Submission (34)

3RD/10TH/2006.

DR IAN MARNANE
INSPECTOR
EPA
P.O. BOX 3000
JOHNSTOWN
CASTLE ESTATE
CO, WEXFORD

YOUR REF WO-231-01

Dear Ian,

Enclosed please find Dr paul ashleys report as discussed in support of the information Delivered to you yesterday by paddy boyle.

Kind regards
Shay Lunney
On behalf of the nevitt lusk action group

Shay Lunney.

Nevitt Lusk Action Group
Windfield
Nevitt
Lusk
County Dublin

Fingal Landfill Project

Review of Environmental Impact Statement

7th September 2006

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Fingal Landfill Project

Review of Environmental Impact Statement

Issue and Revision Record

Rev	Date	Originator	Checker	Approver	Description
C	7th September 2006	Paul Ashley	Anthony Feigl	Paul Ashley	Third issue following client comments

List of Contents

1 Introduction

Fingal County Council (FCC) has identified a site at Nevitt near Lusk, where it proposes to construct a landfill to accept waste from the Dublin area, in the context of the Dublin Waste Management Strategy (2001). An Environmental Impact Statement (EIS) and supporting documents have been prepared in support of a planning application.

A community group, Nevitt Lusk Action Group (NLAG), objects to the proposed location. One of the issues of concern is the risk posed to the local aquatic environment, groundwater in particular, by pollution from the landfill.

This report has been prepared by Dr Paul Ashley of Mott MacDonald on behalf of the NLAG to provide a review of the EIS with reference to the aquatic environment and to groundwater in particular. The curriculum vitae of Dr Ashley, showing his credentials as an expert in the field, is included in Appendix B.

The report is based on:

- A review of the following documents.
  - Dublin Landfill Siting Study, RPS/MCOS, September 2004
  - Fingal Landfill Project, EIA - Preliminary Scoping Report for Consultation, RPS/MCOS, December 2004.
  - Fingal Landfill Project – Ground Investigations Factual Report, Glover Site Investigations Ltd, October 2005.
  - Fingal Landfill Project - Environmental Impact Statement, RPS/MCOS, April 2006.
- Discussions with, and information provided by, the Geological Survey of Ireland (GSI) during a meetings on 21st March 2005, and 18th August 2006.
- Observations made by Dr Ashley during visits to the site of the proposed landfill on 21st March 2005 and 24th April 2006.

2 Summary of issues

The sections of the EIS concerning hydrogeology and water pollution are based on detailed investigations carried out since spring 2005, many of which arose from recommendations by Mott MacDonald after reviewing the Dublin Landfill Siting Study.

Few major errors or omissions have been identified in the factual data in the EIS, although we have identified a number of matters that are presented in a misleading or incorrect manner (see Chapter 3).

However, it is also considered that the assessments of a number of risks or issues have been carried out in a simplistic or incomplete manner, or have not been considered at all. If carried out in full, they may lessen the feasibility of developing the landfill, increase the requirements for additional mitigation measures, or increase the risk to water users and the environment. They are summarised below, and described in more detail in subsequent chapters.

(a) **Risk assessment methodology:** The method of assessment of the risk that leachate will escape from the landfill and pollute local groundwater is very weak. Based only on the assumption that the landfill liner will be impermeable, that leachate will not seep through the subsoil, that pollutants will be absorbed in the subsoil, and that residual pollutants will be diluted in the aquifer, it is stated that the risk is not significant. It is remarkable that a quantitative risk assessment has not even been attempted (Chapter 4).

(b) **Leachate management:** More specific information should be provided on how leachate will be managed: in particular, it is not clearly stated, except as a brief reference in the section on hydrogeology, whether leachate will be maintained at a specific depth above the base (which is critical for minimising the risk of leakage). The risk that groundwater will enter the landfill and add to the amount of leachate generated is not considered (Chapter 5).

(c) **Landfill site below the water table:** The siting of the landfill such that its base is below the local water table may contravene the requirements of the EU Groundwater Directive by permitting the release of "List I" pollutants directly to groundwater. This issue has not been addressed in the EIS. (Chapter 6).

(d) **Aquifer vulnerability:** The EIS assessment of risks of pollution of groundwater is critically dependent on the assessed thickness of clay overburden above the aquifer. It is considered that the assessment of thickness is based too much on the data from boreholes that are located only on relatively high ground and do not measure the thickness in local water courses that are steeply incised. In other words, local topographic variation is ignored. Indeed, there is evidence of actual flow from the aquifer up through the overburden into a stream on the proposed site. Furthermore, the remaining thickness of the overburden beneath the proposed landfill base after construction appears not to have been estimated. The EIS also assumes that the permeability of the clayey overburden is sufficiently low that it is effectively a barrier to flow, though based on the actual permeability data there is the potential for significant flow through the overburden. (Chapter 7).

(e) **Protection of the Bog of the Ring water source:** A key issue identified at the scoping stage was whether the site falls within the zone of contribution to the Bog of the Ring public supply wellfield: a large number of new boreholes were drilled to determine this issue. The EIS omits to take account of data from three boreholes, and fails to extend and update the existing GSI computer model of the regional aquifer. The reasons for not doing so are based on a simplistic view of the local hydrogeology and take no account of drought or wet seasonal conditions. (Chapter 8).

