Nevitt Lusk Action Group
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Recd From: DR PAUL ASHLEY.

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Proposed Fingal Landfill

Comments on the Hydrogeological Risk Assessment

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Dr Paul Ashley, Environment Practice Leader

Mott MacDonald
Demeter House
Station Road
Cambridge CB1 2RS
UK
Tel : 44 (0)1223 463500
Fax : 44 (0)1223 461007

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1 Introduction

My name is Paul Ashley, and I am Environment Practice Leader for Mott MacDonald. I submitted evidence in March 2008 to the first EPA oral hearing concerning the application for a waste licence for the proposed landfill at Nevitt, Lusk, as well as to the An Bord Pleanala oral hearing in October 2006 and to the reopened An Bord Pleanala oral hearing in November 2008.

My evidence to the initial An Bord Pleanala oral hearing concluded that "*given the size and sensitivity of the project, the extent of the ground investigation that has been carried out, and the apparently significant rate of downward flow of groundwater (and any contamination it may contain) from the landfill site, the absence of a quantitative risk assessment is a major flaw in the EIS*".

My evidence to the EPA oral hearing in March 2008 was presented orally, and again put forward arguments and recommendations for a quantitative hydrogeological risk assessment to be carried out.

My evidence to the reopened An Bord Pleanala oral hearing (which occurred after the request by the EPA to Fingal County Council for the completion of a quantitative risk assessment) commented that "*a comprehensive assessment of the risks of environmental pollution is a necessary part of the environmental impact assessment for a scheme of this nature and should therefore be a requirement of a planning application, not just of the waste licence application*".

Subsequently I wrote to my client, in a letter (19/11/08) forwarded to the EPA, setting out my comments on the scope of the work that would be needed for a satisfactory quantitative risk assessment. I also highlighted two aspects that necessarily should be included: an agreed comprehensive conceptual model of the site and the inclusion of the former landfill (in accordance with the requirements of EU legislation regarding cumulative effects).

This document is a review of the *Fingal Landfill Project, Hydrogeological Risk Assessment* report (HRA) by RPS on behalf of Fingal County Council, dated February 2009. I have taken account also of the comments made by Golder Associates in their own review of the HRA, in a letter to Greenstar dated 20 March 2009.

2 Comments

2.1 Conceptual model

In my letter of 19th November 2008, I identified a number of requirements for a conceptual model developed in accordance with normal good practice:

The model to be agreed by all parties, using the geological and hydrogeological information available from the various investigations and data gathering exercises by all the parties (including the data collected by objectors on private well usage in the area).	**Comment:** RPS has made no attempt to agree the conceptual model with the experts working on behalf of objectors to the proposals.
Plans and sections showing the thickness, depth	**Comment:** The conceptual model is described

and lateral extent, and the geological and hydrogeological properties of the various strata that have now been identified at the site (including the gravel strata that are recognised as being present at the site), and showing the occurrence and depth to groundwater in the strata.	essentially on one side of paper (section 4.1), with no plans or sections, and only brief summaries of the properties of the strata in section 5.2
Information on the usage of groundwater by private wells in the area for potable and agricultural use.	**Comment:** No such information is provided or employed. The justification given is that the furthest receptor considered is within the bedrock and overlying sands and gravels upstream of other groundwater well receptors.
Information on how the development of the landfill would proceed, including schedules and plans showing the depth of excavation and residual till thickness beneath the landfill during its lifetime.	**Comment:** Only limited information is given on the development of the landfill, including one small scale section through the site at an unspecified time in the operational phase and another in the post management phase.

There are a number of errors and significant omissions of the conceptual model:

Sand and gravel deposits: it is stated that these are "localised". Sufficient information is available from the various site investigations to demonstrate that these deposits are widespread and apparently continuous.

Thickness of the low permeability layer: it is stated that this will have a minimum thickness of 10 m beneath the proposed landfill footprint following excavation. In the absence of plans and sections showing the geology beneath the site and the thickness of the various strata, supported by borehole data, plus plans and sections showing the proposed depth of excavation in each part of the landfill footprint, this simple assertion cannot be accepted.

