Mr Misstear referred Mr Boyle to the HRA and in particular Figures 3a, 3b and 3c where the x-axes are incorrect: the new figures provided are identical, with just the dates on the x-axis corrected. The graphs are in colour in the HRA. Ms Burden confirmed what Mr Misstear stated.

Ms Larkin noted that Mr Flanagan in his closing statement referred to an exemption under EU regulations if sufficient monitoring data are supplied, and noted that it is not something that came up before and is something that is totally unacceptable because when an alarm goes off in a monitoring well down gradient it would be too late for everyone and the environment. It would be too much of a risk for the horticultural sector.

The Chair noted that the 'exemption' was a quote from legislation.

Ms Larkin also noted that Mr Flanagan referred to the GSI reference to the area as a resource; however, the NLAG consider that the classification is based on the GSI not being aware of the wells which would be sources rather than a resource.

Mr Boyle stated that he believes that Mr Flanagan has misled the inspectorate, the GSI did not say that the status was 'poor' but talked about quantity rather than quality. The Bog of the Ring is at its limit in relation to quantity, but we know there is a water divide between the Bog of the Ring and the Nevitt. The status of the water in the Nevitt is 'good' because of the quality and quantity of water.

Hearing Closed

Appendix F

Written Presentations to the Re-opened Oral Hearing 2009

(Available on the Environmental Protection Agency website, www.epa.ie)