(f) **Aquifer classification and resource protection:** The aquifer beneath the site (formed from the Loughshinny, Naul and Lucan formations) is currently classified by the GSI as a Locally Important Moderately Productive Aquifer, which envisages landfill construction as long as there is sufficient thickness of low permeability overburden. However, although not used for public supply, the aquifer appears to be widely used for local private and commercial supply, including market gardening that requires high quality water. There is also the potential for higher capacity wells along the fault zone just east of the M1 motorway. The proposed landfill location would place such new wells, and other existing wells downstream at risk of contamination (Chapter 9).

(g) **Surface water management:** The landfill would extend across one significant water course and up to the edges of others. More details should be given of the design of rerouted channels, and of the flood protection measures needed to prevent erosion of the landfill edges (Chapter 10).

3 Issues of errors and omissions in the EIS

3.1 Completeness

The Scoping report of June 2005[1] describes the scope of work for the EIA with regard to groundwater.

Table 1: Comparison of scoping study commitments with the EIS

Proposed task	How addressed in EIS
Assess the presence of structural features that may be present below the site that could influence groundwater flow and aquifer transmissivity.	There appears to be no evidence for "structural features" beneath the site, although the issue is not specifically addressed in the EIS
Assess groundwater flow below the site in the shallow and deep bedrock in both the horizontal and vertical directions.	Horizontal flow is considered in some detail. Vertical flow, which is critical to an assessment of the risk that pollution from the landfill could reach bedrock groundwater, is only qualitatively considered, noting that there is a downward hydraulic gradient from the overburden to the bedrock. **This is a significant omission.**
Assess the seasonal variations in groundwater levels and flow directions, particularly between winter and summer periods across the landfill and Bog of the Ring study area.	Actual variations are recorded only for the period from June '05 to January '06. No assessment is made of longer term seasonal variations under drought or high rainfall conditions. **This is a significant omission.**
Assess the aquifer parameters of the bedrock below the site.	Largely addressed
Improve understanding of the hydrogeological setting of the landfill site in relation to the wider hydrogeology surrounding the site and the potential linkages with the Bog of the Ring Source Protection zone (e.g. through fault zones).	This has been partly addressed by analysis of the additional data obtained during the EIA. However, no attempt has been made to assess the impact of the fault zones and overlying gravel on localised flow patterns. This would most effectively have been done by extending and refining the GSI groundwater model. **This is a significant omission.**
Assess groundwater recharge and age below the landfill site.	Recharge is assessed, but not the age of groundwater beneath the site. This is not considered a significant omission.

3.2 Errors and issues of clarity

The following statements in the EIS are considered to be incorrect or involve misleading or unclear use of terminology.

- Throughout the EIS the soils and unconsolidated strata overlying bedrock are often referred to as "clay". This is a potentially misleading use of the term, and in most cases "overburden"

[1] *Scoping of Environmental Impact Assessment for Fingal Landfill Project – Draft*, RPS-MCOS, 2nd June 2005

or "drift" deposits should have been used. It is of critical importance for siting of the landfill in this location to demonstrate whether or not there exists a ten metre thickness of clay or other low-permeability strata above the bedrock aquifer. Use of the term "clay" implies that the overburden is everywhere of low-permeability, whereas although clay is the dominant overburden material gravels and other higher permeability lithologies are also present. Where it is important to distinguish between overburden layers of different origin, the term "till" is best used for the low-permeability material.

- Gravels occur at different stratigraphic levels in the proposed landfill area: occasionally above the till deposits, though most commonly below them. There also appears to be a significant increase in thickness in gravel deposits close to the fault zone just east of the M1, which may imply a different origin. While the Non Technical Summary is not intended for making fine scientific distinctions, some indication of these significant differences should have been given. The Non Technical Summary also erroneously states that the gravel rages in thickness up to ten metres: it actually ranges up to 17 m, as noted in the Main Report.
- Groundwater level data from three boreholes appears to have been omitted from consideration, possibly because the levels were not measured. The three boreholes (BGB1, ER1 and HR6) all appear to be flowing artesian: the water level is therefore above ground level and should be measured either with a pressure gauge or by extending the borehole liner upwards until a water level can be determined. A recent inspection of BGB1 on 18th August 2006 shows no sign that such measurements have been attempted. The omission of this data has a significant impact on interpretation of groundwater flow (e.g. Figure 3.18.5 in the EIS Main Report).

4 Issue: risk assessment methodology

The only assessment of the risk that leachate will leak from the landfill and cause pollution of local groundwater is contained in EIS Appendix H, section 5. It is purely a qualitative assessment: no attempt has been made to estimate or calculate the possible or likely quantities of pollutants that could reach the aquifer under alternative scenarios.

A quantitative risk assessment is a normal requirement of landfill planning in other European jurisdictions. The UK Environment Agency, for example, has developed a risk assessment model, LANDSIM, for the specific purpose of landfill risk assessment. (LANDSIM is not suitable for use at this site: in the UK, landfills are not normally permitted where it is to be constructed below the water table, as in this case, and LANDSIM cannot simulate such conditions).