Presence of a confining layer: it is stated that the clay layers act as confining layers above the aquifer. While the aquifer is considerably more permeable than the aquifer unit, it is not impermeable in accordance with the normal use of the term "confining". Although this is just a matter of definitions, it should not be allowed to imply that there is no groundwater flow in the low permeability layer.

Perched groundwater: Although various definitions of "perched" exist, the normal use of the term is represented by the definition of the US Geological Survey: "*Unconfined ground water separated from an underlying main body of ground water by an unsaturated zone*". In this case, there is no evidence of an unsaturated zone beneath the clay subsoil: there is continuity in groundwater from the shallow subsoil to the aquifer. The use of the term in the HRA is incorrect.

Recharge and surface waters: no information is provided in the conceptual model on recharge to the subsoil or to the aquifer, or the relationship of groundwater with streams. The Environmental Statement suggests recharge of 18-54 mm/yr. This recharge enters the shallow subsoil: some will seep into the low permeability deposits, and, according to the vertical hydraulic data, will seep to the aquifer, while some will eventually return to the surface in streams. There is clearly a potential pathway for any contamination seeping from the landfill to mix with this groundwater and enter streams. This has not been considered in the HRA – a major shortcoming.

Receptors - groundwater: The HRA assesses potential impacts on only two receptors: that for List I substances is the aquifer unit immediately beneath the landfill and prior to dilution. For List II substances it is within the aquifer 100 m down gradient. EU legislation (the Groundwater and Water Framework Directives) essentially include all water below ground level in the definition of groundwater, and consequently for List I substances the compliance point should be immediately below the landfill liner. The choice of compliance point at the top of the aquifer is therefore incorrect.

Receptors – surface water: Based on my previous comments about groundwater, recharge and surface water, 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. The failure to include local surface waters as a receptor is a major shortcoming of the HRA.

2.2 Landsim modelling

Landsim is designed explicitly for simulating the behaviour of landfills where the base is above the water table, with an unsaturated zone between the base and the water table. It has long been recognised as unsuitable for the case where the base is below the water table and the leachate level in the landfill is also below the water table, which is the design for the proposed landfill.

The application of Landsim in the HRA has been thoroughly reviewed by the expert authors of Landsim (of Golder Associates, developers acting on behalf of the Environment Agency). I concur with their comments. In summary:

- It is not clear whether, if ever in the life of the landfill, the conditions for application of Landsim will exist. At present they do not, as the landfill base is below the water table.
- Limited justification has been given for adoption of some of the parameters used in modelling.

In addition, I would add:

- Landsim is not capable of simulating the movement of groundwater from recharge into the shallow subsoil and low permeability layer, and then laterally to surface water courses. A more sophisticated model is needed for this purpose.

The use of Landsim is therefore inappropriate and invalidates the conclusions drawn from it.

2.3 Contaminant Fluxes spreadsheet

The Contaminant Fluxes from Hydraulic Containment Landfills spreadsheet is designed explicitly for the scenario proposed for the Fingal Landfill, where the base would be below the water table, and the level of leachate in the landfill would also be below the water table. However, the EA states in the user manual "*It should be noted that there are a number of limitations to the model that will generally make it a scoping tool rather than a detailed final risk assessment model. …… If the appraisal of a risk assessment does not allow a clear decision to be made, more sophisticated modelling and/or well constrained site specific data will be required*".

One of the limitations is the assumption that the only means for leachate contaminants to escape from the landfill is by diffusion across the liner i.e. it cannot assess the possibility of loss of leachate liquid in the event that the water table drops locally or occasionally below the level of leachate in the landfill during construction, operation, aftercare or post management.

It should be noted therefore, that this modelling tool only simulates diffusion of contaminants across the liner, between leachate on the inside and groundwater on the outside. It is thus of only minor value is the risk assessment process.

It is noted that RPS has modified the spreadsheet so that it can carry out a probabilistic assessment of risks rather than a simple deterministic assessment. The HRA does not indicate whether the model as modified has been validated either by an independent third party, or by internal procedures.