The qualitative assessment appears to assume that the geomembrane liner would be impermeable at the outset, and would remain impermeable during operation and aftercare. However, there is widespread research into defects in HDPE liners that shows that some defects are inevitable, particular with age, and that some common substances in non-hazardous domestic waste can cause degradation of a liner. It is normal practice in quantitative risk assessments, therefore, to assume that some defects, however minor, may occur, increasing with the age of the site: a certain low level of permeability of the liner is therefore taken as normal, without considering it as an unacceptable defect, as long as there are sufficient alternative barriers or attenuation mechanisms. **The assumption that the geomembrane liner will be "impermeable" is a significant flaw and does not correspond with real conditions.**

Where vertical hydraulic gradients in the ground have been measured, they typically show a downward gradient, indicating that groundwater flow is downwards through the subsoil. The actual

rate of flow depends also on the permeability of the subsoil: the EIS provides permeability values ranging between 10^{-5} and 10^{-9} m/s which, while classified as low to very low, can actually transmit significant quantities of water.

For example, the simple calculations in section 7.2 below show that the rate of downward seepage may be of the order of 10% of the horizontal flow beneath the landfill site. In the event of seepage of leachate from the landfill, therefore, **there may be only limited dilution of contaminants as they enter the bedrock groundwater.**

The EIS notes that bacterial and other contamination was detected in the aquifer around the site, but interprets this as originating from septic tanks or cess pits some distance from the site where the clay subsoil is thinner. It gives no justification for this interpretation, and does not consider the alternative, that it is **evidence that pollutants can seep down through the subsoil to the aquifer around the site.**

These comments regarding leakage through a liner, downward flow and dilution have been made here not as definitive statements of risks, but as an indication that there are potentially significant risks of movement of leachate in groundwater downwards from the landfill to the bedrock aquifer and of pollution of the aquifer. **Therefore, 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.**

5 Issue: leachate management

The EIS describes in general terms (Main Report, section 2) how leachate would be managed during construction and operation of the landfill. Specific details are missing, however, and one particular issue has not been considered.

- It is normal in landfill operation to maintain the level of leachate in a landfill at a low level above the base in order to minimise pressure that would increase the seepage of leachate through minor defects in the liner. For a landfill operator, however, the lower the level at which leachate is maintained, the higher the cost of pumping and treatment. **The level of leachate that will be maintained in the landfill should be specified**: typically at one metre above the base. This figure is referred it in the assessment of pollution risks (Main Report, section 3.18.9) but it is not clear if this is an operational requirement or simply an indicative figure for the purpose of assessing risks.
- The quantity of leachate that will be generated appears to be estimated solely from rainfall and other hydrometric data, and does not take account of possible ingress of groundwater to the landfill. In landfills that are sited so that they are above the water table this is a reasonable approach. The Fingal landfill, however, is located such that its base will be below the perched water table in the subsoil and below the piezometric surface of the bedrock aquifer. There is thus a risk that in the event of any defect in the liner (see Chapter 4 above) some groundwater may enter the landfill, adding to the quantity of leachate to be treated. The significance of this is that the landfill design assumes that excess leachate will be disposed off-site at Portrane, Swords or Malahide wastewater treatment works: if this additional leachate is generated, then **there may be insufficient leachate handling capacity in the sewer system or the proposed road tanker arrangements**.

6 Issue: siting the landfill below the water table

The EU Groundwater Directive 80/68/EEC requires that certain high-toxicity pollutants ("List I") should be prevented from entering groundwater, and the entry of certain other less toxic pollutants ("List II") into groundwater should be limited. Member states are required to "prohibit all direct discharges of substances in List I" to groundwater. Groundwater is defined as:

> *"all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil".*

Direct discharge is defined as:

> *"the introduction into groundwater of substances in List I and List II without percolation through the soil or subsoil"*

The groundwater in the subsoil at the proposed landfill site clearly falls within the definition of "groundwater" in the directive. The landfill will be sunk partly below ground, and its base will be below the water table in the subsoil and below the piezometric surface of the bedrock aquifer – it will therefore be in direct contact with local groundwater.

Leachate at the landfill is likely to contain both List I and List II substances although, given that the waste would be inert or non-hazardous, the concentrations of List I substances are likely to be low.

Any seepage from the landfill that contained List I or List II substances would therefore effectively be a direct discharge to groundwater, and should be prohibited. As it is impossible to be certain that the landfill liner will be absolutely impermeable (see Chapter 4 above), it is likely that the landfill would contravene the Groundwater Directive.

It is likely that the authors of the EIS consider that the clayey overburden is of such low permeability as effectively not being an aquifer, but rather an aquiclude that seals the underlying aquifer from pollution and water ingress. However, measured permeabilities in the field (which are more representative of actual flow than laboratory measurements), range between 10^{-06} and 10^{-09} m/s. Materials with permeabilities around 10^{-06}-10^{-07} m/s can transmit significant groundwater flow, and it is unreasonable to treat such groundwater in the clayey overburden as excluded from the requirements for protection under the Groundwater Directive.

This issue has been considered in other countries in the EU including the UK, and it has commonly been addressed by avoiding landfills in areas where they are in direct contact with groundwater: they are designed so that the base is above the water table, which allows for attenuation of List I substances in the unsaturated zone before they enter the water table. Where they are constructed below the water table, as in this case, there are specific requirements for site location and design, and for quantitative modelling and risk assessment to ensure that the risks from List I substances are reduced to an acceptable level.

A review of national law, case law and regulatory requirements to determine how such issues should be addressed has not been provided in the EIS and is beyond the scope of this report. **Nevertheless, it is clear that, because the landfill is in direct contact with shallow groundwater, it has the potential to contravene the EU Groundwater Directive. The fact that that the EIS does not discuss the placing of the landfill below the water table in this particular context, does not**

recognise the issues and potential risks and makes no attempt to assess the risks quantitatively, are significant flaws.

7 Issue: aquifer vulnerability

7.1 Thickness of low-permeability overburden

The Dublin Landfill Siting Study selected the site at Nevitt on the grounds that, with regard to environmental issues, there is minimal risk of water pollution because of the thickness of low-permeability glacial deposits, and because of the perception that it was outside the zone of contribution of the nearest public water supply wellfield.

The importance of these criteria arises from the requirements laid down by the GSI for the siting of landfills on aquifers. The EIS has concluded that the aquifer beneath the site should have a 'Low' Vulnerability Rating under the GSI classification, which, for a Locally Important Aquifer results in a Response Category 'R1'. R1 is the lowest level of Response Category, where landfill development is considered "Acceptable subject to guidance in the EPA Landfill Design Manual or conditions of a waste licence".

However, only a relatively small change in the site conditions would give the aquifer a 'Moderate' Vulnerability Rating and a Response Category of R2[2], where, in addition:

- "Special attention should be given to checking for the presence of high permeability zones. If such zones are present then the landfill should only be allowed if it can be proven that the risk of leachate movement to these zones is insignificant. Special attention must be given to existing wells down- gradient of the site and to the projected future development of the aquifer" and
- "Groundwater control measures such as cut-off walls or interceptor drains may be necessary to control high water table or the head of leachate may be required to be maintained at a level lower than the water table depending on site conditions"

The factor that separates 'Low' from 'Moderate' Vulnerability is the thickness of subsoil above the aquifer: for clayey soils, the thickness must be greater than 10 m for 'Low'.

The EIS bases its assessment of the thickness of the clay subsoil (Appendix I, section 4.2) on data from boreholes drilled across the site, all showing greater than 10 m, and some greater than 20 m thickness of clay subsoil. However, these boreholes are all drilled on relatively high ground away from water courses. The water courses across the site are incised by several metres (Photo 1), and it is likely that the thickness of subsoil is significantly reduced beneath them.

The EIS should have examined this possibility both by drilling some boreholes through the beds of streams and by using a topographic survey of the site to calculate the reduction in subsoil thickness beneath the streams. It is surprising, given the importance of this factor, that the EIS does not provide a map of clay subsoil thickness across the site after excavation of the landfill footprint, showing the distribution of boreholes, topography and water courses.

Figures 2 and 3 show groundwater levels in the bedrock beneath the clayey overburden. An obvious feature, not referred to or discussed in the EIS, is the steep gradient in the water table in the western

half of the landfill site area, and the sudden flattening out of the gradient in the eastern half. In hydraulic terms, the only possible causes are a sudden increase in aquifer permeability, for which there is no evidence, or a loss of groundwater from the aquifer. As the change in gradient coincides with the line of a stream, the most likely explanation is that groundwater is seeping upwards to the stream, confirming that the clay overburden is not a barrier to groundwater flow.

Figure 1 is a map of the present thickness of clay subsoil across the site, showing the watercourses and borehole locations. There is scope for uncertainty and interpretation in what constitutes "clay thickness" as, in some boreholes, the clay is not a continuous uniform sequence, but contains sand and gravel, or is described as "sandy, gravelly clay" or similar. Nevertheless, this map provides an indication of how close the landfill is to falling into the 'Moderate' Vulnerability classification.

Photo 1. Water course in centre of site

In summary, the EIS is at fault because:

- The EIS has not estimated the thickness of the clay till beneath streams.
- The EIS has not shown a map of thickness of the clay till beneath the proposed base of the landfill.
- It ignores the evidence for actual groundwater flow through the clayey overburden.

The failure to takes these steps means that the aquifer at the site cannot readily be classified as 'Low' rather than 'Moderate' Vulnerability.

7.2 Vertical flow and pollution migration in the overburden

As noted in chapter 4 above, the EIS assessment of vertical flow is limited. It notes that water levels in boreholes in the clayey till are typically two metres above those in bedrock boreholes, but does not analyse the implications of these measurements.