2.4 Conclusions of the risk assessment

The conclusions presented in the HRA are a simple summary of the mathematical results of modelling using Landsim and the Contaminant Fluxes spreadsheet:

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.

No attempt is made to assess the validity of the conclusions in the context of the discrepancy between the conceptual model as defined and the conceptual model that underlies both tools.

2.5 Former landfill

In my letter of 19th November 2008, I noted that the EPA letter requesting the risk assessment does not clarify the relationship of the risk assessment to the former landfill known to be on the site. A part of the proposed landfill development project includes remediation of the old landfill. The remediation process, which may include capping and/or excavation and redeposition of the old waste, has not been finally determined. Such works have the potential to release old leachate and contaminants while the waste is being excavated.

The EU Environmental Assessment Directive (amendment 97/11/EC) states, however, that *"The characteristics of projects must be considered having regard, in particular, to.....the cumulation with other projects."* The EU has also published "Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions, 1999" which covers the same issue.

It appears from this that the risk assessment (and the EIA) ought to cover the complete project of both old landfill remediation and new landfill development. This has clearly not been addressed in the HRA.

2.6 Appraisal of overall approach and methodology

Complexity issues

As has been described above, the site for the proposed landfill is complex:

- A spatially complex site, with incised streams and an old landfill.
- Shallow subsoil, a low permeability non-uniform clay layer, and an underlying aquifer unit, all with variable thickness and properties.

- Groundwater present throughout, but with upward and downward gradients in different locations, as well as localised artesian conditions, and the probability of lateral movement from shallow and intermediate groundwater to streams.

The development itself is also expected to be complex: a long phased development of multiple cells, with variable cell base depths, and major remediation works at an existing landfill on the site.

The simplistic models of Landsim and the Contaminant Fluxes spreadsheet are quite incapable of simulating the behaviour of all the relevant processes occurring at the site.

EPA requirements

I note that the EPA requested (17/10/08) a "*detailed quantitative probabilistic risk assessment …… to examine in detail the fate and transport of contaminants within the leachate and risk to groundwater……*".

In my opinion, the HRA does not comply with the EPA's requirements for a "*detailed ….. assessment*", nor does it examine "*in detail the fate and transport of contaminants*".

EA guidance compliance

RPS states that it has carried out the risk assessment in accordance with *Hydrogeological Risk Assessments for Landfills TGN01* guidance (2003) published by the Environment Agency of England & Wales. However, it has not complied with this guidance in a number of areas, such as:

- Receptors/compliance point: TGN01 states that the receptor for List I substances should be the point of entry into groundwater (to comply with EU legislation), which, in this case, is immediately below the landfill, just outside the liner. The HRA has placed it at the top of the aquifer.
- Scenarios: TGN01 states that "*A variety of scenarios should be developed to reflect different phases of the landfill's life*". The HRA appears to have carried out the modelling using some variation in parameters to reflect leachate quality changes and landfill liner defect growth, but no attempt seems to have been made to reflect the real construction phasing of the landfill.

3 Conclusions

My conclusions are as follows:

(a) The conceptual model employed by the 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.

(b) 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.

(c) 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.

(d) 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.

(e) 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*" requested by the EPA. It also effectively simulates only one process – diffusion. RPS 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.

(f) 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.

(g) 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.

(h) No attempt is made to comment on or assess the validity of the HRA conclusions in the context of how well the conceptual model matches the actual conditions at the site, or how well the conceptual model employed matches the conceptual model that underlies the risk assessment tools.

(i) 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.

In summary, my opinion is that the HRA is quite inadequate as a basis for understanding the real contamination risks that could arise from the proposed landfill.

4 References

1. *Landsim 2.5* (summary report), Environment Agency

2. *Hydrogeological Assessment for Landfills*, Technical Guidance Note 01, Environment Agency March 2003.

3. *Contaminant fluxes from hydraulic containment landfills spreadsheet v1.0: user manual*, Environment Agency, 2004.

4. *Fingal Landfill Project, Environmental Impact Statement*, RPS, April 2006.

5. *Fingal Landfill Project, Hydrogeological Risk Assessment*, RPS, February 2009.