Based on the data given in the EIS:

Permeability	10^{-07} m/s
Thickness of clay layer	20 m
Hydraulic head difference	2 m
Area of landfill	500,000 m^2

- and using Darcy's Law (a fundamental law of groundwater flow), groundwater would flow downwards to the bedrock aquifer at a rate of:

$(500{,}000 \times 10^{-07} \times 2) / 20$

$= 0.005\ m^3/s$ or $432\ m^3/day$

A similar calculation can be made fore the horizontal flow in the bedrock beneath the landfill site. With the following realistic data values

Transmissivity	50 m^2/d
Hydraulic head gradient	0.08
Width of aquifer beneath site	1000 m

- the flow rate is therefore:

$0.08 \times 50 \times 1000$

$= 4000\ m^3/day$

While there is some scope for argument about precise values of parameters to be used in these calculations, it is clear that downward vertical migration of groundwater, potentially contaminated by leachate, could form a significant proportion of the horizontal groundwater. **The failure of the EIS to make a quantitative assessment of vertical flows is therefore a significant omission and casts further doubt on the classification of the aquifer at the site as 'Low' rather than 'Moderate' Vulnerability.**

8 Issue: protection of the Bog of the Ring

At the scoping stage for the EIA it was concluded by RPS-MCOS that the proposed site did not fall within the zone of contribution to the Bog of the Ring wellfield. This conclusion was based on a combination of:

- Measurements of groundwater levels in the boreholes that then existed in the area, which allow a broad delineation of groundwater catchments.
- A computer model of the groundwater system around the Bog of the Ring developed by the GSI.

The edge of the zone of contribution, which coincided with the boundary between two catchments, one flowing north and the other flowing south, was determined to be just north of the proposed landfill site; the site therefore fell outside the zone of contribution.

It was recognised that additional groundwater level measurement points were needed, and so the EIA included the drilling of a large number of additional boreholes. The groundwater levels, as monitored in the boreholes from summer 2005 to spring 2006 (see Figures 2-3, which include estimated values for the water level in the artesian boreholes referred to in Chapter 3 but omitted in the EIS), show the boundary of the zone of contribution to be about half a kilometre north east of the proposed landfill site.

A particular feature of the groundwater levels is the closed 37.5 m contour one kilometre north east of the site. This implies that there is groundwater seeping upwards to the headwaters of the north-flowing stream.

These figures, however, represent only a "snapshot" of groundwater flow patterns in less than one year. A further assessment is needed as to how these flow patterns would change in exceptionally dry or exceptionally wet conditions. Unless data from such extreme years is available, such an assessment would normally be made using a computer model, within which rainfall and aquifer recharge can be altered to see the effect on groundwater levels.

The GSI acknowledges that its computer model is only of limited value for such an assessment because:

- Its southern extent was artificially fixed at the catchment boundary as it was then understood. Any attempt to simulate how the catchment boundary, and hence the zone of contribution, might change under varying rainfall or pumping conditions would be unrealistic because of the effect of the artificially fixed edge of the model.
- The model is based on a grid mesh that is particularly coarse in the area of the southern boundary, which means that it cannot be used to represent accurately the local geology and simulate flow patterns around the narrow fault zone and narrow buried channel of gravels along it.

It is considered that the EIS has not conclusively demonstrated that the proposed landfill site is outside the zone of contribution to the Bog of the Ring under all likely seasonal and annual fluctuations of rainfall. The failure to develop a new computer model which could have been used for this purpose is considered a significant flaw in the EIS.

9 Issue: protection of other water resources

The aquifer beneath the proposed landfill site, which is laterally extensive to east, west and south, is classified by the GSI as a Locally Important Moderately Productive Aquifer. From discussions with Ms Hunter-Williams of the GSI, it is understood that the classification of "locally important" rather than "regionally important" was based partly on the relatively low permeability of the aquifer and partly because rainfall recharge to the aquifer is considered to be limited by the clayey overburden.

It is noted, however, that actual transmissivities (a term that refers to the permeability times the thickness of the aquifer) of the bedrock aquifer are 10-76 m^2/d, a range that certainly permits productive wells for private supplies, market gardening and low-consumption industrial uses. It is

indeed the case that such uses are well-known in the area. A survey of such uses is currently in hand by our Client.

There is a significant thickness of gravel along the fault zone that lies east of the M1, which has a greater permeability. Wells in this area would be able to draw water from a much wider zone of contribution than wells in the bedrock alone, exploiting the ability of the gravel bed along the fault to intercept groundwater flow over a greater width of the bedrock aquifer.

It is our opinion that the value of the aquifer on which the landfill would be sited is not adequately assessed in the EIS. The EIS has relied too rigidly on the classification as Locally Important Moderately Productive. Even if this is correct, the current use of the aquifer, and its potential future use for market gardening and light industry would be placed at risk by a landfill placed at the proposed site.

10 Issue: surface water management

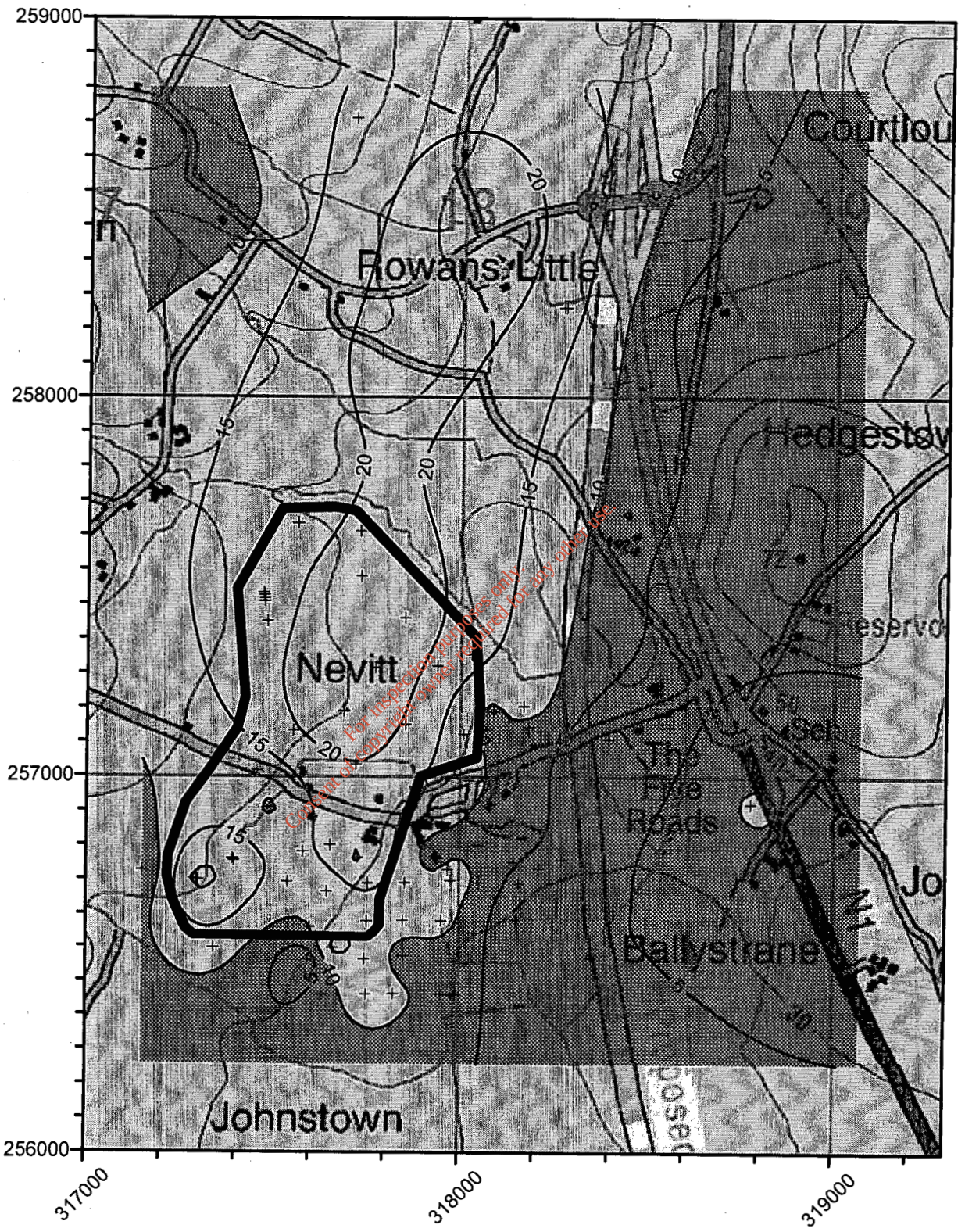
The EIS states (Main Report, section 2.4.2.4) that surface water courses and land drains will be diverted at the time of construction, but provides no details regarding which watercourses will be diverted and the routing of diversions. The risks arising from inadequate provisions in this regard are:

- High rainfall during construction while diversions have been only partly completed, resulting in high concentrations of silt run-off, causing pollution downstream.
- Poorly designed or insufficient diversion could cause erosion of the margins of the landfill, including the leachate containment system, as a result of flooding during site operation, causing pollution downstream.
- Diversion channels with insufficient capacity could result in local flooding.

The description of surface water management in the EIS is therefore considered inadequate.

Appendix A Figures

Figure 1. Thickness of clay overburden (m)



Area where clay overburden is less than 10 m

21st June 2006
Clay thickness.srf

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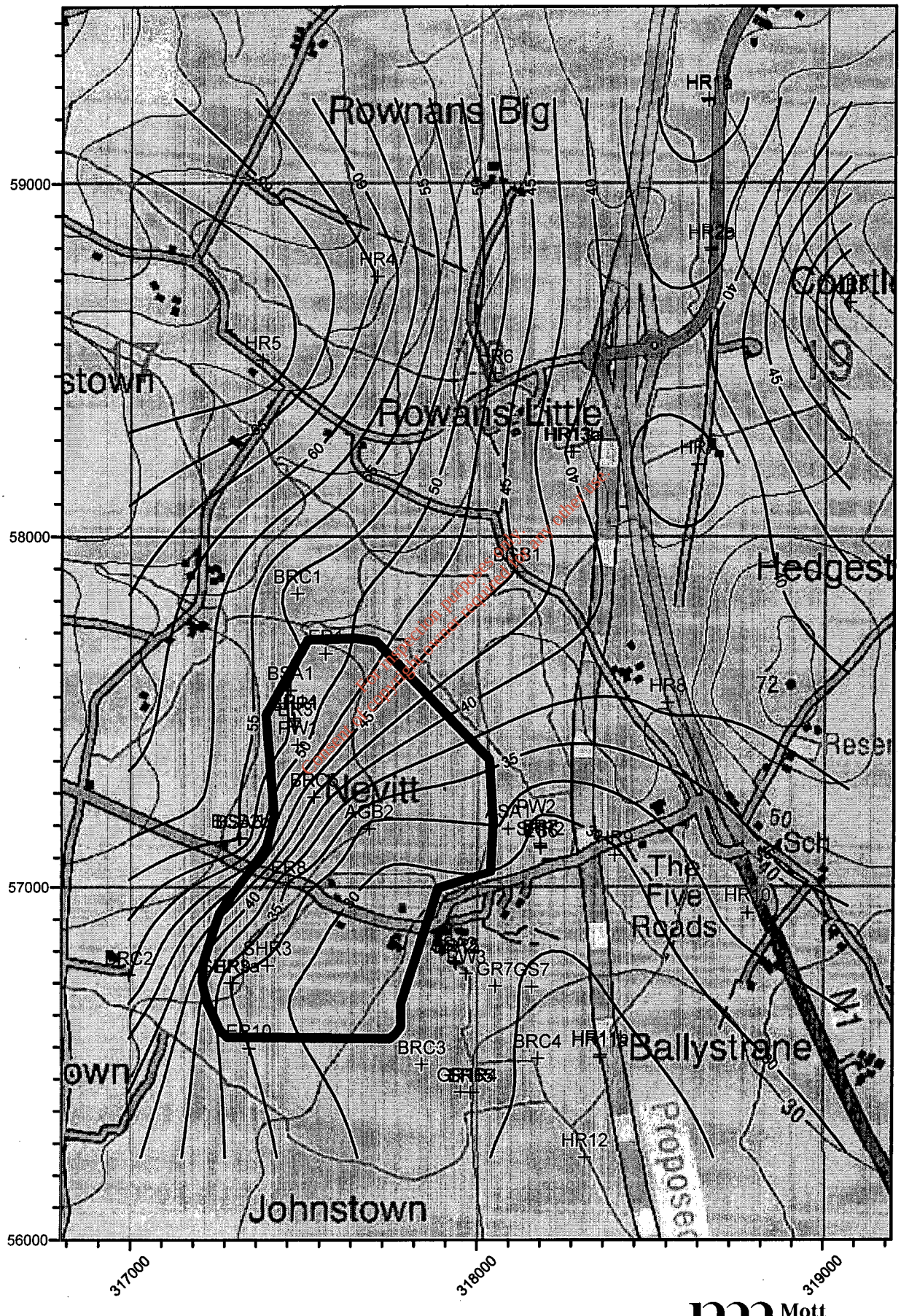
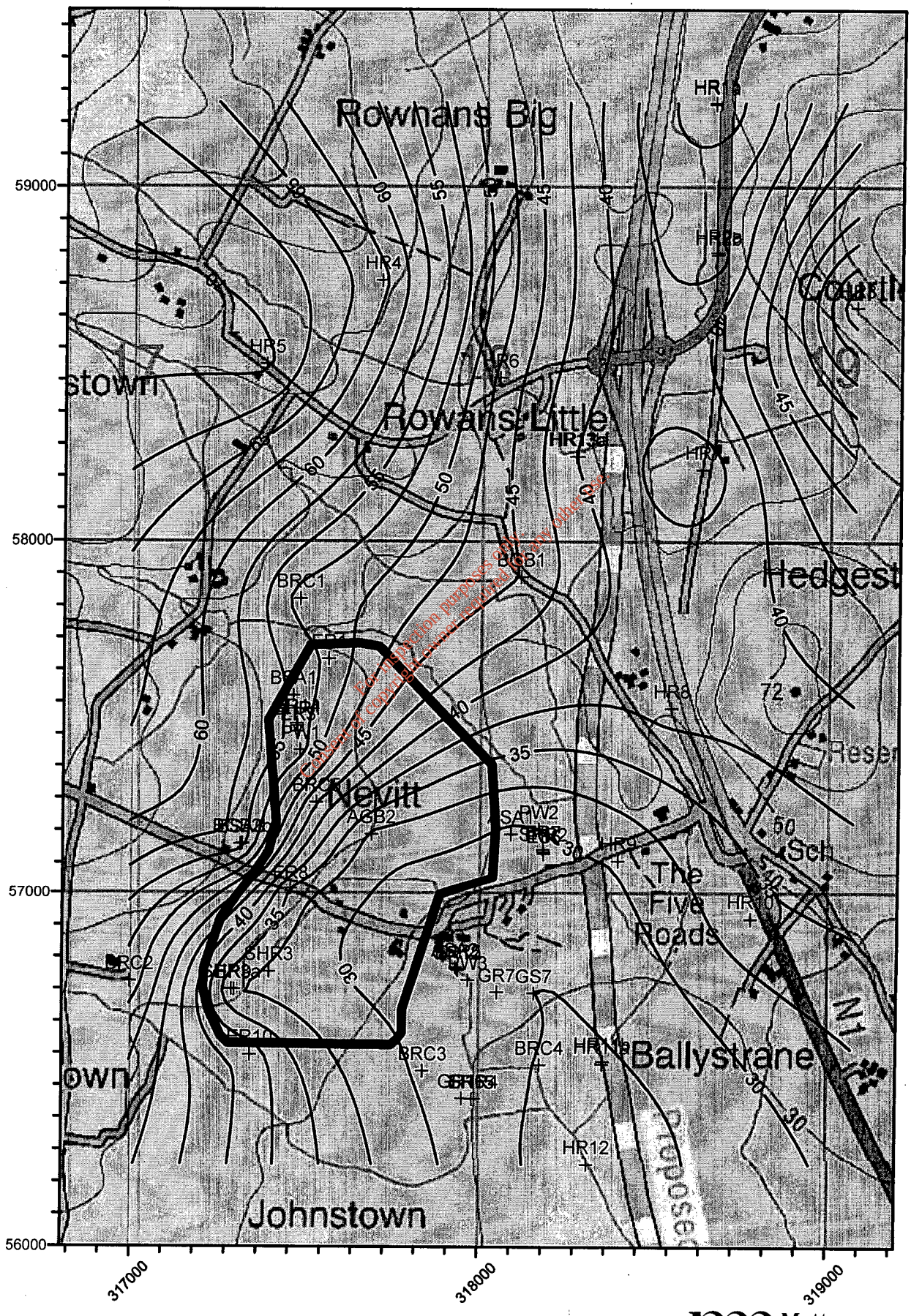
Figure 2. Bedrock and gravel water levels October 2005, including artesian boreholes



31st August 2006
Oct 05 bedrock and gravel water levels.srf

Mott MacDonald

Figure 3. Bedrock & gravel water levels April 2006 - including artesian boreholes



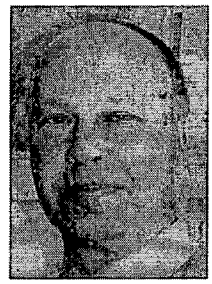
31st August 2006
April 06 bedrock and gravel water levels.srf

Mott MacDonald

Appendix B Curriculum vitae of Dr Paul Ashley

Summary CV

Paul Ashley
Environment Manager



Position
Environment Manager, Divisional Director

Year of birth
1953

Nationality
British

Language
English (mother tongue)
French, German, Indonesian (basic)

Qualifications
Chartered Geologist
PhD Groundwater Pollution
MSc Hydrogeology
BSc (Hons) Geology
Member of the Charted Institution of Water & Environmental Management
Member of the Institute of Petroleum

Key skills
Hydrogeology, contaminated land, water quality, environmental management, risk assessment

Profile
A qualified and experienced hydrogeologist, with nearly 30 years experience of water resources, contaminated land, water pollution, and environmental management.

Experience and skills
Joined Mott MacDonald in 1997 as Groundwater Manager and, in 2000, Environment Manager. Responsible for a 52-strong subdivision covering environmental planning, aquatic environment, ground & environmental engineering and corporate sustainability.

From 1995 to 1997 worked for Parsons Engineering Science as UK contaminated land and water manager and Cambridge office manager.

In 1988 he established his own consultancy, Ashley Associates, focusing on contaminated land and water. The firm became a part of the growing environmental arm of the Parsons Corporation in 1995.

Carried out research, leading to a PhD, into the behaviour of oil in a Chalk aquifer, based on the investigation of a site of a large oil spill in Royston, Hertfordshire.

Joined Sir M MacDonald & Partners after graduation in 1976 as a hydrogeologist and groundwater modeller. Worked on a range of water resource projects in the UK, Indonesia, Oman, Saudi Arabia, Cambodia, Egypt, Ethiopia, Somalia and Nigeria.

Selected projects

Packington Landfill Hydrogeological Risk Assessment, UK
SITA UK Ltd
Project manager and director. Development of groundwater model and risk assessment for a large existing landfill sited on a minor aquifer (Mercia Mudstone).

Ballybrack Landfill, Co Waterford
Community group
Provided advice on the risks of groundwater pollution from a proposed new landfill site. The proposed site was removed from consideration because of these issues.

Groundwater monitoring lectures
Cranfield University (Silsoe College)
Lecturer on monitoring well design, well sampling and monitoring data management in this long-running and popular series of 1-day courses.

Ashton Canal Corridor, Manchester
New East Manchester Ltd
Contaminated land specialist. Provided strategic advice of the remediation of this massive area as part of the Commonwealth Games redevelopment.

Supplementary information
Former chairman of the British committee of the International Association of Hydrogeologists, and the Hydrogeology Group of the Geological Society. His many papers include:

Groundwater pollution by chlorinated solvents: the landmark Cambridge Water Company case, in *Groundwater Contaminants and their Migrations*, Mather et al (eds), 1998 (lead author Misstear B, coauthor Lawrence A R).

Environmental and safety auditing in Great Britain: standards, qualifications and practices: Umweltschutz- und Sicherheitsaudits - Planung, Durchfuhrung und Erfahrungen, Haus der Technic, Essen, 7 March 1994.

The investigation of contaminant distribution and composition in the unsaturated zone of a Chalk aquifer following a diesel oil spillage, J Hydrology 1994 (co-authors Lerner D N and Lloyd J W).

Mott MacDonald